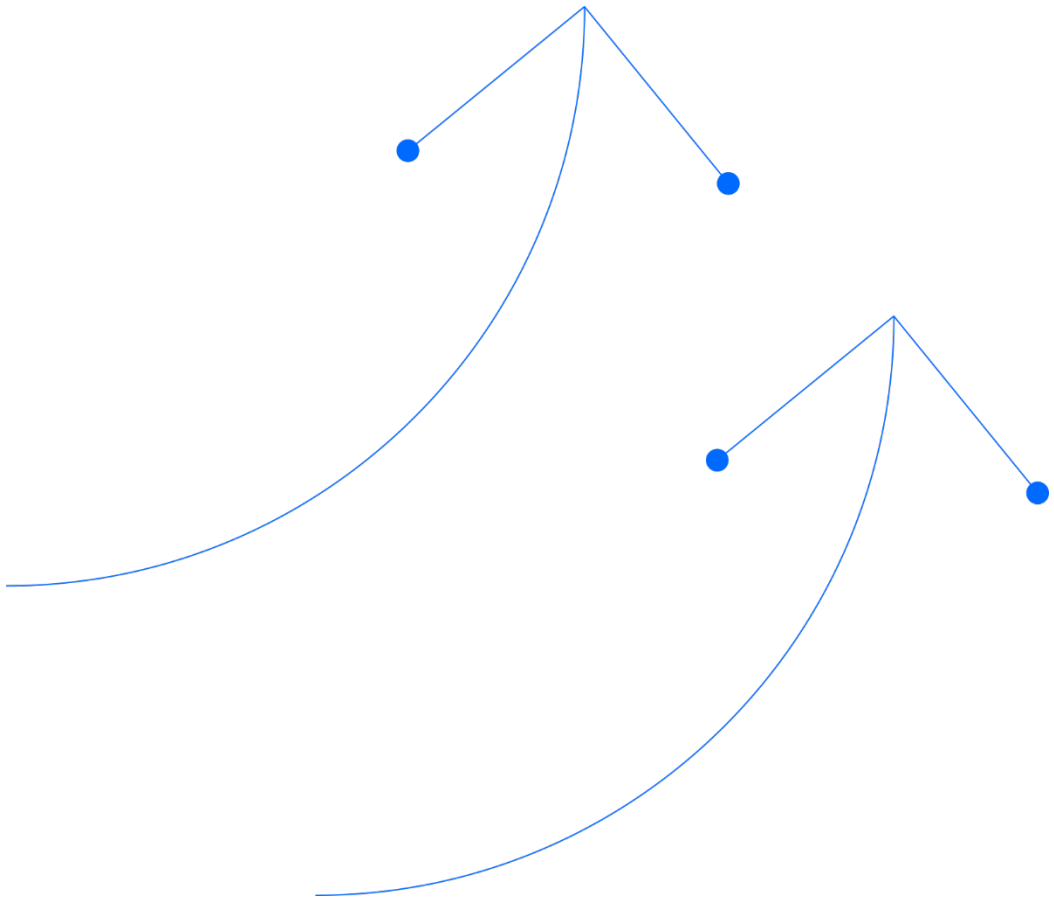
Santos

Eos 3D Marine Seismic Survey

Environment Plan

10 September 2025

Document No.: 7710-650-EMP-0011



Santos

Eos 3D Marine Seismic Survey

Environment Plan

Document No.: 7710-650-EMP-0011

Project / Facility	Eos 3D Marine Seismic Survey
Review interval (months)	No Review Required
Safety critical document	Yes

Rev	Owner	Reviewer(s) *Managerial/Technical/Site*	Approver
	Team Leader CCS Growth	**Environment Approvals Manager**	**General Manager CCS Subsurface**
2			

Rev	Rev Date	Author / Editor	Amendment
A	22/05/2023	Xodus	Draft for Santos Review
A.01	18/07/2023	Xodus	Draft for Santos Review
B	20/09/2023	Xodus	Draft for Santos Review
0	04/01/2024	Xodus	Final
0.01	12/03/2024	Xodus	Updates
0.02	30/10/24	Santos	Internal updates
0.03	20/03/2025	Santos	Review of EP for currency since Rev 0.02 updates.
0.04	24/06/2025	Santos / JASCO	Noise sections updated to reflect new NMFS 2024 and Accomando 2025 criteria.
1	31/06/2025	Santos	Final
2	10/09/2025	Santos	Final – post public comment submission

Any hard copy of this document, other than those identified above, is uncontrolled. Refer to the Santos Offshore Business Document Management System for the latest revision.

Contents

Terms 13

Environment Plan summary 19

1. Introduction 20

1.1 Background 20

1.2 Purpose of this Environment Plan 20

1.3 Titleholder 20

1.3.1 Details of titleholder 20

1.3.2 Details for Santos' nominated liaison person 21

1.3.3 Notification procedure in the event of changed details 23

1.4 Environmental management framework 23

1.4.1 Environmental health and safety policy 23

1.4.2 International legislation 23

1.4.3 Commonwealth legislation 23

2. Activity description 24

2.1 Terminology 24

2.2 Activity overview 25

2.3 Location and operational area 25

2.4 Activity duration and timing 25

2.5 Acquisition parameters 27

2.6 Support vessels 29

2.7 Aircraft 29

3. Description of the environment 30

3.1 Environment that may be affected (EMBA) 30

3.1.1 Underwater acoustic emissions EMBA 30

3.1.2 Unplanned vessel hydrocarbon spill EMBA 30

3.2 Environmental values and sensitivities 30

3.3 Bioregions 42

3.3.1 Marine regions 42

3.3.2 Provincial bioregions 42

3.4 Physical environment 45

3.4.1 Climate 45

3.4.2 Oceanography 45

3.4.3 Bathymetry and geomorphology 47

3.4.4 Sedimentology 47

3.5 Protected / significant areas 49

3.5.1 Australian Marine Parks 49

3.5.2 State / Territory parks and reserves 51

3.5.3 Threatened ecological communities 56

3.5.4 World, Commonwealth and National Heritage Places 56
3.5.5 Wetlands of national importance 56
3.5.6 Wetlands of international importance (Ramsar sites) 57
3.6 Biological environment 59
3.6.1 Key ecological features 59
3.6.2 Shoreline habitats 63
3.6.3 Coral reefs 65
3.6.4 Seagrasses and macroalgae 65
3.6.5 Crustaceans 65
3.6.6 Molluscs 66
3.6.7 Plankton communities 66
3.6.8 Fish assemblages 67
3.7 Protected species 72
3.7.1 EPBC Act-listed threatened and migratory species 72
3.7.2 Summary of biologically important areas 86
3.7.3 Marine mammals 88
3.7.4 Marine reptiles 99
3.7.5 Sharks and rays 108
3.7.6 Seabirds and migratory shorebirds 114
3.8 Socio-economic and cultural features 124
3.8.1 Commercial fisheries 124
3.8.2 Shipping 169
3.8.3 Oil and gas activities 171
3.8.4 Tourism and recreation 173
3.8.5 Defence 173
3.8.6 Maritime heritage 175
3.8.7 Cultural features 175
3.9 Submarine cables 178
3.10 Periods of peak sensitivity or activity 178

4. Stakeholder consultation 181
4.1 Consultation background 181
4.2 Regulatory requirements 181
4.3 Government and industry guidance 182
4.4 Applicable case law and guidance 183
4.5 Santos' consultation methodology 183
4.5.1 Overview 183
4.5.2 Identifying relevant persons 185
4.5.3 Identification and consultation of First Nations peoples and groups 188
4.5.4 International persons 188
4.5.5 Public awareness campaign and self-identification opportunities 189
4.5.6 Relevant persons 191
4.5.7 Consultation planning, preliminary and consultation activities 201

4.5.8 Provision of sufficient information 204
4.5.9 Reasonable period for consultation 205
4.5.10 Consultation opportunities 205
4.5.11 Ongoing consultation 205
4.6 Consultation report 206

5. Impact and risk assessment 333
5.1 Impact and risk assessment methodology 333
5.2 Summary of the environmental impact and risk assessment approach 335
5.2.1 Overview 335
5.2.2 Context setting 335
5.2.3 Describe the activity and hazards (planned and unplanned events) 336
5.2.4 ALARP evaluation 336
5.2.5 Identify receptors and determine nature and scale of impacts 336
5.3 Describe the environmental performance outcomes and control measures 336
5.4 Determine the impact consequence level and risk rankings (on the basis that all control measures have been implemented) 337
5.5 First Nations cultural heritage features assessment 338
5.6 Evaluating if impacts and risks are ALARP 339
5.7 Evaluating impact and risk acceptability 339

6. Environmental assessment for planned events 341
6.1 Interaction with commercial fisheries 342
6.1.1 Description of event 342
6.1.2 Nature and scale of environmental impacts 342
6.1.3 Environmental performance outcomes and control measures 347
6.1.4 Environmental impact assessment 353
6.1.5 ALARP evaluation 354
6.1.6 Acceptability evaluation 355
6.2 Interaction with other marine users 357
6.2.1 Description of event 357
6.2.2 Nature and Scale of environmental impacts 357
6.2.3 Environmental performance outcomes and control measures 358
6.2.4 Environmental impact assessment 362
6.2.5 ALARP evaluation 362
6.2.6 Acceptability evaluation 363
6.3 Noise emissions 365
6.3.1 Description of event 365
6.3.2 Nature and scale of environmental impacts 365
6.3.3 Nature and scale of environmental impacts – helicopter and vessel noise 420
6.3.4 Environmental performance outcomes and control measures 421
6.3.5 Environmental impact assessment 438
6.3.6 ALARP evaluation 440
6.3.7 Acceptability evaluation 441

6.4 Cumulative and additive seismic impacts 451
6.4.1 Description of event 451
6.4.2 Nature and scale of cumulative impacts 451
6.4.3 Nature and scale of additive impacts 456
6.4.4 Environmental performance outcomes and control measures 459
6.4.5 Environmental impact assessment 462
6.4.6 ALARP evaluation 462
6.4.7 Acceptability evaluation 464
6.5 Light emissions 467
6.5.1 Description of event 467
6.5.2 Nature and scale of environmental impacts 467
6.5.3 Environmental performance outcomes and control measures 468
6.5.4 Environmental impact assessment 471
6.5.5 ALARP evaluation 471
6.5.6 Acceptability evaluation 472
6.6 Planned operational discharges 474
6.6.1 Description of event 474
6.6.2 Nature and scale of environmental impacts 474
6.6.3 Environmental performance outcomes and control measures 475
6.6.4 Environmental impact assessment 479
6.6.5 ALARP evaluation 479
6.6.6 Acceptability evaluation 480
6.7 Atmospheric emissions 482
6.7.1 Description of event 482
6.7.2 Nature and scale of environmental impacts 482
6.7.3 Environmental performance outcomes and control measures 482
6.7.4 Environmental impact assessment 485
6.7.5 ALARP evaluation 485
6.7.6 Acceptability evaluation 486

7. Environmental assessment for unplanned events 488
7.1 Marine diesel oil (MDO) release from vessel collision (surface) 489
7.1.1 Description of event 489
7.1.2 Quantitative spill modelling 489
7.1.3 Spill risk assessment approach 499
7.1.4 Environmental performance outcomes and control measures 508
7.1.5 Spill response strategies for MDO release from vessel collision 512
7.1.6 Identification of hotspots for consequence analysis 516
7.1.7 Environmental risk assessment 522
7.1.8 ALARP evaluation 522
7.1.9 Acceptability evaluation 524
7.2 Minor hydrocarbon release 525
7.2.1 Description of event 525

7.2.2 Nature and scale of environmental impacts 525
7.2.3 Environmental performance outcomes and control measures 525
7.2.4 Environmental risk assessment 528
7.2.5 ALARP evaluation 528
7.2.6 Acceptability evaluation 529
7.3 Spill response operations 530
7.3.1 Description of event 530
7.3.2 Details of the environmental impacts and risks for the activities 530
7.3.3 Environmental performance outcomes and control measures 533
7.3.4 Environmental risk assessment 536
7.3.5 ALARP evaluation 539
7.3.6 Acceptability evaluation 540
7.4 Hazardous and non-hazardous unplanned discharges – liquid 541
7.4.1 Description of event 541
7.4.2 Nature and scale of environmental impacts 541
7.4.3 Environmental performance outcomes and control measures 541
7.4.4 Environmental risk assessment 544
7.4.5 ALARP evaluation 544
7.4.6 Acceptability evaluation 545
7.5 Hazardous and non-hazardous unplanned discharges – solid 546
7.5.1 Description of event 546
7.5.2 Nature and scale of environmental impacts 546
7.5.3 Environmental performance outcomes and control measures 547
7.5.4 Environmental risk assessment 550
7.5.5 ALARP evaluation 550
7.5.6 Acceptability evaluation 551
7.6 Marine fauna collisions 552
7.6.1 Description of event 552
7.6.2 Nature and scale of environmental impacts 552
7.6.3 Environmental performance outcomes and control measures 554
7.6.4 Environmental risk assessment 558
7.6.5 ALARP evaluation 558
7.6.6 Acceptability evaluation 559
7.7 Introduction of invasive marine species 560
7.7.1 Description of event 560
7.7.2 Nature and scale of environmental impacts 560
7.7.3 Environmental performance outcomes and control measures 561
7.7.4 Environmental risk assessment 564
7.7.5 ALARP evaluation 564
7.7.6 Acceptability evaluation 565

8. Implementation strategy 566

8.1 Environmental management system 566

8.2 Environment, Health and Safety policy 566
8.3 Leadership, accountability and responsibility 567
8.4 Workforce training and competency 569
8.4.1 Activity inductions 569
8.4.2 Training and competency 569
8.5 Hazard identification, risk and impact assessment and controls 570
8.6 Environmental performance outcomes 570
8.6.1 Control measures and performance standards 571
8.6.2 Commercial fishers payment claim protocol 591
8.7 Workforce Involvement and Stakeholder Communication 591
8.8 Information management and document control 591
8.9 Management of change 591
8.10 Emergency preparedness and response 592
8.11 Incident reporting, investigation and follow-up 592
8.12 Regulatory notifications and compliance reporting 593
8.13 Monitoring and recording emissions and discharges 600
8.14 Reviews, audits and inspections 600
8.14.1 Reviews 600
8.14.2 Audits 601
8.14.3 Inspections 601
8.14.4 Non-conformance management 601
8.14.5 Continuous Improvement 601
8.15 Post acceptance consultation implementation strategy 602
8.15.1 Post-acceptance consultation implementation strategy – First Nations people and groups and local governments, communities and industry 602
8.15.2 Post-acceptance consultation implementation strategy – approach 602

References **604**

Appendix A **Santos Environment Operating Standard** **630**

Appendix B **Legislation** **631**

Appendix C **EPBC Act Protected Matters Search reports** **642**

Appendix D **Aboriginal cultural heritage searches** **643**

Appendix E **Stakeholder consultation** **644**

Appendix F **Santos risk matrix and consequence table** **645**

Appendix G **Eos 3D MSS acoustic modelling** **646**

Appendix H **Noise impact technical appendix** **647**

Appendix I **Values and sensitivities of the marine and coastal environment** **648**

Tables

Table 1-1: Titleholder details 21
Table 2-1: Key terminology 24
Table 2-2: Proposed Eos 3D MSS areas and coordinates 27
Table 2-3: Acquisition parameters 27
Table 3-1: Summary of largest credible unplanned vessel hydrocarbon spill scenarios 30
Table 3-2: Key environmental values and sensitivities relevant to the EMBA 33
Table 3-3: Seasonal mean temperature, rainfall and wind speed ranges 45
Table 3-4: Monthly average sea surface temperature and salinity in the Operational Area 46
Table 3-5: Water depths in the Operational Area and Active Source Area 47
Table 3-6: Geomorphic features relevant to the Operational Area 47
Table 3-7: Australian Marine Parks relevant to the EMBA 49
Table 3-8: Wetlands of national importance within the EMBA 57
Table 3-9: Key ecological features within the EMBA 59
Table 3-10: Summary of habitat preference and depth range for syngnathid species that may occur within the EMBA 68
Table 3-11: EPBC Act-listed threatened and migratory species that may occur within the Operational Area and EMBA 73
Table 3-12: Relevant threats identified in Recovery Plans and Conservation Advice for species that occur or may occur within the EMBA and which may be affected by the Activity 79
Table 3-13: Threatened and migratory species BIAs within the EMBA and potential for overlap with Operational Area 86
Table 3-14: Threatened and migratory marine mammals potentially occurring within the Operational Area and EMBA 90
Table 3-15: Threatened and migratory marine reptiles potentially occurring within the Operational Area 101
Table 3-16: Threatened and migratory sharks and rays potentially occurring within the Operational Area and EMBA 109
Table 3-17: Threatened and migratory seabirds potentially occurring within the Operational Area and EMBA 115
Table 3-18: Relevant Commonwealth-managed fisheries 125
Table 3-19: Relevant Western Australian-managed fisheries 135
Table 3-20: Relevant Northern Territory-managed fisheries 147
Table 3-21: Key prawn species relevant to the survey 162
Table 3-22: Key indicator finfish species relevant to the survey 165
Table 3-23: Oil and gas permits within 150 km of the Operational Area 171
Table 3-24: Timing of key sensitivities relevant to the Operational Area 179
Table 4-1: Consultation requirements under the OPGGS(E)R 181
Table 4-2: Relevant person terms and definitions 183
Table 4-3: Preliminary identification methodology 185
Table 4-4: Environmental aspects considered for Relevant Person category identification 185
Table 4-5: Actions for identifying Relevant Persons by category 186
Table 4-6: Public awareness campaign overview 189
Table 4-7: Targeted advertising campaign details (September–November 2023) 190
Table 4-8: Relevant persons for this EP 191
Table 4-9: Summary of consultation activities 206

Table 5-1: Impact and risk assessment terms and definitions 333
Table 5-2: Summary of environmental consequence descriptors 337
Table 5-3: Likelihood description 338
Table 5-4: Santos risk matrix 338
Table 5-5: Activity relevant principles of ecologically sustainable development 339
Table 6-1: Summary of the consequence level rankings for hazards associated with planned events 341
Table 6-2: Control measures evaluation for interaction with commercial fisheries 348
Table 6-3: Control measures evaluation for interaction with other marine users 359
Table 6-4: Sound level metrics definition 366
Table 6-5: Far-field source level specifications for a 3,050 in^3 source, with an 8 m tow depth 369
Table 6-6: Key acoustic model inputs 370
Table 6-7: Sound level threshold criteria and values for mortality, injury, TTS and behavioural impacts to plankton 373
Table 6-8: Sensitives for invertebrates 376
Table 6-9: Sound level threshold criteria and values for mortality, injury, TTS and behavioural impacts to invertebrates 378
Table 6-10: Impact pathways and sensitivities for fish 384
Table 6-11: Sound level threshold criteria and values for mortality and impairment in fish 386
Table 6-12: Spatial and temporal overlap of the Eos 3D MSS with the spawning range and spawning periods of key indicator fish stocks 395
Table 6-13: Stock assessments of key indicator fish species 398
Table 6-14: Marine mammal functional hearing groups (excluding pinnipeds) 400
Table 6-15: Impact pathways and sensitivities for marine mammals 401
Table 6-16: Sound level threshold criteria and values for impairment and behavioural response in marine mammals 403
Table 6-17: Sound level threshold criteria and values for impairment and behaviour in marine turtles 409
Table 6-18: Active Source Area overlap with commercial fisheries 415
Table 6-19: Control measures evaluation for noise emissions 422
Table 6-20: Previous seismic surveys acquired in the JBG since 2017 overlapping or adjacent to the Eos 3D MSS 453
Table 6-21: NPF banana prawn catch and effort data, 2010–2019 455
Table 6-22: Control measures evaluation for cumulative and additive seismic impacts 460
Table 6-23: Control measures evaluation for light emissions 469
Table 6-24: Control measures evaluation for planned operational discharges 476
Table 6-25: Control measures evaluation for atmospheric emissions 483
Table 7-1: Summary of the environmental risks for events associated with unplanned events 488
Table 7-2: Characteristics of MDO 490
Table 7-3: Summary of the hydrocarbon exposure thresholds 491
Table 7-4: Summary of oil spill modelling results for surface hydrocarbons, including sensitive receptors with predicted exposure above threshold concentrations 493
Table 7-5: Summary of oil spill modelling results for shoreline hydrocarbon accumulation, including sensitive receptors with predicted exposure above threshold concentrations 493
Table 7-6: Maximum entrained hydrocarbon exposure levels and probability for each threshold to individual sensitive receptors 494

Table 7-7: Maximum dissolved hydrocarbon exposure levels and probability for each threshold to individual sensitive receptors 496
Table 7-8: Physical and chemical pathways and oil impacts to marine organisms 500
Table 7-9: Potential for exposure of sensitive receptors found within the overall EMBA to hydrocarbons 503
Table 7-10: Control measures evaluation for an MDO release from vessel collision 509
Table 7-11: Spill response strategies considered for the mitigation of contact from MDO release from vessel collision 513
Table 7-12: Identified hotspots receptors – Eos 3D MSS MDO vessel spill 516
Table 7-13: Hotspot consequence assessment results from surface release of MDO 519
Table 7-14: Control measures evaluation for minor hydrocarbon releases 526
Table 7-15: Control measures evaluation for spill response operations 534
Table 7-16: Control measures evaluation for hazardous and non-hazardous unplanned discharges – liquid 542
Table 7-17: Control measures evaluation for hazardous and non-hazardous unplanned discharges – solid 548
Table 7-18: Control measures evaluation for marine fauna collisions 555
Table 7-19: Control measures evaluation for invasive marine species 562
Table 8-1: Chain of command, key leadership roles and responsibilities 567
Table 8-2: Environmental performance outcomes 570
Table 8-3: Control Measures and Environmental Performance Standards for the Activity 572
Table 8-4: Regulator activity notification and reporting requirements 594

Figures

Figure 1-1: Location of the Eos 3D MSS and the G-11-AP Permit area 22
Figure 2-1: Eos 3D MSS location 26
Figure 2-2: Example sail line plan 28
Figure 3-1: EMBA from planned activities and unplanned events 32
Figure 3-2: IMCRA 4.0 Provincial Bioregions 44
Figure 3-3: Geomorphic features of the EMBA 48
Figure 3-4: Protected areas within the EMBA 55
Figure 3-5: Key ecological features within the EMBA 62
Figure 3-6: Distribution of habitats and biological communities in the JBG 65
Figure 3-7: BIAs for blue whales and humpback whales 97
Figure 3-8: Breeding and foraging BIAs for inshore dolphins 98
Figure 3-9: Foraging BIAs for marine turtles within the EMBA 106
Figure 3-10: Marine turtle internesting BIAs and Habitat Critical within the EMBA 107
Figure 3-11: BIAs within the EMBA for whale sharks and river sharks 113
Figure 3-12: BIAs for seabird and migratory shorebirds in the EMBA 123
Figure 3-13: Northern Prawn Fishery management area 130
Figure 3-14: Areas fished and relative fishing intensity in the Northern Prawn Fishery (2010–2023) 131
Figure 3-15: NPF fishing areas reporting low, medium and high intensity (<0.1–0.55 day/km^2) fishing in the JBG (2010–2023) 132
Figure 3-16: Northern Prawn Fishery seasonal closure area 133
Figure 3-17: Relevant Western Australian-managed fisheries 143
Figure 3-18: Northern Demersal Scalefish managed fishery total fishing day count (2013–2023) 144

Figure 3-19: Mackerel Managed Fishery total fishing day count (2013–2023) 145
Figure 3-20: Northern Territory-managed fisheries 151
Figure 3-21: Demersal Fishery total fishing day count (2016–2020) 153
Figure 3-22: Spanish Mackerel Fishery total fishing day count (2016–2020) 155
Figure 3-23: Offshore Net and Line Fishery total fishing day count (2016–2020) 157
Figure 3-24: Aquarium Fishery total fishing day count (2016–2020) 159
Figure 3-25: Size of the probable advection envelope for post larval *P. indicus* in the JBG 161
Figure 3-26: Vessel traffic within and surrounding the Operational Area (May 2024 to April 2025) 170
Figure 3-27: Petroleum titles and infrastructure 172
Figure 3-28: Defence exercise and training areas 174
Figure 5-1: Hazard identification and assessment procedure 335
Figure 5-2: Hierarchy of controls 337
Figure 6-1: Indicative area of potential interaction with the NPF in the JBG 344
Figure 6-2: Location of acoustic modelling single impulse sites and SEL_{24h} scenario 369
Figure 6-3: Red emperor spawning biomass as a percentage of unfished levels (top) and recruitment (millions of fish) (bottom) 397
Figure 6-4: Goldband snapper spawning biomass as a percentage of unfished levels (top) and recruitment (thousands of fish) (bottom) 397
Figure 6-5: Previous seismic surveys acquired since 2016 overlapping and/or adjacent to the Eos 3D MSS 452
Figure 6-6: Other concurrent surveys in the Bonaparte Basin 457
Figure 7-1: Weathering and fates graph, as a function of volume (%), under constant calm wind condition (2.6 m/s) 492
Figure 7-2: Weathering and fates graph, as a function of volume (%), under variable wind condition 492
Figure 7-3: Modelled EMBA from Release Location 1 for 1,065 m^3 MDO (diesel) spill 497
Figure 7-4: Modelled EMBA from Release Location 2 for a 1,065 m^3 MDO (diesel) spill 498
Figure 8-1: Environment management of change 592

Terms

Term	Definition
$	Dollars (Australian dollars unless specified otherwise)
%	Percent
‘	Minutes
“	Seconds
°	Degrees
°C	Degrees Celsius
<	Less than
AASM	Airgun Array Source Model
ABARES	Australian Bureau of Agricultural and Resource Economics
AEP	Australian Energy Producers (formerly APPEA)
AET	Australian External Territory
AF	Aquarium Fishery (NT)
AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
AHO	Australian Hydrographic Office
AIMS	Australian Institute of Marine Science
AIS	Automatic Identification System
ALARP	As low as reasonably practicable
AMF	Abalone Managed Fishery
AMOSC	Australian Marine Oil Spill Centre
AMP	Australian Marine Park
AMSA	Australian Maritime Safety Authority
ANSI	American National Standard Institute
API	American Petroleum Institute gravity (A measure of how heavy or light a petroleum liquid in comparison to water)
APPEA	Former Australian Petroleum Production and Exploration Association (now Australian Energy Producers [AEP])
ARPA	Automatic Radar Plotting Aid
AS	Australian Standard
BACI	Before and After Control Impact
BF	Barramundi Fishery
BIA	Biologically Important Area
BNF	Bait Net Fishery
BOD	Biochemical Oxygen Demand
BOM	Bureau of Meteorology
BPMF	Broome Prawn Managed Fishery
BRUVS	Baited Remote Underwater Video System
CAES	Catch and effort systems
CFA	Commonwealth Fisheries Association
CH4	Methane
CLF	Coastal Line Fishery

Term	Definition
CM	Control Measure
CMIA	Common Marine Inspection Audit
CO_2	Carbon dioxide
COLREGS	International Regulations for Preventing Collisions at Sea
cP	Centipoise (unit of viscosity)
CPUE	Catch Per Unit Effort
CSIRO	Commonwealth Scientific and Industrial Research Organisation
cui / cu. in. / in^3	Cubic inches
dB	Decibel
DAWE	Commonwealth Department of Agriculture, Water and the Environment (formerly Department of Agriculture)
DAWR	Commonwealth Department of Agriculture and Water Resources (superseded by Department of Agriculture)
DBCA	WA Department of Biodiversity, Conservation and Attractions (formerly Department of Parks and Wildlife)
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DEWHA	Commonwealth Department of Sustainability, Environment, Water, Heritage and Arts (superseded by Department of the Environment and Energy)
DF	Demersal Fishery (NT)
DEMIRS	WA Department of Environment, Mines, Industry Regulations and Safety
DO	Dissolved Oxygen
DoA	Commonwealth Department of Agriculture (superseded by Department of Agriculture, Water and the Environment)
DoD	Department of Defence
DoEE	Commonwealth Department of the Environment and Energy
DoE	Commonwealth Department of Environment (superseded by Department of the Environment and Energy)
DoF	WA Department of Fisheries (superseded Department of Primary Industries and Regional Development)
DNP	Director of National Parks
DITT	NT Department of Industry, Tourism and Trade (formerly NT Department of Primary Industry and Resources)
DoIIS	Commonwealth Department of Industry, Innovation and Science (superseded by Department of Industry, Science, Energy and Resources)
DNP	Director of National Parks
DoT	WA Department of Transport
DPaW	WA Department of Parks and Wildlife (superseded by the Department of Biodiversity, Conservation and Attractions)
DPIR	Department of Primary Industry and Resources
DPIRD	WA Department of Primary Industries and Regional Development (formerly Department of Fisheries)
DSEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities (superseded by Department of the Environment)
DSP	Development – Small Pelagic
EEZ	Exclusive Economic Zone
EHS	Environment, Health and Safety
EMBA	Environment that may be affected
ENVID	Environmental Risk Assessment

Term	Definition
EP	Environment Plan
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
EPO	Environmental Performance Outcome
EPS	Environmental Performance Standard
ERM	Environmental Resources Management Australia Pty Ltd
ESD	Ecologically Sustainable Development
FRC	Fast Rescue Craft
FRDC	Fisheries Research and Development Corporation
GDEM	Generalised Digital Environmental Model
GHG	Greenhouse Gas
HF	High Frequency
HFO	Heavy Fuel Oil
hrs	hours
HSE	Health, Safety and Environment
Hz	Hertz
IAPP	International Air Pollution Prevention
IFO	Intermediate Fuel Oil
IMCA	International Marine Contractors Association
IMCRA	Integrated Marine and Coastal Regionalisation of Australia
IMDG Code	International Maritime Dangerous Goods Code
IMO	International Maritime Organization
IMS	Invasive Marine Species
IMT	Incident Management Team
IOPP	International Oil Pollution Prevention
IPIECA	International Petroleum Industry Environmental Conservation Association
ISO	International Organisation for Standardisation
ISPP	International Sewage Pollution Prevention
ITF	Indonesian Throughflow
ITOPF	International Tanker Owners Pollution Federation
ITQ	Individual Transferable Quota
IUCN	International Union for the Conservation of Nature
IWC	International Whaling Commission
JASCO	JASCO Applied Science
JBG	Joseph Bonaparte Gulf
JHA	Job Hazard Analysis
JRCC	Joint Rescue Coordination Centre
KCMF	Kimberley Crab Managed Fishery
KEF	Key Ecological Feature
kg	Kilograms
KGBMF	Kimberley Gillnet and Barramundi Managed Fishery
kHz	Kilohertz
km	Kilometre
km^2	Square kilometres

Term	Definition
km/h	Kilometres per hour
KPMF	Kimberley Prawn Managed Fishery
LAT	Lowest Astronomical Tide
LF	Low Frequency
LNG	Liquefied Natural Gas
m	Metre
m^3	Cubic metre
MAFMF	Marine Aquarium Fish Managed Fishery (WA)
MARPOL	(Marine Pollution) International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978
MDO	Marine Diesel Oil
MF	Mid-Frequency
MFO	Marine Fauna Observer
MGO	Map Grid of Australia
mg/l	Milligrams per litre
MGO	Marine Gas Oil
mins	minutes
mm	Millimetre
MMF	Mackerel Managed Fishery (WA)
MNES	Matters of National Environmental Significance
MoC	Management of Change
MOD	Maximum Over Depth
MODU	Mobile Offshore Drilling Unit
MOP	Marine Oil Pollution
MSS	Marine Seismic Survey
N_2O	Nitrous Oxide
National Plan	National Plan for Maritime Environmental Emergencies
NAXA	Northern Australia Exercise Area
NDSMF	Northern Demersal Scalefish Managed Fishery (WA)
NEBA	Net Environmental Benefit Analysis
NERP	National Environmental Research Program
NKMP	North Kimberley Marine Park
nm	nautical mile
NMFS	National Marine Fisheries Service
NMR	North Marine Region
NNTT	National Native Title Tribunal
NOAA	National Oceanic and Atmospheric Administration
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NOPIMS	National Offshore Petroleum Information Management System
NOPTA	National Offshore Petroleum Titles Administrator
NOx	Nitrogen Oxides
NPF	Northern Prawn Fishery
NPFI	Northern Prawn Fishing Industry Pty Ltd

Term	Definition
NPRAG	NPF Resource Assessment Group
NRSMPA	National Representative System of Marine Protected Areas
NSF	Northern Shark Fishery
NSW	New South Wales
NT	Northern Territory
NTM	Notice To Mariners
NTOWRP	Northern Territory Oiled Wildlife Response Plan
NTSC	Northern Territory Seafood Council
NWA	North West Alliance
NWMR	North-west Marine Region
NWS	North-west Shelf
NZ	New Zealand
ODS	Ozone-depleting Substances
ONLF	Offshore Net and Line Fishery (NT)
OPEP	Oil Pollution Emergency Plan
OPGGS(E)R	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023
OSMP	Operational Scientific Monitoring Program
OVID	Offshore Vessel Inspection Document
PAM	Passive Acoustic Monitoring
PK	Peak Pressure
PMI	Potential Mortality Injury
PMS	Planned Maintenance System
PMST	Protected Matters Search Tool
POB	Persons On Board
Polarcus	Polarcus Seismic Limited
POMF	Pearl Oyster Managed Fishery (WA and NT)
PPA	Pearl Producer Association
ppm	parts per million
psi	pounds per square inch
psu	Practical Salinity Unit
PTS	Permanent Threshold Shift
PTTEP	PTTEP Australasia (Ashmore Cartier)
QLD	Queensland
ROV	Remote Operated Vehicle
SAFS	Status of Australian Fish Stocks
SBTF	Southern Bluefin Tuna Fishery
SDS	Safety Data Sheet
SEL	Sound Exposure Level
SFR	Statutory Fishing Right
SL	Source Level
SMF	Spanish Mackerel Fishery
SMPEP	Shipboard Marine Pollution Emergency Plant
SMS	Santos Management System

Term	Definition
SOPEP	Shipboard Oil Pollution Management Plan
SOx	Sulfur oxides
SOLAS	Safety Of Life At Sea
SPL	Sound Pressure Level
SPI	Seismic Pulse Interval
SRA	Stock Reduction Analysis
SSMF	Specimen Shell Managed Fishery
SW	South West
SWCSMF	South West Coast Salmon Managed Fishery
t	Tonne
TACC	Total Allowable Commercial Catches
TECs	Threatened Ecological Communities
TF	Trepang Fishery
TRF	Timor Reef Fishery
TSS	Total Suspended Solids
TTS	Temporary Threshold Shift
WA	Western Australia
WAFIC	Western Australian Fishing Industry Council
WAOWRP	Western Australia Oiled Wildlife Response Plan
WASCF	West Australian Sea Cucumber Fishery
WCDSCMF	West Coast Deep Sea Crustacean Managed Fishery
WHP	Well-head platform
WTBF	Western Tuna and Billfish Fishery
WTO	Wildlife Trade Operation
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UXO	Unexploded Ordnance
VHF	Very High Frequency
VSP	Vertical Seismic Profiling

Environment Plan summary

An Environment Plan (EP) summary is presented below based on material provided in this EP, as required by Section 35(7) of the Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023.

EP summary material requirement	Relevant section of EP containing EP summary material
Details of the titleholders nominated liaison person for the activity	Section 1.3
The location of the activity	Section 2.3
A description of the activity	Section 2
A description of the receiving environment	Section 3
Consultation already undertaken and plans for ongoing consultation	Section 4 and Section 8
Details of the environmental impacts and risks	Section 6 and Section 7
The control measures for the activity	Section 8.6.1
The arrangements for ongoing monitoring of the titleholder's environmental performance	
Response arrangements in the oil pollution emergency plan (OPEP)	Section 8.10 (EP); and in the OPEP (7710-650-EMP-0011-1)

1. Introduction

1.1 Background

Santos Offshore Pty Ltd (Santos) plans to acquire a three-dimensional (3D) marine seismic survey (MSS) in Commonwealth waters in the Bonaparte Basin.

The proposed activity is required to complete an appraisal of the carbon storage potential of Santos' greenhouse gas assessment permit G-11-AP. The primary purpose of the 3D MSS is to facilitate future Carbon Dioxide (CO_2) injection activities by providing detailed structural and amplitude imaging of the reservoir/seal interface for each identified storage target to confirm suitability for injection and storage of CO_2. The Eos 3D Marine Seismic Survey (Eos 3D MSS) will be used to high grade and define future injection well locations and act as a baseline survey for possible future 4D seismic monitoring.

The survey extends into greenhouse gas assessment permit G-7-AP and overlaps petroleum permit WA-548-P, WA-27-R, NT/P88, NT/RL1, WA-454P and WA-6-R and surrounding waters in the Petrel Sub-Basin. Santos will apply for a Greenhouse Gas Special Authority to permit those parts of the survey that are outside the existing greenhouse gas assessment permit area.

1.2 Purpose of this Environment Plan

The Eos 3D MSS Environment Plan (EP) has been prepared in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023 (OPGGS (E) Regulations) for assessment and acceptance by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA). This EP details the environmental impacts and risks associated with the Eos 3D MSS, the defined Greenhouse Gas Activity (or 'Activity') and demonstrates how these will be reduced to as low as reasonably practicable (ALARP) and to an acceptable level.

The EP also provides an implementation strategy that will be used to measure and report on environmental performance during planned activities and unplanned events. The environmental management of the Activity described in the EP complies with the Santos Environment Operating Standard (Appendix A) and with all relevant legislation. This EP documents relevant stakeholder consultation performed during the planning of the Activity.

1.3 Titleholder

OPGGS(E)R 2023 Requirements
Section 23. Details of titleholder and liaison person.
23(1) The environment plan must include the following details for the titleholder: a) name b) business address c) telephone number (if any) d) fax number (if any) e) email address (if any) f) if the titleholder is a body corporate that has an Australian Company Number (ACN) (within the meaning of the *Corporations Act 2001*). 23(2) The environment plan must also include the following details for the titleholder's nominated liaison person: a) name b) business address c) telephone number (if any) d) fax number (if any) e) email address (if any).

1.3.1 Details of titleholder

Santos is the titleholder undertaking the Activity within Greenhouse Gas Permit G-11-AP (Figure 1-1) and surrounding waters.

Other titleholders of the permit are Chevron Australia Pty Ltd and PRISM Darwin Pipeline Pty Ltd. Titleholder details are provided in Table 1-1.

Table 1-1: Titleholder details

Titleholder	ACN / ARBN	Title interest	Address
Santos Offshore Pty Ltd	005 475 589	40%	Business Address: Level 7, 100 St Georges Terrace, Perth, Western Australia 6000 Telephone number: (08) 6218 7100 Fax number: (08) 6218 7200 Email address: offshore.environment.admin@santos.com
Chevron Australia Pty Ltd	086 197 757	30%	Business Address: Level 2, 1 the Esplanade Perth, Western Australia 6000 Telephone number: (08) 9216 4000
PRISM Darwin Pipeline Pty Ltd	655 024 963	30%	Business Address: 60 Martin Place Sydney NSW 2000

1.3.2 Details for Santos' nominated liaison person

Details for Santos' Nominated Liaison Person for the Activity are as follows:

Name: Karolis Kicas (Acting Team Leader CCS Growth)

Business address: Santos Centre, 60 Flinders Street, Adelaide South Australia 5000

Telephone number: (08) 8116 5000

Email address: offshore.environment.admin@santos.com

ACN: 005 475 589

Additional information about Santos and its operations can be obtained from the website at: www.santos.com

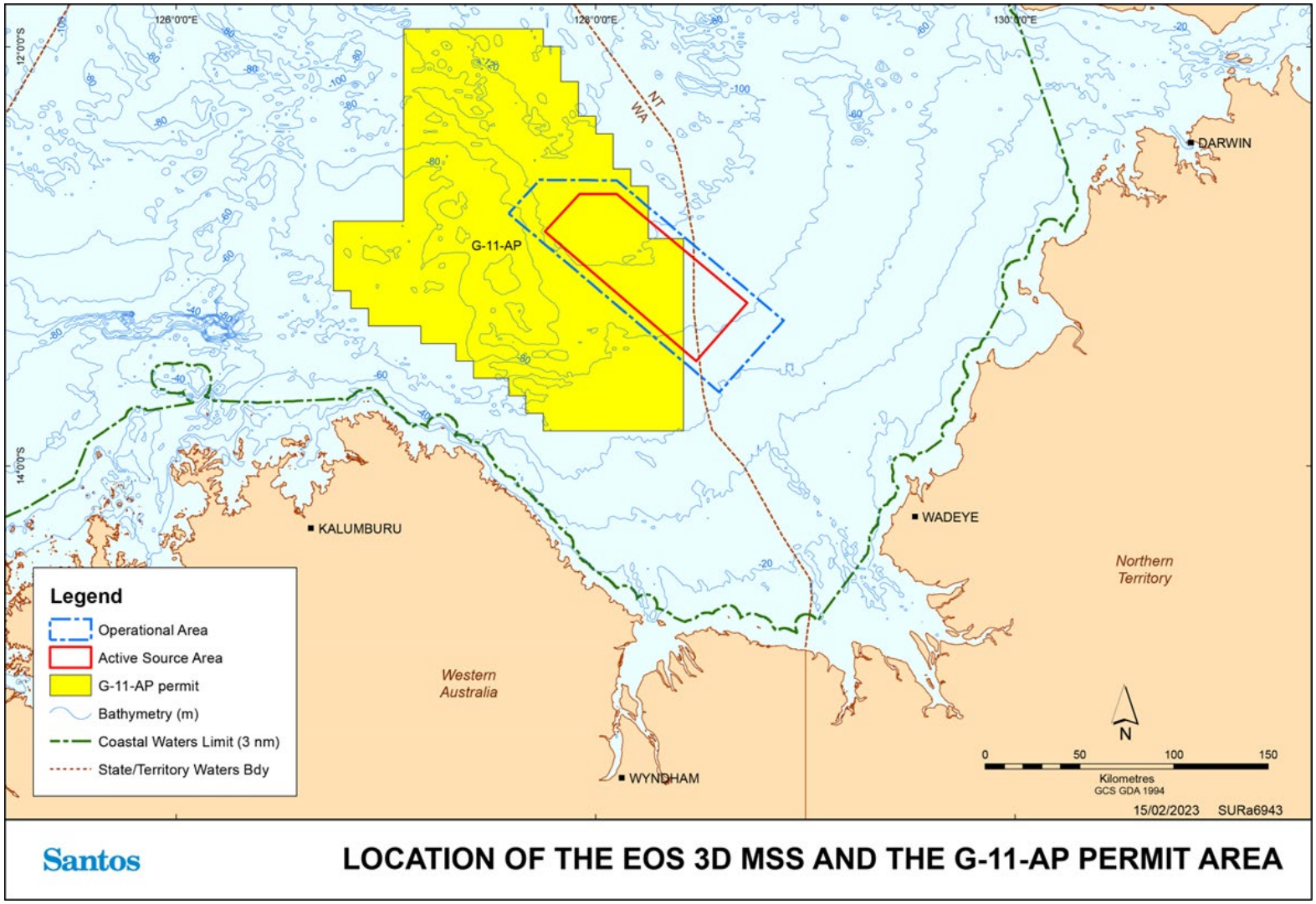


Figure 1-1: Location of the Eos 3D MSS and the G-11-AP Permit area

1.3.3 Notification procedure in the event of changed details

If there is a change in the titleholder, the titleholder's nominated liaison person or a change in the contact details for the titleholder or liaison person, Santos will notify NOPSEMA in writing and provide the updated details.

1.4 Environmental management framework

OPGGS(E)R 2023 Requirements
Section 21. Environmental assessment.
Requirements 21(4) The environment plan must: i. describe the requirements, including legislative requirements, that apply to the Activity and are relevant to the environmental management of the Activity ii. demonstrate how those requirements will be met.
Section 24. Other information in the environment plan.
The environment plan must contain the following: a) a statement of the operator's corporate environmental policy.

1.4.1 Environmental health and safety policy

The Activity will be conducted in accordance with the Santos Environment Operating Standard (Appendix A) and relevant legislative requirements presented within Sections 6, 7 and 8, inclusive of references to the relevant EP sections where the legislation may prescribe or control how the Activity is undertaken.

Sections 6, 7 and 8 of this EP detail and evaluate impacts and risks from planned activities and unplanned events, provide control measures, set environmental performance outcomes and standards, and provide the strategy for ensuring environmental performance is achieved, as outlined within the EP.

1.4.2 International legislation

Australia is signatory to numerous international conventions and agreements that obligate the Commonwealth government to prevent pollution and protect specified habitats, flora and fauna. Those that are relevant to the Activity are detailed in Sections 6, 7 and 8.

1.4.3 Commonwealth legislation

All activities conducted under the EP will comply with legislative requirements established under relevant Commonwealth legislation. These are further detailed in Sections 6, 7 and 8.

2. Activity description

OPGGS(E)R 2023 Requirements
Section 21. Environmental assessment.
Description of the Activity: 21 (1) The environment plan must contain a comprehensive description of the Activity including the following: a) the location or locations of the Activity b) general details of the construction and layout of any facility c) an outline of the operational details of the Activity (for example, seismic surveys, exploration drilling or production) and proposed timetables d) any additional information relevant to consideration of environmental impacts and risks of the Activity. Note: An environment plan will not be capable of being accepted by the Regulator if an Activity or part of the Activity, other than arrangements for environmental monitoring or for responding to an emergency, will be undertaken in any part of a declared World Heritage property – see Section 34.

2.1 Terminology

To help interpret the Activity description and impact assessment sections, Table 2-1 defines key terminology used.

Table 2-1: Key terminology

Term	Explanation
GHG Activity (the Activity)	The Eos 3D MSS, including all supporting activities.
Active Source Area	The Active Source Area defines the area within which the seismic source will be operated to acquire the seismic data and achieve the geophysical objectives of the survey. Typically, this area will be used to: • Incrementally build the power of the seismic source from non-operation to full capacity, for the purpose of soft starts during line run-ins. • Complete seismic acquisition and data collection along pre-determined sail lines, during which time the seismic source will be operated at full capacity. • Complete line run-outs, during which the seismic source will be operated at full capacity • Additionally, the Active Source Area may also be used for occasional source testing at, or below, full capacity. • The seismic source or individual source elements within the array may be infrequently discharged at or less than full capacity for testing (e.g. bubble tests) or maintenance purposes (which are sometimes necessary to complete during line changes). Testing typically takes just minutes or a few hours to complete and is required to ensure seismic source integrity, both in terms of measured output and discharge timing. Testing and maintenance of the seismic source may occur anywhere within the Active Source Area.
Operational Area	The Operational Area defines the area within which the seismic survey vessel will operate during the normal conduct of the Activity[1]. It includes the Active Source Area and a working buffer beyond the Active Source Area. The operations to be conducted within the Operational Area include active acquisition and source emissions within the Active Source Area, line changes and equipment maintenance. The seismic source or individual source elements within the array will not be discharged outside of the Active Source Area.
Racetrack	The method by which sail lines (also known as acquisition lines) are traversed to acquire the seismic survey data, comprising circuits that resemble a simple racetrack.
Seismic source	Comprises a configuration of multiple seismic source elements (‘airguns’) which discharge seismic pulses necessary to achieve the survey objectives.
Seismic source interval	Interval between individual seismic pulses, sometimes referred to as ‘source point interval’.
Seismic survey vessel	Vessel towing the seismic source arrays and streamers.
Streamers	A series of cables towed underwater behind the seismic survey vessel. The streamers accommodate hydrophones and vertical sensor, which record seismic reflections.

Term	Explanation
Support vessel	Vessel undertaking support functions such as assisting with the management of on the water communications with other third-party vessels, refuelling and resupply. Support vessel includes a 'chase boat'.

[1] *At any time during the survey, the seismic survey vessel may depart the Operational Area if, in the opinion of the vessel master, the safety of the vessel and crew is at risk e.g. in the event of sea/weather conditions restricting manoeuvring capabilities. In this instance, the seismic survey vessel may have its seismic equipment deployed in the water but will not be permitted to discharge the seismic source. Likewise, during mobilisation and demobilisation to the Operational Area the seismic vessel may have its seismic equipment deployed in water, as permitted under maritime law, but will not be permitted to discharge a seismic source. When vessels are outside the Operational Area (e.g. transiting to or from location or holding position outside the Operational Area) and remain within Australian waters, they come under the regulatory jurisdiction of AMSA and the* Navigation Act 2012*. Accordingly, this EP and associated OPEP do not cover activities performed by the vessels while outside the Operational Area.*

2.2 Activity overview

Santos plans to conduct the Eos 3D MSS in the Bonaparte Basin within greenhouse gas assessment permit G-11-AP and surrounding waters. The survey extends into greenhouse gas assessment permit G-7-AP and overlaps petroleum permit WA-548-P, WA-27-R, NT/P88, NT/RL1 and WA-6-R.

During the survey, a seismic survey vessel will tow a seismic source array and a series of streamers within the Operational Area, as defined in Section 2.3. The seismic source will emit pulses of low-frequency sound, which once reflected from the underlying rock layers beneath the seabed are recorded by the towed streamers. The seismic survey vessel will be assisted by other support vessels, and helicopter operations may be required in emergencies and for crew change operations.

2.3 Location and operational area

The Eos 3D MSS is in Commonwealth waters of the southern Bonaparte Basin, in the Joseph Bonaparte Gulf (JBG). There are two areas defined for the Activity (Table 2-1) based on the type of activities that will be undertaken and the output of the seismic source. These are:

- Active Source Area
- Operational Area

These areas are presented in Figure 2-1, and coordinates for each area are provided in Table 2-2.

The Operational Area is located approximately 107 kilometres (km) from the nearest Western Australia (WA) coastline and approximately 102 km from the nearest Northern Territory (NT) coastline. Approximate distances from the Operational Area to local towns are 192 km to Kalumburu (WA), 209 km to Wyndham (WA), 230 km to Darwin (NT) and 119 km from Wadeye (NT) (Figure 2-1).

Water depths in the Operational Area range between 60 and 115 metres (m) (below mean sea level). Water depths in the Active Source Area range from 67–111 m.

2.4 Activity duration and timing

The survey area to be acquired is shown in Figure 2-1. The survey is estimated to take up to 50 days to complete. This includes the deployment of in-sea equipment prior to the survey commencing and the recovery of in sea equipment prior to vessel demobilisation at the end of the survey. The estimated survey duration also includes provisions for potential delays caused by slow vessel speeds, extreme weather events, equipment failure or other delays caused by difficult to predict factors. Operations will be undertaken on a 24-hour basis.

Santos intends to acquire the full survey anytime from the date of EP acceptance by NOPSEMA until 31 December 2027.

The precise timing of the survey is subject to NOPSEMA's acceptance of the EP, weather conditions, vessel availability and other operational considerations, and will take into account the seasonality of environmental sensitivities, where practicable. The exact start and end dates of the survey will be communicated to stakeholders; in accordance with the ongoing stakeholder consultation process described in Section 4.5.10.

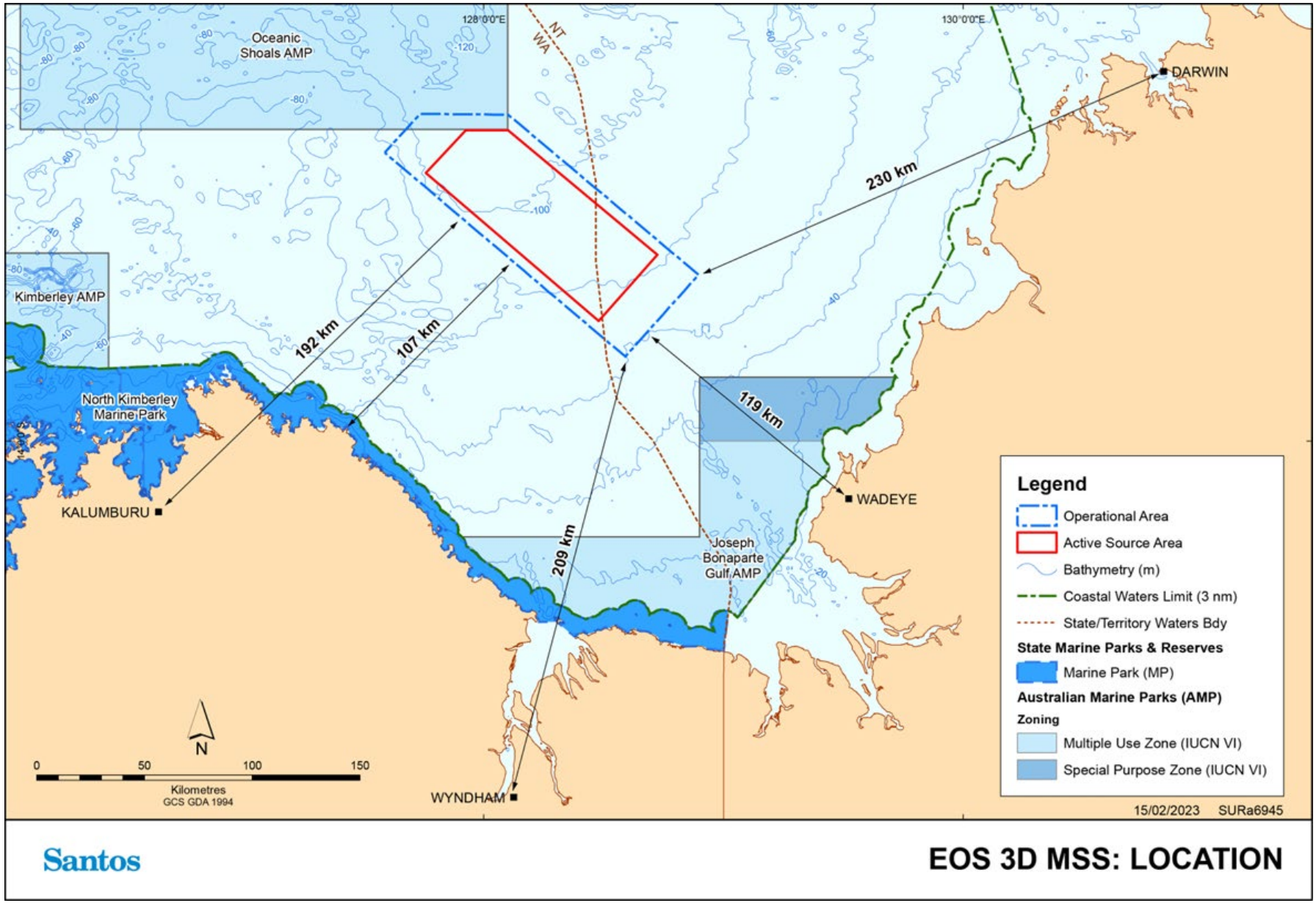


Figure 2-1: Eos 3D MSS location

Table 2-2: Proposed Eos 3D MSS areas and coordinates

Operational Area		Active Source Area	
Total Area: 6,801 km^2		Total Area: 4,028 km^2	
Water depths: 60–115 m		Water depths: 67–111 m	
Latitude	**Longitude**	**Latitude**	**Longitude**
12° 47' 45.870" S	127° 35' 9.014" E	12° 52' 52.261" S	127° 45' 28.575" E
12° 38' 5.216" S	127° 44' 2.253" E	12° 42' 9.215" S	127° 55' 28.219" E
12° 38' 16.443" S	128° 6' 3.199" E	12° 42' 8.964" S	128° 6' 5.702" E
13° 18' 22.214" S	128° 53' 45.423" E	13° 13' 21.492" S	128° 43' 23.459" E
13° 38' 52.656" S	128° 35' 23.154" E	13° 29' 56.111" S	128° 28' 44.239" E

2.5 Acquisition parameters

During the proposed seismic acquisition, the seismic survey vessel will traverse a series of pre-determined sail lines within the Active Source Area at a speed of approximately 4.5 knots (8.3 kilometres per hour [km/h]). The seismic survey vessel will turn to make line changes within the Operational Area. Adjacent sail lines will be spaced approximately 500–700 m apart. The seismic survey vessel will typically complete the lines in a 'racetrack' (loop) formation, whereby a line is completed, and the vessel turns to survey a parallel line offset by several kilometres, before turning again to survey a line adjacent to the first line, offset by approximately 500–700 m. The racetrack pattern is repeated as the seismic survey vessel gradually moves across the Full-fold Acquisition Area.

Sail lines will be acquired in a north-west to south-east orientation. Figure 2-2 shows an indicative sail line configuration.

The seismic source will be towed behind the seismic survey vessel and at a depth of approximately 6–8 m below sea level. The seismic source will be discharged at a minimum of 8.33 m (resulting in a source point interval of at least 3.6 seconds), depending on the specific seismic source selected to complete the survey. Although the discharge interval is not yet confirmed, the most conservative discharge interval applicable to the survey has been used for acoustic modelling and impact assessment purposes (8.33 m). The streamers will be towed at a depth of between 10 m and 30 m below sea level and will not contact the seabed at any time, in order to prevent seabed disturbance. The streamers will be up to 8,100 m long. The total width of the streamer spread is approximately 1,350 m. A summary of the survey parameters is provided in Table 2-3.

Table 2-3: Acquisition parameters

Parameter	Seismic Survey Parameters
Volume of seismic source	Max. 3,050 cubic inches (in^3)
Operating pressure	2,000 psi
Seismic source depth	Approx. 6–8 m
Source point interval	Minimum of every 3.6 seconds
Seismic source interval	Approx. 8.33 m
Vessel speed	Approx. 4.5 knots (8.33 km/h)
Number of streamers	12
Seismic streamer length	Approximately 8.1 km
Streamer spacing	112.5 m
Total seismic streamer spread width	Approximately 1,350 m
Seismic streamer depth	Between 10 and 30 m
Sail line spacing	Approximately 500–700 m
Survey azimuth (line orientation)	North-west / South-east
Time to traverse a single sail line	Approximately 8 hours and 30 minutes
Sail line turn time	Approximately 3–4 hours
Total expected duration (includes contingency)	50 days

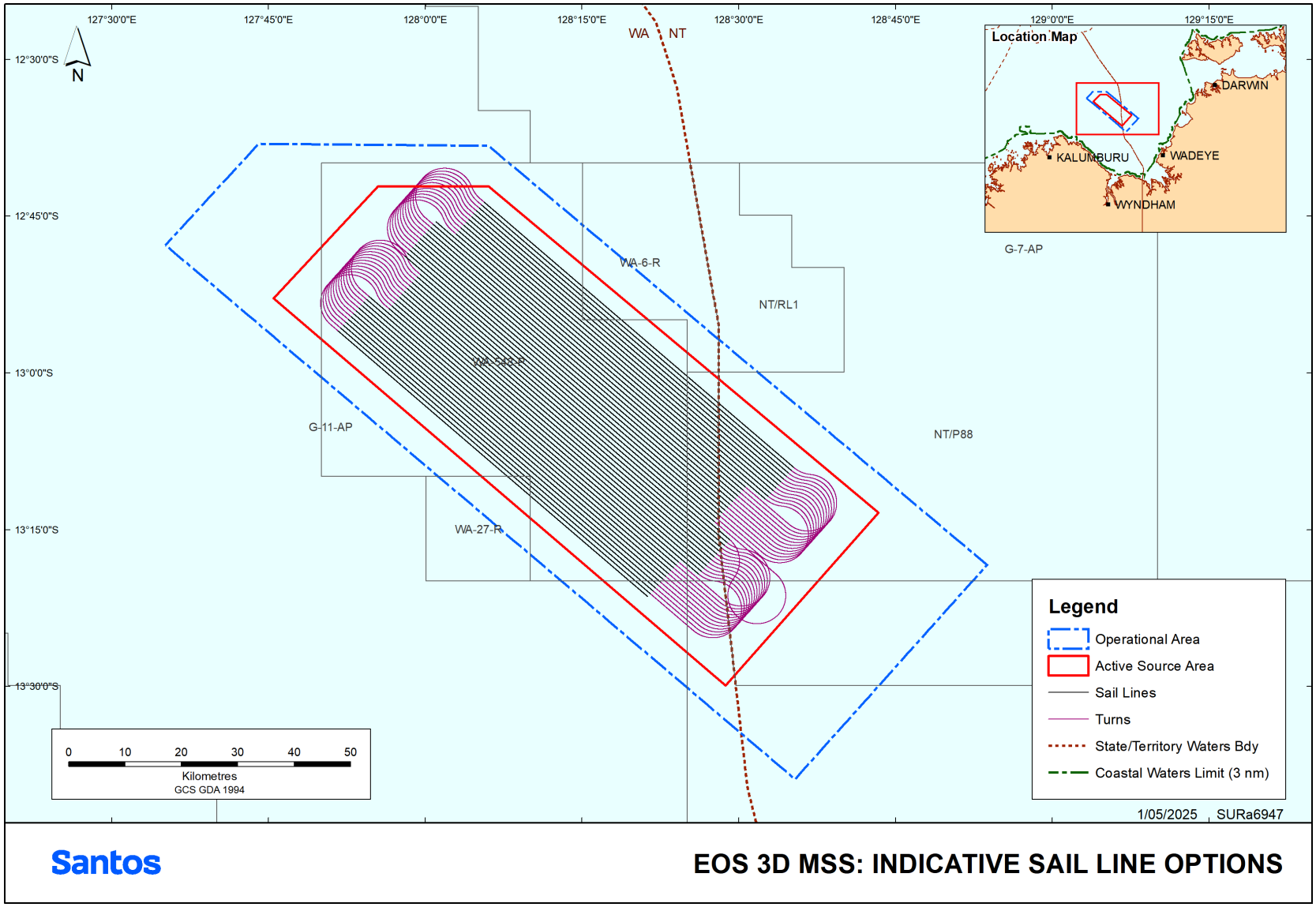


Figure 2-2: Example sail line plan

2.6 Support vessels

Up to two dedicated support vessels (one being a chase vessel) will accompany the seismic survey vessel to provide logistical, safety and equipment management duties. At least one vessel will be rigged and capable of towing the seismic survey vessel in the case of an emergency. The vessels will also mobilise to and from the mainland to undertake re-supply, refuelling and other support functions for the Activity. The support vessels may be required to leave the Operational Area to respond to unplanned events such as retrieval of accidentally over boarded floating objects, or communicating with a third-party vessel, or for other logistical and safety reasons.

The seismic survey vessel will have a small on-board workboat, which may be launched from the seismic survey vessel to assist with equipment deployment and retrieval, or to carry out streamer maintenance activities. The seismic survey vessel will also have a fast rescue craft (FRC) on-board.

2.7 Aircraft

Aircraft maybe used for crew changes, critical equipment supply, surveillance and emergency response uses. Aircraft includes helicopters and drones.

3. Description of the environment

OPGGS(E)R 2023 Requirements
Section 21. Environmental assessment.
Description of the environment 21(2) The environment plan must — a) describe the existing environment that may be affected by the Activity; and b) include details of the particular relevant values and sensitivities (if any) of that environment.

3.1 Environment that may be affected (EMBA)

This section summarises the key physical, biological, socio-economic and cultural characteristics of the existing environment that may be affected (EMBA), both from planned activities and unplanned events associated with the Activity. The description of the environment applies to two areas:

- The Operational Area, as presented in Figure 2-1 and described in Table 2-1
- The EMBA, as shown in Figure 3-1.

Most planned activities and unplanned events associated with the Activity may affect the environment up to a few hundred metres from the marine vessel or aircraft. However, a large unplanned vessel hydrocarbon spill would extend substantially beyond a few hundred metres.

3.1.1 Underwater acoustic emissions EMBA

Numerical acoustic modelling shows that noise levels exceeding predefined impact thresholds (refer to Section 6.3) do not exceed the boundary of the unplanned vessel hydrocarbon spill EMBA, as described below. Therefore, the unplanned hydrocarbon spill EMBA represents the overall EMBA for activities conducted under this EP.

3.1.2 Unplanned vessel hydrocarbon spill EMBA

Credible scenarios for unplanned vessel hydrocarbon spills considered for the EMBA and assessed in **S**ection 7.1 of this EP are outlined in Table 3-1. Stochastic hydrocarbon dispersion and fate modelling applied to the largest credible hydrocarbon spill scenario, as summarised in Section 7.1, were undertaken to inform the EMBA. The EMBA has therefore been based on the largest credible hydrocarbon spill scenario – the instantaneous release of 1,065 cubic metres (m^3) of marine diesel oil (MDO) from the seismic survey vessel within the Operational Area. The spill trajectories from three modelled release locations have been combined to form a single EMBA. The EMBA is illustrated in Figure 3-1.

While the EMBA represents the largest possible spatial extent that could be affected by the worst-case hydrocarbon spill event, it is important to understand that the stochastic modelling considers 100 different simulations for one-spill event (with three events modelled in total). Simplistically, each simulation considers a different combination of metocean conditions over time. An actual spill event is realistically represented by only one of the simulations and hence, has a much smaller spatial footprint.

Table 3-1: Summary of largest credible unplanned vessel hydrocarbon spill scenarios

Event	Hydrocarbon type	Modelled spill volume	Comment	Section
Hydrocarbon spill (MDO) from vessel collision – surface release	MDO	1,065 m^3	Modelled spill volume based on the predicted largest fuel tank on a seismic and support vessel.	**7.1**
Hydrocarbon spill (MDO) during refuelling	MDO	37.5 m^3	Spill volume based on 15 minutes of flow at a pumping rate of 150 m^3/h.	**7.2**

3.2 Environmental values and sensitivities

A comprehensive description of the environmental values and sensitivities of the existing environment within the EMBA (as required by Regulation 21(3) of the OPGGS(E)R), is provided in this section of the EP.

The Department of Climate Change, Energy, the Environment and Water (DCCEEW) Protected Matters Search Tool (PMST) was used to determine potential receptors such as Matters of National Environmental Significance (MNES) listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) within the

Operational Area and the EMBA. The results of these searches are provided in Appendix C. In addition, desktop research was conducted to identify other State and Territory parks and reserves whose coastal features are overlapped by the EMBA. A summary of the information derived from the PMST and desktop research, Bioregional Plans and the identified Fauna Recovery Plans of relevance to the Operational Area and the EMBA is provided in this section of the EP.

Table 3-2 identifies the key values and sensitivities relevant to the Operational Area and EMBA and cross-references the relevant sections of this EP where the values and sensitivities are described.

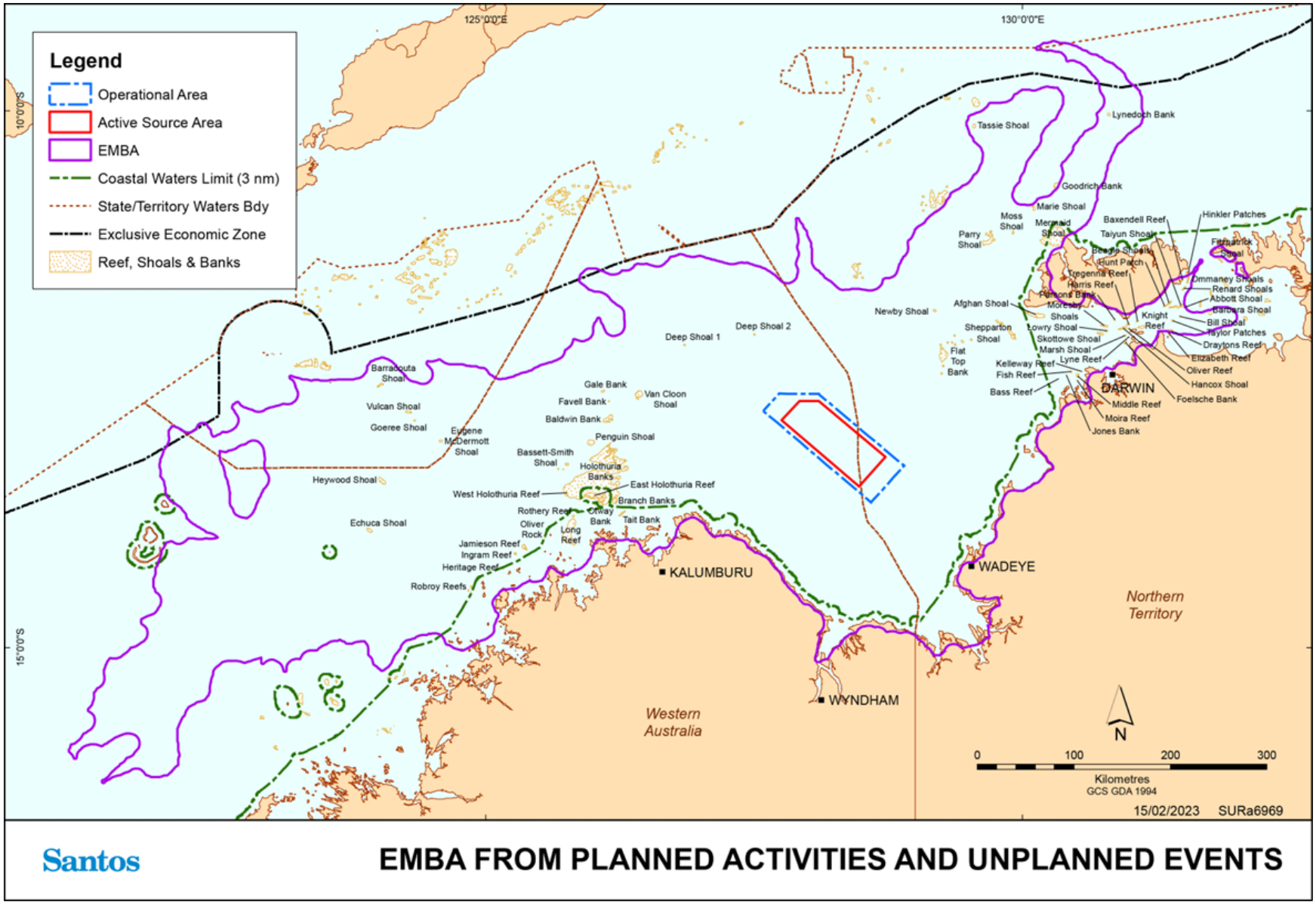


Figure 3-1: EMBA from planned activities and unplanned events

Table 3-2: Key environmental values and sensitivities relevant to the EMBA

Category	Key values and sensitivities within the EMBA	Proximity to Operational Area	Relevant Sections of this EP	Relevant events that may impact on the receptors
Marine planning region	North-west Marine Region	Within	3.3.1	Planned: • Noise emissions • Light emissions • Planned operational discharge Unplanned: • Hazardous and non-hazardous unplanned discharges – liquid and solid • MDO release from vessel collision • Minor hydrocarbon release • Spill response operations • Marine fauna collisions • Introduction of invasive marine species
	North Marine Region	Within		
Provincial bioregions	Northwest Shelf Transition	Within	3.3.2	
	Northwest Shelf Province	255 km SW		
	Timor Province	280 km SW		
	Northern Shelf Province	282 km NE		
	Timor Transition	328 km NE		
Climate	-	Within	3.4.1	Planned: • Noise emissions • Light emissions • Planned operational discharge Unplanned: • Hazardous and non-hazardous unplanned discharges – liquid and solid • MDO release from vessel collision • Minor hydrocarbon release • Spill response operations • Marine fauna collisions • Introduction of invasive marine species
Oceanography	-	Within	3.4.2	
Bathymetry and geomorphology	-	Within	3.4.3	
Sedimentology	-	Within	3.4.4	
Australian Marine Parks	Oceanic Shoals AMP (IUCN Category VI – Multiple Use Zone)	Within	3.5.1	Unplanned: • MDO release from vessel collision • Spill response operations
	JBG AMP (IUCN Category VI – Special Purpose)	32 km SE		
	JBG AMP (IUCN Category VI – Multiple Use)	51 km SE		
	Oceanic Shoals AMP (IUCN Category VI – Special Purpose Zone (Trawl)	82 km NE		

Category	Key values and sensitivities within the EMBA	Proximity to Operational Area	Relevant Sections of this EP	Relevant events that may impact on the receptors
	Kimberley AMP (IUCN VI – Multiple Use Zone)	133 km SW		
	Oceanic Shoals AMP (Habitat Protection Zone) IUCN Category IV)	156 km NE		
	Oceanic Shoals AMP (National Park Zone – IUCN Category II)	240 km NE		
	Cartier Island AMP (IUCN Category Ia – Sanctuary Zone)	432 km WNW		
	Kimberley AMP (National Park Zone – IUCN Category II)	449 km SW		
	Ashmore Reef AMP (IUCN Category Ia)[1]	474 km WNW		
	Ashmore Reef AMP (IUCN Category IV)[1]	501 km WNW		
State/Territory Marine Parks and Reserves	North Kimberley Marine Park	105 km SW	3.5.2	
	Lesueur Island Nature Reserve	107 km SSW		
	Pelican Island Nature Reserve	125 km SSE		
	Channel Point Coastal Reserve	133 km ENE		
	Ord River Nature Reserve	133 km SSW		
	Keep River National Park Extension (Proposed)	148 km SSE		
	Niiwalarra Islands National Park	156 km SSW		
	Low Rocks Nature Reserve	232 km WSW		
	Casuarina Coastal Reserve	236 km ENE		
	Buffalo Creek Management Area	242 km ENE		
	Shoal Bay Coastal Reserve	252 km ENE		
	Tree Point Conservation Area	253 km ENE		
	Djukbinj National Park	274 km ENE		
	Garig Gunak Barlu	398 km NE		
	North Lalang-garram	422 km SW		
	Lalang-garram / Camden Sound	450 km SW		
	Browse Island Nature Reserve	461 km WSW		

Category	Key values and sensitivities within the EMBA	Proximity to Operational Area	Relevant Sections of this EP	Relevant events that may impact on the receptors
	Scott Reef Nature Reserve	624 km SW		
Key Ecological Features (KEFs)	Carbonate bank and terrace system of the Sahul Shelf	Within	3.6.1	
	Pinnacles of the Bonaparte Basin	Closest feature: 3 km W		
	Carbonate bank and terrae system of Van Diemen Rise	80 km NE		
	Shelf break and slope of the Arafura Shelf	301 km NE		
	Ancient coastline at 125 m depth contour	307 km SW		
	Continental slope demersal fish communities	415 km SW		
	Ashmore Reef and Cartier Island and surrounding Commonwealth waters	433 km NW		
	Seringapatam Reef and Commonwealth waters	608 km W		
Commonwealth Heritage Places (Natural)	Scott Reef and Surrounds – Commonwealth Area	637 km W	3.5.4	
	Bradshaw Defence Area	176 km N		
National Heritage Places	The West Kimberley	101 km SW		
Wetlands of National Importance	Moyle Floodplain and Hyland Bay System	117 km SE	3.5.5	
	Ord Estuary System	133 km SSW		
	Finniss Floodplain and Fog Bay Systems	141 km NE		
	Daly-Reynolds Floodplain-Estuary System	143 km E		
	Legune Wetlands	175 km SE		
	Parry Floodplain	178 km SW		
	Port Darwin	213 km NE		
	Adelaide river floodplain system	230 km NE		
	Shoal Bay – Micket Creek	255 km NE		
	Cobourg Peninsula System	381 km NE		
Wetlands of International Importance (Ramsar sites)	Ord River Floodplain	133 km SSW	3.5.6	
	Cobourg Peninsula System	381 km NE		

Category	Key values and sensitivities within the EMBA	Proximity to Operational Area	Relevant Sections of this EP	Relevant events that may impact on the receptors
	Ashmore Reef National Nature Reserve	474 km NW		
Non-coral benthic Invertebrates	-	Within	-	Planned: • Noise emissions Unplanned: • MDO release from vessel collision • Spill response operations • Introduction of invasive marine species
Coral Reefs	Shepparton Shoal	171 km NE	3.6.3	Unplanned: • MDO release from vessel collision • Spill response operations
	Darwin Harbour	222 km ENE		
	Marie Shoal	294 km NNE		
	Goodrich Bank	320 km NNE		
	Tassie Shoal	324 km NNE		
	Blackwood Shoal	340 km NNE		
	Evans Shoal	344 km NNE		
	Cobourg Peninsula	430 km ENE		
	Cartier Island	432 km NW		
	Browse Island	461 km SW		
	Hibernia Reef	467 km NW		
	Ashmore Reef	501 km NW		
Seagrasses and Macroalgae	Seagrass meadows of Arnhem Land and Gulf of Carpentaria	389 km ENE	3.6.4	
Mangroves	Port Keats	101 km ESE	3.6.2	Unplanned: • MDO release from vessel collision • Spill response operations
	Little Moyle Inlet	109 km ESE		
	Moyle River	118 km ESE		
	Buckle Head Creek	120 km SSW		
	Thurburn Creek	122 km SSW		
	Ord River	122 km SSW		
Islands	Dorcherty Island	101 km SE	3.6.2	
	Pelican Island	125 km SSE		

Category	Key values and sensitivities within the EMBA	Proximity to Operational Area	Relevant Sections of this EP	Relevant events that may impact on the receptors
	Tiwi Island	206 km E		
	Cartier Island	432 km WNW		
	Browse Island	461 km WSW		
	Ashmore Reef	501 km NW		
Marine Mammals	Australian snubfin dolphin foraging/breeding/calving/resting Biologically Important Area (BIA)	101 km SSW	3.7.3	Planned: • Noise emissions • Light emissions • Planned operational discharge Unplanned: • Hazardous and non-hazardous unplanned discharges – liquid and solid • MDO release from vessel collision • Minor hydrocarbon release • Spill response operations • Marine fauna collisions • Introduction of invasive marine species
	Indo-Pacific humpback dolphin breeding BIA	202 km ENE		
	Indo-Pacific humpback dolphin foraging BIA	153 km SSW		
	Indo-Pacific humpback dolphin calving BIA	318 km WSW		
	Pygmy blue whale migration BIA	363 km WNW		
	Pygmy blue whale foraging BIA	607 km WSW		
	Humpback Whale migration, nursing, calving, and resting BIA	326 km WSW		
Marine Turtles	Loggerhead turtle foraging BIA	Within	3.7.4	Planned: • Noise emissions • Light emissions • Planned operational discharge Unplanned: • Hazardous and non-hazardous unplanned discharges – liquid and solid • MDO release from vessel collision • Minor hydrocarbon release • Spill response operations • Marine fauna collisions • Introduction of invasive marine species
	Flatback turtle foraging BIA	Within		
	Flatback turtle internesting and internesting buffer BIAs	39 km SSW		
	Flatback turtle nesting BIA	127 km SSW		
	Olive ridley turtle foraging BIA	Within		
	Olive ridley turtle internesting BIA	151 km ENE		
	Green turtle foraging BIA	Within		
	Green turtle internesting buffer BIAs	224 km WSW		
	Green turtle nesting BIA	243 km WSW		
	Hawksbill turtle foraging BIA	437 km WNW		
	Hawksbill turtle internesting BIA	379 km ENE		
EPBC Act-listed Threatened and Migratory Fish Species	Whale shark foraging BIA	205 km WSW	3.7.5	

Category	Key values and sensitivities within the EMBA	Proximity to Operational Area	Relevant Sections of this EP	Relevant events that may impact on the receptors
Seabirds	Lesser crested tern breeding and foraging BIAs	75 km SSW	3.7.6	Planned: • Noise emissions • Light emissions • Planned operational discharge Unplanned: • Hazardous and non-hazardous unplanned discharges – liquid and solid • MDO release from vessel collision • Minor hydrocarbon release • Spill response operations • Introduction of invasive marine species
	Roseate tern breeding and foraging BIAs	131 km SSW		
	Lesser frigatebird breeding and foraging BIAs	108 km WSW		
	Greater Crested Tern breeding and foraging BIAs	265 km NNE		
	Greater frigatebird breeding and foraging BIAs	384 km WNW		
	Wedge-tailed shearwater breeding and foraging BIAs	389 km WNW		
	White-tailed tropicbird breeding and foraging BIAs	392 km WNW		
	Red-footed booby breeding and foraging BIAs	384 km WNW		
	Brown booby breeding and foraging BIAs	371 km WSW		
	Little tern breeding and foraging BIAs	232 km WSW		
	Little tern resting BIA	619 km WSW		
Commercial Fisheries	Commonwealth Northern Prawn Fishery	Historical fishing effort within the Operational Area shows an overlap between the southern corner of the Operational Area and the low intensity fishing area for the NPF.	3.8.1	Planned: • Physical interaction • Noise emissions (to target species) Unplanned: • MDO release from vessel collision • Spill response operations • Introduction of invasive marine species
	Commonwealth Western Tuna and Billfish Fishery	Activity is concentrated in the south-west of Western Australia and South Australia.		
	Commonwealth North-west Slope Trawl Fishery	818 km		
	Commonwealth Southern Bluefin Tuna Fishery	Activity is concentrated in the Great Australian Bight and South Australia.		
	Commonwealth Western Skipjack Fishery	Currently not in operation.		

Category	Key values and sensitivities within the EMBA	Proximity to Operational Area	Relevant Sections of this EP	Relevant events that may impact on the receptors
	WA Abalone Managed Fishery	Activity is concentrated in the south-west and southern parts of Western Australia.		
	WA Broome Prawn Managed Fishery	Operates off Broome.		
	WA Kimberley Crab Managed Fishery	39 km*		
	WA Kimberley Gillnet and Barramundi Fishery	Limited historical fishing effort (less than three vessels) within the Operational Area*		
	WA Kimberley Prawn Managed Fishery	91 km – distance to closest reporting block with activity.		
	WA Mackerel Managed Fishery (Area 1 – Kimberley)	Limited historical fishing effort (less than three vessels) within the Operational Area.		
	WA Marine Aquarium Fish Managed Fishery	91 km – distance to closest reporting block with activity.		
	Northern Demersal Scalefish Managed Fishery (WA)	Limited historical fishing effort (less than three vessels) within the Operational Area.		
	WA Northern Shark Fishery	Currently not in operation in this region.		
	WA Pearl Oyster Managed Fishery	182 km – distance to closest reporting block with activity.		
	WA South West Coast Salmon Managed Fishery	Known activity is south of the Perth metropolitan area.		
	WA Specimen Shell Managed Fishery	154 km distance to closest reporting block with activity.		
	WA West Australian Sea Cucumber Fishery	126 km – distance to closest reporting block with activity.		
	WA West Coast Deep Sea Crustacean Managed Fishery	1,668 km		
	NT Demersal Fishery	Limited historical fishing effort within the Operational Area.		
	NT Spanish Mackerel Fishery	Limited historical fishing effort within the Operational Area.		

Category	Key values and sensitivities within the EMBA	Proximity to Operational Area	Relevant Sections of this EP	Relevant events that may impact on the receptors
	NT Offshore Net and Line Fishery	Limited historical fishing effort within the Operational Area.		
	NT Timor Reef Fishery	Limited historical fishing effort within the Operational Area.		
	NT Aquarium Fishery	Limited historical fishing effort within the Operational Area.		
	NT Barramundi Fishery	11.4 km – distance to closest reporting block with activity.		
	NT Coastal Line Fishery	11.4 km – distance to closest reporting block with activity.		
	NT Trepang Fishery	124 km – distance to closest reporting block with activity.		
	NT Development-Small Pelagic	11.4 km – distance to closest reporting block with activity.		
	NT Coastal Net Fishery	124 km – distance to closest reporting block with activity.		
Key Commercial Fish and Shellfish Species	Banana prawns	Within	3.8.1	Planned: • Noise emissions • Light emissions • Planned operational discharge Unplanned: • Hazardous and non-hazardous unplanned discharges – liquid and solid • MDO release from vessel collision • Minor hydrocarbon release • Spill response operations • Introduction of invasive marine species
	Tiger prawns			
	Endeavour prawns			
	King prawns			
	Mud crabs			
	Aquarium fishes and invertebrates			
	Silver-lipped pearl oysters			
	Sandfish			
	Redfish			
	Barramundi			
	King threadfin			
	Blue threadfin			
	Cods			
	Black jewfish			

Category	Key values and sensitivities within the EMBA	Proximity to Operational Area	Relevant Sections of this EP	Relevant events that may impact on the receptors
	Mullet			
	Goldband snapper			
	Red emperor			
	Red and blue spotted emperor			
	Saddletail snapper			
	Crimson snapper			
	Red snapper			
	Goldband snapper			
	Black-tip sharks			
	Grey mackerel			
	Spanish mackerel			
Shipping	Vessel traffic	Within	3.8.2	Planned: • Physical interaction Unplanned: • MDO release from vessel collision • Spill response operations
Oil and Gas Activities	-	Various, within EMBA	3.8.3	Planned: • Physical interaction Unplanned: • MDO release from vessel collision • Spill response operations
Tourism and recreation	-	Various, within EMBA	3.8.4	
Defence	Northern Australian Exercise Area (NAXA)	Within	3.8.5	
Maritime and Cultural Heritage	Historic shipwrecks	11 km NE	3.8.6	Unplanned: • MDO release from vessel collision • Spill response operations
	Aboriginal heritage sites	Present on shoreline of EMBA		
	Native Title areas	101 km SE		

[1] *Ashmore Reef AMP is outside the EMBA, but the PMST Report identifies this AMP 10 km away. Because of its sensitivity and significance to the environment, Ashmore Reef AMP is included in the EMBA for all aspects of this EP that apply to it.*

** Assessed on 60 x 60 nm grid blocks as location of 10 x 10 nm grid blocks for the fishery were not available in the FishCube dataset.*

3.3 Bioregions

3.3.1 Marine regions

Under the national marine bioregional planning framework, the Australian marine environment was separated into six broad marine regions. Marine Bioregional Plans describe the marine environment and conservation values of each marine region, set out broad biodiversity objectives, identify regional priorities and outline strategies and actions to address these priorities.

Both the Operational Area and EMBA are located within the North-west Marine Region (NWMR) and North Marine Region (NMR) (Commonwealth waters offshore from the NT).

The Bioregional Plans for the NWMR (DSEWPaC 2012a) and NMR (DEWHA 2008a; DSEWPaC 2012b) have been used in conjunction with other relevant management plans, reports and published papers to inform this description of the environment.

3.3.1.1 North-west Marine Region

The NWMR comprises Commonwealth waters from the WA-NT border to Kalbarri, south of Shark Bay. The NWMR is characterised by the large area of continental shelf and continental slope, highly variable tidal regions and very high cyclone incidence. The NWMR is characterised by shallow-water tropical marine ecosystems, which is home to globally significant populations of internationally threatened species (DSEWPaC 2012a). Main physical features of the marine region include:

Extensive areas of continental shelf and slope, plateaus and terraces.

The narrowest continental shelf on Australia's coastal margin.

Coralline algal reefs, and carbonate pinnacles and shoals.

Coral reefs which support high delivery of corals and associated fish and other species.

The JBG, a muddy basin with sparse coverage of sessile filter-feeding organisms and mobile invertebrates.

A number of major canyons on the continental slope that act as conduits for sediment and nutrient transport.

Two areas of abyssal plain with deep waters.

The Indonesian Throughflow (ITF).

3.3.1.2 North Marine Region

The NMR comprises Commonwealth waters from west Cape York Peninsula to the WA-NT border. The marine environment of the NMR is known for its high diversity of tropical species but relatively low endemism, in contrast to other bioregions. This region is highly influenced by tidal flows and less by ocean currents. The region is dominated by monsoonal climatic patterns characterised by a pronounced wet season and a generally dry season. Tropical cyclones are a dominant feature in the wet season (DEWHA 2008b). Physical features of the region include:

A wide continental shelf with water depths generally less than 70 m.

The Van Diemen Rise, characterised by complex geomorphology with features including shelves, shoals, banks, terraces and valleys.

The north of the region, a series of shallow canyons approximately 80–100 m deep.

Numerous limestone pinnacles.

The Arafura Shelf, an area of continental shelf.

Submerged patch and barrier reefs that form a broken margin around the perimeter of the Gulf of Carpentaria.

The Gulf of Carpentaria coastal zone – waters up to 20 m deep.

Currents driven largely by strong winds and tides.

Complex weather cycles and a tropical monsoonal climate.

3.3.2 Provincial bioregions

Based on the Integrated Marine and Coastal Regionalisation of Australia (IMCRA) Version 4.0, both the Operational Area and EMBA overlap the Northwest Shelf Transition bioregion. The EMBA also overlaps the Timor Transition and the Northern Shelf Province within the North-west Marine Region (NWMR); and the Northwest Shelf Province and Timor Province within the North Marine region (NMR) (refer to Figure 3-2).

3.3.2.1 Northwest Shelf Transition

The Northwest Shelf Transition, which straddles both the NWMR and NMR, is characterised by these biophysical features (DSEWPaC 2012a):

- Located mostly on the continental shelf, with some small areas extending onto the continental slope.
- Water depths range between 0 and 330 m, with the majority of the bioregion occurring in depths of 10–100 m.
- The Indonesian Throughflow (ITF) is the dominant oceanographic feature and dominates the majority of the water column.
- The strength of the ITF and its influence in the bioregion varies seasonally in association with the North-west Monsoon.
- Contains a variety of geomorphic features, including terraces, plateaus, sand banks, canyons and reefs.
- The biological communities of the North-west Shelf Transition are typical of Indo-west Pacific tropical flora and fauna and occur across a range of soft-bottom and harder substrate habitats.

3.3.2.2 Northwest Shelf Province

The Northwest Shelf Province, within the NWMR, is characterised by these biophysical features (DEWHA 2008b):

- Located mostly on the continental shelf between North West Cape and Cape Bougainville.
- Water depths range between 0 and 200 m.
- Dynamic oceanographic environment, influenced by strong tides, cyclonic storms, long-period swells and internal tides. Warm, oligotrophic waters derived from the ITF.
- The biological communities include diverse benthic and pelagic fish communities associated with different depth ranges, seabird breeding sites and cetacean (humpback whale) migration route.

3.3.2.3 Timor Province

The Timor Province, within the NWMR, is characterised by these biophysical features (DEWHA 2008b):

- Covers almost 15% of the NWMR, predominantly covering the continental slope and abyss between Broome and Cape Bougainville.
- Water depths range from 200 m near the shelf break to over 5,920 m over the Argo Abyssal Plain.
- Major geomorphic features include the Scott Plateau, the Ashmore Terrace, part of the Rowley Terrace and the Bowers Canyon.
- Important features include Ashmore Reef, Cartier Island, Seringapatam Reef and Scott Reef.
- Dominated by warm, oligotrophic waters derived from the ITF. The thermocline in the water column in particularly pronounced and associated with the generation of internal tides.
- Several distinct habitats and biological communities occur within the region, and the reefs and islands are regarded as biodiversity hotspots. A high level of endemicity exists in the demersal fish communities of the continental slope in the Timor Province.

3.3.2.4 Northern Shelf Province

The Northern Shelf Province contains submerged patch or barrier reefs in areas with approximately 30–50 m depth of water, these mainly occur around the margin of the Gulf of Carpentaria (which lies outside the combined EMBA) (DEWHA 2008c). The majority of the province is relatively featureless with sandy and muddy sediments and this is expected to be the case for the portion of the combined EMBA that overlaps the Northern Shelf Province.

3.3.2.5 Timor Transition

Due to the deep, offshore nature of the Timor Transition (up to 300 m with no coastal areas), there are no corals expected within this area (DEWHA 2008c). However, there is evidence of relic reef next to drainage channels of the outer slope of the Timor Transition. This is thought to be associated with local upwellings of cooler nutrient rich water from the Timor Sea (DEWHA 2008c).

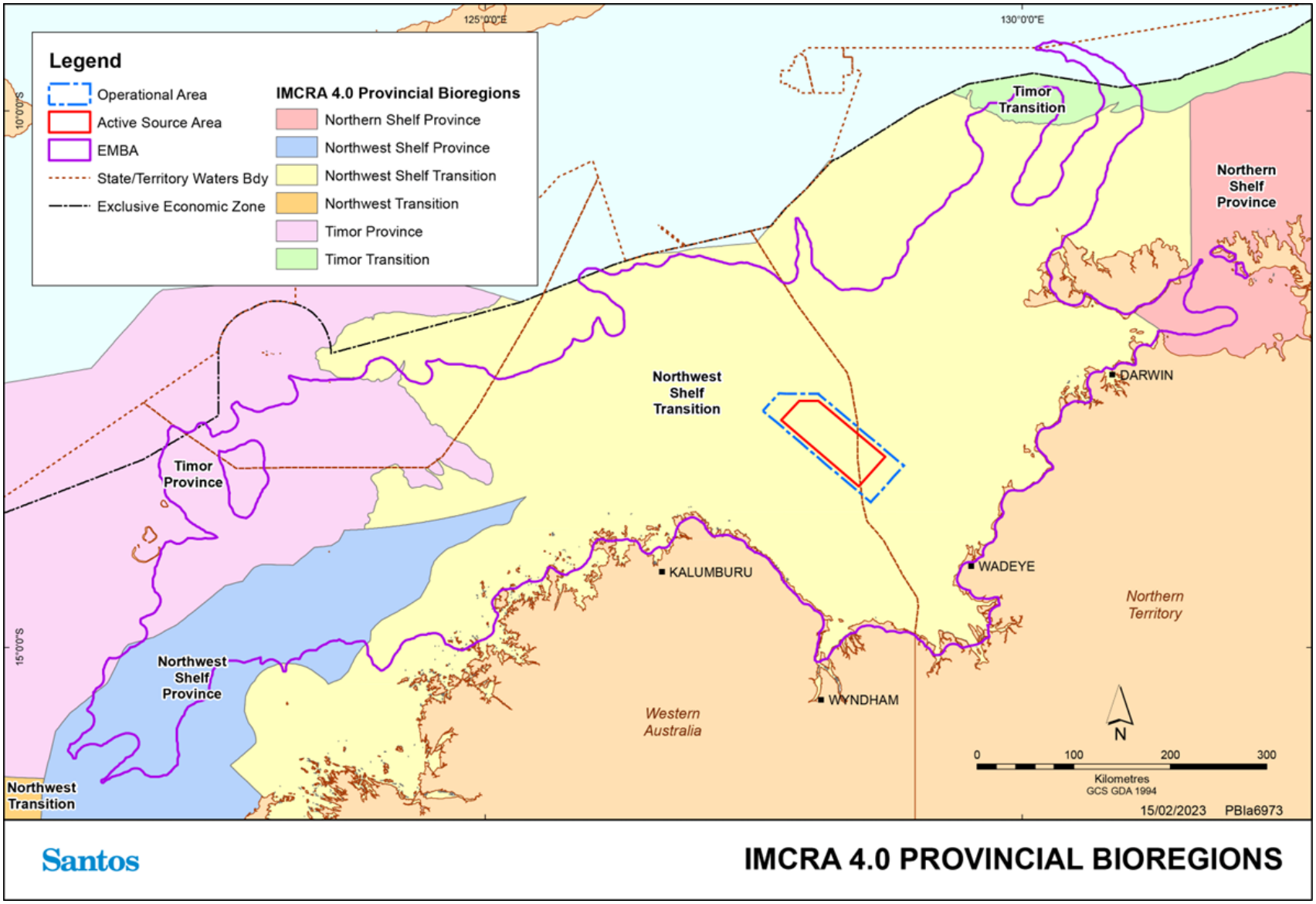


Figure 3-2: IMCRA 4.0 Provincial Bioregions

3.4 Physical environment

3.4.1 Climate

The region has a tropical monsoonal climate with two distinct seasons known as the North-west Monsoon or 'wet season' (late October to mid-March) and the South-east Monsoon or 'dry season' (May to mid-October) (DSEWPaC 2012a). The North-west Monsoon is characterised by regular and high rainfall, particularly over coastal areas and during cyclones. This is due to large amounts of moisture being gathered as the monsoon crosses the sea from the Asian high-pressure belt on its way to the intertropical convergence zone, which migrates southward close to or over northern Australia. Conversely, the South-east Monsoon originates from the Southern Hemisphere high-pressure belt and is relatively dry and cool (DSEWPaC 2012a).

Tropical cyclones are common in the region, occurring between December and April (BoM 2019a). These phenomena result in severe storms with gale force winds and a rapid rise in water levels. Tropical cyclones usually form in an active monsoon trough, producing heavy rains, strong wind, large swells and storm surges. On average, about five cyclones occur each year in the NWMR, two of which make landfall and one of which is severe (Category 3 or higher). The chance of a severe cyclone occurring is highest in March and April (BoM 2019a).

Dum In Mirrie Airstrip, Channel Point, Port Keats Airport and Truscott are four weather stations near to the Operational Area, providing an overview of the localised climate. A summary of the seasonal ranges in mean temperature, rainfall and wind speeds recorded are summarised in Table 3-3.

Table 3-3: Seasonal mean temperature, rainfall and wind speed ranges

Weather station	Approx. distance from Operational Area	Season	Temperature (°C)	Monthly rainfall (mm)	Wind speed (km/h)
Dum In Mirrie Airstrip	205 km east-north-east	Wet	25.4–33.1	128.3–424.2	10.2–15.5
		Dry	18.3–32.3	1.0–60.7	9.5–15.7
Channel Point	170 km east	Wet	24.7–32.3	130.1–459.8	5.4–10.7
		Dry	17.2–32.3	0.1–66.1	5.6–13.0
Port Keats Airport	158 km south-east	Wet	20.2–34.4	80–312.2	No data
		Dry	16.8–34.4	0.7–43.8	No data
Truscott	186 km south-west	Wet	25.2–35.1	28.6–325.0	No data
		Dry	18.5–30.3	0.2–24.5	No data

BoM 2019b, 2019c, 2019d and 2019e. N.B. Wind speed ranges include both 9am and 3pm conditions.

3.4.2 Oceanography

3.4.2.1 Currents

The Operational Area is dominated by surface currents heavily influenced by both tidal motions and the ITF, which transports warm waters from the Pacific Ocean into the Indian Ocean through the Indonesian seas. The strength of the ITF is seasonal; it is weakened during the wet season when the strong south-westerly winds cause intermittent reversals of the currents (Brewer et al. 2007). The strengthening of the ITF in the dry season coincides with the development of the prevailing south-westerly flowing Holloway Current, which transports waters from the Banda and Arafura seas and the Gulf of Carpentaria southwards along the shelf (DEWHA 2008b).

Circulation in the JBG is dominated by the large tidal currents, which rotate in a clockwise direction. Current speeds increase towards the shoreline and become increasingly directed longshore. These large currents are responsible for the generation of dune forms on the seabed, as noted in Admiralty Charts for the region (ENI 2006).

3.4.2.2 Waves

Short period waves within the JBG are generated by local synoptic winds and are typically largest during winter months when the south-easterly trade winds dominate (Maxwell et al. 2004).

Long period waves are influenced by swells generated in the Southern Ocean. In the Bonaparte Basin, the Southern Ocean swell is slightly higher during winter than in summer due to the northerly migration of swell-generating storms. The wave period and significant wave height generated by this swell is highly dependent on the exact location within the basin (e.g. the JBG is protected from the Southern Ocean swell and therefore swells affecting the area are limited to those generated by cyclones or prolonged storm winds [Maxwell et al. 2004]).

The region Is a moderate-energy environment except when influenced by tropical cyclones, which generate short-term major fluctuations in sea levels. Depending on the size, intensity, speed and relative location of the cyclone, swells generated may have periods of 6–18 s and wave heights of 0.5–9 m.

3.4.2.3 Tides

The tides of the region are mixed and predominantly semi-diurnal (two high and two low tides per day), with well-developed spring to neap tidal variation (DSEWPaC 2012a). The oceanographic environment of the JBG features some of the largest tidal ranges, exceeding 8 m along the western side of the Gulf during the spring tide (CSIRO 2005). There is a well-defined spring–neap lunar cycle—spring tides occur two days after the new and full moon.

Within the Northwest Shelf Transition provincial bioregion, tides range from 2–3 m offshore (micro-tidal) rising to 3–4 m inshore (meso-tidal). The tidal range within the Operational Area is expected to be variable, with the highest ranges occurring nearshore in the JBG along the western portion of the Operational Area, and a relatively low range along the eastern portion, following a north-east to south-west contour. The predicted tidal range south-west of the Operational Area at Rocky Island (approximately 111 km away) is expected to be between 0.12 m and 3.32 m (BOM 2019f).

Superimposed on the astronomical tide are ‘meteorological’ tides resulting from changes in atmospheric pressure and strong onshore or offshore winds. Seasonal changes of mean sea level in Darwin are only approximately 0.15 m, while offshore the changes are expected to be considerably less and quite insignificant (approximately 0.05 m) (RPS 2011).

3.4.2.4 Sea temperature and salinity

Sea temperatures and salinity in the region are heavily influenced by the ITF, which transports warm, low salinity water from the western Pacific Ocean through to the Indian Ocean (DSEWPaC 2012a). Although water temperatures in the region are among the highest in Australia and considered high by global standards (DSEWPaC 2012a), during the North-west Monsoon, a thermocline flow of relatively cool water dominates resulting in the tropical Indian Ocean being cooled rather than warmed. Average surface water temperature in the Operational Area ranges from 26.0–30.2 °C (Table 3-4).

Salinity in the Operational Area ranges from 33.4–34.7 psu (Table 3-4). Modelled seawater salinity profiles in the Bonaparte Basin indicated little variation in salinity through the water column, monthly or seasonally (RPS 2011).

Table 3-4: Monthly average sea surface temperature and salinity in the Operational Area

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (°C)	29.6	30.2	29.6	29.9	27.3	27.2	26.2	26.0	27.4	28.8	29.3	29.5
Salinity (psu)	35.1	34.5	35.2	35.3	34.5	34.8	34.6	35.5	35.4	35.1	34.9	34.8

Source: NOAA 2019a, 2019b

Environmental Resources Management Australia Pty Ltd (ERM) undertook two marine baseline studies in 2010 (wet season) and 2011 (dry season) within the Bonaparte Basin (within petroleum titles WA-6-R, NT/RL1, WA-27-R) in support of GDF SUEZ Bonaparte LNG Project (ERM 2011). The studies indicated that temperature gradients throughout the water column did not display a thermocline. Instead, a vertical gradient in seawater temperature was observed in which temperature decreased progressively from the surface to the bottom ranging from 32.1–25.3 °C (ERM 2011).

3.4.2.5 Water quality

The ITF brings in oligotrophic (low in nutrients) waters from the western Pacific Ocean through to the Indian Ocean (DEWHA 2008b). Exceptions in the region occur in the event of local or regional upwelling activity at the shelf break, where deeper, cooler nutrient rich water is brought to the surface (DEWHA 2008b). These upwelling activities include, but are not limited to, internal wave and tide regimes, horizontal shear due to strong tidal currents and tropical cyclones. However, understanding of the nature and spatial distribution of biological productivity in the region is limited (DEWHA 2008b).

The marine baseline studies undertaken by ERM in 2010 and 2011 showed that water quality in the Bonaparte Basin is relatively pristine with results typical of nutrient poor offshore northern Australian waters. The surveys measured dissolved oxygen (DO) concentrations and total suspended solids (TSS). DO concentrations ranged from a minimum of 3.64 mg/L (49.8%) near the seabed to 7.80 mg/L (117.2%) at the sea surface. DO was found to decrease with depth consistently. This is often linked to higher photosynthetic activity at the seawater surface and wave/wind generated mixing. These values are typical of unpolluted seawater (ERM 2011). TSS levels were low across the area during the time of sampling. The data represents relatively low suspended solid values as would be expected for offshore waters in the region (ERM 2011).

3.4.3 Bathymetry and geomorphology

The Operational Area is predominately characterised by a relatively flat and largely featureless seabed, which gradually slopes from south (approximately 60 m deep) to north (approximately 115 m deep). The water depths of the Operational Area and Active Source Area are outlined in Table 3-5.

Table 3-5: Water depths in the Operational Area and Active Source Area

	Water Depth Range (m)	
	Operational Area	Active Source Area
Eos Seismic Survey	60–115	67–111

Seabed morphology in parts of the JBG is influenced by the strong tidal movement and channels of the Ord, Keep, Victoria and Fitzmaurice rivers. A series of extensive sandbars, known as the King Shoals and Medusa Banks (approximately 110 km south of the Operational Area), have been generated by the strong outflows of sediment-laden water from Cambridge Gulf. Similar sandbars can be found in the south-east of the JBG.

Ten key geomorphic features have been identified in the JBG (Przeslawski et al. 2011). The inner gulf comprises mostly 'shelf' with 'sand banks' and 'valleys'. The outer gulf and Timor Sea mostly comprise 'basin' with 'banks/shoals', 'terraces' and 'pinnacles' separated by 'deep/hole/valley' features and escarpment. Four of these features are present in the Operational Area, as detailed below and as shown in Table 3-6 and Figure 3-3.

The majority of the Operational Area and Active Source Area are characterised as relatively featureless 'shelf' and 'basin' geomorphologic features (Figure 3-3). The north-western corner of the Operational Area overlaps a small portion (0.30%) of the Carbonate Bank and Terrace System of the Sahul Shelf KEF (refer to Section 3.6.1). At their shallowest points, these banks rise to approximately 62 m below the sea surface. The Active Source Area does not overlap any KEFs.

There are two pinnacles outside the western boundary of the Operational Area, which rise sharply from seabed of around 69–80 m depth. The pinnacles form part of the Pinnacles of the Bonaparte Basin KEF (refer to Section 3.6.1.1). Some of the banks and pinnacles present in the wider region can rise to within less than 30 m of the sea surface (Brewer et al. 2007; Nichol et al. 2013). An area of shallow banks and shoals to this level occurs near the north-west corner of the Operational Area, around 15 km west of the Active Source Area (Appendix G).

Table 3-6: Geomorphic features relevant to the Operational Area

Geomorphic feature	Operational Area	Active Source Area
Shelf – sediment plains that are swept by strong tidal currents and are subject to large influxes of suspended sediment and freshwater.	✓	✓
Pinnacle – hard substrate in an otherwise soft sediment environment.	-	-
Bank/ Shoals – elevated features with a relatively high proportion of hard substrate that support patches of moderately dense flora and fauna.	✓	-
Basin – low-relief expanses of unconsolidated sediment.	✓	✓

Source: Przeslawski et al. 2011; DSEWPaC 2012a

3.4.4 Sedimentology

The sedimentology of the NWMR is varied due to the diversity of physical features from coral reefs to a number of major canyons that act as conduits for sediment and nutrient transport (DSEWPaC 2012a). Sedimentology in the NMR is also varied, with physical features including shallow canyons, which mainly consist of calcium carbonate, based sediments, as well as limestone pinnacles and reefs (DEWHA 2008b).

The continental shelf in the JBG is the widest in Australia, extending up to 400 km from the shore. The sedimentology of the JBG is unique, with most of the inner shelf being characterised by relatively flat expanses of soft sediment seabed with localised rocky outcrops, gravel deposits and sands banks. The soft sediments in the region typically consist of sandy and muddy substrate, occasionally made up of patches of coarser sediments (Baker et al. 2008). The inner shelf section of the JBG receives significant loads of sediments from several large rivers including the Daly and Victoria rivers (Przeslawski et al. 2011).

The distribution of seabed sediments in the JBG, and in particular within the Sahul Shelf, reflects the present-day oceanographic condition and displays a distinct seaward fining pattern (Lees 1992, in Baker et al. 2008).

Sediment sampling undertaken by ERM in 2010 and 2011 (within WA-6-R and NT/RL1) confirms that the area is mainly dominated by sand, with similar proportions of smaller gravel, silt and clay (ERM 2011).

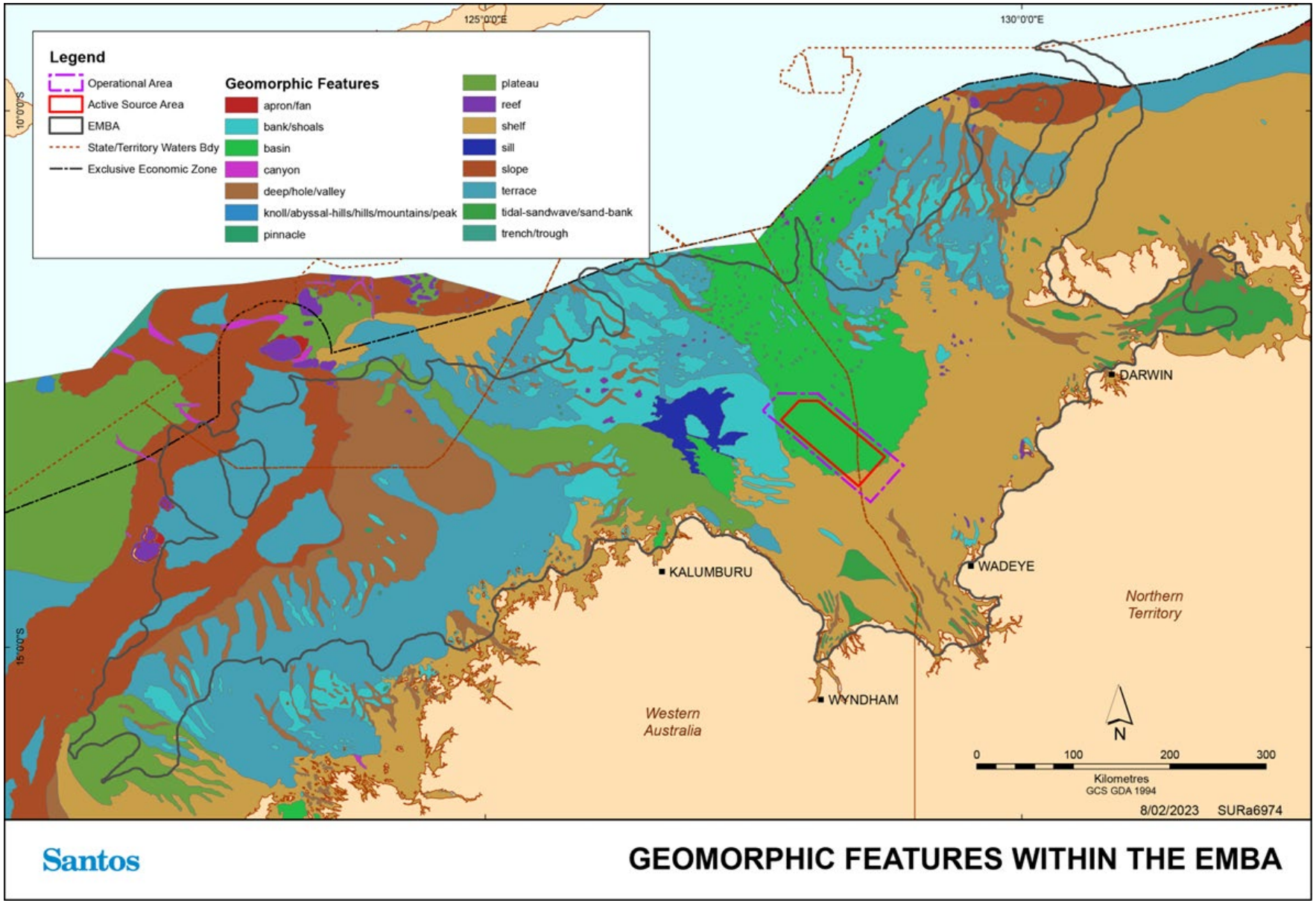


Figure 3-3: Geomorphic features of the EMBA

3.5 Protected / significant areas

3.5.1 Australian Marine Parks

The Australian Marine Park (AMP) Network has been established around Australia as part of the National Representative System of Marine Protected Areas (NRSMPA). The primary goal of the NRSMPA is to establish and effectively manage a comprehensive, adequate and representative system of marine parks to contribute to the long-term conservation of marine ecosystems and protect marine biodiversity.

Under the EPBC Act, the AMP Network, and any zones within it, must be assigned to an International Union for Conservation of Nature (IUCN) Category. Conservation objectives for IUCN categories include:

- Ia: Strict Nature Reserve
- Ib: Wilderness Area
- II: National Park
- III: Natural Monument or Feature
- IV: Habitat/Species Management Area
- V: Protected Landscape
- VI: Protected area with sustainable use of natural resources – allows human use but prohibits large-scale development.

The Operational Area overlaps one AMP and the EMBA overlaps five AMPs (Figure 3-4 and Table 3-7).

Table 3-7: Australian Marine Parks relevant to the EMBA

AMP	IUCN Category Zone	Distance to Operational Area
Oceanic Shoals AMP	Multiple Use Zone (IUCN VI)	Within
	Special Purpose Zone (Trawl) (IUCN VI)	82 km north-east
	Habitat Protection Zone (IUCN IV)	156 km north-east
	National Park Zone (IUCN II)	240 km north-east
JBG AMP	Special Purpose Zone (IUCN VI)	32 km south-east
	Multiple Use Zone (IUCN VI)	51 km south-east
Kimberley AMP	Multiple Use Zone (IUCN VI)	133 km south-west
	National Park Zone (IUCN II)	449 km south-west
Cartier Island AMP	Sanctuary Zone (IUCN Ia)	432 km west-north-west
Ashmore Reef AMP[1]	Sanctuary Zone (IUCN Ia)	474 km west-north-west
	Recreational Use Zone (IUCN IV)	501 km west-north-west

[1] *Ashmore Reef AMP is outside the EMBA, but the PMST Report identifies this AMP 10 km away. Because of its sensitivity and significance to the environment, Ashmore Reef AMP is included in the EMBA for all aspects of this EP that apply to it.*

The Kimberley, Cartier Island and Ashmore Reef AMPs are formally managed under the NWMR management framework, while the Oceanic Shoals and JBG AMPs are formally managed under the NMR management framework (see Section 3.3.1).

Each AMP and their values are summarised below based on the values described in the North-west Marine Parks Network Management Plan (Director of National Parks [DNP] 2018a) and North Marine Parks Network Management Plan (DNP 2018b).

The overarching values of the North-west Marine Parks Network Management Plan and North Marine Parks Network Management Plan are:

- **Natural values** – habitats, species and ecological communities within marine parks, and the processes that support their connectivity, productivity and function.
- **Cultural values** – living and cultural heritage recognising Indigenous beliefs, practices and obligations for country, places of cultural significance and cultural heritage sites.
- **Heritage values** – non-indigenous heritage that has aesthetic, historic, scientific or social significance.

- **Socio-economic values** – the benefit of marine parks for people, businesses, and the economy.

3.5.1.1 Joseph Bonaparte Gulf AMP

The JBG AMP is located approximately 15 km west of Wadeye, NT, and approximately 90 km north of Wyndham, WA, in the JBG. The JBG AMP covers an area of 8,597 km² with water depths from less than 15 m to 100 m. The JBG AMP is designated as IUCN Category VI, with two zones assigned under this category: Special Purpose Zone (VI) and Multiple Use Zone (VI). Commercial activities, such as fishing, tourism, and oil and gas exploration, are permitted within the JBG AMP Multiple Use Zone and Special Purpose Zone.

The JBG AMP is characterised by:

- A number of prominent shallow seafloor features including an emergent reef system, shoals, and sand banks.
- Habitats connecting to and complementing the adjacent WA State North Kimberley Marine Park.
- Ecosystems representative of the Northwest Shelf Transition— a dynamic environment influenced by strong tidal currents, monsoonal winds, cyclones and wind generated waves. The large tidal ranges and wide intertidal zones near the AMP create a physically dynamic and turbid marine environment.
- Biologically Important Areas (BIAs) for foraging and internesting marine turtles and the Australian snubfin dolphin. Further information on BIA and species of conservation interest is provided in Section 3.7.2.
- Sea country within the marine park is valued for Indigenous cultural identity, health and wellbeing.
- Tourism, commercial fishing, mining and recreation (including fishing) are important activities in the AMP.
- The presence of the Carbonate Bank and Terrace System of the Sahul Shelf KEF (refer to Section 3.6.1).

3.5.1.2 Oceanic Shoals AMP

The Oceanic Shoals AMP is located west of the Tiwi Islands, approximately 155 km north-west of Darwin, NT and 305 km north of Wyndham, WA. It extends to the limit of Australia's Exclusive Economic Zone (EEZ). The Oceanic Shoals AMP covers an area of 71,743 km² and water depths from less than 15 m to 500 m, and is the largest marine park in the North Marine Parks Network.

The Oceanic Shoals AMP is characterised by:

- Examples of ecosystems representative of the Northwest Shelf Transition. The pinnacles, carbonate banks and shoals within the AMP are sites of enhanced biological productivity.
- Four KEFs (refer to Section 3.6.1), namely:
  - Carbonate bank and terrace systems of the Van Diemen Rise
  - Carbonate bank and terrace system of the Sahul Shelf
  - Pinnacles of the Bonaparte Basin
  - Shelf break and slope of the Arafura Shelf.
- Foraging and internesting BIA for marine turtles (Section 3.7.2).
- Sea country within the marine park is valued for Indigenous cultural identity, health and wellbeing.
- Several ecologically important shoals, including the Van Cloon Shoal.
- Commercial fishing and mining are important activities in the AMP.

3.5.1.3 Kimberley AMP

The Kimberley AMP is approximately 100 km north of Broome, WA and the central part of the Kimberley AMP is adjacent to the WA Camden Sound State Marine Park. It covers 74,469 km^2, with depths from less than 15 m to 800 m.

The Kimberley AMP is characterised by:

- High numbers of marine mammals such as dolphins, whales and dugong. The humpback whale breeds and calves in the Kimberley AMP annually after undertaking an extensive migration from Antarctica. Three dolphin species (Australian snubfin dolphin, Info-Pacific humpback dolphin and spotted bottlenose dolphin) use the Kimberley AMP to forage within and travel to coastal waters to calve and raise their young in inshore, protected waters.

- Important foraging rounds for seabirds and shorebirds known to breed on Adele Island (outside of the EMBA), including critically endangered eastern curlews and curlew sandpipers.
- Sea country within the AMP is valued for Indigenous cultural identity, health and wellbeing.
- Tourism, commercial fishing, mining, recreation (including fishing) and traditional use are important activities in the AMP.
- There are no KEFs within the Kimberley AMP.

3.5.1.4 Cartier Island AMP

The Cartier Island AMP lies in the Timor Sea within the Australian External Territory (AET) of Ashmore and Cartier Islands, approximately 600 km north of Broome, WA. It covers 172 km², with water depths from less than 15 m to 500 m. The south-flowing Leeuwin Current originates in this region, and transports marine life southwards.

The entire Carter Island AMP is characterised by:

- Important habitat for seasnakes, turtles, whale sharks, corals, sea fans and sponges. This marine park and the nearby Ashmore Reef AMP are marine biodiversity hotspots, supporting a rich diversity of species and high numbers of individuals.
- Sea country within the AMP is valued for Indigenous cultural identity, health and wellbeing.
- Scientific research is an important activity in the AMP.
- Two KEFs, namely:
  - The continental slope demersal fish communities KEF, characterised by high levels of endemic fish
  - The Ashmore Reef and Cartier Island and surrounding Commonwealth waters KEF, characterised by enhanced primarily productivity and aggregations of marine life.

Further information on the KEFs is provided in Section 3.6.1.

3.5.1.5 Ashmore Reef AMP

The Ashmore Reef AMP is in the AET of Ashmore and Cartier Islands, approximately 630 km north of Broome, WA. The Ashmore AMP it is not within the EMBA, however it was included due its sensitivity. It covers 583 km², with depths less than 15 m to 500 m. The Ashmore Reef AMP is comprised of three small islands, lagoons, sand flats, reef flats with a high diversity of hard and soft corals and sponges, and large seagrass meadows. The AMP is a Sanctuary Zone with a small Recreational Use Zone allowing access to the most westerly island (Australian Marine Parks 2021b).

The Ashmore Reef AMP is characterised by:

- The presence of around 100,000 seabirds that come to breed each year, including greater crested terns, white-tailed tropicbirds and greater frigatebirds, and tens of thousands of migratory shorebirds that forage in the surrounding waters, such as curlew sandpipers, bar-tailed godwits and great knots. It is also a breeding site for green turtles.
- Sea country within the AMP is valued for Indigenous cultural identity, health and wellbeing.
- Tourism, recreation and scientific research are important activities in the Marine Park.
- Two KEFs, namely:
  - The continental slope demersal fish communities KEF
  - The Ashmore Reef and Cartier Island and surrounding Commonwealth waters KEF.
- The presence of the Ashmore Reef National Nature Reserve Ramsar site (Australian Marine Parks 2021b).

Further information on KEFs and Ramsar sites is provided in Sections 3.6.1 and 3.5.5 respectively.

3.5.2 State / Territory parks and reserves

A review of WA and NT marine parks and reserves did not identify any current or proposed marine parks or reserves within the Operational Area. However, there are 18 that overlap the EMBA. These were identified through the PMST Report as well as desktop research. The closest State/Territory park is the North Kimberley Marine Park (NKMP), located within the EMBA and in WA waters, approximately 105 km south-west of the Operational Area (DPaW 2016a) (Figure 3-4). Values for parks and reserves within the EMBA are outlined below.

3.5.2.1 North Kimberley Marine Park (WA)

The North Kimberley Marine Park is in the Indian Ocean and Timor Sea, in the waters of WA's Kimberley region. It extends north-east from York Sound, around Cape Londonderry and the JBG, to the WA-NT border, and from the mainland high water mark to the limit of state coastal waters (DPaW 2016b). It covers approximately 18,450 km² and is the largest marine park in WA and the second largest state marine park in Australia (DPaW 2016b).

The marine park surrounds thousands of islands with diverse and rich habitats. Marine turtle nesting sites and breeding sites for seabirds and migratory shorebirds have been identified within the marine park, and fringing reefs line the shores of almost all of the islands (DPaW 2016b). The productive deep waters that surround the islands and open sea reefs provide foraging habitat for marine mammals and pelagic fish, such as mackerel (DPaW 2016b). The complex coastline of the mainland also creates a variety of habitats and communities, including important areas for dugongs, Australian snubfin dolphins and Australian humpback dolphins (DPaW 2016b).

The marine park also contains many places of cultural and spiritual importance to traditional owners (DPaW 2016b).

3.5.2.2 Lesueur Island Nature Reserve (WA)

Lesueur Island Nature Reserve is 107 km south south-west of the Operational Area. The island is located 12 km off the coast, north-north-west of Koolama Bay at the mouth of the King George River (DBCA 2019).

The vegetation of the islands is suitability for nesting Roseate Terns, and management options explored. The island is important for seabird and turtle nesting, and it is considered nationally important as part of the naturally and culturally significant North Kimberley National Biodiversity Hotspot and West Kimberley National Heritage Area. The remoteness of the islands and their fringing reefs helps in protecting the unique and mostly intact ecosystems, but it also poses a challenge for access and undertaking management operations (DBCA 2019).

3.5.2.3 Pelican Island Nature Reserve (WA)

Pelican Island Nature Reserve is 125 km south south-east of the Operational Area. The island is of 19.1 ha, approximately 8 km distant from shore in the Joseph Bonaparte Gulf. It is an important habitat for many birds including the Australian darter, common greenshank, eastern reef egret, rufous night heron, brahminy kite, and sacred kingfisher (CCWA 2010).

3.5.2.4 Channel Point Coastal Reserve (NT)

The Channel Point Coastal Reserve is 133 km east north-east of the Operational Area. The Reserve is located opposite the Peron Islands, between the Daly River mouth and Channel Point. It consists of 250 ha of intact and isolated coastal habitats. Wadjigan and Kiuk people are Aboriginal custodians and spokespeople for this area (NT Government 2023a).

3.5.2.5 Ord River Nature Reserve (WA)

See Ord River Floodplain (Section 3.5.6.1)

3.5.2.6 Keep River National Park Extension (Proposed) (NT)

The Keep River National Park is 148 km south south-east of the Operational Area. The estuary formed at the river mouth is in near pristine condition and it occupies an area of 230 km^2. It is tide dominated environment that has multiple channels and is surrounded by an area of 55.5 km^2 of mangroves (NT Government 2023).

Important wetlands are found in the lower reaches of the river, forming suitable habitat for waterfowl breeding colonies and roosting sites for migratory shorebirds. Large areas of rice-grass floodplain grasslands are also found along the river (NT Government 2023).

3.5.2.7 Niiwalarra Islands National Park (WA)

Niiwalarra Island National Park is 156 km south south-west of the Operational Area. The national park covers an area of 2,770 ha with a large area of consolidated coastal dunes and wetlands diversity, which is uncommon on the Kimberley Islands. The local biota is diverse and reflects the habitat variety, both ecologically and geologically; the island has the third highest documented bird richness of the Kimberley islands, and its beaches serve as nesting areas for marine turtles. The island is subject to a fire regime; however, it has not been subject to regular, extensive fires that have modified and damaged vegetation (DBCA 2019).

The island has high significance regarding aboriginal cultural heritage, including burial sites, which require culturally appropriate management. However, the island has serious management issues such as unregulated access from visitors and boats, biodiversity knowledge gaps, impacts from weeds, and potential incursions of introduced animals (DBCA 2019).

3.5.2.8 Low Rocks Nature Reserve (WA)

Low Rocks Nature Reserve is 232 km west south-west of the Operational Area. It is a 4 ha islet with low scrub and grass and it is part of the Montesquieu Islands in Admiralty Gulf, Kimberley (BirdLife International 2023).

The vegetation on the island is suitability for Roseate Terns nesting, however, Coate et al. (2004) reported that seabirds stopped breeding on Low Rocks in about 2000 and the terns appeared to have relocated to Sterna Island, perhaps because the vegetation on Low Rocks had become too dense for terns to breed (Coate et al. 2004).

3.5.2.9 Casuarina Coastal Reserve (NT)

The Casuarina Coastal Reserve is 236 km east north-east of the Operational Area. The Reserve is an 8 km narrow coastal strip that covers 1,361 ha and protects coastal habitats between Rapid and Buffalo Creeks, including sandy beaches, dramatic cliffs and shady casuarinas. The Reserve is an important site for migratory shorebirds and Flatback turtles that nests annually at the reserve. The Reserve extends past the low water mark and includes tidal flats, estuaries, mangrove communities and seagrass meadows that provides important feeding grounds for dugongs (NT Government 2016). Although fishing is permitted the removal of shellfish at this site is prohibited (NT Government 2016).

3.5.2.10 Buffalo Creek Management Area (NT)

The Buffalo Creek Management Area is 242 km east north-east of the Operational Area. The area is a popular recreational fishing location which includes a boat ramp, picnic area, car park and a stretch of beach that serves as resting and feeding place for many migratory shorebirds. The Buffalo Creek Management Area covers an area of 222 ha and extends to the low water mark (NT Government 2016).

3.5.2.11 Shoal Bay Coastal Reserve (NT)

The Shoal Bay Coastal Reserve is 252 km east north-east of the Operational Area. The Reserve protects a large area of eucalypt woodland and saline wetlands. It consists of extensive sand and mud-flats with much of the bay exposed at low tide. Numerous swamps surround the bay with remnants of a monsoon vine forest. Patches of rainforest are also found around the margins of the tidal area. The tidal flats are a known feeding and roosting area for migratory shorebirds in their non-breeding season. Aggregations of up to 5,000 waterbirds can be found in freshwater areas when the larger areas further south are dry (NT Government 2023b).

The Reserve also protects areas of cultural significance. A number of Aboriginal shell middens are located on one of the upland intrusions into the swamp area (NT Government 2023b).

3.5.2.12 Tree Point Conservation Area (NT)

The Tree Point Conservation Area is 253 km east north-east of the Operational Area. The area protects a coastal strip of Shoal Bay on the Tree Point Peninsula and a large mangrove habitat with a tidal creek, which runs towards the Shoal Bay Coastal Reserve. The Conservation Area is fringed by coastal vine thicket and a swampy floodplain, which hosts a number of bird species at various times of the year (NT Government 2020e).

3.5.2.13 Djukbinj National Park (NT)

Djukbinj National Park, 274 km east-north-east of the Operational Area, offers a great scenic drive through a floodplain network of billabongs, from Scott Creek through to Twin billabong. The abundance of year-round water has ensured the park's importance as a roosting and feeding site for waterbirds, magpie geese, egrets and brolgas. It is a wetland of national significance due to its ecological and cultural values (NT Government 2023c).

The Park is part of the Adelaide River catchment, which is one of several connected catchments that make up the Top End's coastal wetlands. (NT Government 2023c).

3.5.2.14 Garig Gunak Barlu (Cobourg Peninsula) (NT)

See Cobourg Peninsula (Section 3.5.6.2).

3.5.2.15 North Lalang-garram (WA)

The North Lalang-garram Marine Park is 422 km southwest of the Operational Area. The marine park was established in 2016 under the State Government's Kimberley Science and Conservation Strategy and is managed by Dambimangari Traditional Owners and the Department of Parks and Wildlife (DPaW 2016). The marine park falls within the west Kimberley region, included in the Australian National Heritage List for its nationally significant natural, indigenous and historic values (DoEE 2019c).

The North Lalang-garram Marine Park lies between the Lalang-garram / Camden Sound and North Kimberley Marine Parks and covers approximately 110,000 ha (DBA 2019). The area's large tidal range results in extensive

intertidal areas with diverse ecosystems such as fringing coral reefs, mangroves and mudflat communities. Subtidal habitats and communities common to the marine parks include filter feeding communities of sponges and hard and soft corals. These intertidal and subtidal habitats provide critical foraging and nursery areas for dugong, marine turtles, estuarine crocodiles, snubfin and Indo-Pacific humpback dolphins, several species of sawfish and migratory seabirds. The marine park is also a principal calving habitat for humpback whales (DBA 2019).

3.5.2.16 Lalang-garram/Camden Sound (WA)

The Lalang-garram/Camden Sound Marine Park is 450 km southwest of the Operational Area. The marine park was created on 19 June 2012 under Section 13 of the *Conservation and Land Management Act 1984* (CALM 1984). It is a multiple zone marine park that includes; Sanctuary, Special Purpose, and General Use zones (DPaW 2013). The marine park falls within the west Kimberley, which was recently added to the Australian National Heritage List because of its natural, indigenous and historic values to the nation.

The marine park is located about 150 km north of Derby (or 300 km north of Broome) and lies within the traditional country of three Aboriginal native title groups. The Dambimangari people's determination overlies the majority of the marine park. A section of the Wunambal Gaambera people's Uunguu determination includes a small portion of St George Basin, while a small section of the Mayala people's claim (native title not determined at the time of writing of Management Plan) overlies the southwest corner of the marine park (DPaW 2013).

The marine park covers an area of approximately 705,000 ha. It recognises and provides special management arrangements for this area of the Kimberley, which is a principal calving habitat of the humpback whale (*Megaptera novaeangliae*) population that migrates annually along Western Australia's coast. The marine park also conserves a range of species listed as having special conservation status including marine turtles, snubfin and Indo-Pacific humpback dolphins, dugong, saltwater crocodiles, and several species of sawfish. The park also includes a wide range of marine habitats and associated marine life, such as coral reef communities, rocky shoals, and the extensive mangrove forests and marine life of the St George Basin and Prince Regent River (DPaW 2013).

3.5.2.17 Browse Island Nature Reserve (WA)

The Browse Island Nature Reserve is located approximately 461 km west south-west of the Operational Area. Browse Island is small island (17 ha) located 175 km from the Kimberley coastline. It is a circular sandy beach surrounded by a minor fringing reef exposed to strong winds and swell (DBCA 2018). Assemblages at Browse Island are characteristic of coral platform reefs throughout the Indo-West Pacific region, particularly Cartier Island. Coral diversity was greatest on the reef faces and shallow lagoons, but these areas were of very limited extent (URS 2010). Assemblages at Browse Island are characteristic of coral platform reefs throughout the Indo-West Pacific region, particularly Cartier Island. Coral diversity was greatest on the reef faces and shallow lagoons, but these areas were of very limited extent (URS 2010).

3.5.2.18 Scott Reef (WA)

The Scott Reef Nature Reserve is 624 km southwest of the Operational Area. The Scott Reef is a large, emergent shelf atoll located on the edge of the broad continental shelf, about 300 km from mainland north-western Australia. The listing comprises the areas of Scott Reef that are within Commonwealth waters to the 50 m BSL bathymetric contour. This includes North Reef, an annular reef, 16.3 km long and 14.4 km wide and parts of the lagoon of South Reef, a crescent shaped reef 17 km across (DCCEEW 2014a).

Scott Reef is characterised by environmental conditions which are rare for shelf atolls and include clear, deep oceanic water and large tidal ranges. The sand cays of the place are important habitat for migrating animals in the largely landless expanse of the Timor Sea. They are an important staging area for birds, particularly migrants to and from Australia. Of the 25 bird species identified on Scott Reef, 17 are listed on the China-Australia Migratory Bird Agreement or the Japan-Australia Migratory Bird Agreement (DCCEEW 2014a).

The place is regionally significant both because of its high representation of species not found in coastal waters off Western Australia and for the unusual nature of its fauna which has affinities with the oceanic reef habitats of the Indo-West Pacific as well as the reefs of the Indonesian region (DCCEEW 2014a).

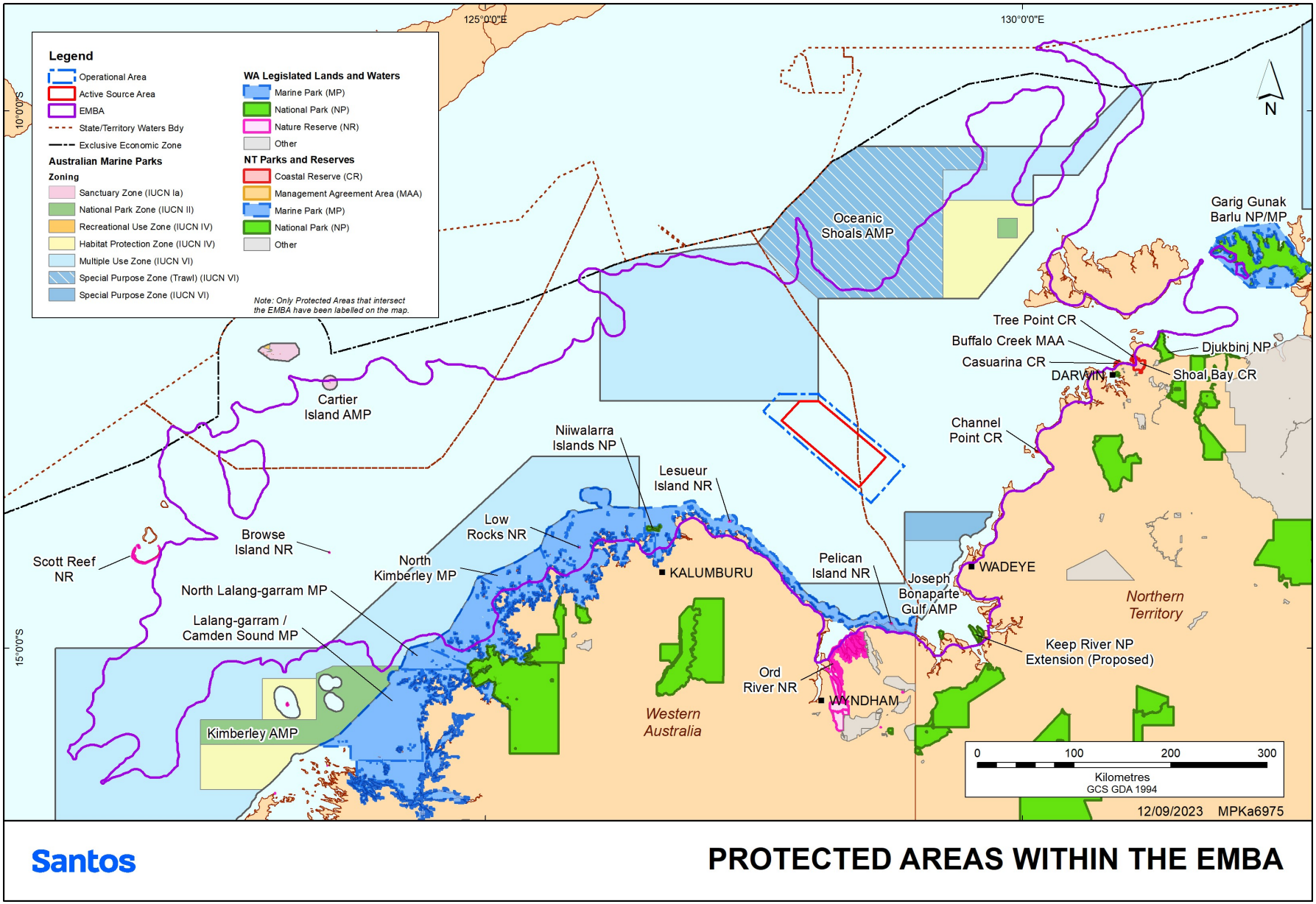


Figure 3-4: Protected areas within the EMBA

3.5.3 Threatened ecological communities

There are no Threatened Ecological Communities within the Operational Area or EMBA.

There are some unique organic mound springs in the Kimberley region that are listed as Priority or Threatened Ecological Communities. Mound springs are associated with permanent groundwater discharge and support distinctive vegetation communities. The primary threat to these features is reduced groundwater discharge, as well as damage by stock and weed infestation. The closest of these to the EMBA is a cluster of mound springs near the Victoria Bonaparte Coast, on the northern edge of Carlton Hill Station; but all are located several kilometres inland and well beyond the extent of the EMBA for this activity (DBCA 2020).

3.5.4 World, Commonwealth and National Heritage Places

World heritage sites are natural or man-made sites, areas, or structures recognized as being of outstanding universal value by the United Nations Educational, Scientific and Cultural Organization (UNESCO). Australia's National Heritage List contains natural, historic, and Indigenous places of significance to the nation, which are protected under the EPBC Act (DoEE n.d.). No listed World or National Heritage places were identified within the Operational Area; however, one national and two Commonwealth heritage places are within the EMBA:

- The West Kimberley national heritage place is located 101 km south-west of the Operational Area
- The Bradshaw Defence Area Commonwealth heritage site is 176 km from the Operational Area
- The Scott Reef and Surrounds Commonwealth heritage site is 637 km west of the Operational Area.
- In addition, the Ashmore Reef National Nature Reserve Commonwealth heritage site is 474 km west north west of the Operational Area and is just outside the EMBA.
- Values for these heritage places are outlined below.
- Several historic heritage places were also listed in the PMST report but are located onshore and not linked to the shoreline. Therefore, they are not relevant to consideration of potential effects from the activity.

3.5.4.1 The West Kimberley

The West Kimberley was included on the National Heritage List in 2011 and has numerous values which contribute to the significance of the property, including indigenous, historic, aesthetic, cultural and natural heritage values (DCCEEW 2014). Of these values, the most relevant to the marine environment is Roebuck Bay as a migratory hub for shorebirds.

The area is characterised by a diversity of landscapes and biological richness found in its cliffs, headlands, sandy beaches, rivers, waterfalls and islands.

3.5.4.2 The Bradshaw Defence Area

The Bradshaw Defence Area is located in the Northern Territory and is bounded by the Fitzmaurice and Victoria Rivers on the shores of the Joseph Bonaparte Gulf and the Bradshaw Defence field training area.

The complex topography of the Bradshaw area results in a broad range of highly distinct environments and habitats that include lowland woodlands, heaths, grasslands, sandstone escarpments, monsoon rainforest patches and wetlands. Compared to surrounding areas, the vegetation within the Bradshaw area is more diverse and incorporates more than one fifth of the vegetation types that occur in the Top End of the Northern Territory and includes grassland, woodland flora that are restricted on a national level (DCCEEW 2014b).

The topological complexity that results in a broad range of environments also contributes to the unusually rich vertebrate fauna. The species richness of frogs, reptiles and mammals is considered significant at a national level. Furthermore, it is also worth noting that the Bradshaw area supports many species that have declined elsewhere in Australia (DCCEEW 2014).

3.5.4.3 Scott Reef and Commonwealth waters

See Scott Reef Nature Reserve (Section 3.5.2.18)

3.5.5 Wetlands of national importance

Wetlands of national importance are wetlands that are a good example in a particular area, an important habitat for native species, or that have outstanding heritage or cultural significance. There are no wetlands of national importance within the Operational Area; however, the EMBA overlaps 10 of these wetland areas. The wetlands of national importance within the EMBA are summarised in Table 3-8. A detailed description of these habitats with

reference to the IMCRA provincial bioregions is provided in *Values and Sensitivities of the Marine and Coastal Environment* (EA00-RI-10062) (Appendix I).

Table 3-8: Wetlands of national importance within the EMBA

Wetland	Distance to the Operational Area
Moyle Floodplain and Hyland Bay System	117 km south-east
Ord Estuary System	135 km south-east
Finniss Floodplain and Fog Bay Systems	141 km north-east
Daly-Reynolds Floodplain-Estuary System	143 km east
Legune Wetlands	175 km south-east
Parry Floodplain	178 km south-west
Port Darwin	213 km north-east
Adelaide River Floodplain System	230 km north-east
Shoal Bay	255 km north-east
Cobourg Peninsula	381 km north-east

From the table above, only two wetlands of national importance are not listed in the Appendix I, namely Legune Wetlands and Parry Floodplain. The description of both wetlands is provided below.

3.5.5.1 Legune Wetlands

Legune Wetlands is located 175 km south-east of the Operational Area. The wetland is located between the mouths of the Victoria and Keep Rivers and 330 km south-west of Darwin in the Joseph Bonaparte Gulf, the Legune Wetlands is the western-most coastal floodplain in the Northern Territory. The floodplain extends across extensive tidal flats to Turtle Point in the north and includes a range of freshwater wetland habitats. Large areas of mangroves are associated with the major rivers and channels. Despite close proximity to major rivers, the catchment area for the floodplain system is relatively small being supplied by Forsyth Creek and other smaller unnamed creeks. This differs from other coastal floodplain systems in the Territory which are directly inundated by the river they are associated with (Chatto 2006).

The Legune wetlands comprise extensive areas of diverse freshwater and saline wetland habitat and are known to support more than 40,000 mixed waterbirds, mostly Wandering Whistling-Ducks and various egrets and herons. At least four waterbird breeding colonies have also been recorded on the floodplain, including the second largest waterbird colony in the Territory. Turtle Point supports high density nesting of the Flatback Turtles and significant aggregations of migratory shorebirds (Chatto 2006).

3.5.5.2 Parry Floodplain

Parry Floodplain is located 178 km south-west of the Operational Area. It comprises the lower reaches and floodplain of Parry Creek including The Grotto, Galileo Precipice, Muggs Lagoon, Palm Spring, 20 Mile Pool, Jogalong Billabong and Flat, Parry Lagoons, Police Hole, Milligan (12 Mile) Lagoons, Marglu Billabong and unnamed billabongs and claypans.

The site has one of the major breeding areas for waterbirds, particularly Magpie Goose (*Anseranas semipalmata*) (the major breeding site in WA) and herons, in the Kimberley; a major migration stop-over area for shorebirds, notably Wood Sandpiper (*Tringa glareola*); and a major drought refuge area for waterbirds, notably Red- kneed Dotterel (*Erythrogonys cinctus*), in the Kimberley. Listed, jointly with Ord Estuary System as a Wetland of International Importance under the Ramsar Convention.

3.5.6 Wetlands of international importance (Ramsar sites)

The Ramsar Convention on Wetlands is an intergovernmental treaty that aims to conserve wetlands of international importance. Ramsar wetlands are recognised as a matter of national environmental significance under the EPBC Act (DCCEEW 2021).

No Ramsar wetlands occur within the Operational Area; however, there are two Ramsar sites present in the EMBA namely the Ord River Floodplain and the Cobourg Peninsula System. The Ashmore Reef Nature Reserve is close to the EMBA (within 10 km of distance) and 474 km west north-west of the Operational Area. Due to its sensibility and environmental importance, the Ashmore Reef Nature Reserve was included in this section, as described below.

3.5.6.1 Ord River Floodplain

The Ord River Floodplain is 133 km south southwest of the Operational Area. The site lies within the Victoria-Bonaparte bioregion and contains a wide range of wetland types and includes all inland and marine components. This Ramsar site comprises of Parry Lagoons, Ord Estuary and the False Mouths of the Ord. Parry Lagoons includes both the permanent waterholes, such as Marglu Billabong, as well as the broader area of the flood plain within the Parry Lagoons Nature Reserve that are subject to periodic inundation. The area from the boundary near Adolphis Island to the Rocks is known as the Ord Estuary. The False Mouths of the Ord is an area of extensive intertidal creeks and flats in the north of the Ramsar site.

The Ord River Floodplain Ramsar site meets seven of the nine Nomination Criteria. The site represents the best example of wetlands associated with the floodplain, and estuary of a tropical river system in the Kimberley Region of Western Australia. Ord River contains extensive and diverse mangrove community containing 14 of the 18 species of mangrove known to occur in Western Australia (Hale 2008).

A number of threatened species including Freshwater Sawfish (*Pristis microdon*), the Green Sawfish (*Pristis zijsron*) and the Australian Painted Snipe (*Rostratula australis*), which are listed as vulnerable under the EPBC Act are supported in this area. The site also provides one of the two known habitats for the nationally endangered Northern River Shark (*Glypis sp. C*). The Ord River Floodplain Ramsar site provides an important nursery, breeding and feeding ground for at least 50 species of fish and a migratory route for 15 diadromous species.

There is sufficient evidence to suggest the site regularly supports 20,000 birds in the site alone, although it should be acknowledged that there are difficulties associated with surveying the Ord River Floodplain. According to the 4th edition of Waterbird Population Estimates, the site regularly supports 1% of the population of Plumed Whistling Duck and Little Curlew (Hale 2008). The Ramsar site is managed under the Ord River and Parry Lagoons Nature Reserves Management Plan (DEC 2012c).

3.5.6.2 Cobourg Peninsula

The Cobourg Peninsula System is 381 km north-east to the Operational Area. Under the Ramsar convention, the Cobourg peninsula site is listed as a Wetland of International Importance. The site is located 163 km north-east of Darwin within the Timor Sea Drainage Division. Within 220,700 ha, the site covers the entire peninsula and several nearby islands including the Sir George Hope Islands, Sandy Island No. I and II, Allaru Island, High Black Rock and Buford Island. Under the *Cobourg Peninsula Aboriginal Land, Sanctuary and Marine Act 1996*, Cobourg peninsula and surrounding waters was declared a Nation Park (Garig Gunak Barlu National Park) BMT WBM (2011).

The Cobourg site is composed of a diverse coastal and inland wetland types. Wetland types present include intertidal forested wetlands and salt flats, seasonal freshwater marshes and permanent freshwater pools. Ramsar topology identifies ten coastal and ten inland types within the site. The site contains unique biodiversity and wildlife including terrestrial, riverine, freshwater, brackish and coastal/marine ecosystems. Identifiable wetland types include intertidal forested wetland and salt flats, seasonal freshwater marshes, and permanent freshwater pools.

Cobourg Peninsula is listed as a Wetland of International importance due to the diversity of coastal and inland wetland types that support population of threatened species, including a number of endangered turtles. The Cobourg site meets five of the current nine nomination criteria of the Ramsar Convention and is therefore recognised as a representative wetland habitat that is at bioregional level, support of populations of threatened species, support for key life-cycle functions such as marine turtle and waterbird breeding, refugia values, and its importance for supporting fish and nursery spawning habitats BMT WBM (2011). The Ramsar site is managed under the Cobourg Marine Park Plan of Management (DNREAS 2011).

3.5.6.3 Ashmore Reef National Nature Reserve

The Ashmore Reef National Nature Reserve is 474 km northwest to the Operational Area and it is not within the EMBA, however was added due to its sensitivity. In addition to being listed as a National Nature Reserve, Ashmore Reef has been designated a Ramsar Wetland of International Importance due to the importance of the islands in providing a resting place for migratory shorebirds and supporting large breeding colonies of seabirds (Hale and Butcher 2013). The reserve provides a staging point for many migratory wading birds from October to November and March to April as part of the migration between Australia and the northern hemisphere (Commonwealth of Australia 2002). Migratory shorebirds use the reserve's islands and sand cays as feeding and resting areas during their migration.

Ashmore is the largest of the atolls in the Timor Province bioregion. The three islands within the site are also the only vegetated islands in the bioregion. Each of the wetland types present are in near natural condition and the site has the largest seagrass coverage in the bioregion. The reserve supports 64 species of internationally and nationally threatened species. This includes 41 species of hard reef forming coral, eight fish, six reptiles (including endangered and critically endangered sea turtles and seasnakes), five sea cucumbers, two giant clams, one soft coral and the dugong.

Ashmore Reef plays a primary role in the maintenance of biodiversity in reef systems in the region. The Reserve supports 275 species of reef building coral, 13 species of sea cucumbers, and high numbers of mollusc species. There are over 760 fish species, 13 species of sea snake, 99 species of decapod crustacean and 47 species of waterbird listed as migratory under international treaties. It supports breeding of 20 species of waterbirds including the brown booby, lesser frigatebird, crested tern, bridled tern, sooty tern and common noddy. The Ramsar site is also important for feeding for green turtles, hawksbill turtle and loggerhead turtle and critical nesting and inter-nesting habitats for green and hawksbill turtles.

Ashmore Reef regularly supports more than 20,000 waterbirds and has been known to support more than 65,000 waterbirds. The Ramsar site regularly supports more than one per cent of at least six species of waterbird including the sooty tern, bar-tailed godwit, grey-tailed tattler, ruddy turnstone, sanderling and greater sand plover. The Ramsar site is managed under the Ashmore Reef National Nature Reserve and Cartier Island Marine Reserve Management Plan (Commonwealth of Australia 2002).

3.6 Biological environment

3.6.1 Key ecological features

KEFs are parts of the marine environment that are important for a marine region's biodiversity or ecosystem function and integrity (DCCEEW 2012). KEFs have been identified by the Australian Government using advice from scientists about the ecological processes and characteristics of the area. There are eight KEFs within the EMBA, as listed in Table 3-9 and described in the following sections. The Operational Area only overlaps one KEF, the Carbonate bank and terrace system of the Sahul Shelf.

Table 3-9: Key ecological features within the EMBA

KEF	Overlap (%)	
	Operational Area	Active Source Area
Pinnacles of the Bonaparte Basin	0	0
Carbonate bank and terrace system of the Sahul Shelf	0.30	0
Carbonate bank and terrace system of the Van Diemen Rise	0	0
Shelf break and slope of the Arafura Shelf	0	0
Ancient Coastline at 125 m Depth Contour	0	0
Continental slope demersal fish communities	0	0
Ashmore Reef and Cartier Island and surrounding Commonwealth waters	0	0
Seringapatam Reef and Commonwealth waters	0	0

3.6.1.1 Pinnacles of the Bonaparte Basin

The limestone pinnacles of the Bonaparte Basin lie on the mid-outer shelf in the western JBG. The pinnacles are defined as a KEF because they are a unique seafloor feature with ecological properties of regional significance.

The pinnacles provide areas of hard substrate in an otherwise soft sediment environment and are therefore important for sessile species. Pinnacles typically rise steeply from depths of about 80 m and emerge to within 30 m of the water surface, allowing light dependent organisms to thrive. Pinnacles that rise to within at least 45 m of the water surface support more biodiversity. Communities include sessile benthic invertebrates including hard and soft corals, sponges, whips, fans, bryozoans and aggregations of demersal fish species such as snappers, emperors and groupers (Brewer et al. 2007; Nichol et al. 2013). The pinnacles are also recognised as a biodiversity hotspot for sponges as they are home to more sponge species and different communities than the surrounding seafloor (NERP MBH 2014).

Surveys undertaken in 2012 suggest the area supports a wide range of high-order pelagic animals with 32 species observed, including 11 shark species, black marlin, barracuda, olive ridley turtle, sea snakes, sawfish, and orcas. Demersal fish communities were found to occur in larger and more diverse populations on the shallower, less turbid banks and pinnacles (Nichol et al. 2013). Marine turtles including flatback, loggerhead and olive ridley are known to forage around the pinnacles (Donovan et al. 2008; Whiting et al. 2007).

The Active Source Area and the Operational Area do not overlap any pinnacle feature. The closest pinnacle to the Operational Area is within 3 km to the west (refer to Figure 3-5).

3.6.1.2 Carbonate bank and terrace system of the Sahul Shelf

The Carbonate Bank and Terrace System of the Sahul Shelf KEF is located in the western JBG and to the north of Cape Bougainville and Cape Londonderry. The carbonate banks and terrace system of the Sahul Shelf is defined as a KEF for its role in enhancing biodiversity and local productivity relative to its surrounds as it is a unique seafloor feature supporting relatively high species diversity, making it regionally significant.

The KEF provides areas of hard substrate in an otherwise soft sediment environment, important for sessile species. Banks rise from depths of approximately 80 m to within 30 m of the surface. Banks that rise to within 45 m water depth support more biodiversity, such as communities of sessile benthic invertebrates including hard and soft corals, sponges, whips, fans and bryozoans (Brewer et al. 2007; Nichol et al. 2013). Brewer et al. (2007) also noted that banks within the KEF support aggregations of demersal fish species such as snappers, emperors and groupers.

The banks are recognised as a biodiversity hotspot for sponges with more species and different communities than the surrounding seafloor (NERP MBH 2014). The KEF is also known as a foraging area for flatback, olive ridley and loggerhead turtles (DSEWPaC 2012a). Common threats to the KEF include changes in sea temperature and ocean acidification, both derived from climate change, as well as extraction of living sources from illegal, unreported and unregulated fishing (Brewer et al. 2007; Nichol et al. 2013).

The Active Source Area does not overlap this KEF, however, the western corner of the Operational Areas overlaps 0.30% of the KEF (refer to Figure 3-5).

3.6.1.3 Carbonate bank and terrace system of Van Diemen Rise

The carbonate bank and terrace system of the Van Diemen Rise KEF is located on the north-eastern side of the JBG and partially overlaps with the north-east of the EMBA (Figure 3-5). The KEF is considered important for its role in enhancing biodiversity and local productivity relative to its surrounds and for supporting relatively high species diversity. The KEF covers an area of 31,278 km^2.

The KEF is characterised by banks, ridges and terraces with relatively high proportions of hard substrate (DAWE 2021a). Channel systems between the banks range from approximately 60–150 m to 10–40 m in depth (Anderson et al. 2011) and supports sponge and octocoral gardens by providing epifauna habitat in an otherwise flat environment (Przeslawski et al. 2011). Whilst reef-forming corals are rare throughout the JBG, some locally dense hard corals were found on the banks of the Van Diemen rise during marine surveys in 2009 and 2010 (Przeslawski et al. 2011).

A study of the sponge diversity and ecology of the Van Diemen Rise identified the region as a sponge biodiversity hotspot (Przeslawski et al. 2014). Sponges were collected with a benthic sled from five geomorphic features (banks, terrace, ridge, plain and valley), resulting in the identification of 283 species. The study found that sponge diversity was generally highest further offshore and on raised geomorphic features, particularly banks. Pelagic fish such as mackerel, red snapper and a distinct gene pool of goldband snapper are found in the Van Diemen Rise (Blaber et al. 2005; Salini et al. 2006). Olive ridley turtles, seasnakes and sharks have also been reported to occur in the area (DAWE 2021a).

3.6.1.4 Shelf Break and Slope of the Arafura Shelf

The Shelf Break and Slope of the Arafura Shelf is an important ecological feature that creates a unique seafloor which enhances biological productivity on the edge of the shelf and attracts feeding aggregations of pelagic marine organisms. The productivity of this area has been recognised as nationally and/or regionally important (Last et al. 2005).

Although the ecosystem processes in this area are largely unknown it is thought that the oceanographic processes associated with the Indonesian Throughflow current and monsoonal winds are strong influence (DEWHA 2007).

The physical characteristics of the Shelf Break and Slope of the Arafura Shelf comprise of continental slope, patch reefs and hard substrate pinnacles (Harris et al. 2005).

Phytoplankton and invertebrates have been sampled at this KEF and the primary production of phytoplankton is thought to be the basis for offshore food webs in the area (DEWHA 2007). Records show approximately 284 demersal fish species in the area (Last et al. 2005) and other marine species that have been recorded include marine turtles, whale sharks and predatory fish species including sharks (DEWHA 2008a).

3.6.1.5 Ancient coastline at 125 m depth contour

The ancient coastline at 125 m depth contour KEF comprises a series of several steps and terraces that form an escarpment along north-west WA centred around the 125 m isobath, although this feature is not continuous.

The KEF is an important divide between carbonate, cemented sands and the fine, less cemented slope materials found offshore. It is valued as a unique seabed feature with ecological properties of regional significance. Hard

substrate areas of the ancient coastline are thought to provide biologically important habitat in an area predominantly made up of soft sediment (DEWHA 2008a).

3.6.1.6 Continental slope demersal fish communities

The continental slope demersal fish communities KEF is considered important due to its high levels of endemism (DEWHA 2008a). The diversity of demersal fish assemblages on the continental slope in the Timor Province, the Northwest Transition and the Northwest Province is high compared to elsewhere along the continental slope (DEWHA 2008a). The KEF supports two distinct demersal community types (biomes) associated with the upper slope (water depth of 225–500 m) and the mid-slope (750–1,000 m) (DAWE 2021a). Although poorly known, demersal-slope communities are thought to rely on bacteria and detritus-based systems comprising infauna and epifauna, which in turn become prey for a range of teleost fish, molluscs and crustaceans (Brewer et al. 2007). Higher-order consumers may include carnivorous fish, deepwater sharks, large squid and toothed whales (Brewer et al. 2007).

3.6.1.7 Ashmore Reef and Cartier Island and surrounding Commonwealth waters

The Ashmore Reef and Cartier Island and surrounding Commonwealth waters KEF is regarded as a biodiversity hotspot which supports a diverse array of pelagic and benthic marine species. The KEF is considered important due to its aggregations of marine life and enhanced primarily productivity in an otherwise low-nutrient environment.

Ashmore Reef and Cartier Island are situated on the shallow upper slope of the Sahul Shelf, north of Scott and Seringapatam reefs. They form part of a series of submerged reef platforms along the outer edge of the continental slope of the NWMR. Localised upwelling and turbulent mixing in the surrounding Commonwealth waters provide nutrients to support the reef structure and ecology (DEWHA 2008b).

Ashmore Reef and Cartier Island and the surrounding Commonwealth waters are regionally important for feeding and breeding aggregations of birds and other marine life, including an unusually high diversity of seasnakes, a genetically distinct breeding population of green turtles and foraging grounds for green, loggerhead and hawksbill turtles (Limpus 2008). The reef system is an important staging post for seabirds and migratory shorebirds and the area is home to some of the most important seabird colonies in the NWMR (Milton 2005). Ashmore Reef supports the highest number of coral species of any reef off the WA coast.

3.6.1.8 Seringapatam Reef and Commonwealth Waters in the Scott Reef Complex

Scott and Seringapatam reefs are part of a series of submerged reef platforms that rise steeply from the sea floor between the 300–700 m contours on the north-west continental slope and lie in the Timor Province (Falkner et al. 2009). Scott Reef consists of two separate reef formations, North Reef and South Reef. The total area of the KEF is approximately 2,418 km². As two of the few offshore reefs in the north-west, they provide an important biophysical environment in the region.

Scott and Seringapatam reefs and the waters surrounding them may attract aggregations of marine life including humpback whales on their northerly migration, Bryde's whales, pygmy blue whales, Antarctic minke whales, dwarf minke whales, minke whales, dwarf sperm whales and spinner dolphins (Jenner et al. 2008). Whale sharks and several species of sea snakes have also been recorded in this area (Donovan et al. 2008). Green and hawksbill turtles nest during the summer months on Sandy Islet on South Scott Reef. These species also internest and forage in the surrounding waters (Guinea 2006). Scott Reef is a particularly biologically diverse system and includes more than 300 species of reef-building corals, approximately 400 mollusc species, 118 crustacean species, 117 echinoderm species and around 720 fish species. Corals and fish at Scott Reef have higher species diversity than the Rowley Shoals (Done et al. 1994).

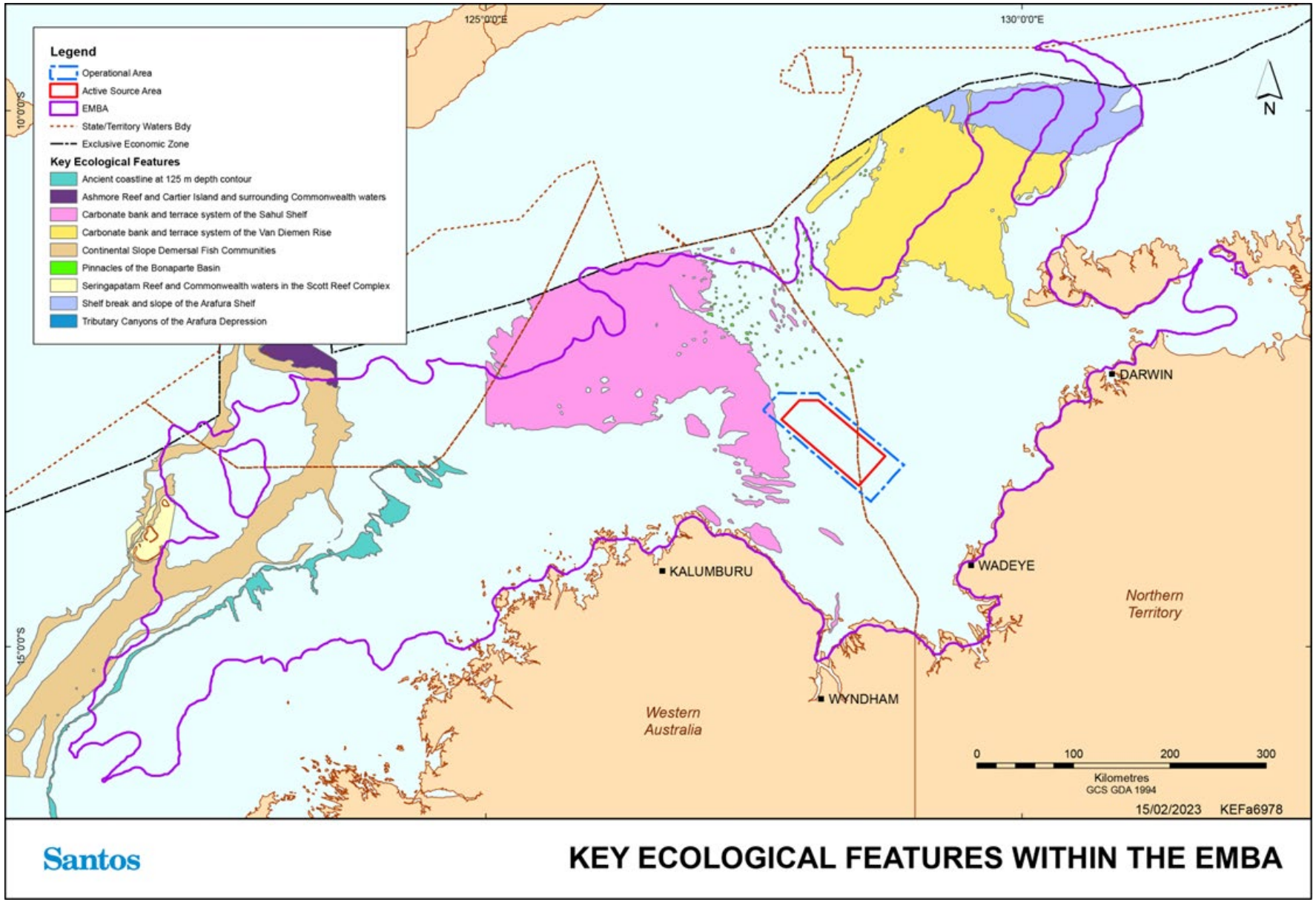


Figure 3-5: Key ecological features within the EMBA

3.6.2 Shoreline habitats

Shoreline habitats are defined as those habitats that are adjacent to the water along the mainland and islands that occur above the LAT, and most often in the intertidal zone. The following section broadly categorises shoreline habitats as the following biological communities that were identified to potentially occur within the EMBA: mangroves and islands. These communities are discussed in Sections 3.6.2.1 to 3.6.2.2.

3.6.2.1 Mangroves

Mangroves commonly occur in sheltered coastal areas in tropical and sub-tropical latitudes (Kathiresan and Bingham 2001). Mangroves are found wherever suitable conditions are present including wave-dominated settings of deltas, beach/dune coasts, limestone barrier islands and ria/archipelago shores (Semeniuk 1993).

Mangroves are important primary producers and have several ecological and economic values, including reducing coastal erosion and providing habitat for a variety of epibenthic, infaunal and meiofaunal invertebrates (Kathiresan and Bingham 2001). Crustaceans known to inhabit the mud in mangrove systems include fiddler crabs, mud crabs, shrimps and barnacles, while water channels of the system support various finfish. Mangroves and their associated invertebrate-rich mudflats are also an important habitat for migratory shorebirds from the northern hemisphere, as well as some avifauna that are restricted to mangroves as their sole habitat (Garnet and Crowley 2000).

There are no mangrove habitats within the Operational Area. However, mangrove habitats are present in coastal waters of the JBG and the Kimberley.

The closest mangroves to the Operational Area are on the NT coast at Port Keats (101 km east-southeast) and Little Moyle Inlet (109 km east southeast). On the WA side of the JBG, there are mangrove areas at Buckle Head Creek (120 km south-southwest) and Thurburn Creek (122 km south-southwest).

3.6.2.2 Islands

No islands or emergent reef systems are located within the Operational Area. However, several islands and emergent reefs are located within the EMBA that provide intertidal and shoreline habitats for a variety of marine fauna and ecological communities. These include very small islands along the JBG Coast such as Pelican Island and Dorchety Island, as well as larger offshore islands such as Browse Island, Cartier Island, the Tiwi Islands and Vernon Islands. The sandy island of Ashmore Reef is located 10 km outside of the EMBA but is included here due to its sensitivity and environmental importance. Information on the larger offshore islands is summarised below.

Browse Island

See Browse Island Nature Reserve (Section 3.5.2.17).

Cartier Island

Cartier Island is located in the West Sahul region of the Indian Ocean, about 300 km off Australia's Kimberley coast and 70 km from Ashmore Reef (Geoscience Australia 2021). The reef flat surrounding Cartier Island rises steeply from the surrounding depths to an un-vegetated sand cay at its centre. These surrounding reefs are high in biodiversity including 547 identified species of fish, which represent about 16% of Australia's fish species (Geoscience Australia 2021), and provide important habitat for seasnakes, turtles, whale sharks, corals, sea fans and sponges (Director of National Parks 2018a). Cartier Island is located approximately 432 km west north-west of the Operational Area.

Tiwi Islands

The Tiwi Islands are located 20 km north of Darwin and include Australia’s second and fifth largest islands – Melville and Bathurst Islands, respectively (Department of Natural Resources, Environment, the Arts and Sport [DNREAS] 2009). The coasts of the Tiwi Islands support important nesting sites for marine turtles, internationally significant seabird rookeries, and some major aggregations of migratory shorebirds (DNREAS 2009). The Tiwi Islands are located approximately 206 km east of the Operational Area.

Vernon Islands

The Vernon islands are located in the Clarence Strait in the NT, between the Australian mainland at Gunn Point and Melville Island's southernmost point, Cape Gambier (Tiwi Land Council 2013). There are three major islands making up the Vernon Islands group: north-west Vernon Island, south-west Vernon Island and east Vernon Island, plus a large reef and numerous lesser reefs and sand islands (Tiwi Land Council 2013). The Vernon Islands are rich in mangrove forests, reef systems, rocky shelves and stacks, and seagrass and algal beds (Tiwi Land Council 2013). The islands are an important coral reef locality, and there is a small number of naturally occurring deep holes (up to 20 m deep) which support coral communities with high species diversity (Tiwi Land Council 2013). The waters surrounding the Vernon Islands support populations of dugong and turtles (Tiwi Land Council 2013). The Vernon Islands are located approximately 269 km east of the Operational Area.

Ashmore Reef

Ashmore Reef is located 840 km west of Darwin and 610 km north of Broome and comprises a shelf-edge reef system of approximately 583 km², rising from the westward limit of the Sahul Shelf (Geoscience Australia 2021). The reef boasts high species and habitat diversity with 14 varieties of seasnake, 433 species of mollusc and 70 fish species identified in the area, along with 255 varieties of coral. The reef flats have a high diversity of hard and soft corals and sponges, and large seagrass meadows. The sand islands at Ashmore Reef also have significant marine turtle nesting areas and migratory bird populations, while dugong, various cetaceans and whale sharks are sighted regularly around the reef (Geoscience Australia 2021). Ashmore Reef is located approximately 501 km north-west of the Operational Area.

3.6.2.3 Benthic habitats and communities

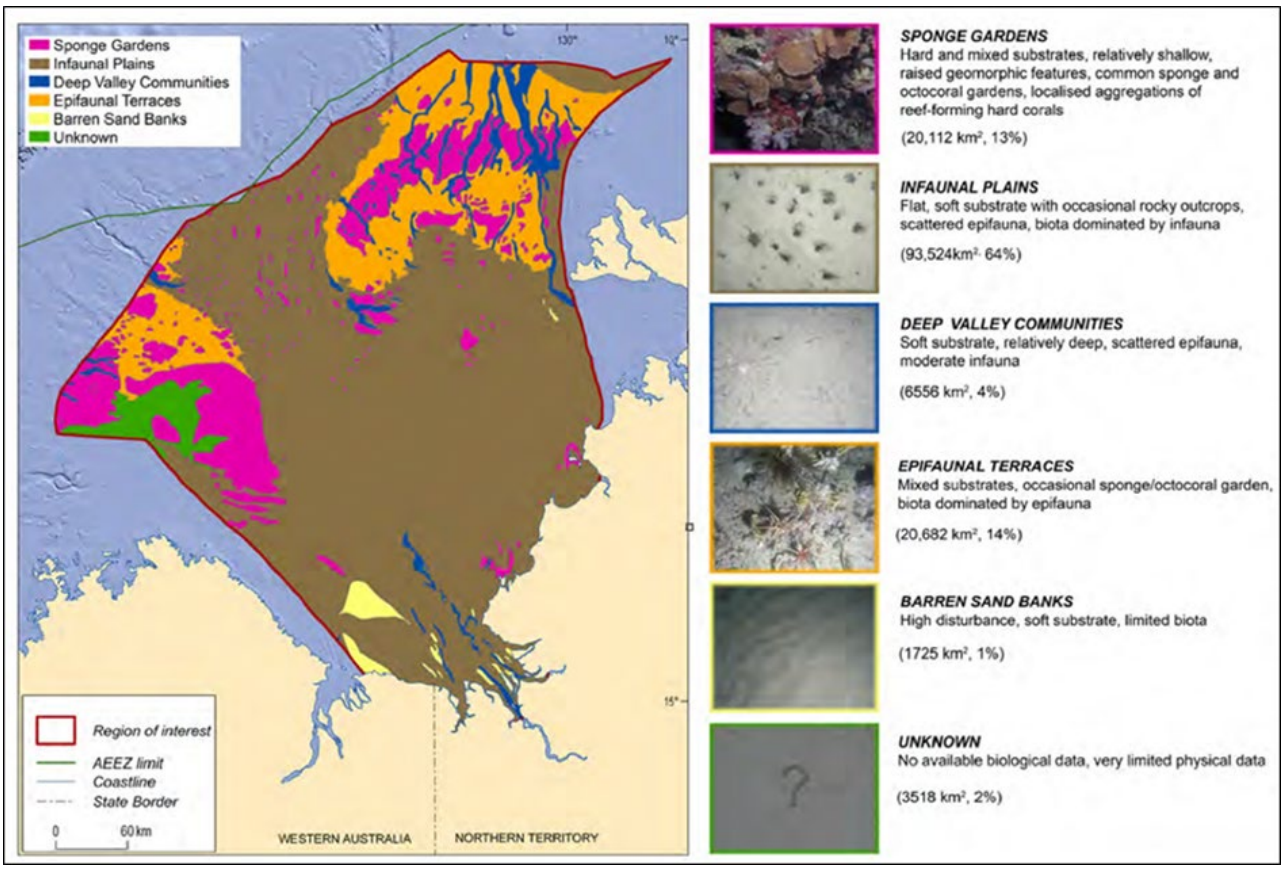
Benthic habitats are defined as those subtidal habitats lying below the lowest astronomical tide (LAT). Benthic habitats are partially driven by light availability. Primary producers (photosynthetic corals, seagrasses and macroalgae) are limited to the photic zone, whereas benthic invertebrates including filter-feeding communities may be found in deeper waters. The distribution of benthic fauna depends on water depth, the substrate and sediment characteristics, the nature of the substrate and available food. The soft sediment habitats that cover the majority of the Operational Area are only sparsely covered by sessile filter-feeding organisms (e.g. gorgonians, sponges, ascidians and bryozoans) and mobile invertebrates (e.g. echinoderms, prawns and detritus-feeding crabs) (Brewer et al. 2007; DSEWPaC 2012a). Previous surveys in the JBG have not recorded seagrass or macroalgae beyond coastal habitats (Brewer et al. 2007).

The benthic habitats and communities associated with the various geomorphic features identified by Przeslawski et al. (2011) and Brewer et al. (2007) are outlined below:

- Shelf – sediment plains that are swept by strong tidal currents and are subject to large influxes of suspended sediment and freshwater, particularly during the wet season. Support diverse infaunal communities that play a key ecological role by contributing to nutrient cycling and sediment turnover (bioturbation) at the local scale. Low abundance of crustaceans, echinoderms and sessile epifauna.
- Banks/shoals – elevated features with a relatively high proportion of hard substrate that support patches of moderately dense octocorals and sponges which in turn provide habitat for other epifauna and cryptofauna. Banks support high numbers of epifaunal species. Infaunal species richness is moderately high in bank sediments. Very few macroalgae (including Halimeda) or reef-forming hard corals have been recorded.
- Basin – low-relief expanses of unconsolidated sediment, where available biological data suggests habitats are dominated by infauna with limited epifauna.
- Pinnacles – hard substrate in an otherwise soft sediment environment. They can be important for sessile benthic invertebrates including hard and soft corals, sponges, whips, fans, bryozoans.

As evident in Figure 3-6, the dominant habitat type across most of the Operational Area is infaunal plains, which are characterised by flat, soft substrates with occasional rocky outcrops, scattered epifauna and biota dominated infauna (Przeslawski et al. 2011). This habitat type is dominant across all shelf and basin features. Sponges and octocorals are predominately located along the western portion of the Operational Area (associated with the Carbonate Banks and Terrace System of the Sahul Shelf KEF).

Infaunal studies conducted within the Blacktip Project area (21 km south from the Operational Area) found infauna to be diverse and abundant, with two major phyla, Arthropoda (crustaceans) and Annelida (polychaete worms) contributing over 80% of the total number of individuals (Woodside 2004). Arthropoda species recorded include tanaids (shrimps), brachyurans (crabs) and grammarid amphipods. Annelida were diverse comprising of 36 families, with the most abundant families being Terebellidae, Spionidae, Onphidae, Maldanidae and Ampharetidae. Members of these families are mainly tube-dwelling worms that feed on detrital material on the surface or in the surface sediments.



Source: Przeslawski et al. 2011

Figure 3-6: Distribution of habitats and biological communities in the JBG

3.6.3 Coral reefs

Corals are both primary producers and filter feeders and thus play a role in the provision of food to marine fauna and in nutrient recycling to support ecosystem functioning (CALM and MPRA 2005a). Coral reefs in the area fall into two general groups: the fringing reefs around coastal islands and the mainland shore; and large platform reefs, banks and shelf-edge atolls offshore (Woodside 2011c). The distribution of corals in an area is governed by the availability of hard substrate for attachment and light availability.

Within the EMBA, offshore coral reefs are found at Shepparton Shoal, Marie Shoal, Goodrich Bank, Tassie Shoal, Blackwood Shoal, Evans Shoal, Cartier Island, Browse Island and Hibernia Reef, Islands, with many other islands in coastal waters supporting fringing coral reefs. No coral reefs are located within or adjacent to the Operational Area.

3.6.4 Seagrasses and macroalgae

Seagrass and macroalgae are important contributors to primary production and nutrient cycling in the region, providing food and habitat for vertebrate and invertebrate fauna. Macroalgae generally require adequate light and a hard substrate, and therefore they largely occur in intertidal and shallow waters less than 5 m deep. Macroalgae exhibit very high seasonal and interannual variation in biomass (Heyward et al. 2006) and distribution, abundance and biodiversity (Rio Tinto 2009, BHPBIO 2011).

Seagrass predominantly occur in sheltered, shallow coastal waters, although they can occur in deeper waters at 30-40 m. A survey of intertidal seagrasses carried out by the WA Museum did not record any seagrasses in the JBG (Walker et al. 1996). The Operational Area is located entirely in water depths greater than those in which macroalgae and seagrass beds typically occur. However, seagrass habitats are reported to be present in the EMBA, including at Ashmore Reef and at the Vernon Islands and Tiwi Islands at the most north-easterly limit of the EMBA.

3.6.5 Crustaceans

In a study of prawn trawl bycatch in the JBG, which included sampling locations within the Operational Area, Tonks et al. (2008) found that four crustacean species dominated the invertebrate component of the bycatch: *Charybdis callianassa* (*Portunidae*); *Trachypenaeus gonospinifer* (*Penaeidae*); *Metapenaeopsis novaeguineae* (*Penaeidae*); and *Solenocera australiana* (*Solenoceridae*).

The dominant prawn species of the JBG are the penaeid species, namely tiger prawn (*Penaeus esculentus*), banana prawn (*P. merguiensis*) and red-legged banana prawn (*P. indicus*). These species can be found from coastal waters to depths of approximately 200 m, and are widely distributed through subtropical and tropical waters, from WA to NSW (Jones and Morgan 1994). Shallower inshore waters such as river and tidal creek systems of the JBG act as nursery grounds for juveniles. Small numbers of prawns can also be found in mangrove habitats. More is known about the distribution and abundance of prawns in the JBG compared to other crustaceans because a number of species are commercially harvested.

As detailed in Section 3.8.1, prawns are commercially targeted in areas of the JBG, mainly in the west of the gulf and in Fog Bay, near Darwin (NT). The juvenile prawns that migrate offshore to the fishery come from mangrove nursery habitats from the Victoria River in the east of the Gulf, to the Ord River and Cambridge Gulf in the west, forming a very extensive migration throughout the lower region of the JBG. Migration of juveniles is thought to be triggered by rainfall and river discharge.

There are occasional reports of very large catches of the cornflake or swimming crab (*Charybdis callianassa*) as bycatch of the Northern Prawn Fishery (NPF), which are believed to be because of spawning aggregations of this species (Brewer et al. 2007).

3.6.6 Molluscs

The JBG has relatively low mollusc species diversity due to the restricted number of habitats available and silty conditions, with less than 100 species (mainly bivalves) recorded in the region (Walker et al. 1996). There is some recreational fishing of rock oysters, and squid are a large bycatch of the NPF. Many different types of molluscs are found in the mangroves including clams (Walker et al. 1996). The soft sediment infaunal plains habitat that dominates the Operational Area (Przeslawski et al. 2011) does not provide extensive hard substrate for bivalve molluscs or other fixed invertebrates to attach.

The Pearl Oyster Managed Fishery (POMF) management area extends to the WA-NT border, including the JBG. However, the JBG is not an area of commercial interest to the fishery. Based on 2009–2019 FishCube data, no fishing for pearl oysters (*Pinctada maxima*) has occurred in the JBG. Irregular fishing for pearl oysters by the NT pearl oyster fishery has also occurred in the JBG since 1994. Within the EMBA, the closest location where fishing for pearl oysters has occurred is at Holothuria Reefs, located 225 km west of the Operational Area. Pearl oyster fishing grounds, holding sites and farm leases are primarily located outside of the EMBA, on the north Kimberley coast, near Broome and Eighty Mile Beach. Pearl oysters are primarily located in shallow sub-tidal waters but can occur to depths in excess of 50 m (Hart et al. 2016). However, studies by Santos (RPS 2019) and AIMS (Miller 2017) of the main pearl oyster fishing grounds near Eighty Mile Beach have found very low abundances of pearl oysters in water depths greater than 40 m. Hart et al. (2016) note that the soft bottom shelf habitats of the JBG are likely to support mobile invertebrate communities, but limited filter feeder habitat associated with pearl oysters. The shallower coastal turbid zone, although poorly understood, may support more suitable habitat for filter-feeders and bivalves (Hart et al. 2016). Given that the Operational Area is in water depths greater than 49 m, limited suitable habitat on the shelf in the JBG, and the absence of commercial pearl oyster fishing activities, significant numbers of pearl oysters are unlikely to be present in the Operational Area.

3.6.7 Plankton communities

Plankton consists of microscopic organisms typically divided into phytoplankton (algae) and zooplankton (fauna including larvae). Plankton play a major role in the trophic system with phytoplankton being a primary producer and zooplankton a primary consumer. Phytoplankton rapidly multiply in response to bursts of nutrient availability and are subsequently consumed by zooplankton that in turn are consumed by other fauna species.

Nutrients and planktonic organisms (including many species of larval recruits) are transported to and from the JBG by the southerly movement of the ITF and the south-east and north-west monsoonal wind driven currents. The primary driver of planktonic primary productivity in the region is from seasonal influences (Brewer et al. 2007).

3.6.7.1 Phytoplankton

In the tropical northern regions of Australia, higher phytoplankton concentrations (as indicated by surface chlorophyll concentrations) generally occur during the winter months (June to August) and are lower in summer (December to February) (Brewer et al. 2007).

Phytoplankton assemblages recorded by ERM in 2010 and 2011 in the JBG were typically characteristic of offshore tropical waters. Phytoplankton assemblages were mainly dominated by cyanobacteria during the 2010 wet season survey, which comprised 99.7% of identified algal cells. During the 2011 dry season survey, diatoms (Bacillariophyceae) dominated the phytoplankton assemblage. Overall, phytoplankton densities were typical of offshore oceanic waters and indicative of a classically oligotrophic (low nutrient) system as is the case across offshore WA and the Timor Sea, which feeds the Leeuwin Circulation in the NWMR (ERM 2011).

3.6.7.2 Larval fish and zooplankton

Sampling undertaken by ERM (2011) indicated that larval fishes in the JBG were found to be dominated by *Serranidae* (cods) and *Lutjanidae* (snappers), both of which are commercially targeted species in the region. Larval fish density varied seasonally with the 2011 dry season recording highest densities of larval fishes in the zooplankton. This seasonal effect is consistent with the notion of an extended spawning season (and possibly planktonic larval duration) of the species dominating the larval fish assemblage in the area (ERM 2011).

Zooplankton sampling indicated that copepods represented the most dominant group within the macro-zooplankton assemblage in both the 2010 wet season and 2011 dry season. The density of these macro-zooplankton varied significantly among seasons, with an overall greater density of these animals recorded during the 2010 wet season. The greater density of macro-zooplankton may be indicative of higher primary productivity in the summer months fuelling population increases of the zooplankton (secondary productivity) at this time.

Overall zooplankton density varied at the level of the assemblage with statistically distinct assemblages found within both the 2010 wet season and 2011 dry season.

3.6.8 Fish assemblages

Demersal bycatch records from the Northern Prawn Fishery (NPF) in the JBG indicate that the area's demersal communities have a relatively high biomass and further suggest that the JBG is an area of high species diversity.

The species group report card – bony fishes (DEWHA 2008b), which supplements and supports the NWMR and NMR bioregional plans, states that almost all syngnathids (pipefish, seahorses and pipehorses) live in nearshore and inner shelf habitats, usually in shallow, coastal waters, among seagrasses, mangroves, coral reefs, macroalgae dominated reefs, and sand or rubble habitats. Temperate water species predominately inhabit seagrasses and macroalgae, while tropical species are primarily found among coral reefs.

A review of information on habitat preference and water depth range has been conducted for 35 syngnathid species identified in the PMST Report (Table 3-10). The water depths of the Operational Area range from 60–115 m. Only ten of the syngnathid species have been recorded in water depths greater than 40 m. Therefore, syngnathids are not expected to occur across the flat, soft substrates and deeper waters that predominate throughout the Operational Area. These species are more likely to be associated with low reef habitats found in shallower coastal waters of the JBG.

Seahorses and pipefishes have been recorded as bycatch in the region from trawl operations of the NPF (DEWHA 2008b); however, no pipefish, seahorse or pipehorse species were identified in a study of species composition of prawn trawl bycatch undertaken within and surrounding the Operational Area (Tonks et al. 2008).

A marine baseline survey undertaken by ERM (2011) recorded a total of 22 genera representing 17 families of fish. The most common families by density were Terapontidae (grunters), Nemipteridae (threadfin breams), and Lutjanidae (snappers). Terapontidae and Nemipteridae are small scavenging opportunists that are often caught as bycatch in demersal trawl and trap fisheries in the NMR. The lutjanids are larger predatory fishes targeted by commercial and recreational fishers in tropical Australia. These species assemblages are known to occur in coastal waters to depths of approximately 200 m, and are widely distributed through subtropical and tropical waters from WA (ERM 2011).

Tonks et al. (2008) identified 112 teleost fish species from 61 families from 53 NPF commercial trawls over two years. The species with the highest mean catch rates were glassy bombay duck (*Harpadon translucens*), threadfin scat (*Rhinoprenes pentanemus*), largehead hairtail (*Trichiurus lepturus*), blackfin threadfin (*Polydactylus nigripinnis*) and smooth croaker (*Johnius laevis)*.

As described in Section 3.6.2.3, the Operational Area predominantly overlaps with the 'infaunal plains' habitat type (Przelawski et al. 2011). The Operational Area also overlaps with the 'sponge gardens' habitat type, a benthic habitat characterised by hard and mixed substrates, relatively shallow water depths, raised geomorphic features, common sponge and octocoral gardens and localised aggregations of reef-forming hard corals.

Therefore, it is unlikely that habitats within the Operational Area support significant assemblages of site-attached fishes given the shallowest parts of the bank and pinnacle features in the Operational Area are at water depths equal to or greater than 60 m. At these water depths, given reduced light availability, occurrences of hard corals and other benthos that may support significant site-attached fish assemblages are expected to be limited.

Table 3-10: Summary of habitat preference and depth range for syngnathid species that may occur within the EMBA

Assemblage	Species	Occurrence within areas		Habitat	Depth range (m)
		Operational Area	EMBA		
Low reef	Corrugated pipefish, Barbed *Bhanotia fasciolata*	Species or species habitat may occur	Species or species habitat may occur	Demersal individuals are most common in reef and tidepool habitats. This species lives openly on muddy or silty substrates in depths of 3–25 m	3–25
Low reef	Three-keel pipefish *Campichthys tricarinatus*	Species or species habitat may occur	Species or species habitat may occur	Sand, coral rubble, algae (including *Sargassum*), isolated coral knolls, soft corals, small sponges, low coral outcrops, sheltered reef and rocky islets	3–11
Low reef/ bedrock/terraces	Pacific Short-bodied pipefish, Short-bodied pipefish *Choeroichthys brachysoma*	Species or species habitat may occur	Species or species habitat may occur	Commonly occurs in seagrass, reef and coral habitats in depths of less than 5 m. They also can be found in coral and shell rubble, coral rock, beach rock, sandstone terraces, isolated rock pools, caves, lagoons, mud, sand, and silt	0–24
Low reef	Pig-snouted pipefish *Choeroichthys suillus*	Species or species habitat may occur	Species or species habitat may occur	Occurs in inshore reef habitats or in association with coral knolls, live corals, coral rubble, shell rubble, coral rock, ledges, sand, seagrass and algae	1–14
Low reef	Fijian Banded pipefish, Brown-banded pipefish *Corythoichthys amplexus*	Species or species habitat may occur	Species or species habitat may occur	This species prefers protected coral habitats, also found in shallow reefs as well as deep walls, with algae and is known from clear coastal to outer reef crests	0–31
Low reef	Reticulate pipefish, Yellow-banded pipefish, Network pipefish *Corythoichthys flavofasciatus*	Species or species habitat may occur	Species or species habitat may occur	Association with fringing coral reefs, coral reef crests, reef flats, live corals (including *Acropora*), gorgonians, limestone rock platforms, soft corals, dead corals, algae, encrusting organisms, rubble, rocky shores, gutters, drop-offs, bomboras, pools, caves and sand.	0–30
Low reef	Australian Messmate pipefish, Banded pipefish *Corythoichthys intestinalis*	Species or species habitat may occur	Species or species habitat may occur	Sand, coral or 'grass' bottoms. They occur on sheltered coastal reefs, often in silty habitat among algae as well as on coral slopes, reef flats, reef edges, bomboras, live corals (including *Acropora*), soft corals, dead corals, rocky shore, mangroves, seagrass, sand rubble, rock rubble, caves, lagoons, mud, sand and silt.	0–10
Low reef	Schultz's pipefish *Corythoichthys schultzi*	Species or species habitat may occur	Species or species habitat may occur	Common on rubble and in corals. It also occurs on sand and among reef on crests and slopes in protected habitats	0–30
Low reef	Roughridge pipefish *Cosmocampus banneri*	Species or species habitat may occur	Species or species habitat may occur	Coral reefs (including outer reefs), ledges, lagoons, live corals, rock, sponges, sand and rubble	6–30
Low reef	Banded pipefish, Ringed pipefish *Doryrhamphus dactyliophorus*	Species or species habitat may occur	Species or species habitat may occur	Free-swimming fishes that are usually found at the front of caves or reef overhangs. This species inhabits protected coastal reefs, in large caves or among boulders with long-spined urchins	10–25

Assemblage	Species	Occurrence within areas		Habitat	Depth range (m)
		Operational Area	EMBA		
Low reef	Bluestripe pipefish, Indian blue-stripe pipefish, Pacific blue-stripe pipefish *Doryrhamphus excisus*	Species or species habitat may occur	Species or species habitat may occur	Free-swimming benthic fishes found in various reef habitats in coastal to outer reefs, and usually stay close to small caves or narrow crevices into which they retreat when threatened	0–49
Low reef	Cleaner pipefish, Janss' pipefish *Doryrhamphus janssi*	Species or species habitat may occur	Species or species habitat may occur	Found in various reef habitats in coastal to outer reefs, and usually stay close to small caves or narrow crevices	5–30
Low Reef	Tiger pipefish *Filicampus tigris*	Species or species habitat may occur	Species or species habitat may occur	Usually seen in estuaries on rubbly, sandy or weedy bottoms	2–30
Low Reef	Brock's pipefish *Halicampus brocki*	Species or species habitat may occur	Species or species habitat may occur	Occurs on coral and rocky reefs with algae. Inhabits patches of coral and macro-algae on coastal reefs	3–45
Low Reef	Red-hair pipefish, Duncker's pipefish *Halicampus dunckeri*	Species or species habitat may occur	Species or species habitat may occur	A reef associated species usually found on sandy and algal-rubble habitats	1–25
Deep	Mud pipefish, Gray's pipefish *Halicampus grayi*	Species or species habitat may occur	Species or species habitat may occur	Inhabits silty and muddy soft bottoms on the continental shelf from inshore bays to deep offshore areas to 100 m	0–100
Low Reef	Spiny-snout pipefish *Halicampus spinirostris*	Species or species habitat may occur	Species or species habitat may occur	Inhabits shallow coral rubble areas in lagoons and intertidal zones of inshore coral reefs	5–10
Low Reef	Ribboned pipehorse, Ribboned seadragon *Haliichthys taeniophorus*	Species or species habitat may occur	Species or species habitat may occur	Inhabits a variety of inshore shallow water areas including weedy regions bordering open substrates, coral reefs, rocky, gravel, sandy and muddy substrates; also associated with sponges, algae, hydroids, shells and seagrass	0–18
Shallow	Beady pipefish, Steep-nosed pipefish *Hippichthys penicillus*	Species or species habitat may occur	Species or species habitat may occur	Found in lower reaches of streams and rivers, seagrass beds in estuaries and other shallow inshore habitats	0–5
Deep	Spiny seahorse, Thorny seahorse *Hippocampus histrix*	Species or species habitat may occur	Species or species habitat may occur	Inhabits areas with both hard and soft bottoms, often attached to soft corals or sponges at 10-95 m, usually 15-40 m. Also found on shallower algae-rubble or rocky reef areas	5–95
Low Reef	Spotted seahorse, Yellow seahorse *Hippocampus kuda*	Species or species habitat may occur	Species or species habitat may occur	Inhabits coastal bays, harbours and lagoons, sandy sediments in rocky littoral zones, macroalgae and seagrass beds, mangroves, muddy bottoms, and shallow reef flats.	0–55
Low Reef	Flat-face seahorse *Hippocampus planifrons*	Species or species habitat may occur	Species or species habitat may occur	Inhabits algal and rubble reefs in shallow bays from the intertidal to about 20 m depth.	0–20

Assemblage	Species	Occurrence within areas		Habitat	Depth range (m)
		Operational Area	EMBA		
Deep	Hedgehog seahorse *Hippocampus spinosissimus*	Species or species habitat may occur	Species or species habitat may occur	Benthic in inner reef waters on rubble substrates and in sponge and seagrass habitats near coral reefs; often attached to corals in deep current-prone channels between reefs or islands	20–70
Low Reef	Tidepool pipefish *Micrognathus micronotopterus*	Species or species habitat may occur	Species or species habitat may occur	Usually inhabits shallow inshore reefs and tidepools, amongst sparse seagrasses and algae-rubble, in depths from 1–5 m, although individuals have been collected from depths to 10 m	1–10
Deep	Pallid pipehorse, Hardwick's pipehorse *Solegnathus hardwickii*	Species or species habitat may occur	Species or species habitat may occur	Mostly known from trawled specimens captured from 12–100 m depth, though it has been collected in depths of up to 180 m	12–180
Deep/ shelf	Gunther's pipehorse, Indonesian pipefish *Solegnathus lettiensis*	Species or species habitat may occur	Species or species habitat may occur	Benthic inhabitant of outer continental shelf waters and has been captured from depths of 42–180 m. Trawl bycatch records in 150–180 m water depths in Australia	42–180
Low Reef	Robust ghost pipefish, Blue-finned ghost pipefish *Solenostomus cyanopterus*	Species or species habitat may occur	Species or species habitat may occur	Reef associated	0–10
Low Reef	Double-end pipehorse, Double-ended pipehorse, Alligator Pipefish *Syngnathoides biaculeatus*	Species or species habitat may occur	Species or species habitat may occur	Inhabits shallow, protected waters of bays, lagoons and estuaries including mangrove areas, in association with seagrass beds and macroalgae	0–10
Low Reef	Bentstick pipefish, Bend Stick pipefish, Short-tailed pipefish *Trachyrhamphus bicoarctatus*	Species or species habitat may occur	Species or species habitat may occur	Inhabits sheltered coastal lagoon and reef areas on sandy and rubble habitats amongst seagrasses and macroalgae at 1–30 m. Has been recorded to 42 m	1–42
Deep	Straightstick pipefish, Long-nosed pipefish, Straight Stick pipefish *Trachyrhamphus longirostris*	Species or species habitat may occur	Species or species habitat may occur	Most specimens have been trawled or dredged from muddy to sandy-bottom habitats in depths of 16-91 m, in association with sand, rubble, seagrasses, algae, sponges, sea pens and hydroids	16–91
Low Reef	Reef-top Pipefish *Corythoichthys haematopterus*	-	Species or species habitat may occur	Most specimens are associated with live and dead corals, dead coral knolls, rocks, reef flats, algae, mangroves, seagrass, coral rubble, rock rubble, sand and silt.	0–20
Low Reef	Short-keel Pipefish, Short-keeled Pipefish *Hippichthys parvicarinatus*	-	Species or species habitat may occur	Usually inhabits mudflats, mangroves, gravel, sandy and rocky habitats, and coral and shell rubble.	0–20
Low Reef	Girdled Pipefish *Festucalex cinctus*	-	Species or species habitat may occur	Most specimens were dredged or trawled in depths of 8-31 m but divers collected some specimens over rubble bottoms in depths of 12 m.	10–20

Assemblage	Species	Occurrence within areas		Habitat	Depth range (m)
		Operational Area	EMBA		
Shallow	Blue-speckled Pipefish, Blue-spotted Pipefish *Hippichthys cyanospilos*	-	Species or species habitat may occur	Inhabiting brackish shallow-water environments in estuaries and lower reaches of coastal rivers and streams.	0–4
Low Reef	Western Spiny Seahorse, Narrow-bellied Seahorse *Hippocampus angustus*	-	Species or species habitat may occur	Inhabits sheltered algal-covered reefs and seagrass beds to about 10 m, although the species has been recorded from depths to 30 m.	10–30

DoEE (2019a); Bray and Thompson (2019); Austin and Pollom (2019); Froese and Pauly 2019); Sparks and Pollom, R. (2017), Pollom (2017); Manning and Pollom (2017); Vaidyanathan and Pollom (2017)

3.7 Protected species

3.7.1 EPBC Act-listed threatened and migratory species

A report from the EPBC Act Protected Matters Search Tool (PMST) was obtained for the Operational Area and EMBA in April 2025 to identify the likelihood of occurrence of listed marine fauna. The results of the searches informed the assessment of planned events in Section 6, as well as unplanned events in Section 7, associated with the Eos 3D MSS. It should be noted that the EPBC Protected Matters database is a general database that conservatively identifies areas in which protected species have the potential to occur.

The results of the EPBC Protected Matters Search are provided in Table 3-11. The search of the Operational Area identified 21 threatened species and 37 migratory species as potentially occurring. The search of the EMBA identified 85 threatened species and 81 migratory species potentially occurring. No threatened ecological communities (TECs) were identified from either search.

The full list of species identified from the PMST is provided in the EPBC Act Protected Matters Search Reports (Appendix C). The PMST is a digital tool that describes species distribution using grid-based data. In coastal areas, grid blocks for terrestrial species may overlap with marine areas, which does not reflect the actual habitat of those species. Literature on terrestrial species reported within the EMBA was reviewed, and in some cases the species was determined not to be at risk from marine-based impacts, and therefore these species have not been included in the EP.

Table 3-12 lists those species that may be affected by the identified threats described in Species Conservation and Recovery Management Plans due to planned or unplanned events associated with the Activity. Cross references to the relevant EP section for the assessment of impacts and risks are also provided in Table 3-12.

Table 3-11: EPBC Act-listed threatened and migratory species that may occur within the Operational Area and EMBA

EPBC Act Status: CE = Critically Endangered, E: Endangered, V = Vulnerable, M = Migratory, CD = Conservation Dependent

Value/Sensitivity		EPBC Act Status	Operational Area Presence	PMST Assessment of value/sensitivity within the Operational Area	EMBA Presence	PMST Assessment of value/sensitivity within the EMBA
Common Name	Scientific Name					
Marine Mammals						
Sei whale	*Balaenoptera borealis*	V, M	✓	Species or species habitat may occur	✓	Foraging, feeding or related behaviour likely to occur
Bryde's whale	*Balaenoptera edeni*	M	✓	Species or species habitat may occur	✓	Species or species habitat likely to occur
Blue whale	*Balaenoptera musculus*	E, M	✓	Species or species habitat likely to occur	✓	Migration route known to occur
Fin whale	*Balaenoptera physalus*	V, M	✓	Species or species habitat may occur	✓	Foraging, feeding or related behaviour likely to occur
Humpback whale	*Megaptera novaeangliae*	M	✓	Species or species habitat likely to occur	✓	Breeding known to occur
Killer whale	*Orcinus orca*	M	✓	Species or species habitat may occur	✓	Species or species habitat may occur
Spotted bottlenose dolphin (Arafura/Timor sea population)	*Tursiops aduncus*	M	✓	Species or species habitat likely occur	✓	Species or species habitat known to occur
Dugong	*Dugong dugon*	M	x	N/A	✓	Species or species habitat known to occur
Australian snubfin dolphin	*Orcaella heinsohni*	V, M	x	N/A	✓	Breeding known to occur
Sperm whale	*Physeter macrocephalus*	M	x	N/A	✓	Species or species habitat may occur
Australian Humpback dolphin	*Sousa sahulensis*	V, M	x	N/A	✓	Breeding known to occur
Marine Reptiles						
Loggerhead turtle	*Caretta caretta*	E, M	✓	Species or species habitat known to occur	✓	Foraging, feeding or related behaviour known to occur
Green turtle	*Chelonia mydas*	V, M	✓	Species or species habitat known to occur	✓	Breeding known to occur
Leatherback turtle	*Dermochelys coriacea*	E, M	✓	Species or species habitat likely to occur	✓	Species or species habitat known to occur
Hawksbill turtle	*Eretmochelys imbricata*	V, M	✓	Species or species habitat likely to occur	✓	Breeding known to occur

Value/Sensitivity		EPBC Act Status	Operational Area Presence	PMST Assessment of value/sensitivity within the Operational Area	EMBA Presence	PMST Assessment of value/sensitivity within the EMBA
Common Name	**Scientific Name**					
Olive ridley turtle	*Lepidochelys olivacea*	E, M	✓	Species or species habitat known to occur	✓	Breeding known to occur
Flatback turtle	*Natator depressus*	V, M	✓	Species or species habitat known to occur	✓	Breeding known to occur
Pig-nosed Turtle, Pitted Shell Turtle	*Carettochelys insculpta*	V	x	N/A	✓	Species or species habitat likely to occur
Salt-water crocodile	*Crocodylus porosus*	M	✓	Species or species habitat likely to occur	✓	Species or species habitat likely to occur
Short-nosed seasnake	*Aipysurus apraefrontalis*	CE	x	N/A	✓	Species or species habitat likely to occur
Leaf-scaled seasnake	*Aipysurus foliosquama*	CE	x	N/A	✓	Species or species habitat may occur
Dusky seasnake	*Aipysurus fuscus*	E	x	N/A	✓	Species or species habitat known to occur within area
Northern Blue-tongued Skink	*Tiliqua scincoides intermedia*	CE	x	N/A	✓	Species or species habitat known to occur within area
Mertens' Water Monitor	Varanus mertensi	E	x	N/A	✓	Species or species habitat known to occur within area
Mitchell's Water Monitor	*Varanus mitchelli*	CE	x	N/A	✓	Species or species habitat known to occur within area
Fish, Sharks and Rays						
Great white shark	*Carcharodon carcharias*	V, M	✓	Species or species habitat may occur	✓	Species or species habitat may occur
Northern river shark	*Glyphis garricki*	E	✓	Species or species habitat may occur	✓	Breeding known to occur
Freshwater sawfish	*Pristis pristis*	V, M	✓	Species or species habitat may occur	✓	Species or species habitat known to occur
Green sawfish	*Pristis zijsron*	V, M	✓	Species or species habitat known to occur	✓	Species or species habitat known to occur
Whale shark	*Rhincodon typus*	V, M	✓	Species or species habitat may occur	✓	Foraging, feeding or related behaviour known to occur
Shortfin mako	*Isurus oxyrinchus*	M	✓	Species or species habitat likely to occur	✓	Species or species habitat likely to occur

Value/Sensitivity		EPBC Act Status	Operational Area Presence	PMST Assessment of value/sensitivity within the Operational Area	EMBA Presence	PMST Assessment of value/sensitivity within the EMBA
Common Name	Scientific Name					
Longfin mako	*Isurus paucus*	M	✓	Species or species habitat likely to occur	✓	Species or species habitat likely to occur
Oceanic whitetip shark	*Carcharhinus longimanus*	M	✓	Species or species habitat may occur	✓	Species or species habitat may occur
Speartooth shark	*Glyphis glyphis*	CE	x	N/A	✓	Species or species habitat known to occur
Grey Nurse Shark	*Carcharias taurus*	M	✓			Species or species habitat known to occur
Reef manta ray	*Manta alfredi*	M	✓	Species or species habitat likely to occur	✓	Species or species habitat known to occur
Giant manta ray	*Manta birostris*	M	✓	Species or species habitat likely to occur	✓	Species or species habitat likely to occur
Narrow sawfish	*Anoxypristis cuspidata*	M	✓	Species or species habitat likely to occur	✓	Species or species habitat known to occur
Dwarf sawfish	*Pristis clavata*	V, M	✓	Species or species habitat known to occur	✓	Breeding known to occur
Southern Blue Fin Tuna	*Thunnus maccoyii*	CD	x	N/A	✓	Breeding known to occur
Scalloped Hammerhead	*Sphyrna lewini*	CD	✓	Species or species habitat likely to occur	✓	Species or species habitat known to occur
Seabirds and Migratory Shorebirds						
Red knot	*Calidris canutus*	E, M	✓	Species or species habitat may occur	✓	Species or species habitat known to occur
Curlew sandpiper	*Calidris ferruginea*	CE, M	✓	Species or species habitat may occur	✓	Species or species habitat known to occur
Eastern curlew	*Numenius madagascariensis*	CE, M	✓	Species or species habitat may occur	✓	Species or species habitat known to occur
Little curlew	*Numenius minutus*	M	x	N/A	✓	Roosting known to occur
Common noddy	*Anous stolidus*	M	✓	Species or species habitat may occur	✓	Foraging, feeding or related behaviour known to occur
Streaked shearwater	*Calonectris leucomelas*	M	✓	Species or species habitat likely to occur	✓	Species or species habitat known to occur

Value/Sensitivity		EPBC Act Status	Operational Area Presence	PMST Assessment of value/sensitivity within the Operational Area	EMBA Presence	PMST Assessment of value/sensitivity within the EMBA
Common Name	Scientific Name					
Lesser frigatebird	*Fregata ariel*	M	✓	Species or species habitat likely to occur	✓	Breeding known to occur
Great frigatebird	*Fregata minor*	M	✓	Species or species habitat may occur	✓	Species or species habitat known to occur
Common sandpiper	*Actitis hypoleucos*	M	✓	Species or species habitat may occur	✓	Species or species habitat known to occur
Sharp-tailed sandpiper	*Calidris acuminata*	V, M	✓	Species or species habitat may occur	✓	Roosting known to occur
Pectoral sandpiper	*Calidris melanotos*	M	✓	Species or species habitat may occur	✓	Species or species habitat known to occur
Marsh sandpiper	*Tringa stagnatilis*	M	x	N/A	✓	Roosting known to occur
Terek sandpiper	*Xenus cinereus*	V, M	x	N/A	✓	Roosting known to occur
Osprey	*Pandion haliaetus*	M	x	N/A	✓	Breeding known to occur within area
Whimbrel	*Numenius phaeopus*	M	x	N/A	✓	Roosting known to occur
Australian lesser noddy	*Anous tenuirostris melanops*	V	x	N/A	✓	Foraging, feeding or related behaviour known to occur
Great knot	*Calidris tenuirostris*	CE	x	N/A	✓	Roosting known to occur
Red goshawk	*Erythrotriorchis radiatus*	V	x	N/A	✓	Species or species habitat known to occur
Nunivak bar-tailed godwit	*Limosa lapponica baueri*	V	x	N/A	✓	Species or species habitat known to occur
Northern Siberian bar-tailed godwit	*Limosa lapponica menzbieri*	CE	x	N/A	✓	Species or species habitat known to occur
Black-tailed godwit	*Limosa limosa*	E, M	x	N/A	✓	Roosting known to occur
Australian painted snipe	*Rostratula australis*	E	x	N/A	✓	Species or species habitat likely to occur
Fork-tailed swift	*Apus pacificus*	M	x	N/A	✓	Species or species habitat likely to occur
Roseate tern	*Sterna dougallii*	M	x	N/A	✓	Breeding likely to occur
Little tern	*Sternula albifrons*	V, M	x	N/A	✓	Breeding known to occur
Bridled tern	*Onychoprion anaethetus*	M	x	N/A	✓	Breeding known to occur

Value/Sensitivity		EPBC Act Status	Operational Area Presence	PMST Assessment of value/sensitivity within the Operational Area	EMBA Presence	PMST Assessment of value/sensitivity within the EMBA
Common Name	Scientific Name					
Greater crested tern	*Thalasseus bergii*	M	x	N/A	✓	Breeding known to occur
Abbott's booby	*Papasula abbotti*	E	x	N/A	✓	Species or species habitat may occur
Brown booby	*Sula leucogaster*	M	x	N/A	✓	Breeding known to occur
Red-footed booby	*Sula sula*	M	x	N/A	✓	Breeding known to occur
Oriental reed-warbler	*Acrocephalus orientalis*	M	x	N/A	✓	Species or species habitat known to occur
White-tailed tropicbird	*Phaethon lepturus*	E, M	✓	Species or species habitat may occur within area	✓	Species or species habitat known to occur
Red-tailed tropicbird	*Phaethon rubricauda westralis*	E	✓	Breeding known to occur within area	✓	Breeding known to occur within area
Christmas Island White-tailed Tropicbird	*Phaethon lepturus fulvus*	E	x	N/A	✓	Foraging, feeding or related behaviour likely to occur within area
Greater sand plover	*Charadrius leschenaultii*	V, M	x	N/A	✓	Species or species habitat known to occur
Lesser sand plover	*Charadrius mongolus*	E, M	x	N/A	✓	Roosting known to occur
Oriental plover	*Charadrius veredus*	M	x	N/A	✓	Roosting known to occur
Little ringed plover	*Charadrius dubius*	M	x	N/A	✓	Roosting known to occur
Pacific golden plover	*Pluvialis fulva*	M	x	N/A	✓	Roosting known to occur
Grey plover	*Pluvialis squatarola*	V,M	x	N/A	✓	Roosting known to occur
Sanderling	*Calidris alba*	M	x	N/A	✓	Roosting known to occur
Oriental pratincole	*Glareola maldivarum*	M	x	N/A	✓	Roosting known to occur
Red-necked stint	*Calidris ruficollis*	M	x	N/A	✓	Roosting known to occur
Long-toed stint	*Calidris subminuta*	M	x	N/A	✓	Roosting known to occur
Swinhoe's snipe	*Gallinago megala*	M	x	N/A	✓	Roosting known to occur
Pin-tailed snipe	*Gallinago stenura*	M	x	N/A	✓	Roosting known to occur
Broad-billed sandpiper	*Limicola falcinellus*	M	x	N/A	✓	Roosting known to occur
Wood sandpiper	*Tringa glareola*	M	x	N/A	✓	Roosting known to occur
Asian dowitcher	*Limnodromus semipalmatus*	V, M	x	N/A	✓	Roosting known to occur
Grey-tailed tattler	*Tringa brevipes*	M	x	N/A	✓	Roosting known to occur

Value/Sensitivity		EPBC Act Status	Operational Area Presence	PMST Assessment of value/sensitivity within the Operational Area	EMBA Presence	PMST Assessment of value/sensitivity within the EMBA
Common Name	Scientific Name					
Wandering tattler	*Tringa incana*	M	x	N/A	✓	Roosting known to occur
Common greenshank	*Tringa nebularia*	E, M	x	N/A	✓	Species or species habitat known to occur
Ruddy turnstone	*Arenaria interpres*	V, M	x	N/A	✓	Roosting known to occur
Hooded Robin (Tiwi Islands)	*Melanodryas cucullata melvillensis*	CE	x	N/A	✓	Species or species habitat known to occur
Tiwi Masked Owl	*Tyto novaehollandiae melvillensis*	E	x	N/A	✓	Species or species habitat known to occur
Barn Swallow	*Hirundo rustica*	M	x	N/A	✓	Species or species habitat known to occur
Curlew Sandpiper	*Calidris ferruginea*	CE, M	x	N/A	✓	Species or species habitat known to occur
Bar-tailed Godwit	*Limosa lapponica*	M	x	N/A	✓	Species or species habitat known to occur
Night Parrot	*Pezoporus occidentalis*	E	x	N/A	✓	Species or species habitat may occur
Yellow Chat (Alligator Rivers)	*Epthianura crocea tunneyi*	E	x	N/A	✓	Species or species habitat may occur
Oriental Cuckoo	*Cuculus optatus*	M	x	N/A	✓	Species or species habitat known to occur
Gouldian Finch	*Erythrura gouldiae*	E	x	N/A	✓	Species or species habitat known to occur
Masked Owl (northern)	*Tyto novaehollandiae kimberli*	V	x	N/A	✓	Species or species habitat known to occur
Red-rumped Swallow	*Cecropis daurica*	M	x	N/A	✓	Species or species habitat known to occur
Grey Falcon	*Falco hypoleucos*	V	x	N/A	✓	Species or species habitat known to occur
Partridge Pigeon (western)	*Geophaps smithii blaauwi*	V	x	N/A	✓	Species or species habitat likely to occur
Grey Wagtail	*Motacilla cinerea*	M	x	N/A	✓	Species or species habitat known to occur
Yellow Wagtail	*Motacilla flava*	M	x	N/A	✓	Species or species habitat known to occur

Value/Sensitivity		EPBC Act Status	Operational Area Presence	PMST Assessment of value/sensitivity within the Operational Area	EMBA Presence	PMST Assessment of value/sensitivity within the EMBA
Common Name	Scientific Name					
Crested Shrike-tit (northern)	*Falcunculus frontatus whitei*	V	x	N/A	✓	Species or species habitat likely to occur
Partridge Pigeon (eastern)	*Geophaps smithii smithii*	V	x	N/A	✓	Species or species habitat known to occur

Note: Species identified in the PMST Report that are considered terrestrial were excluded from this table as they are not relevant to the impacts and risks of this activity.

Table 3-12: Relevant threats identified in Recovery Plans and Conservation Advice for species that occur or may occur within the EMBA and which may be affected by the Activity

Common Name	Recovery Plan / Conservation Advice	Threats identified as relevant to the Activity	Requirements / advice relevant to the Eos 3D MSS	Addressed in EP Section
Marine Mammals				
Blue whale	Blue Whale Conservation Management Plan 2015–2025 (2015)	Noise interference	• Anthropogenic noise in biologically important areas will be managed such that any blue whale continues to use the area without injury and is not displaced from a foraging area. • EPBC Act Policy Statement 2.1—Interaction between offshore seismic exploration and whales is applied to all seismic surveys.	6.3
		Habitat modification	• Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1, 7.2
		Vessel disturbance	• Ensure all vessel strike incidents are reported in the National Ship Strike Database. • Ensure the risk of vessel strikes on blue whales is considered when assessing actions that increase vessel traffic in areas where blue whales occur and, if required, implement appropriate mitigation measures.	7.6
Fin whale	Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (2015)	Pollution (persistent toxic pollutants)	• Implement measures to manage and reduce, where possible waste generation. • Reduce and, where possible, eliminate any adverse impacts of marine debris.	7.1, 7.2, 7.3
		Vessel strike	• Ensure all vessel strike incidents are reported in the National Vessel Strike Database.	7.6
		Anthropogenic noise and acoustic disturbance	• All seismic surveys must be undertaken consistent with Part A of the EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales.	6.3

Common Name	Recovery Plan / Conservation Advice	Threats identified as relevant to the Activity	Requirements / advice relevant to the Eos 3D MSS	Addressed in EP Section
		Habitat degradation	• Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1, 7.2
Sei whale	Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (2015a)	Pollution (persistent toxic pollutants)	• Implement measures to manage and reduce, where possible, waste generation.	7.1, 7.2, 7.3
		Vessel strike	• Ensure all vessel strike incidents are reported in the National Vessel Strike Database.	7.6
		Anthropogenic noise and acoustic disturbance	• All seismic surveys must be undertaken consistent with Part A of the EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales.	6.3
		Habitat degradation including pollution (increasing port expansion and coastal development)	• Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1, 7.2
Marine Reptiles				
Green turtle Hawksbill turtle Flatback turtle Leatherback turtle Loggerhead turtle Olive ridley turtle	Recovery plan for marine turtles in Australia 2017–2027 (2017)	Deteriorating water quality	• Implement measures to manage and reduce, where possible waste generation.	7.1, 7.2, 7.3
		Marine debris	• Reduce and, where possible, eliminate any adverse impacts of marine debris on marine turtles.	7.5
		Light pollution	• Manage artificial light from onshore and offshore sources to ensure biologically important behaviours of nesting adults and emerging/dispersing hatchlings can continue.	6.5
		Vessel disturbance	• Manage activities to ensure marine turtles are not displaced from identified habitat critical to the survival and biological important areas.	7.6
		Noise interference	• A precautionary approach should be applied to seismic work, such that surveys planned to occur inside important internesting habitat should be scheduled outside the nesting season. • Seismic surveys must undertake soft starts during surveys irrespective of location and time of year to protect marine turtles.	6.3
Leatherback turtle	Approved Conservation Advice for *Dermochelys coriacea* Leatherback Turtle (TSSC 2009)	Boat strike	• No explicit relevant management actions; vessel strikes identified as a threat.	7.6
		Habitat degradation (Changes to breeding sites and degradation of foraging areas)	• Identify and protect migratory corridors between nesting beaches and common foraging areas to facilitate colonization.	6.5, 7.1

Common Name	Recovery Plan / Conservation Advice	Threats identified as relevant to the Activity	Requirements / advice relevant to the Eos 3D MSS	Addressed in EP Section
		Marine Debris	• No explicit relevant management actions; marine debris identified as a threat.	7.5
		Climate Change	• No explicit relevant management actions; climate change identified as a possible threat	6.7
Short-nosed seasnake	Commonwealth Conservation Advice on *Aipysurus apraefrontalis* (short-nosed seasnake) (2010)	Degradation of reef habitat	• Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1, 7.2
Leaf-scaled seasnake	Approved Conservation Advice for *Aipysurus foliosquama* (Leaf-scaled seasnake) (2010)	Degradation of reef habitat	• Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1, 7.2
Fish, Sharks and Rays				
Dwarf sawfish	Sawfish and River Sharks Multispecies Recovery Plan (2015)	Habitat degradation and modification	• Reduce and, where possible, eliminate any adverse impacts of marine debris on sawfish and river shark species noting the linkages with the Threat Abatement Plan for the Impact of Marine Debris on Vertebrate Marine Life. • Take into account and protect BIAs for sawfish and river sharks when assessing the impact of proposed activities in the marine environment.	7.1, 7.2
Green sawfish	Commonwealth Conservation Advice on *Pristis zijsron* (green sawfish) Sawfish and River Sharks Multispecies Recovery Plan (2015)	Habitat degradation and modification	• Reduce and, where possible, eliminate any adverse impacts of marine debris on sawfish and river shark species noting the linkages with the Threat Abatement Plan for the Impact of Marine Debris on Vertebrate Marine Life. • Take into account and protect BIAs for sawfish and river sharks when assessing the impact of proposed activities in the marine environment.	7.1, 7.2, 7.5
Freshwater sawfish	Approved Conservation Advice for *Pristis pristis* (largetooth sawfish) (2014).	Habitat degradation/ modification	• Implement measures to reduce adverse impacts of habitat degradation and/or modification. • Take into account and protect BIAs for sawfish and river sharks when assessing the impact of proposed activities in the marine environment.	7.1, 7.2
Great white shark	Recovery plan for the White Shark (*Carcharodon carcharias*) (2013)	Ecosystem effects as a result of habitat modification and climate change	• Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1, 7.2
Whale shark		Boat strike from large vessels	• Minimise transit time of large vessels in areas close to marine features likely to correlate with whale shark aggregations	7.6

Common Name	Recovery Plan / Conservation Advice	Threats identified as relevant to the Activity	Requirements / advice relevant to the Eos 3D MSS	Addressed in EP Section
	Approved Conservation Advice for *Rhincodon typus* (whale shark) (2015)		(Ningaloo Reef, Christmas Island and the Coral Sea) and along the northward migration route.	
		Habitat disruption from mineral exploration, production and transportation	• Implement measures to reduce adverse impacts of habitat disruption.	7.6
		Marine debris	• Reduce and, where possible, eliminate any adverse impacts of marine debris on whale sharks. • Take into account and protect BIAs for whale sharks when assessing the impact of proposed activities in the marine environment.	6.6, 7.1, 7.2, 7.5
Northern river shark	Approved Conservation Advice for *Glyphis garricki* (Northern River Shark) (2014)	Marine debris	• Reduce and, where possible, eliminate any adverse impacts of marine debris on sawfish and river shark species noting the linkages with the Threat Abatement Plan for the Impact of Marine Debris on Vertebrate Marine Life. • Take into account and protect BIAs for sawfish and river sharks when assessing the impact of proposed activities in the marine environment.	7.5
Speartooth shark	Approved Conservation Advice for *Glyphis glyphis* (speartooth shark) (2014c) Sawfish and River Sharks Multispecies Recovery Plan (2015)	Habitat degradation/ modification	• Implement measures to reduce adverse impacts of habitat disruption. • Reduce and, where possible, eliminate any adverse impacts of marine debris on sawfish and river shark species noting the linkages with the Threat Abatement Plan for the Impact of Marine Debris on Vertebrate Marine Life. • Take into account and protect BIAs for sawfish and river sharks when assessing the impact of proposed activities in the marine environment.	7.1, 7.2, 7.3, 7.5
Grey nurse shark	Recovery Plan for the Grey Nurse Shark (Carcharias taurus) (2014)	Habitat degradation/ modification	• Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1, 7.2
Seabirds and Migratory Shorebirds				
Australian lesser noddy	Approved Conservation Advice for *Anous tenuirostris melanops* (Australian lesser noddy) (2015)	Habitat loss, disturbance and modification	• Manage disturbance at important sites when Australian lesser noddy are present. • Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1, 7.2, 7.3
Bar-tailed godwit	Approved Conservation Advice for *Limosa lapponica baueri*	Habitat loss and degradation from pollution	• Manage disturbance at important sites when bar-tailed godwits are present.	7.1, 7.2, 7.3

Common Name	Recovery Plan / Conservation Advice	Threats identified as relevant to the Activity	Requirements / advice relevant to the Eos 3D MSS	Addressed in EP Section
	(bar-tailed godwit western Alaskan) (2016)		• Implement measures to reduce adverse impacts of habitat degradation and/or modification.	
Curlew sandpiper	Approved Conservation Advice for *Calidris ferruginea* (Curlew Sandpiper) (2015)	Habitat loss and degradation from pollution	• Manage disturbance at important sites when curlew sandpipers are present. • Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1, 7.2, 7.3
Eastern curlew	Approved Conservation Advice for *Numenius madagascariensis* (Eastern Curlew) (2015)	Habitat loss and degradation from pollution	• Manage disturbance at important sites when eastern curlews are present. • Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1, 7.2, 7.3
Northern Siberian bar-tailed godwit	Approved Conservation Advice for *Limosa lapponica menzbieri* (bar-tailed godwit northern Siberian)(2016)	Habitat loss and degradation from pollution	• Manage disturbance at important sites when northern Siberian bar-tailed godwits are present. • Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1, 7.2, 7.3
Red knot	Approved Conservation Advice for *Calidris canutus* (Red knot) (2024)	Chronic and acute pollution	• Implement measures to manage and reduce, where possible, waste generation.	7.1, 7.2, 7.3
		Climate change	• No explicit relevant management actions; climate change identified as a possible threat	6.7
		Habitat loss or disturbance	• Implement measures to reduce adverse impacts of habitat degradation and/or modification. • Manage disturbance at important sites when red knots are present.	7.1, 7.2, 7.3
Great knot	Approved Conservation Advice for *Calidris tenuirostris* (Great knot) (2016)	Habitat loss and degradation	• Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1, 7.2, 7.3
		Pollution/contamination impacts	• Implement measures to manage and reduce, where possible, waste generation.	7.1, 7.2, 7.3
		Disturbance	• Manage disturbance at important sites when great knots are present.	7.1, 7.2, 7.3
Red goshawk	Approved Conservation Advice for *Erythrotriorchis radiates* (red goshawk) (2015)	Habitat loss and degradation	• Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1, 7.2, 7.3
Australian painted snipe	Approved Conservation Advice for *Rostratula australis* (Australian painted snipe) (2013)	Habitat loss, disturbance and modification	• Manage disturbance at important sites when Australian painted snipes are present. • Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1, 7.2, 7.3

Common Name	Recovery Plan / Conservation Advice	Threats identified as relevant to the Activity	Requirements / advice relevant to the Eos 3D MSS	Addressed in EP Section
Lesser sand plover	Approved Conservation Advice for *Charadrius mongolus* (lesser sand plover) (2016)	Habitat loss and degradation	• Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1, 7.2, 7.3
		Pollution/contamination impacts	• Implement measures to manage and reduce, where possible, waste generation.	7.1, 7.2, 7.3
		Disturbance	• Manage disturbance at important sites when lesser sand plovers are present.	7.1, 7.2, 7.3
Greater sand plover	Approved Conservation Advice for *Charadrius leschenaultia* (greater sand plover) (2016)	Habitat loss and degradation	• Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1, 7.2, 7.3
		Pollution/contamination impacts	• Implement measures to manage and reduce, where possible, waste generation.	7.1, 7.2, 7.3
		Disturbance	• Manage disturbance at important sites when greater sand plovers are present.	7.1, 7.2, 7.3
Common sandpiper, red knot, oriental plover, grey plover, little ringed plover, lesser sand plover, greater sand plover, Pacific golden plover, oriental pratincole, bar-tailed godwit, black-tailed godwit, pin-tailed snipe, Swinhoe's snipe, whimbrel, little curlew, terek sandpiper, common sandpiper, marsh sandpiper, wood sandpiper, common greenshank, ruddy turnstone, Asian dowditcher, great knot, sanderling, red-necked stint, long-toed stint, broad-billed sandpiper, pectoral sandpiper, sharp-tailed sandpiper	Wildlife conservation plan for migratory shorebirds (2015)	Habitat degradation/ modification (oil pollution)	• Manage disturbance at important sites migratory shorebirds are present. • Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1, 7.2, 7.3
Red-tailed tropicbird	Conservation advice for *Phaethon rubricauda westralis)*	Habitat loss and degradation	• Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1, 7.2, 7.3

Common Name	Recovery Plan / Conservation Advice	Threats identified as relevant to the Activity	Requirements / advice relevant to the Eos 3D MSS	Addressed in EP Section
	(Indian Ocean red-tailed tropicbird)(2023)			

3.7.2 Summary of biologically important areas

BIAs are regions where a particular species is known or likely to display important behaviours such as aggregation, resting, breeding, foraging, nesting or migration (DAWE 2016). BIAs have no legal status; however, they provide information to help inform regulatory and management decisions.

Table 3-13 identifies the BIAs associated with threatened and/or migratory species occurring within the EMBA with potential for overlap with the Operational Area. The distances in Table 3-13 are from the boundary of the Operational Area to the closest boundary of the respective BIA.

Table 3-13: Threatened and migratory species BIAs within the EMBA and potential for overlap with Operational Area

Species	BIA	Location	Distance from Operational Area
Marine mammals			
Australian snubfin dolphin	Foraging	Cape Londonderry and King George River	101 km SSW
		Ord River	112 km SSW
		Napier Broome Bay	147 km SSW
		Vansittart Bay, Anjo Peninsula	153 km SSW
		Bougainville Peninsula	191 km WSW
		Admiralty Gulf and Parry Harbour	218 km WSW
		Maret and Biggee Island	318 km WSW
		Port Nelson, York Sound, Prince Frederick Harbour	335 km SSW
	Breeding	Cape Londonderry and King George River.	101 km SSW
		Ord River	112 km SSW
		Napier Broome Bay	147 km SSW
		Vansittart Bay, Anjo Peninsula	153 km SSW
		Bougainville Peninsula	191 km WSW
		Darwin Harbour	214 km ENE
		Admiralty Gulf and Parry Harbour	218 km WSW
		Port Nelson, York Sound, Prince Frederick Harbour	335 km SSW
	Calving	Cape Londonderry and King George River.	101 km SSW
		Ord River	112 km SSW
		Napier Broome Bay	147 km SSW
		Vansittart Bay, Anjo Peninsula	153 km SSW
		Bougainville Peninsula	191 km WSW
		Admiralty Gulf and Parry Harbour	218 km WSW
		Port Nelson, York Sound, Prince Frederick Harbour	335 km SSW
	Resting	Cape Londonderry and King George River	101 km SSW
		Ord River	112 km SSW
		Napier Broome Bay	147 km SSW
		Vansittart Bay, Anjo Peninsula	153 km SSW
		Bougainville Peninsula	191 km WSW
		Admiralty Gulf and Parry Harbour	218 km WSW
		Port Nelson, York Sound, Prince Fredrick Harbour	335 km SSW
Indo-Pacific humpback dolphin	Breeding	Darwin Harbour	202 km ENE
		Port Nelson, York Sound, Prince Frederick Harbour	335 km SSW
	Foraging	Vansittart Bay, Anjo Peninsula	153 km SSW

Species	BIA	Location	Distance from Operational Area
		Bougainville Peninsula	191 km WSW
		Admiralty Gulf and Parry Harbour	218 km WSW
		Maret and Biggee Island	318 km WSW
		Port Nelson, York Sound, Prince Frederick Harbour	335 km SSW
	Calving	Maret and Biggee Island	318 km WSW
		Port Nelson, York Sound, Prince Frederick Harbour	335 km SSW
Pygmy blue whale	Migration	Augusta to Derby	363 km WNW
	Foraging	Scott Reef	607 km WSW
Humpback Whale	Reproduction	Kimberley/Coastal North Lacepede Island, Camden Sound	326 km WSW
	Migration		
Indo-Pacific/Spotted Bottlenose Dolphin	Breeding	Darwin Harbour	214 km ENE
Marine Reptiles			
Loggerhead turtle	Foraging	Western Joseph Bonaparte Depression	Within
Flatback turtle	Foraging	Western Joseph Bonaparte Depression	Within
		Holothuria Zone (Northern Kimberley, Holothuria Banks)	224 km WNW
	Internesting	Melville Island, Cobourg Peninsula	90 km ENE
	Internesting buffer	Cape Domett	39 km SSW
		Lacepede Island	645 km SWS
	Nesting	The main nesting beach at Cape Domett is a 1.9-km-long north-west-facing sandy beach on the east of the Cambridge Gulf, East Kimberley, Western Australia (14 48.10S, 128 24.50E), located approximately 80 km north-north-east of the nearest town, Wyndham.	127 km S
Olive Ridley	Foraging	Western Joseph Bonaparte Depression	Within
		JBG	Within
		Western JBG – banks	Within
		Northern JBG	98 km NNE
		Fog Bay	147 km ENE
	Internesting	Fog Bay to Cox Peninsula	151 km ENE
		Bathurst Island/Melville Island – North-west	237 km NNE
		Greenhill Island	379 km ENE
Green turtle	Foraging	JBG	Within
		Browse Island	462 km WSW
	Internesting	North-west of Melville Island	263 km NNE
	Nesting	Cassini Island	243 km WSW
		Cartier Island	438 km WNW
	Internesting buffer	Cassini Island	224 km WSW
		Cartier Island	418 km NW
Hawksbill turtle	Foraging	Cartier Island	437 km WNW
	Internesting	Greenhill Island	379 km ENE

Species	BIA	Location	Distance from Operational Area
Fish, Sharks and Rays			
Whale shark	Foraging	Northward from Ningaloo along 200 m isobaths	205 km WSW
Seabirds and Migratory Shorebirds			
Lesser crested tern	Breeding	Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef	75 km SSW
	Foraging		
Roseate tern	Breeding	Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef	131 km SSW
		Low Rocks and Stern Island in Admiralty Gulf	200 km WSW
	Foraging	Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef	131 km SSW
		Low Rocks and Stern Island in Admiralty Gulf	200 km WSW
Lesser frigatebird	Breeding	Kimberley and Pilbara coasts and islands also Ashmore Reef.	108 km WSW
	Foraging		
Greater frigatebird	Breeding	Kimberley and Ashmore Reef	384 km WNW
	Foraging		
Wedge-tailed shearwater	Breeding	Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef	389 km WNW
	Foraging		
White-tailed tropicbird	Breeding	Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef	392 km WNW
	Foraging		
Red-footed booby	Breeding	North west Kimberley and Ashmore reef	384 km WNW
	Foraging		
Brown booby	Breeding	Kimberley and northern Pilbara coasts and islands also Ashmore Reef.	371 km WSW
	Foraging		
Little tern	Breeding	Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef	232 km WSW
	Foraging		
	Resting	Ashmore Reef	619 km WSW
Great crested tern	Breeding	Seagull Island, off NW of Cape Van Diemen, Melville Island	265 km NNE

3.7.3 Marine mammals

Several species of marine mammals are known to occur in the region and have wide distributions that are associated with feeding and migration patterns linked to reproductive cycles. Within EMBA, there are three species of dolphins known to occur regularly in the area; namely the spotted bottlenose dolphin (Arafura/Timor sea population), the Australian snubfin dolphin and the Australian humpback dolphin (DSEWPAC 2012b). Regarding whales, there are seven species that occur regularly within EMBA including the sei whale, the Bryde's whale, the pygmy blue whale, the fin whale, the humpback whale, the killer whale and the sperm whale (DSEWPAC 2012a). The dugong is also a mammal species known to occur within the EMBA.

There are three threatened and migratory species and four migratory marine mammal species identified by the EPBC Act PMST Report as potentially occurring in the Operational Area. Three threatened and migratory and eight migratory species were identified as potentially occurring in the EMBA (refer to Table 3-14). No BIAs for marine mammals are located within the Operational Area. The following BIAs are located within the EMBA (refer to Table 3-14, Figure 3-8 and Figure 3-9):

+ The closest Australian snubfin dolphin breeding/calving/resting and foraging BIAs are located near Cape Londonderry and King George River, approximately 101 km south south-west of the Operational Area at the closest point. Other breeding/calving/resting and foraging BIAs are located around Ord River and Napier Broome Bay, approximately 112 km and 147 km south south-west respectively, from the Operational Area.

- Indo-Pacific humpback dolphin foraging BIAs are located along the Kimberley coastline, 153 km south south-west of the Operational Area at the closest point. The nearest breeding BIA for the species is located near Darwin Harbour (approximately 202 km east north-east of the Operational Area).
- Pygmy blue whale migration BIA (Augusta to Derby and Scott Reef) is located approximately 363 km west north-west of the Operational Area. The closest foraging BIA for this species is located at the Scott Reef, 607 km west south-west of the Operational Area.
- Humpback whale reproduction and migration BIAs are located adjacent to Kimberley/Coastal North Lacepede Island, Camden Sound, approximately 326 km west south-west of the Operational Area.
- Indo-Pacific/Spotted Bottlenose dolphin breeding BIA is located near Darwin Harbour, approximately 214 km east north-east of the Operational Area.

A description of the distribution, migration movements, preferred habitat and life stages of the identified marine mammal species is provided in Table 3-14, including commentary on their likely presence in the Operational Area and EMBA.

Although not listed as a listed threatened or migratory species under the EPBC Act, the Omura's whale is also described in Table 3-14. Limited information is available on Omura's whales, but current data includes numerous accounts of the species in the Indo-Pacific region (Cerchio et al. 2019). The species has been detected across north-western Australia between Exmouth and Darwin including in the JBG and in the Timor Sea (McCauley 2009, 2014, cited in Cerchio et al. 2019; McPherson et al. 2016, 2017), as well as off north-east Queensland (Cerchio et al. 2019). It is believed that some populations may be non-migratory, and, therefore, foraging, breeding, calving and resting are likely to occur in waters where the population is distributed. A review of acoustic data by McPherson et al. (2016, 2017) suggests they may be transient across north-western Australia; however, habitat use and life stages across the region are unknown.

Table 3-14: Threatened and migratory marine mammals potentially occurring within the Operational Area and EMBA

Species	Protection status	Distribution, habitat and life stages	Presence in the Operational Area and EMBA
Australian snubfin dolphin	Migratory	• The Australian snubfin dolphin is included in the EPBC Act finalised priority assessment list, proposed for assessment as 'Vulnerable'[1]. • Records indicate that the Australian snubfin dolphin only occurs in waters off the northern half of Australia from Broome on the west coast to Brisbane River on the east coast. • The Australian snubfin dolphin occurs almost exclusively in protected shallow waters close to the coast and close to river and creek mouths (estuarine). They prefer shallow waters, less than 20 m deep (DoEE 2019a). • There are records of Australian snubfin dolphins in waters out to 23 km offshore (Peddemors and Harcourt 2006, pers. comm., cited in DAWE 2021b).	• Breeding/calving/resting and foraging BIAs are located within the EMBA, with the closest near Cape Londonderry and King George River approximately 101 km south south-west from the Operational Area at the closest point (refer to Figure 3-8). • Other breeding/calving/resting and foraging BIAs are located around Ord River approximately 112 km south south-west of the Operational Area (refer to Figure 3-8). • Given the species preference for shallow coastal waters, the presence of the species within the deeper offshore waters of the Operational Area is unlikely. Further, the Operational Area does not represent a key habitat for the species or an area where sensitive life stages (e.g. breeding, calving) occur, and there were no sightings of Australian snubfin dolphins in the offshore waters of the JBG during the Santos Beehive 3D MSS (directly south of the Operational Area) in 2018. • The species may be encountered within the EMBA.
Indo-Pacific humpback dolphin	Migratory	• Indo-Pacific humpback dolphins occur in coastal lagoons and enclosed bays with mangrove forests and seagrass beds, but are also found in open coastal waters around islands and coastal cliffs in association with rock or coral reefs. The species usually occurs close to the coast, generally at depths of up to 20 m, but the species has been seen 55 km offshore in shallow water. • The species does not appear to undergo large-scale seasonal migrations, although seasonal shifts in abundance have been observed (DoEE 2019a). • Indo-Pacific humpback dolphins eat a wide variety of coastal and estuarine-associated fishes, as well as reef, littoral and demersal fish species. • A suspected pod of 10 Indo-Pacific humpback dolphins were reported by marine fauna observers (MFOs) onboard the seismic vessel during Santos' Beehive 3D MSS (late-July to mid-August) at a location in the southern JBG approximately 34 km south-east from the Operational Area.	• Two breeding BIAs for Indo-Pacific humpback dolphins were identified. The closest is located in Darwin Harbour, approximately 202 km away from the Operational Area, and the other one is located at Prince Frederick Harbour, 335 km north-east of the Operational Area (see Figure 3-8). • The closest foraging BIA for this species is located in Vansittart Bay on the Anjo Peninsula, which is approximately 153 km south south-west of the Operational Area (see Figure 3-8). • Given the location of the BIAs relative to the Operational Area, the species may be encountered within the Operational Area.
Spotted bottlenose dolphin	Migratory	• Bottlenose dolphins have been recorded within the Oceanic Shoals Marine Park (10 km from the Operational Area).	• The closest breeding BIA for this species is located near Darwin Harbour, 214 km east north-east of the Operational Area (see Figure 3-8).

[1] https://www.awe.gov.au/sites/default/files/documents/2021-finalised-priority-assessment-list.pdf

Species	Protection status	Distribution, habitat and life stages	Presence in the Operational Area and EMBA
(Arafura/Timor Sea populations)		• The spotted bottlenose dolphin occurs in tropical and subtropical coastal and shallow offshore waters of the Indian Ocean, Indo-Pacific region and the western Pacific Ocean (DoEE 2019a). • The species is typically found close to shore, within approximately 1 km from the nearest land or oceanic islands, or in water depths of less than 30 m. • Knowledge of the species seasonal migration and breeding is largely unknown, however it is inferred that only the Arafura-Timor Sea population is migratory.	• This species undertakes foraging and breeding from April to November. • Given the species preference for shallow water and close proximity to shore, the presence of the species within the Operational Area is likely to be limited. The species may occasionally be present in the coastal region of the EMBA. • Between February and March 2022, Santos conducted the Petrel Sub-Basin South-West (SW) three-dimensional (3D) marine seismic survey (MSS) in Commonwealth waters (located directly west of the Eos 3D MSS Active Source Area, including 115 km^2 overlap). During the 350 hours of survey, four Indo-Pacific bottlenose dolphins were sighted in the area, supporting the low likelihood of encountering this species in the OA (Santos 2022).
Omura's whale	N/A	• The Omura's whale is listed as migratory and cetacean under the EPBC Act. • Omura's whale is a recently described species, found to be distinct from similar species, Bryde's whales, sei whale and the larger fin whale (Wada et al. 2003; Cerchio et al. 2019). • The Omura's whale is widely distributed in primarily tropical and warm-temperate locations, between 35°S and 35°N (Cerchio et al. 2019). • In Australia, acoustic detections, photographic accounts and a single stranding record has documented Omura's whales around the northern coast of Australia from Exmouth in the west to the Great Barrier Reef in the east (Cerchio et al. 2019). • Acoustic recordings documented in Australia between 2010 and 2013 (McCauley 2009 2014) were previously attributed to Bryde's whales before the description of Omura's whale song by Cerchio et al. (2015) and the attribution of the detections as potential Omura's whales by Erbe et al. (2017), based a review of spectrograms. The data from McCauley (2009, 2014) indicates the potential year-round presence of Omura's whales near Scott Reef, northwest of Broome, and in the JBG. • Additionally, McPherson et al. (2017) examined recordings from the Pilbara, west Kimberley, Browse Basin and Timor Sea for the period 2010–2015. The JBG was not included in the study. Water depths at the recording stations ranged from 130–500 m. In the Timor Sea, to the north of the JBG, Omura's whales were detected year-round, but more commonly between April and September, with a peak in the winter months of June and July. Based on the recordings, the whales seem to enter the Timor Sea in a south-west to north-east direction and leave the region in a	Given the year round detection of potential Omura's whale vocalisations in the JBG and across north-western Australia, the Omura's whale may be encountered within the Operational Area and EMBA.

Species	Protection status	Distribution, habitat and life stages	Presence in the Operational Area and EMBA
		north-east to south-west direction, leaving the area by the start of November (McPherson et al. 2016, 2017). Fewer calls were detected in the Timor Sea between October and March (McPherson et al. 2017). Conversely, there were fewer detections in the Pilbara, west Kimberley and Browse basin between May and December (McPherson et al. 2017). The results indicate presence across north-west Australian continental shelf, with potential seasonal movements across the region, however, McPherson et al. (2017) state that more data and analysis are needed to understand coastal / oceanic basin movements and population structure. • It is believed that some Omura's whale populations may be non-migratory, and, therefore, foraging, breeding, calving and resting are likely to occur in waters where the population is distributed (Cerchio et al. 2019). However, habitat use and movements across north-western Australia are still unknown. • No Omura's whales (or similar species) were reported by MFOs onboard the seismic vessel during Santos' Beehive 3D MSS in the JBG (late-July to mid-August) during 2018 campaign.	
Sei whale	Vulnerable	• The movements and distributions of sei whales are unpredictable and not well documented with information suggesting that they have the same general pattern of migration as most other baleen whales, although it is timed a little later and they do not move to such high latitudes (DoEE 2019a). • There are no known mating or calving areas in Australia. • Sei whales feed intensively between the Antarctic and subtropical convergences and mature animals may also feed in higher latitudes. • Sei whales feed on planktonic crustaceans, in particular copepods and amphipods.	• Given the wide-ranging nature of this species, lack of nearby important habitat and a preference for deeper offshore waters, the presence of the species within the Operational Area and EMBA is likely to be limited.
Blue whale / pygmy blue whale	Endangered	• In Australia, there are two recognised sub-species of blue whale; the Antarctic or true blue whale (*Balaenoptera musculus intermedia*) and the pygmy blue whale (*B. m. brevicauda*) (DoEE 2019a). • Pygmy blue whales feed throughout their migratory range. Between November and April they are primarily found in summer foraging grounds located in southern Australian waters and the subtropical convergence. Between March and August known foraging aggregations occur in the Perth Canyon off Western Australia, as well as other known foraging areas along the North West Shelf. Pygmy Blue whales may also feed opportunistically while migrating (DoEE 2019a).	• The EMBA partially overlaps with a pygmy blue whale migration BIA (Augusta to Derby), approximately 363 km west north-west of the Operational Area (refer to Figure 3-7). Whales tend to pass along the shelf edge at depths of 500 m to 1000 m and appear close to the coast in the Exmouth-Montebello Island areas on their southern migration. • The EMBA also partially overlaps with a pygmy blue whale foraging BIA at Scott Reef, approximately 607 km west south-west of the Operational Area (Figure 3-7). • Given the distance between the foraging habitat and the Operational Area, the presence of the pygmy blue whale within

Species	Protection status	Distribution, habitat and life stages	Presence in the Operational Area and EMBA
		• Pygmy blue whales migrate from summer feeding grounds to lower temperate and/or tropical latitudes for mating and calving (Bannister et al. 1996). The waters off Australia are used by the species to migrate from feeding grounds to calving grounds, as well as to exploit predictable areas of seasonal productivity, and are recognised as a BIA. • The following information is known about the pygmy blue whale migration along the western coast of Australia: – The population around southern Australia commence heading north along the WA coast towards Indonesian waters from April to May (McCauley 2011). – Individuals have been recorded by satellite tags to travel along the shelf break along the WA coast up to North West Cape, after which they continued in a north-east directional route to Indonesia, west of the Operational Area (Double et al. 2014). – They are expected to pass the latitude of the Operational Area between April and August on their northerly migration and between lSeptember and December on their southerly migration (McCauley 2011). Based on recent satellite tracking data (Double et al. 2014), five tagged whales on their northern migration passed the latitude of the Operational Area during April and May (Double et al 2014). – The migration extends to the Banda and Molucca Seas near Indonesia, where calving is understood to occur (Double et al. 2014). • Pygmy blue whales prefer to travel alone or in small groups (McCauley 2011; Gilmour et al. 2013).	the Operational Area and EMBA is likely to be infrequent and consist of transitory individuals during migration months.
Fin whale	Vulnerable	• Fin whales occur from polar to tropical waters, but rarely in inshore waters (DoEE 2019a). Fin whales are widely distributed in both hemispheres between latitudes 20–75° S (Mackintosh 1965). This species is also common in temperate waters, the Arctic Ocean and Southern Ocean. • There is insufficient data to prescribe migration times and routes for fin whales; however recent sightings in Australian waters include summer and autumn months. Fin whale calls have been detected in Antarctic waters from February to July (DoEE 2019a). • Fin whales feed intensively in high latitudes and may feed to some extent in lower latitudes, depending upon prey availability and locality. Fin whales feed on planktonic crustaceans, some fish and cephalopods (crustaceans).	• Given the wide-ranging nature of this species, lack of nearby important habitat and a preference for deeper offshore waters, the presence of the species within the Operational Area and EMBA is likely to be limited.

Species	Protection status	Distribution, habitat and life stages	Presence in the Operational Area and EMBA
		• The fin whale is the second-largest whale species, after the blue whale. • Fin whales are killed by ship strikes more than any other whale, which may be due to surface feeding (DoEE 2019a).	
Humpback whale	Vulnerable, Migratory	• Camden Sound forms the northern extent of the humpback whale migration, breeding, calving and resting BIAs (refer to Figure 3-7). The numbers of humpback whales at Camden Sound peak between June and September each year (DoEE 2019a). The migration corridor tends to be within the 200 m isobath (Jenner et al. 2001). • The humpback whale annual migration from the summer feeding grounds in Antarctica to the breeding and calving grounds in Camden Sound (approximately 385 km southwest of the Operational Area) occurs between May and October. • Humpback whales occur globally and throughout Australian waters with their distribution being influenced by migratory pathways and aggregation areas for resting, breeding and calving. There are two genetically distinct populations of humpback whales in Australia (west coast and east coast) (DoEE 2019a). • The west coast population of the humpback whale is thought to be increasing in size by about 9% per year (DoEE 2019a; Bejder et al. 2015); estimates conducted suggest that in 2008 the population migrating up the WA coast was at 21,750 individuals (Hedley et al. 2011). • Humpback whales were reported by MFOs onboard the seismic vessel during Santos' Beehive 3D MSS in the JBG (late-July to mid-August).	• Humpback whales migration and reproduction BIAs are located adjacent to Kimberley/Coastal North Lacepede Island, Camden Sound, approximately 326 km west south-west of the Operational Area and within EMBA. • Humpback whale migration and reproduction occurs from May to October.
Bryde's whale	Migratory	• The nearest known area of aggregation area for Bryde's whales is Ningaloo Reef (approximately 1,800 km away from the Operational Area) (DOE 2015). Aerial surveys carried out in 2009, between mainland Australia and Scott Reef recorded Bryde's whales in low numbers (RPS 2010). Between September 2006 and June 2009, sea noise loggers deployed within Scott Reef also recorded Bryde's whales calls year round (McCauley 2011; RPS 2010). • Bryde's whales are distributed throughout oceanic and inshore, tropical and warm temperate waters, between 40°N and 40°S year-round (DOE 2015). They have been recorded off all states of Australia, with the exception of the NT (DOE 2015). • The inshore form of the Bryde's whale is typically limited to the 200 m depth contour and breeds / calves year-round, whilst the offshore form is found in deeper waters (500–1,000 m) and breeds	• No specific feeding or breeding grounds have been discovered off Australia and given the distance to the closest known aggregation area at Ningaloo Reef (approximately 1,800 km away), the presence of the species within the Operational Area and EMBA is likely to be infrequent.

Species	Protection status	Distribution, habitat and life stages	Presence in the Operational Area and EMBA
		and calves over several months during winter (Best et al. 1984; Kato 2002).	
Sperm whale	Migratory	• Sperm whales have been recorded in all Australian states, however their distribution is primarily assumed from incidental sightings and beach-cast animals. • Sperm whales tend to inhabit offshore areas with a water depth of 600 m or more and are uncommon in waters less than 300 m (DoEE 2019a).	• Given that sperm whales are typically found in deeper, colder waters, along the south coast of WA, interactions with the species in the Operational Area and EMBA is likely to be infrequent.
Killer whale	Migratory	• The killer whale is found in all of the world's oceans, from the Arctic and Antarctic regions to tropical seas (DoEE 2019). The species has been recorded in all the coastal waters of Australia, with concentrations reported in Tasmania, and common sightings in South Australia and Victoria. • Sightings of killer whale around the Australian coast are typically recorded along the continental slope and shelf, and predominantly in the vicinity of seal colonies, which are not known to exist in the region (DEWHA 2008b). • No areas of significance and no determined migration routes have been identified for this species within waters off WA (DoEE 2019a). • The specific diet of killer whales in Australian waters is not known, but there are reports of attacks on dolphins, young humpback whales, blue whales, sperm whales, dugongs and Australian sea lions.	• There are no BIA for killer whales near the Operational Area; however, they have been reported within the Oceanic Shoals Marine Park (approximately 10 km north of the Operational Area). • Given the wide-ranging nature of this species, presence within the Operational Area is possible however expected to be infrequent due to the lack of nearby important habitat and a preference for coastal waters.
Dugong	Migratory	• Dugongs have been reported to occur along the coastline in the JBG from Cape Hay to Point Pearce, with the main populations concentrated around Dorcherty Island (Woodside 2004), approximately 133 km south-east of the Operational Area. • Some of the coastal waters adjacent to the region support significant populations of dugongs, including Shark Bay, which has an estimated population of around 10,000 individuals (DSEWPaC 2012c). Dugongs are also known to occur along the coast throughout the Kimberley to the WA-NT border; however, population estimates for these areas are not available (DSEWPaC 2012c). • Dugongs inhabit protected shallow coastal areas, such as wide shallow bays and mangrove channels. Although the patterns of dugong movement in WA are not well understood, it is thought that dugongs move in response to seagrass and water temperature.	• The PMST Report identified the species as potentially occurring within the EMBA but not within the Operational Area. • There are no dugong BIAs inside the EMBA. The closest dugong foraging BIA is located south of Ashmore Reef (approximately 487 km north-west of the Operational Area). Ashmore Reef supports a population of less than 50 individuals that are genetically distinct from other Australian populations. The reef provides breeding and feeding habitats, with seagrass beds of the reef flats and lagoon their preferred food source. Breeding occurs year-round at Ashmore Reef (DoEE 2019a). • Due to the species' foraging BIA being located 487 km from the Operational Area, absence of suitable habitat and preference for shallow waters, presence of the species within the Operational Area is likely to be limited.

Species	Protection status	Distribution, habitat and life stages	Presence in the Operational Area and EMBA
		• Dugongs feed primarily on seagrass in shallow waters less than 10 m deep and mostly above 3 m depth (Burbidge et al. 2014). A survey carried out in northern Australia between 1994 and 2001 using time-depth recorders deployed on 15 dugongs logged 39,507 dives. The survey identified that dugongs spend the majority of their time in water depths of less than 3 m (Chilvers et al. 2004).	

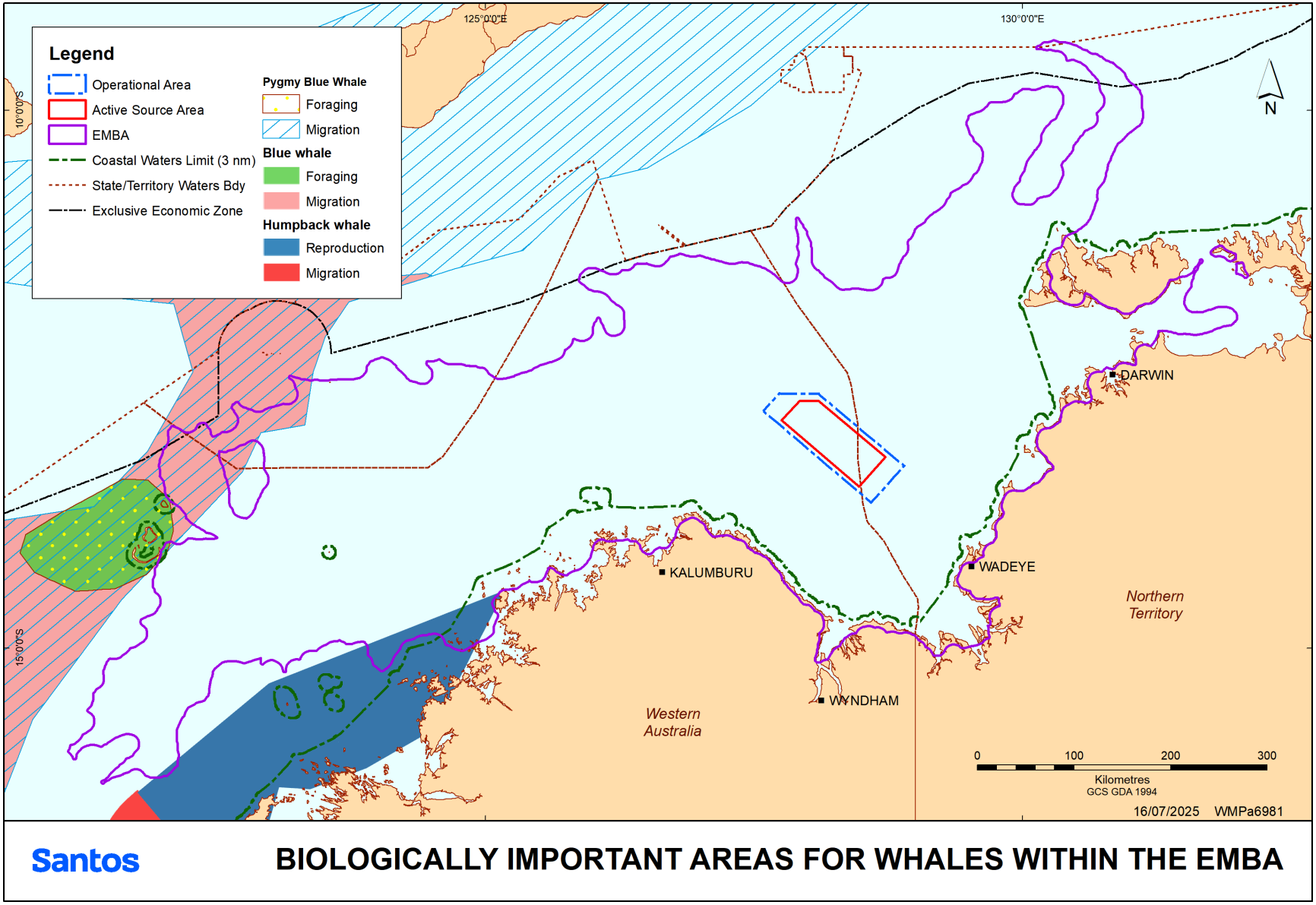


Figure 3-7: BIAs for blue whales and humpback whale

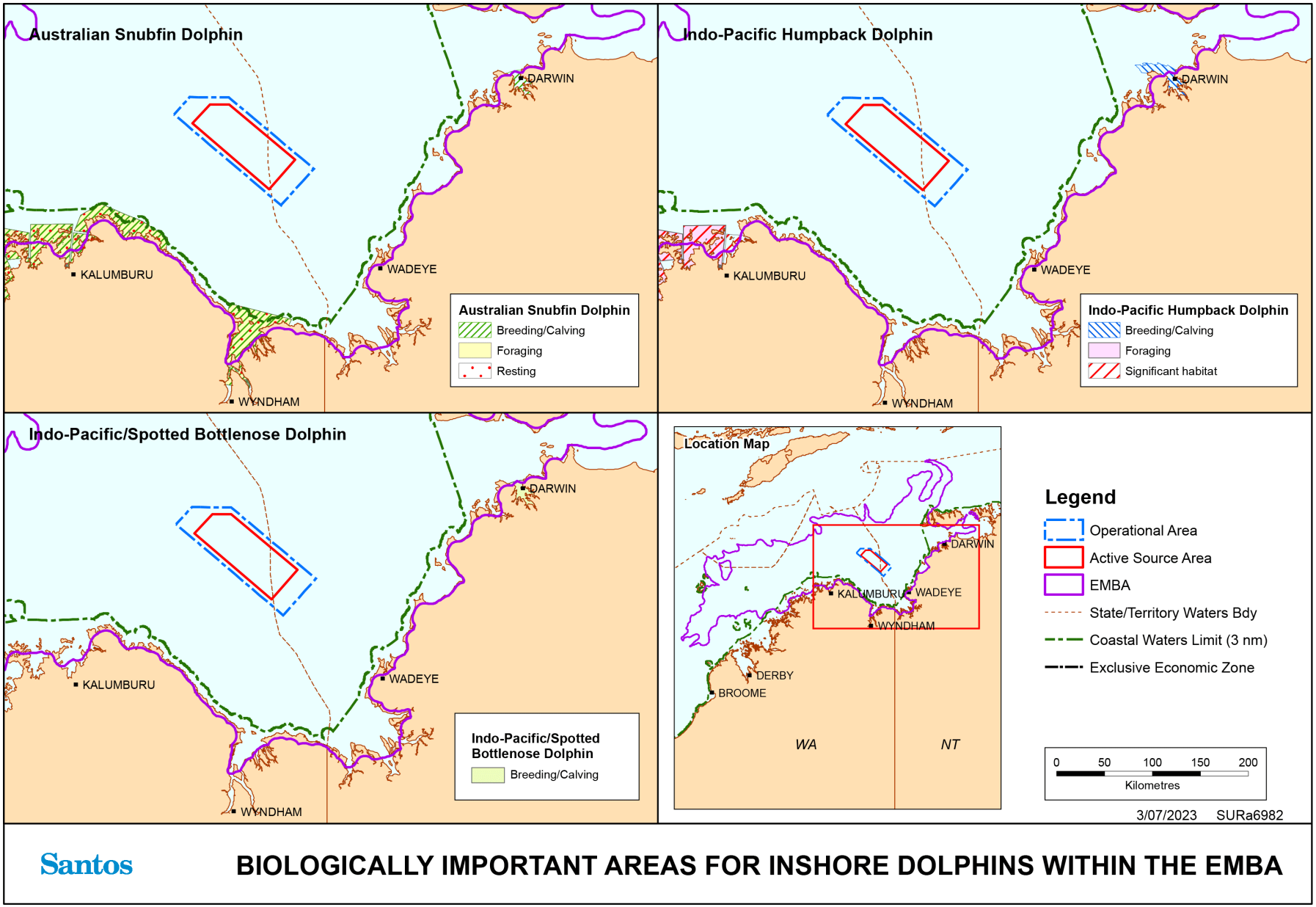


Figure 3-8: Breeding and foraging BIAs for inshore dolphins

3.7.4 Marine reptiles

3.7.4.1 Marine turtles

Marine turtles are known to migrate from foraging areas to mating and nesting areas. All species with the exception of flatback turtles have an oceanic pelagic stage before moving to nearshore waters to breed. The NWMR and NMR are considered to be significant for supporting large feeding and nesting turtle populations.

The Recovery Plan for Marine Turtles in Australia (DoEE 2017) identifies areas 'habitat critical to the survival of a species' ('habitat critical') for marine turtle stocks under the EPBC Act. 'Habitat critical' is defined by the EPBC Act Significant Impact Guidelines 1.1 – Matters of National Environmental Significance as areas necessary:

- For activities such as foraging, breeding or dispersal
- For the long-term maintenance of the species (including the maintenance of species essential to the survival of the species)
- To maintain genetic diversity and long-term evolutionary development
- For the reintroduction of populations or recovery of the species.

It is noted that 'habitat critical' differs from 'Critical Habitat' as defined under Section 207A of the EPBC Act (Register of Critical Habitat). No 'Critical Habitat' has been identified and listed for marine turtles.

The Operational Area overlaps foraging areas of the green turtle, Olive Ridley, flatback turtle and loggerhead turtle. There are 13 habitats critical to survival of the species within the EMBA. The nearest habitat critical area is for the flatback turtle at Cape Dormett, 39 km from the Operational Area (refer to Figure 3-10).

Seven threatened and migratory marine turtle species were identified in the EPBC Act Protected Matters Database search as having the potential to occur in the Operational Area and EMBA. A description of their distribution, habitats, life stages and likely presence within and around the Operational Area during the survey is provided in Table 3-15.

There are several BIAs for turtle species in the region, including along the coastline and offshore islands adjacent to the Operational Area, within the EMBA (Figure 3-9 and Figure 3-10). These include:

- Foraging BIAs for loggerhead, flatback, olive ridley and green turtles that overlap with the Operational Area
- Internesting buffer BIA for the flatback turtle (Cape Domett) which is located adjacent (south) to the Operational Area (but not overlapping)
- Internesting BIA for the flatback turtle (Melville Island, Coburg Peninsula) located approximately 90 km east north-east of the Operational Area.
- Internesting BIAs for the olive ridley turtle located off the coast of Fog Bay, approximately 151 km east north-east of the Operational Area
- Internesting buffer BIAs for the green turtle, the nearest located at Cassini Island, 224 km west south-west of the Operational Area.
- Nesting BIA for the green turtle (Cassini Island) located 243 km west north-west of the Operational Area.
- Foraging BIAs for the hawksbill turtle, located at Cartier Island, approximately 437 km west north-west of the Operational Area.
- Internesting BIA for the hawksbill turtle, located at Greenhill Island, 379 km east north-east of the Operational Area.

Although the Operational Area overlaps a number of BIAs, there is a low likelihood of marine turtles occurring in the Operational Area. Between February and March 2022, Santos conducted the Petrel Sub-Basin SW 3D MSS, located in the JBG. During the 350 hours of survey, only two unidentified turtles were observed in Petrel's Operational Area.

The INPEX Bonaparte MSS, 175 km west of Darwin, undertaken between 6 January and 27 February 2024 over 52 days, detected 7 unidentified turtles within the Operational Area. These sightings within the JBG, support the low probability of marine turtles occurring in Eos Operational Area (Santos 2022).

During consultation, a community member at the Wurankuwu Clan meeting confirmed the importance of the importance of turtles to their Clan.

3.7.4.2 Seasnakes

Seasnakes are essentially tropical in distribution, and habitats reflect influences of factors such as water depth, nature of seabed, turbidity and season (Heatwole and Cogger 1993). Some species have extensive distributions and individuals may cover large distances, while other species have limited home ranges (Heatwole and Cogger 1993). Most seasnake species tend to be found in the shallower parts of the region to allow for increased benthic foraging time (DEWHA 2008b).

Seasnakes that inhabit coral reefs in the region (e.g. Ashmore Reef, located approximately 474 km to the north west of the Operational Area) live out their lives within a few hectares, with little movement between the reefs (Guinea 2013; PTTEP 2013). The distance between reefs in the region and the deep water between reefs inhibits migration and supports the concept that seasnakes at each reef form a discrete 'management unit' for each species and prevents species from occupying all reefs (PTTEP 2013).

There are several species of seasnake occurring within the region (DEWHA 2008b). Three threatened marine seasnake species are identified by the PMST Report as potentially occurring in the EMBA, the short-nosed, leaf-scaled and dusky seasnakes.

No coral reefs occur within the Operational Area and therefore seasnakes are expected to occur only in low numbers. It is noted however that the pinnacles of the Bonaparte Basin KEF, can support high-order pelagic animals including seasnakes (DoEE 2019b).

A description of the distribution, migration movements, preferred habitat and life stages of the identified seasnakes species is provided in Table 3-15, including commentary on their likely presence in the Operational Area and EMBA.

3.7.4.3 Crocodiles

One migratory crocodile species, the salt-water crocodile was identified in the EPBC Act PMST Report as potentially occurring in the Operational Area and EMBA. The salt-water crocodile is found in Australian coastal waters, estuaries, lakes, inland swamps and marshes. The species has a tropical distribution that extends across the northern coastline of Australia (Webb et al. 1987). The salt-water crocodile has been known to inhabit the Daly and Moyle rivers (approximately 240 km and 150 km, respectively, south-east of the Operational Area).

During consultation, a community member at the Wurankuwu Clan meeting confirmed the importance of the importance of crocodiles to their Clan.

A description of the distribution, migration movements, preferred habitat and life stages of the crocodile is provided in Table 3-15, including commentary on its likely presence in the EMBA.

Table 3-15: Threatened and migratory marine reptiles potentially occurring within the Operational Area

Species	Protection status	Distribution, habitat and life stages	Presence in the Operational Area and EMBA
Flatback turtle	Vulnerable, Migratory	• The flatback turtle is found in the tropical waters of northern Australia, Papua New Guinea and Irian Jaya, and nesting is only known to occur in Australia (Limpus 2007). • Breeding occurs all year round, however, in northern Australia most nesting occurs between June and August (DoEE 2019a). The nearest nesting beach for flatback turtles to the Operational Area is at Cape Domett (approximately 127 km south). The Cape Domett nesting population appears to be one of the largest known nesting populations of this species, with an estimated yearly population in the order of several thousand turtles. Flatback turtles nest at Cape Domett throughout the year and peak nesting occurs during July, August and September (Whiting et al. 2008). • The 60 km habitat critical internesting buffer for flatback turtles in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017) is based primarily on the movements of tagged internesting flatback turtles along the NWS reported by Whittock et al. (2014), which found that flatback turtles may demonstrate internesting displacement distances up to 62 km from nesting beaches. However, these movements were confined to longshore movements in nearshore coastal waters or travel between island rookeries and the adjacent mainland (Whittock et al. 2014). There is no evidence to date to indicate flatback turtles swim out into deep offshore waters during the internesting period. A year round 80 km buffer distance is applied to the internesting BIA. • Flatback turtle hatchlings do not have an offshore pelagic phase. Instead, hatchlings grow to maturity in shallow coastal waters thought to be close to their natal beaches (DoEE 2017). Flatback turtle hatchlings do not undertake oceanic migrations like the juveniles of other turtle species do but spend their juvenile life phase within continental shelf waters (Limpus 2009). • Although turtles remain close to nesting beaches during the internesting period, there is evidence that flatback turtles undertake long-distance migrations between breeding and feeding grounds. A survey carried out in the region between 2005 and 2012 identified the distances 73 female flatback turtles travelled to their foraging grounds; 11 remained within 100 km of their rookeries, four migrated an average of 400 km and 58 migrated between 1,000 and 1,500 km (Pendoley et al. 2014). • More recent tagging studies further identified waters used by flatback turtles during post-nesting migration and foraging (Whittock et al. 2016a, 2016b; Thums et al. 2017). The studies found that turtles from the Pilbara region migrated north-east along the inner continental shelf, foraging in waters around Broome and James Price Point, Quondong Point, the Lacepede Islands, Lynher Bank, and at the Holothuria Banks in the Timor Sea (Whittock et al. 2016a, 2016b). Foraging areas were typically located in less than 50 m water depth (36.5 m mean depth) and 66 km from shore. • Thums et al. (2017) studied flatback turtles during their post-nesting migration from the Lacepede Islands and during foraging. The study found that flatback turtles migrated along the coast in water depths of 63 ± 5 m, passing near Adele Island on the way to foraging grounds on the Sahul Shelf in the Timor Sea.	• The Operational Area overlaps with a foraging BIA for the species (refer to Figure 3-9). Therefore, foraging and transient turtles may occur within the Operational Area and EMBA. • The nearest internesting BIA is located 90 km east-north-east to the Operational Area (but does not overlap) (refer to Figure 3-10). • A 'habitat critical to the survival of a marine species' is located 39 km south of Operational Area (refer to Figure 3-10).

Species	Protection status	Distribution, habitat and life stages	Presence in the Operational Area and EMBA
		• Adult flatback turtles are primarily carnivorous, feeding on soft-bodied invertebrates. Juveniles eat gastropod molluscs, squid, siphonophores, and limited data indicate that cuttlefish, hydroids, soft corals, crinoids, molluscs and jellyfish are also eaten (DoEE 2019a). • Trawl bycatch data indicates that the species likely forages primarily in water depths of 10 m to 40 m in northern Australia, including catch records near the Carbonate Bank and Terrace System of the Sahul Shelf KEF and around the pinnacles of the Bonaparte Basin KEF (Robins 1995; Poiner and Harris 1996). • Eight flatback turtles were reported by MFOs onboard the seismic vessel during Santos' Beehive 3D MSS (late-July to mid-August) in the southern JBG.	
Loggerhead turtle	Endangered, Migratory	• The loggerhead turtle has a global distribution and occurs in eastern, northern and western parts of Australia (Limpus 2008). Loggerhead turtles are known to show fidelity to both their foraging and breeding areas and can make reproductive migrations of over 2,600 km between foraging and nesting areas (DoEE 2019a). The species are known to forage nearshore, in water depths up to approximately 50–60 m (DoEE 2019a). • In WA, the species is known to nest between October and February, with a peak in December (DoEE 2019a). • Juveniles feed on algae, pelagic crustaceans, molluscs and flotsam, whilst as an adult it feeds on gastropod molluscs, clams, jellyfish, starfish, coral, crabs and fish (DoEE 2019a). • Loggerhead turtles are known to forage around the pinnacles of the Bonaparte Basin and the Carbonate Bank and Terrace System of the Sahul Shelf KEFs.	• The northern portion of the Operational Area overlaps with a foraging BIA for loggerhead turtles (refer to Figure 3-9). • Therefore, foraging and transient turtles are likely to occur within the Operational Area and EMBA.
Green turtle	Vulnerable, Migratory	• Ashmore Reef and Cartier Island (approximately 445 km away) support a genetically distinct population in the region and provide critical nesting and internesting habitats (DoEE 2019a). Green turtles have been recorded to nest mainly on West Island at Ashmore Reef. They mainly nest at Ashmore Reef and Cartier Island during the mid-summer months (December to February) occasionally occurring year round, while the peak hatching period is March to April (DEWHA 2008a; Guinea 1995; Guinea 2013). • Distributed globally throughout tropical and subtropical waters, with WA supporting one of the largest green turtle populations in the world. Green turtles nest, forage and migrate across tropical northern Australia (DoEE 2019a). • Female green turtles go into an internesting cycle after each nesting occurrence. The internesting cycle takes approximately two weeks once nesting starts. The females spend this period in shallow waters beyond the reef edge, where they visit different substrates, occupy different depths and move up to tens of kilometres from the nesting beach. • The species undertakes extensive post-nesting migrations from foraging areas to traditional breeding areas, with individuals recorded migrating up to 2,600 km from nesting beaches (DoEE 2019a). One tagged female made a post-breeding migration through the Operational Area from Ashmore Reef to the Cobourg Peninsula in north-western NT (Limpus 2008). • The species primarily forages in shallow benthic habitats (<10 m) such as tropical tidal and subtidal coral and rocky reef habitat or inshore seagrass beds, feeding on seagrass beds or algae mats (Hazel et al. 2009; DoEE 2019a). Large feeding aggregations of green turtles are	• The Operational Area overlaps with a foraging BIA for the species. Therefore, foraging and transient turtles may occur within the Operational Area and EMBA. • The closet biologically important nesting area for green turtles is located 224 km west south-west of the Operational Area at Cassini Island. The north-west of Melville Island, 263 km north north-east of the Operational Area, is a biologically important internesting area for this species (refer to Figure 3-10).

Species	Protection status	Distribution, habitat and life stages	Presence in the Operational Area and EMBA
		present at Ashmore Reef. It is the only reef recorded on the Sahul Shelf, where such large numbers of green turtles gather to feed (Guinea 2013). • Adult green turtles feed on seagrass, sponges and algae. • The pinnacles of the Bonaparte Basin are thought to be a KEF where green turtles transverse between foraging and nesting grounds. Further, a large portion of the Operational Area overlap a foraging BIA for this turtle species (refer to Figure 3-9).	
Leatherback turtle	Endangered, Migratory	• Leatherback turtles are pelagic feeders, spending extended periods in tropical, subtropical and temperate open ocean waters (Limpus 2009). The species has been recorded feeding in the coastal waters of all Australian States and Territories in low densities. • Nesting occurs on tropical beaches and subtropical beaches (Marquez 1990) but no major centres of nesting activity have been recorded in Australia. The species is understood to migrate from Australian waters to breed at larger rookeries in neighbouring countries such as Indonesia, Papua New Guinea and Solomon Islands between December and January (DoE 2015b). • Leatherback turtle forage on pelagic soft bodied creatures (such as jellyfish, squid, salps, siphonophores and tunicates) all year round in Australian waters (DoEE 2019a).	• The closest confirmed internesting site for the leatherback turtle is at the Cobourg Peninsula (DoEE 2019a), approximately 440 km northeast of the Operational Area and outside the EMBA. • Given the species distribution, and low-density population in Australian waters, the presence of the species within the Operational Area and EMBA is expected to be low.
Hawksbill turtle	Vulnerable, Migratory	• Hawksbill turtles are found in tropical, subtropical and temperate waters, with nesting mainly confined to tropical beaches (Limpus and Miller 2008). The hawksbill turtle is commonly found in the NWMR and NMR, nesting extensively along the coasts and foraging in the region. However, no hawksbill turtle nesting stocks are known to occur within the JBG (DoEE 2017). • The species is highly migratory and is known to migrate long distances between nesting and foraging areas (ranging from 35 to 2,400 km) (DoEE 2019a). • Australia has the largest breeding population of hawksbill turtles in the world (Limpus 2008). • Hawksbill turtles' nest year round, with a peak between October and December (DSEWPaC 2012d). Internesting females are known to stay within approximately 20 km of nesting beaches. • The north-east subpopulation breeds throughout the year with a peak nesting period during July to October (DoEE 2019a), whilst breeding in the WA population peaks around October to January. • As a juvenile, the hawksbill turtle feeds on plankton in the open ocean and then feeds on sponges, hydroids, cephalopods, gastropods, jellyfish, seagrass and algae as an adult (DoEE 2019a). • Hawksbill turtles were found to forage in waters ranging from 1.5 m to 84 m deep, and Fossette et al. (2021) report that 17% of satellite tagged turtles (total n=42) foraged in relatively deep waters greater than 20 m. Fossette et al. (2021) reported less than a quarter of foraging area overlapped with designated foraging BIAs for hawksbill turtles and/or Commonwealth and State-managed protected areas.	• The closest inter-nesting area to the Operational Area for hawksbill turtles is located at the Cartier Island, Peninsula (within the NWMR), approximately 437 km west north-west. • Given the species wide distribution in Australian waters, transient turtles may occur within the Operational Area and EMBA.
Olive ridley turtle	Endangered, Migratory	• The olive ridley turtle has a worldwide tropical and subtropical distribution and is known to occur in both WA and NT (DSEWPaC 2012d). Whilst nesting has been recorded in WA, it is far more common in the NT (DoEE 2019a).	• The Operational Area overlaps with a foraging BIA for this turtle species (refer to Figure 3-9). Therefore, foraging and

Species	Protection status	Distribution, habitat and life stages	Presence in the Operational Area and EMBA
		• Although olive ridley turtles nest all year-round nesting activity peaks around April to November, with the majority of nesting occurring from the Arnhem Land coast (including Bathurst Island, a biologically important internesting area) to the north-western coast of Cape York Peninsula (DoEE 2019a). After nesting, olive ridley turtles are known to migrate up to 1,050 km to various foraging areas (DoEE 2019a) including the pinnacles of the Bonaparte Basin and the Carbonate Bank and Terrace System of the Sahul Shelf KEFs (DEWHA 2008a). • The olive ridley turtle is known to primarily forage in soft-bottom habitats ranging in depths from 6–35 m. They are also known to forage in pelagic waters (DEWHA 2008a). • The olive ridley turtle is known to forage in the western Joseph Bonaparte Depression and Gulf. • Adult turtles forage for crabs, shrimp, tunicates, jellyfish, salps and algae in depths ranging from several metres to over 100 m (DoEE 2019a).	transient turtles may occur within the Operational Area and EMBA. • The closest internesting area is off the coast of Fog Bay; approximately 151 km east north-east of the Operational Area (refer to Figure 3-10).
Pig-nosed turtle	Migratory, Vulnerable	• The pig-nosed turtle is a very large freshwater turtle, weighing up to 16 kg (DCCEEW, 2024). • In Australia the species occurs in the larger rivers of the NT, this includes the Daly River and its tributaries the Katherine and Flora Rivers (DCCEEW, 2024).	• Given that the nearest pig-nosed turtle habitat is the Daly river, approximately 151 km from the Operational Area, the presence of the species within the Operational Area and EMBA is likely to be infrequent.
Salt-water crocodile	Migratory	• The salt-water crocodile is found in Australian coastal waters, estuaries, lakes, inland swamps and marshes. The species' distribution ranges from Rockhampton in QLD throughout coastal NT to King Sound (near Broome) in WA (DoEE 2019a). • The salt-water crocodile has been found in most major river systems in WA and the NT. The species mostly occurs in tidal rivers, coastal floodplains and channels, billabongs and swamps up to 150 km inland from the coast (DoEE 2019a). • The salt-water crocodile's primary food sources are crustaceans, insects and mammals; however, only larger individuals eat mammals. In areas of higher salinity (mangroves), the salt-water crocodile eats larger volumes of crab and a smaller volume of shrimp and insects. • Preferred nesting habitat of the salt-water crocodile includes elevated, isolated freshwater swamps that do not experience the influence of tidal movements. Floating rafts of vegetation also provide important nesting habitat. In the NT, most nest sites are found on the north-west banks of rivers. The species nest during the wet season with peak nesting during January and February.	• Given that the nearest salt-water crocodile habitats are in the Daly and Moyle rivers, approximately 151 km and 118 km from the Operational Area respectively, the presence of the species within the Operational Area and EMBA is likely to be infrequent.
Short-nosed sea snake	Critically Endangered	• Short-nosed Sea Snakes are found in waters offshore of north-western Australia, including coastal waters between Exmouth and Broome, and remote reefs on the North-West Shelf. • Short-nosed Sea Snakes are associated with coral reefs, which they use for shelter and for foraging on small coral reef fish and eels.	• Given the preferred habitat and water depth the presence of the species within the Operational Area and EMBA is likely to be infrequent.
Leaf-scaled sea snake	Critically Endangered	• The Leaf-scaled Sea Snake occurs primarily on the reef flats or in shallow waters of the outer reef edges to depths of 10 m. • The species is known to shelter under coral or rubble at low tide, predating on small coral reef fish that it catches by poking its head into burrows in the sand and then striking at prey.	• Given the preferred habitat and water depth the presence of the species within the Operational Area and EMBA is likely to be infrequent.

Species	Protection status	Distribution, habitat and life stages	Presence in the Operational Area and EMBA
		• This species occurs within the North Western Marine Bioregion. The distribution of this species also falls within the Ashmore and Cartier Reef Marine Reserve	
Dusky sea snake	Endangered	• The dusky sea snake is a benthic, coral reef-associated species endemic to the shallow (less than 15 m deep), emergent reefs of the Sahul Shelf off the coast of Western Australia in the Timor Sea, between Timor and Australia. These reefs are relatively isolated and lie at the edge of the continental shelf over several hundred kilometres from the mainland. • The dusky sea snake is viviparous, which means embryos develop internally and young undergo live birth. Because this species never ventures on land, mating occurs at sea and young are born alive in the water. • Little is known about the juvenile life stage of dusky sea snakes. The dusky sea snake's lifespan is 10 years.	• Given the preferred habitat and water depth the presence of the species within the Operational Area and EMBA is likely to be infrequent.

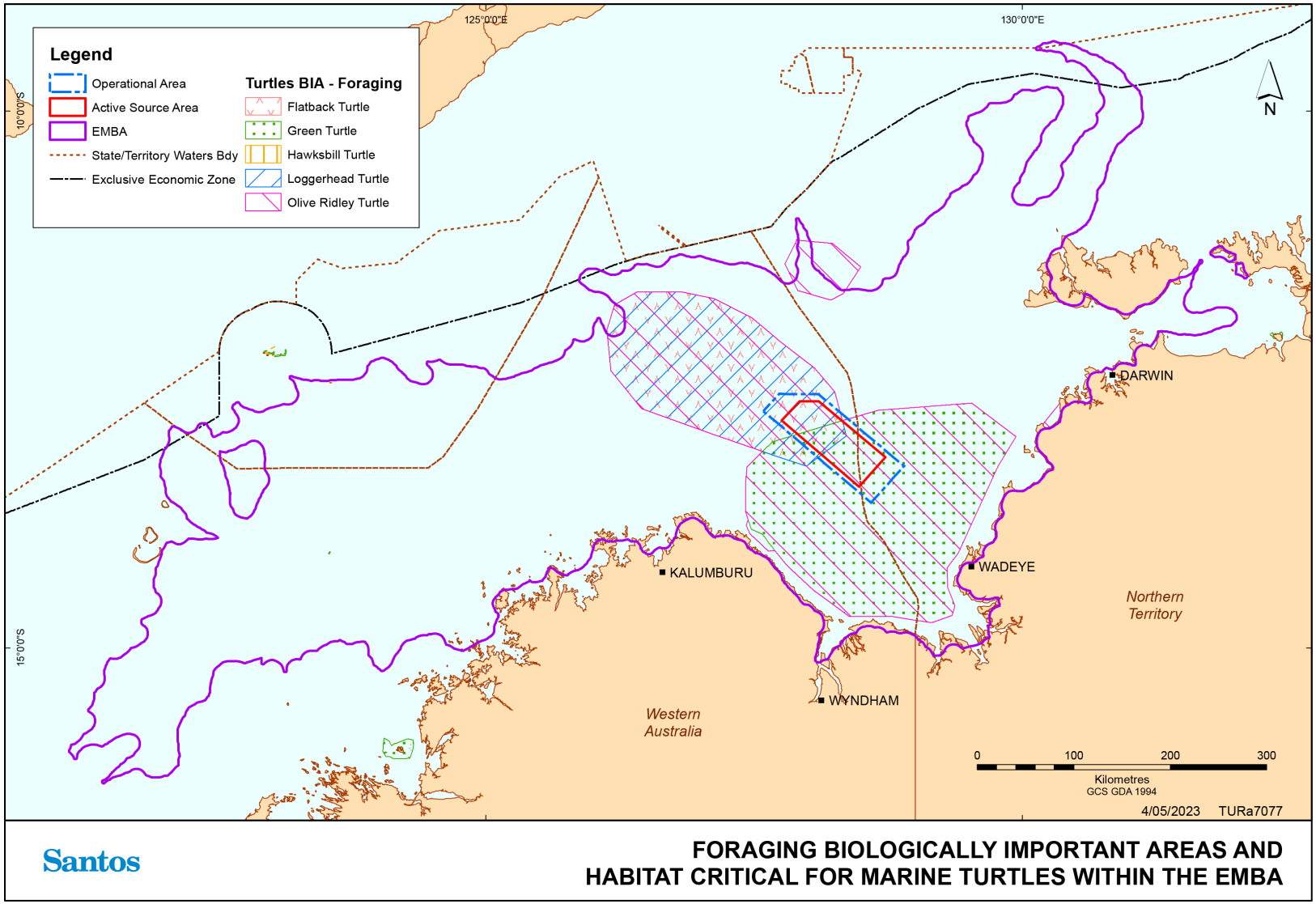


Figure 3-9: Foraging BIAs for marine turtles within the EMBA

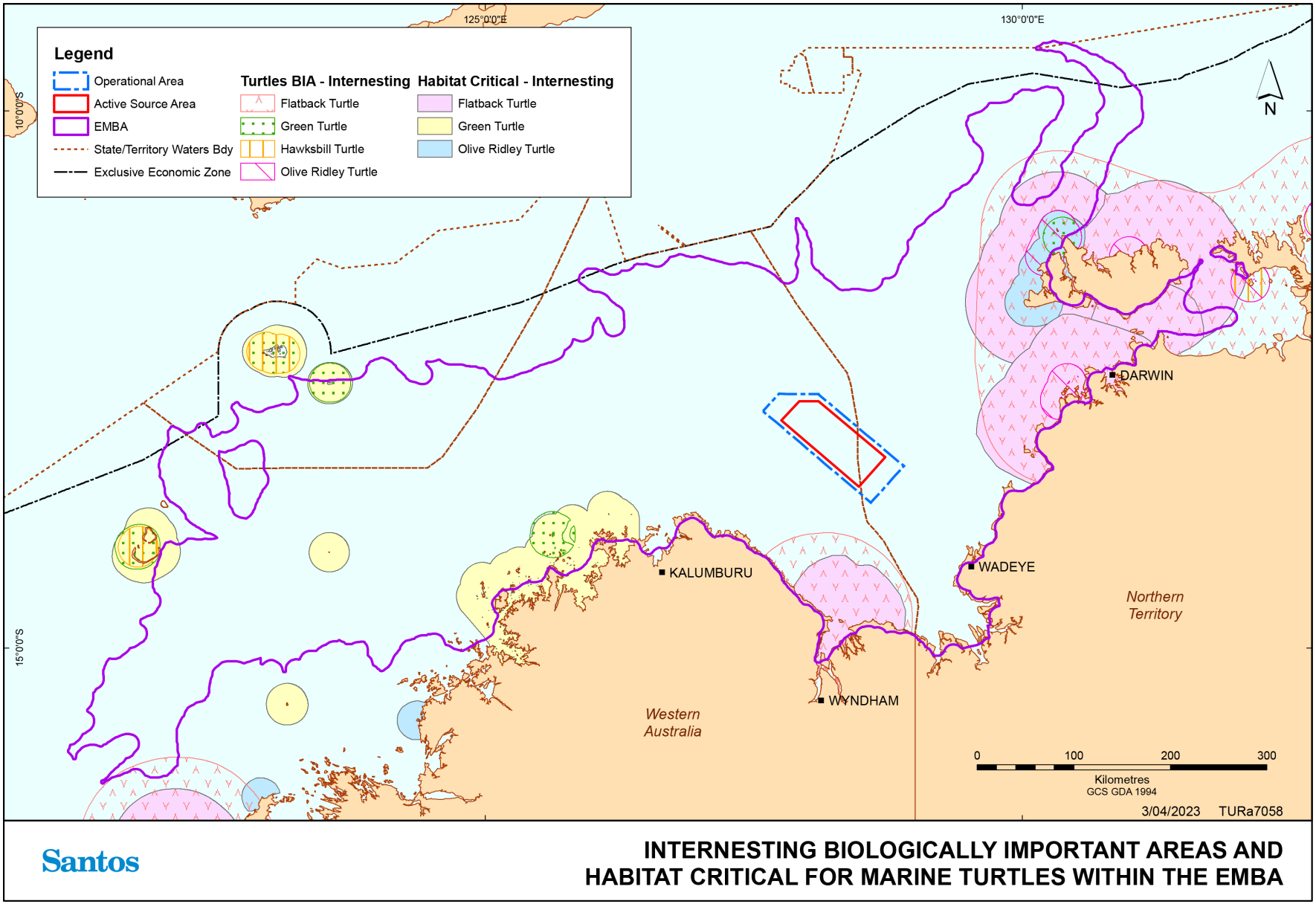


Figure 3-10: Marine turtle internesting BIAs and Habitat Critical within the EMBA

3.7.5 Sharks and rays

The NWMR and NMR experiences high species richness of shark, sawfish and rays stemming from the diversity of marine environments (DEWHA 2008a, DEWHA 2008b). There are approximately 500 shark and sawfish species globally, with 94 of these found in the region (i.e. 19% of the world's shark species) (DEWHA 2008b).

Two threatened, five threatened and migratory, and seven migratory shark and ray species were identified by a search of the EPBC Act PMST Report as potentially occurring in the Operational Area (Table 3-16).

No BIAs for sharks or rays were identified to occur within the Operational Area. A whale shark foraging BIA overlaps with the western portion of the EMBA, approximately 205 km west south-west of the Operational Area (Figure 3-11). This migration and foraging route follows the continental shelf within the 200 m isobath and extends from Ningaloo to waters in the north Kimberley region. Individuals tagged at Ningaloo Reef have been shown to migrate north, north-east or north-west into Indonesian waters, using both inshore and offshore habitats (Reynolds et al. 2017; Sleeman et al. 2010; Wilson et al. 2006). The foraging BIA represents waters where solitary whale sharks may forage during the migration from Ningaloo, which occurs primarily in spring (September to November).

BIAs for the dwarf sawfish, freshwater sawfish and green sawfish occur in Kimberley coastal waters, but outside the EMBA for this activity (Figure 3-11).

A description of the distribution, migration movements, preferred habitat and life stages of the identified sharks and rays species is provided in Table 3-16, including commentary on their likely presence in the Operational Area and EMBA.

Table 3-16: Threatened and migratory sharks and rays potentially occurring within the Operational Area and EMBA

Species	Protection status	Distribution, habitat and life stages	Presence in the Operational Area and EMBA
Whale shark	Vulnerable, Migratory	• The whale shark occurs in both tropical and temperate waters with a typically oceanic and cosmopolitan distribution (Colman 1997). They are most commonly recorded in WA, the NT and Queensland, although they have been sighted occasionally in New South Wales and Victoria. • According to the DoEE's Conservation Advice on whale sharks, the species is known to aggregate at Christmas Island (approximately 2,400 km away) between December and January and at Ningaloo Reef (approximately 1,800 km away) between March and July to feed on krill and baitfish associated with coral spawning events (DoEE 2019a). • The whale shark migration between Christmas Island and Ningaloo Reef is expected to occur in deep waters away from the Operational Area between January and March (Colman 1997). • The population participating in the Ningaloo aggregation is estimated to comprise between 300 and 500 individuals, although the total population size in the region is unknown (Meekan et al. 2006).	The eastern boundary of the whale shark BIA for foraging (the northern WA coastline along the 200 m isobath) is approximately 205 km west south-west of the Operational Area (Figure 3-11). Whale sharks are known to forage within the BIA during spring. Due to the species widespread distribution and highly migratory nature, individuals may transit through the Operational Area. Given the recorded migratory routes in the region, the cosmopolitan distribution of the species and location of the foraging BIA, whale sharks may be encountered in the Operational Area and EMBA in low numbers.
Green sawfish	Vulnerable, Migratory	• The Carbonate Bank and Terrace System of the Sahul Shelf KEF is known to support green sawfish (Donovan et al. 2008). A portion of this KEF overlaps with the eastern portion of the Operational Area. • The green sawfish occurs in both inshore and offshore marine coastal waters of northern Australia. Its current known distribution stretches from Broome in WA around northern Australia and down the east coast as far as Jervis Bay, NSW (DoEE 2019a). • The green sawfish has been recorded in inshore marine waters, estuaries, river mouths, embankments and along sandy and muddy beaches (Peverell et al. 2004). They have also been recorded from very shallow water (<1 m) to offshore trawl grounds in over 70 m of water (Stevens et al. 2005).	The closest foraging BIA for green sawfish in the area is located along the eastern shore of Camden Sound, over 450 km away from the Operational Area and outside of the EMBA (Figure 3-11). Given green sawfish are known to occur in the JBG (both adults and juveniles), the species may be encountered in low numbers in the Operational Area. The species may be present in higher numbers in the coastal region of the EMBA.
Reef manta ray	Migratory	• The reef manta ray is found around the northern coast of Australia between south-western Australia, and central New South Wales (DoEE 2019a). • This species is often resident in or along productive near-shore environments, such as island groups, atolls or continental coastlines. This species tends to inhabit warm tropical or sub-tropical waters (Marshall et al. 2018a). The species is commonly sighted inshore, however is also found around offshore coral reefs, rocky reefs and seamounts (Marshall et al. 2018a). • Movement patterns are likely site-specific and correlated with cycles in productivity. Individuals have been documented to make seasonal migrations of several hundred kilometres as well as daily migrations of almost 70 km (Marshall et al. 2018a).	Given the species is generally associated with nearshore environments, the presence of the species within the Operational Area is expected to be limited. The species may be present in higher numbers within the coastal region of the EMBA.

Species	Protection status	Distribution, habitat and life stages	Presence in the Operational Area and EMBA
Giant manta ray	Migratory	• The giant manta ray has a widespread distribution along the coast of Australia and is also known to seasonally migrate between aggregation sites (Marshall et al. 2018b). • The giant manta ray is commonly sighted along productive coastlines with regular upwelling, oceanic island groups and particularly offshore pinnacles and seamounts (Marshall et al. 2018b). This species has been recorded within the Oceanic Shoals Marine Park (Nichol et al. 2013). • The giant manta ray lives in tropical, marine waters worldwide, and occasionally in temperate seas between latitudes 30°N and 35°S (Australian Museum 2014). • The year-round population of giant manta rays present at Ningaloo Reef extends to Exmouth from mid- May through to mid-September.	Given the species wide-distribution, the presence of the species within the Operational Area is expected to be low. The species may be present in higher numbers in the coastal region of the EMBA.
Narrow sawfish	Migratory	• The exact distribution of the narrow sawfish is uncertain, but it is highly likely that its full range extended from Indo-Australian Archipelago to Japan and South Korea. • The narrow sawfish is a benthic-pelagic species that inhabits estuarine, inshore and offshore waters to at least 40 m depth (Last and Stevens 2009). Inshore and estuarine waters are critical habitats for juveniles and pupping females, whilst adults predominantly occur offshore (Peverell 2004).	Given the species wide-distribution, the presence of the species within the Operational Area is expected to be low. The species may be present in higher numbers in the coastal region of the EMBA.
Northern river shark	Endangered	• The northern river shark is known to occur in WA and the NT, occupying both marine and freshwater environments including the JBG, Daly River, Adelaide River and the South and East Alligator rivers. • Northern river sharks are elasmobranchs capable of living and moving between freshwater and seawater. The species uses rivers, tidal sections of large tropical estuarine systems, macro tidal embayments, inshore and offshore marine habitats. • Northern river sharks are thought to be endemic to Australia and southern New Guinea.	Given the species preferred estuarine habitat, the presence of the species within the Operational Area is expected to be low. The species may be present in the coastal region of the EMBA.
Dwarf sawfish	Vulnerable, Migratory	• The dwarf sawfish usually inhabits shallow (2–3 m deep) coastal waters and estuarine habitats. Its distribution is thought to extend north from Cairns around the Cape York Peninsula in Queensland, across northern Australian waters to the Pilbara coast in WA (DoEE 2019a). • The dwarf sawfish uses its rostrum to stun schooling fish by sideswiping or threshing while swimming through a school. The main prey species is popeye mullet (*Rhinomugil nasutus*).	The closest foraging BIA for dwarf sawfish in the area is located along the eastern shore of Camden Sound, approximately 450 km away from the Operational Area and outside of the EMBA (Figure 3-11). Given the species preferred coastal habitat, and the location of the foraging BIA, the presence of the species within the Operational Area is expected to be low. The species may be present in the coastal region of the EMBA.
Freshwater sawfish	Vulnerable, Migratory	• The freshwater sawfish is a marine/estuarine species that spends its first three–four years in freshwater growing to about half its adult size (4 m+) (Allen 2000 pers. Comm.). Juveniles and sub-adult freshwater sawfish predominantly occur in	The nearest freshwater sawfish foraging BIA is at King Sound, approximately 633 km away from the Operational Area and outside the EMBA (Figure 3-11).

Species	Protection status	Distribution, habitat and life stages	Presence in the Operational Area and EMBA
		rivers and estuaries, while large mature animals tend to occur more often in coastal and offshore waters up to 25 m depth (DoEE 2019a). • In northern Australia, this species appears to be confined to freshwater drainages and the upper reaches of estuaries, occasionally being found as far as 400 km from the sea. It is likely to occur within the Carbonate Bank and Terrace System of the Sahul Shelf KEF. • The freshwater sawfish feeds on fishes and benthic invertebrates. The saw is used to stun schooling fish, such as mullet, and for extracting molluscs and small crustaceans from the benthic sediment.	Given the species preferred estuarine habitat, and the location of the foraging BIA, the presence of the species within the Operational Area is expected to be low.
Speartooth shark	Critically Endangered	• Speartooth sharks occur in geographically distinct locations across northern Australia in the NT and Queensland, and have been recorded in tidal rivers and estuaries with turbid waters, fine muddy substrates and temperatures ranging from 27–33 °C (DoE 2014). • In the NT, they are found in the Van Diemen Gulf drainage, including the Adelaide River, South, East and West Alligator rivers and Murganella Creek (Field et al. 2008; Pillans et al. 2009). • Due to their similarity to bull sharks, it is thought that adult speartooth sharks may live outside of rivers in the coastal marine environment (Stevens et al. 2005; Pillans et al. 2008).	Due to the species preference for estuarine and coastal waters, the presence of the speartooth sharks within the Operational Area is expected to be low. The species may be present in the coastal region of the EMBA.
Great white shark	Vulnerable, Migratory	• Great white sharks have been recorded from central Queensland around the south coast to north-west WA, with movements occurring between the mainland coast and the 100 m depth contour (DoEE 2019a). • They are known to undertake migrations along the WA Coast, with some individuals travelling as far north as North West Cape during spring, before returning south for summer (DoEE 2019a). • Great white sharks are frequently recorded in waters around fur seal and sea lion colonies (DoEE 2019a).	Due to the species preference for cold temperate waters and feeding grounds in waters around seal colonies further south, the presence of the species within the Operational Area and EMBA is likely to be infrequent.
Shortfin mako shark	Migratory	• The shortfin mako is a pelagic species with a circumglobal, wide-ranging oceanic distribution in tropical and temperate seas (Mollet et al. 2000). The shortfin mako is found in tropical and warm-temperate seas in water depths up to 500 m. The species is rarely found in waters cooler than 16° C, and is occasionally found close inshore where the continental shelf is narrow (Cailliet et al. 2009). • It is widespread in Australian waters having been recorded in offshore waters all around the continent's coastline with exception of the Arafura Sea, the Gulf of Carpentaria and Torres Strait (Last and Stevens 2009). • Shortfin makos are also highly migratory and travel large distances.	Given the species distribution in deep offshore waters, the presence of the species within the Operational Area and EMBA is expected to be low.
Longfin mako shark	Migratory	• In Australian waters, longfin mako sharks are found from Geraldton, in WA, and north to Port Stephens in New South Wales (Last and Stevens 2009).	Given the species distribution in deep offshore waters, the presence of the species within the Operational Area and EMBA is expected to be low.

Species	Protection status	Distribution, habitat and life stages	Presence in the Operational Area and EMBA
		• Longfin makos inhabit oceanic and pelagic habits, typically in tropical regions. They are a highly mobile species and have a wide-ranging distribution (DEWHA 2008b) but are rarely encountered. • Whilst assumed to be a deep-water shark, sightings on the ocean surface, and the species' diet, suggest a broader depth range (Rigby et al. 2019).	
Oceanic whitetip shark	Migratory	• Within Australian waters, the oceanic whitetip shark is found from Cape Leeuwin, WA, through parts of the NT and down the east coast of Queensland and New South Wales to Sydney (Last and Stevens 2009). It has not been recorded within the Gulf of Carpentaria or the Arafura Sea. • The oceanic whitetip shark is a circumglobal deep-water pelagic species inhabiting tropical to warm-temperate waters (Compagno 1984). • Oceanic whitetip sharks prefer water temperatures above 20 °C and can reach depths of >180 m (Castro et al. 1999).	Given the species distribution in deep offshore waters, the presence of the species within the Operational Area and EMBA is expected to be low.
Scalloped Hammerhead	Conservation Dependent	• The Scalloped Hammerhead is a large (to 420 cm total length) coastal and semi-oceanic pelagic shark that is circumglobal in warm-temperate and tropical seas, from the surface and intertidal zone to depths of 1,043 m. • Within Australian waters the scalloped hammerhead extends from New South Wales (approximately from Wollongong, where it is less abundant), around the north of the continent and then south into Western Australia to approximately Geographe Bay. • The principal threat to the scalloped hammerhead is historic and ongoing fishing. The species is caught in recreational and commercial line fisheries, gillnets, trawls and bather protection programs. Because of their unique head shape, hammerheads are particularly vulnerable to capture by gillnets.	Given the species distribution in deep offshore waters, the presence of the species within the Operational Area is expected to be low. The species may be present in the EMBA.
Grey Nurse Shark	Migratory	• Grey Nurse Sharks are large, rather stout sharks that can grow up to 3.6 m long. They are slow but strong swimmers. • Grey Nurse Shark is a migratory species and is known to migrate north and south along the east coast of Australia and aggregate at known locations along the coasts of NSW and southern Queensland.	Given the species distribution, the presence of the species within the Operational Area and EMBA is expected to be low.

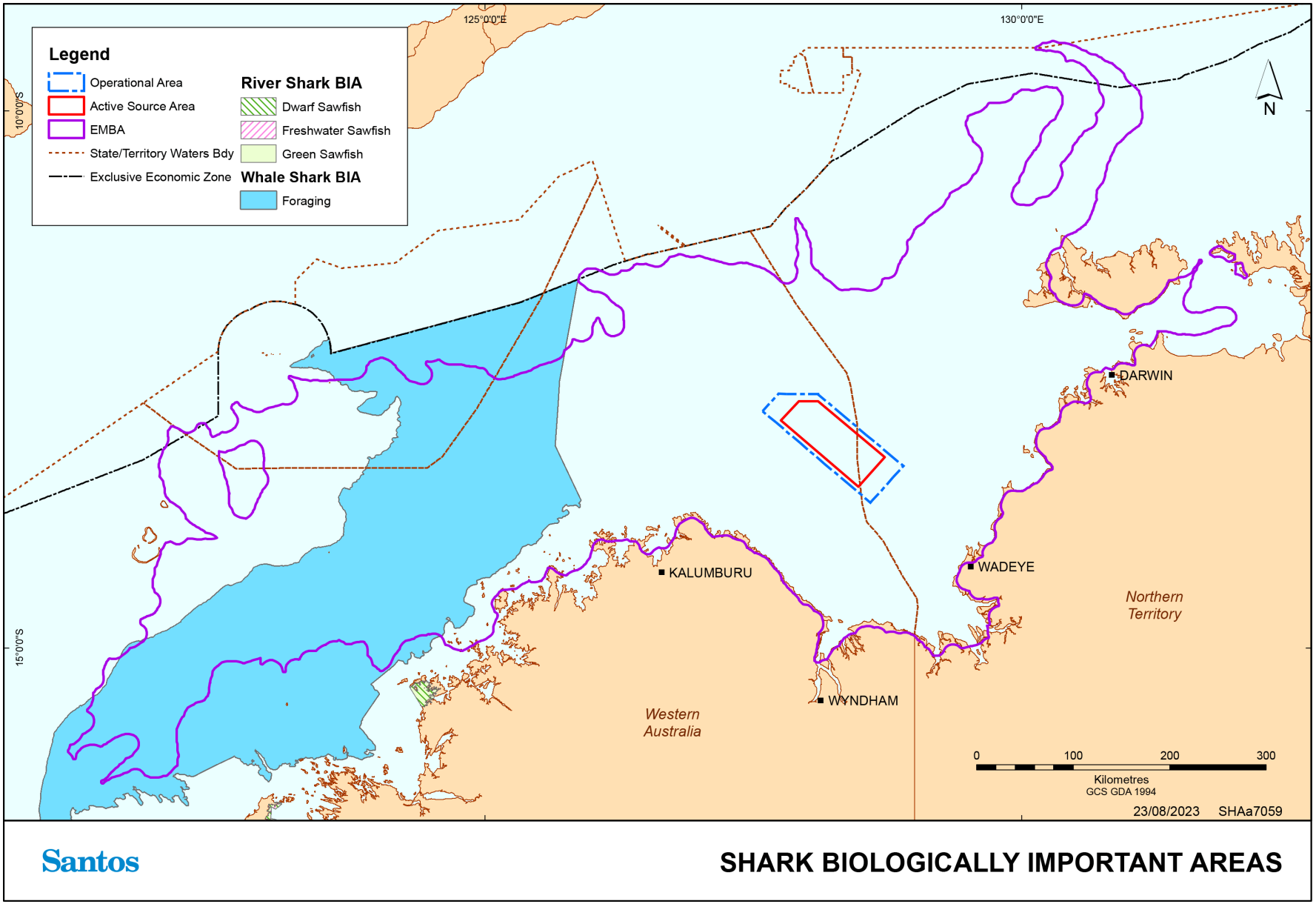


Figure 3-11: BIAs within the EMBA for whale sharks and river sharks

3.7.6 Seabirds and migratory shorebirds

Many migratory shorebirds (including those frequenting offshore islands) and seabird species are known to occur in the NWMR and NMR. Migratory shorebird species forage and rest in the region on their way between Northern Hemisphere breeding grounds and Northern Australian feeding grounds, known as the East Asian–Australasian Flyway. Seabird species spend the majority of their lives foraging across large distances over the open ocean and many also breed within the region (DSEWPaC 2012f).

There is no emergent land within the Operational Area to support breeding colonies of seabirds. The closest known breeding sites occur at the Kimberley, 75 km south southwest of the Operational Area. Extensive areas of shorebird and waterbird feeding habitat are associated with the mangroves and mudflats in this region. The Anson Bay to Fog Bay area, on the eastern side of the JBG, is one of the most important areas for colonial waterbird breeding in the NT. There is extensive shorebird feeding and roosting habitat in Fog Bay, Anson Bay and the Little Moyle River (DEWHA 2008b). Additionally, the Cartier Island and Ashmore Reef, within the EMBA, support breeding colonies of seabirds and migratory shorebirds. Given coastal habitats support large migratory populations, seabirds may fly over the Operational Area during migrations.

Results from the EPBC Act Protected Matters Database revealed that there are three threatened and migratory, and eight migratory seabird species within the Operational Area. Within the EMBA there are 17 threatened, six threatened and migratory, and 46 migratory seabird species.

There are several BIAs for marine bird species in the region, including along the coastline and offshore islands adjacent to the Operational Area, within the EMBA (Figure 3-12). These include:

- Lesser crested tern breeding and foraging BIAs with the nearest located approximately 75 km south southwest of the Operational Area.
- Roseate tern breeding and foraging BIAs, with the nearest located approximately 131 km south southwest of the Operational Area.
- Lesser frigatebird breeding and foraging BIAs located approximately 108 km west southwest of the Operational Area.
- Greater frigatebird breeding and foraging BIAs, with the nearest located 384 km west north-west of the Operational Area.
- Wedge-tailed shearwater breeding and foraging BIAs, with the nearest located 389 km west north-west of the Operational Area.
- White-tailed tropicbird breeding and foraging BIAs, located 392 km west north-west of the Operational Area
- Red-footed booby breeding and foraging BIAs, located 384 km west north-west of the Operational Area.
- Brown booby breeding and foraging BIAs, located 371 km west north-west of the Operational Area.
- Little tern breeding and foraging BIAs, with the nearest located approximately 232 km west south-west of the Operational Area.
- Little tern resting BIA (Ashmore Reef) located approximately 619 km west south-west of the Operational Area.
- Great crested tern breeding BIA near Seagull Island located approximately 265 km north north-east of the Operational Area.

A description of the distribution, migration movements, preferred habitat and life stages of the identified marine bird species in provided in Table 3-17, including commentary on their likely presence in the Operational Area and EMBA.

Table 3-17: Threatened and migratory seabirds potentially occurring within the Operational Area and EMBA

Species	Protection status	Distribution, habitat and life stages	Presence in the Operational Area and EMBA
Lesser crested tern	N/A	• The lesser crested tern inhabits tropical and sub-tropical dandy and coral coasts and estuaries (DSEWPaC 2012e). • In Australia, lesser crested terns are found on coasts and in coastal waters, primarily in the north. The species occurs around most of the NT, with the highest density of confirmed sightings along the coast to the south-west of Darwin (DSEWPaC 2012e). • The species breeds on low-lying islands, coral flats, sandbanks and flat sandy beaches, and may move nesting sites from one year to the next (DSEWPaC 2012e). • Lesser crested terns forage for small pelagic fish and shrimp in the surf and over offshore waters in areas of reef and deeper shelf waters (DSEWPaC 2012e). • The lesser crested tern is not listed as threatened or migratory under the EPBC Act 1999.	The closest breeding site to the Operational Area for the lesser crested tern is on the coastline of the Kimberley, approximately 75 km SSW away where there is a breeding BIA (Figure 3-12). The species is likely to be present in the EMBA, but unlikely to occur in the Operational Area.
Red knot	Endangered, Migratory	• The red knot is common in all the main suitable habitats around the coast of Australia, very large numbers are regularly recorded in northern Australia. • In Australasia, the red knot mainly inhabits intertidal mudflats, sandflats and sandy beaches of sheltered coasts or shallows pools on exposed wave-cut rock platforms or coral reefs. • The red knot usually forages in soft substrate near the edge of water on intertidal mudflats or sandflats exposed by low tide. At high tide, they may feed at nearby lakes, sewage ponds or floodwaters. They have also been observed foraging on thick algal mats in shallow water and in shallow pools on crests of coral reefs. • The red knot is diurnal and nocturnal. In non-breeding areas, feeding activity is regulated by tide; they feed less just before and after high tide. The red knot is omnivorous and eats mostly worms, bivalves, gastropods, crustaceans and echinoderms. • The red knot lays eggs in June and nests on open vegetated tundra or stone ridge, often close to a clump of vegetation. The red knot is migratory, breeding in the high Artic and moving south to non-breeding between 58° N and 50 °S. • Peak numbers of this species in the NWMR and NMR are usually between September and October.	Red knots were recorded in large numbers along the coastal strip from Fog Bay to Peron Island North (130 km from the Operational Area). Given the range and distribution of this species, the survey is likely to encounter low numbers of this species in the Operational Area during October. Higher population densities may be encountered in the nearshore waters of the EMBA.
Curlew sandpiper	Critically Endangered, Migratory	• The curlew sandpiper's breeding areas are mainly restricted to the Arctic (DoEE 2019a). This species does not breed in Australia. • Within Australia, curlew sandpipers occur around the coasts while also being widespread inland, though in smaller numbers (DoEE 2019a). • This species forages mainly on invertebrates, including worms, molluscs, crustaceans, and insects, as well as seeds. Outside Australia, they also forage on	Given the distribution of this coastal wetland bird species, the survey is likely to encounter low numbers of this species in the Operational Area, during the April/May period. Higher population densities may be encountered in the coastal waters of the EMBA.

Species	Protection status	Distribution, habitat and life stages	Presence in the Operational Area and EMBA
		shrimp, crabs and small fish. Curlew sandpipers usually forage in water, near the shore or on bare wet mud at the edge of wetlands (DoEE 2019a). • The species move into certain areas in Australia during northward migration in April, fatten up, and migrate out of Australia during May. They start returning to the area in August and throughout September (Chatto 2003).	
Little tern	Migratory	• The closest breeding site to the Operational Area for the non-Asian migrants of the little tern is on the coastline of the Kimberley (approximately 150 km away). Breeding is thought to occur in June, July and October (DoEE 2019a). • The little tern is widespread in Australia, with breeding sites widely distributed. The species has three separate populations in Australia; the northern subpopulation breeds across northern Australia, the eastern subpopulation breeds in the eastern and south-eastern coast of Australia; and the third subpopulation comprises of Asian migrants that migrate to spend their non-breeding season in Australia. The species has a widespread and continuous distribution from north-western Australia, around the north and east coast to south eastern Australia (DoEE 2019a). • The little tern is a coastal seabird, which usually forages in very shallow water, more often in brackish lagoons and saltmarsh creeks. The little tern usually forages close to breeding colonies (Commonwealth of Australia 2012). • The Asian migrants' non-breeding season is between spring and summer (September to May). The Asian migrants leave for their northern Hemisphere Breeding grounds between March and April (DoEE 2019a).	The closest breeding and foraging site to the Operational Area for the non-Asian migrants of the little tern is on the coastline of the Kimberley (approximately 232 km away) (Figure 3-12). Breeding is thought to occur in June, July and October (DoEE 2019a). Given the wide distribution and migration pattern, this species may be present in the Operational Area and EMBA in low numbers or isolated individuals/groups.
Sharp-tailed sandpiper	Migratory	• The sharp-tailed sandpiper spends the non-breeding season in Australia with small numbers occurring regularly in New Zealand (NZ). Most of the population migrates to Australia, mostly to the south-east and are widespread in both inland and coastal locations. In WA, they are widely distributed from Cape Arid to Carnarvon, around coastal plains of the Pilbara Region to south-west and east Kimberley Division. In NT, the most important area is the area from Darwin to Murgenella Creek and the Port McArthur. • In Australasia, the sharp-tailed sandpiper prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emerged grass or low vegetation. • The sharp-tailed sandpiper forages on seeds, worms, molluscs, crustaceans and insects. • The sharp-tailed sandpiper migrates to Australia in late June, early July, departing the breeding grounds. The species then departs the non-breeding grounds in Australia by April/March (DoEE 2019a).	Given the wide distribution of this species and the migratory pattern, it is likely this species will be encountered in low numbers within the Operational Area and EMBA.
Eastern curlew	Critically Endangered, Migratory	• Within Australia, the eastern curlew has a primarily coastal distribution. They have a continuous distribution from Barrow Island and Dampier Archipelago, WA, through the Kimberley and along the NT, QLD, and NSW coasts and the islands of Torres Strait. Elsewhere they are patchily distributed (DoEE 2019a).	Given the distribution of this coastal wetland bird species, the survey is likely to encounter low numbers of this species in the Operational Area. Higher population densities may be encountered in the coastal waters of the EMBA.

Species	Protection status	Distribution, habitat and life stages	Presence in the Operational Area and EMBA
		• This species does not breed in Australia, rather in the Northern Hemisphere during summer, between early May and late June (DoEE 2019a). They start to depart early March and begin to arrive back in late July. • During the non-breeding season in Australia, the eastern curlew is most commonly associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass (Zosteraceae) (DoEE 2019a).	
Common noddy	Migratory	• In Australia, the common noddy occurs mainly in the ocean off the QLD coast, but the species also occurs off the north-west and central WA coast. • During the breeding season, the common noddy usually occurs on or near islands, on rocky islets and stacks with precipitous cliffs, or on shoals or cays of coral or sand. When not at the nest, individuals will remain close to the nest, foraging in the surrounding waters. During the non-breeding period, the species occurs in groups throughout the pelagic zone. Birds may nest in bushes, saltbush, or other low vegetation. The seasonality of breeding varies greatly between sites. Depending on locations, birds breed annually or twice a year (spring to early summer and again at autumn). • The common noddy feeds mainly on fish, although they are known to also take squid, pelagic molluscs, medusa and aquatic insects.	Given the wide distribution of the species and preferred habitat, the species may be present in low numbers in the Operational Area and in the EMBA.
Streaked shearwater	Migratory	• The streaked shearwater occurs frequently in northern Australia from October to March, with some records as early as August and as late as May (Marchant and Higgins 1990). Whilst the species does not breed in Australia, it is known to forage in the NMR, in particular north-west of the Wellesley Islands (1,195 km from the Operational Area). • The streaked shearwater feeds mainly on fish and squid. • The streaked shearwater is a colonial breeder that lays a single egg in a burrow. Colonies are usually in a well-forested area (Birdlife 2019a).	Given the distribution of the species and preferred habitat, the species may be present in low numbers in the Operational Area and EMBA during the October – May period.
Lesser frigatebird	Migratory	• The lesser frigatebird is usually seen in tropical or warmer waters off northern WA, NT, QLD and northern NSW. The species forages in the NMR and breeds in areas adjacent to the region (Marchant and Higgins 1990). • The species is usually pelagic and often found far from land, but is also found over shelf waters, in inshore areas, and inland over continental coastlines (Marchant and Higgins 1990). • The lesser frigatebird breeds in mangroves or bushes, and even on bare ground. It feeds mainly on fish (especially flying-fish) and squid, but also on seabird eggs and chicks, carrion and fish scraps (Birdlife 2019b).	The closest biologically important breeding area of this species is at Kimberley coast, approximately 108 km west-south-west of the Operational Area (Figure 3-12). Given the distribution of the species and preferred habitat, this species may be present in the Operational Area and EMBA in low numbers.
Great frigatebird	Migratory	• Great frigatebirds are found in tropical waters globally. The species breeds on small, remote tropical and sub-tropical islands, in mangroves or bushes and occasionally on bare ground. • Great frigatebird feeds on fish, squid and chicks of other bird species.	A BIA has been identified at Kimberley and Ashmore Reef for the species to highlight breeding and foraging behaviours in the area (approximately

Species	Protection status	Distribution, habitat and life stages	Presence in the Operational Area and EMBA
		• Breeding is known to occur between May to June and in August (DoEE 2019a).	384 km west-north-west from the Operational Area) (Figure 3-12). Given the distribution of the species and preferred habitat, this species may be present in the Operational Area in low numbers. Higher population densities may be encountered in the coastal waters of the EMBA.
Common sandpiper	Migratory	• Distributed along all coastlines of Australia and many areas inland, the common sandpiper is widespread in small numbers. • Generally, the species forages in shallow water and on bare soft mud at the edges of wetlands. Birds sometimes venture into grassy adjoining wetlands and mangroves. • Typically, the common sandpiper eats molluscs such as bivalves, crustaceans such as amphipods and crabs and a variety of insects (DoEE 2019a). • The common sandpiper breeds in Eurasia and moves south for the boreal winter, with most of the western breeding populations wintering in Africa, and eastern breeding populations wintering in South Africa and Australia. Individuals usually arrive in WA from July onwards.	Given the distribution of the species and preferred habitat, this species may be present in the Operational Area in low numbers. Higher population densities may be encountered in the coastal waters of the EMBA.
Pectoral sandpiper	Migratory	• In Australasia, the species is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands. • The pectoral sandpiper is omnivorous, consuming algae, seeds, crustaceans, arachnids and insects. While feeding, they move slowly, probing with rapid strokes. They walk slowly on grass fringing water. • In WA, the species is rarely recorded. It has been observed at the Nullarbor Plain, Reid, Stoke's Inlet, Grassmere Lake, Warden Lake, Dalyup and Yellilup Swamp, Swan River, Benger Swamp, Guraga Lake, Wittecarra, Harding River, coastal Gascoyne, the Pilbara and the Kimberley. In NT, the species habitat likely occurs along the coast of Darwin, which is 260 km away from the Operational Area (DoEE 2019a).	Given the wide distribution and migration pattern, this species may be present in the Operational Area and EMBA in low numbers or isolated individuals/groups.
Greater crested tern	Migratory	• The greater crested tern is widespread and numerous along the NT coastline, with 20 breeding colonies reported (DSEWPaC 2012a). • The species shows a preference for nesting on offshore islands, low-lying coral reefs, sandy or rocky coastal islets, coastal spits and lagoon mudflats (DSEWPaC 2012e). • The colony on Seagull Island, off the north-west tip of Melville Island supports a BIA of approximately 60,000 greater crested terns (Woinarski et al. 2003), which is thought to be the largest breeding colony of this species and of international significance. • The species forages in a range of habitats including shallow waters of lagoons, coral reefs, bays, harbours, inlets and estuaries, along shorelines, rocky outcrops	A breeding BIA has been identified at Melville Island approximately 265 km north-east from the Operational Area (Figure 3-12). Given the widespread distribution, this species may be present in the Operational Area in low numbers or isolated individuals/groups. Higher population densities may be encountered in the coastal waters of the EMBA.

Species	Protection status	Distribution, habitat and life stages	Presence in the Operational Area and EMBA
		and in open sea, in mangrove swamps and in offshore and pelagic waters (DSEWPaC 2012e). • The breeding period for the greater crested term is March to July, with most eggs being laid during late April to early June (Chatto 2001).	
Bridled tern	Migratory	• In WA, breeding is widespread from islands off Cape Leeuwin (extending round the southern coast to Seal Rocks) north to Shark Bay and in Pilbara region and Kimberley Division. At sea, distribution extends from Cape Leeuwin north to Dirk Hartog Island, with isolated mainland coastal records at Point Maud and Ningaloo, and from Barrow Island to the Dampier Archipelago, and at sea off the Kimberley coast from waters west of the Dampier Peninsula to Ashmore Reef and JBG. • The species occupies tropical and subtropical seas, breeding on islands, including vegetated coral cays, rocky continental islands and rock stacks. • In WA, birds breed late spring to summer, with eggs recorded from mid-October to late January, and young from mid-December to early March (DoEE 2019a).	Given the wide distribution and migration pattern, this species may be present in the Operational Area and EMBA in low numbers or isolated individuals/groups.
Osprey	Migratory	• The osprey is most abundant in northern Australia, where high population densities occur in remote areas. The breeding range of the osprey extends around the northern coast of Australia (including many offshore islands) from Albany in WA to Lake Macquarie in NSW. • Ospreys occur in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia and offshore islands. • Ospreys mainly feed on fish, especially mullet where available, and rarely take molluscs, crustaceans, insects, reptiles, birds and mammals. The species usually forage diurnally but have also been observed hunting prey at night. • Osprey breed from April to February in Australia.	Given the preferred coastal habitat, the species is unlikely to be present in the Operational Area. Higher population densities may be encountered in the coastal waters of the EMBA.
Australian lesser noddy	Vulnerable	• The Australian lesser noddy is endemic to Australia and nests on the Houtman Abrolhos Islands and, possibly, Ashmore Reef. The species remain near breeding islands throughout the year; however, gales may displace birds many hundreds of kilometres (DoEE 2019a). • The species usually occupies coral-limestone islands that are densely fringed with white mangrove *Avicennia marina* and occasionally occurs on shingle or sandy beaches (Higgins and Davies 1996). • The breeding season is protracted, extending from mid-August to early April; however this can vary year to year (Higgins and Davies 1996). • The Australian lesser noddy may forage out at sea or in seas close to breeding islands and fringing reefs (Johnstone and Storr 1998; Storr et al. 1986; Whittell 1942).	Given the preferred habitat, the species is unlikely to be present in the Operational Area. Higher population densities may be encountered in the EMBA.
Bar-tailed godwit	Vulnerable	• The bar-tailed godwit has been recorded in the coastal areas of all Australian states. It is widespread in the Torres Strait and along the east and south-east coasts of Queensland, NSW and Victoria, including the offshore islands.	Given the preferred coastal habitat, the species is unlikely to be present in the Operational Area. Higher population densities may be encountered in the coastal waters of the EMBA.

Species	Protection status	Distribution, habitat and life stages	Presence in the Operational Area and EMBA
		• The bar-tailed godwit is found mainly in coastal habitats such as large intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays. • The species typically roosts on sandy beaches, sandbars, spits and also in near-coastal saltmarsh. • Roebuck Bay and Eighty Mile Beach are internationally important sites for the species, supporting over 50,000 individuals. • At the subspecies level, *Limosa lapponica baueri* is listed as Vulnerable and *Limosa lapponica menzbieri* is listed as Critically Endangered under the WA *Biodiversity Conservation Act 2016*.	
Australian painted-snipe	Endangered	• The Australian painted snipe has been recorded at wetlands in all states of Australia, however the species has been recorded less frequently at a smaller number of more scattered locations farther west in South Australia, the NT and WA • The species generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. • The species may breed in response to wetland conditions rather than during a particular season (DoEE 2019a).	Given the preferred habitat, the species is unlikely to be present in the Operational Area. Higher population densities may be encountered in the EMBA.
Fork-tailed swift	Migratory	• In WA, the fork-tailed swift is scattered along the coast from south-west Pilbara to the north and east Kimberley region, near Wyndham. • The Fork-tailed Swift is almost exclusively aerial, flying from less than 1 m to at least 300 m above ground. • The Fork-tailed Swift does not breed in Australia (DoEE 2019a).	Given the distribution of this species and habitat, it is unlikely this species will be encountered within the Operational Area, however, may be present in low numbers within the EMBA.
Roseate tern	Migratory	• In WA, the subspecies is regularly recorded north from Mandurah to Eighty Mile Beach, in the Pilbara Region. Along the Kimberley coastline, the subspecies occurs at scattered sites, north to the Bonaparte Archipelago and possibly further. In the NT, the subspecies has a scattered occurrence along the north coast, mainly from Darwin to Grove Peninsula, though birds have been recorded west to North Peron Island and east to the Sir Edward Pellow Islands. • The roseate tern occurs in coastal and marine areas in subtropical and tropical seas. The species inhabits rocky and sandy beaches, coral reefs, sand cays and offshore habitats. • Breeding in WA occurs from Second Rock, near Penguin Island, to Lacepede Island (approximately 680 km from the Operational Area), whilst breeding occurs in the NT at Haul Round Island, 605 km from the Operation Area. • Breeding in WA occurs in two quite distinct periods, within peak months for laying April to November. At the same sites, breeding occurs during both late spring-summer and late autumn-winter. Most colonies in the NT nests between September and January/ February (DoEE 2019a).	The closest breeding and foraging BIAs have been identified at Kimberley coast, approximately 131 km south-south-west of the Operational Area (Figure 3-12). Given the preferred coastal habitat, the species is unlikely to be present in the Operational Area. Higher population densities may be encountered in the coastal waters of the EMBA.
Brown booby	Migratory	• The brown booby occurs throughout all tropical oceans, bounded by latitudes 30°N and 30°S (DSEWPaC 2012e).	The closest breeding area for Brown booby is 371 km away of the Operational Area (Figure 3-12)

Species	Protection status	Distribution, habitat and life stages	Presence in the Operational Area and EMBA
		• In Australia, the brown booby is found from Bedout Island in WA, around the coast of the NT to the Bunker Group of islands in Queensland with occasional reports further south in New South Wales and Victoria. • The Brown Booby uses both marine and terrestrial habitat. Off north-west WA, Brown Boobies are most abundant 18–36 km from land, but also occur inside and outside these limits (DoEE 2019a). • The species nests on rugged rocky terrain such as cliffs and steep slopes, on larger islands, beaches, and coral rubble and guano flats on cays. The species typically leaves breeding islands when not breeding, in search of better foraging grounds (DoEE 2019a).	and, given the preferred coastal habitat, the species is unlikely to be present in the Operational Area. Higher population densities may be encountered in the coastal waters of the EMBA.
Red-footed booby	Migratory	• The red-footed booby is found worldwide, essentially confined to tropical waters between 30°N and 30°S in the Atlantic, Indian and Pacific Oceans (DoEE 2019a). • In Australia, a recent or recently re-established breeding colony of red-footed boobys is found at Ashmore Reef (Clarke 2010). • Adult red-footed boobys have been detected up to 125 km from the nearest breeding islands during foraging, with females found to feed mostly at the extremity of their foraging trip (Clarke 2010).	The closest breeding area for Red-footed booby is 384 km away of the Operational Area (Figure 3-12). Given the preferred coastal habitat, the species is unlikely to be present in the Operational Area. Higher population densities may be encountered in the coastal waters of the EMBA, particularly in waters surrounding Ashmore Reef.
Oriental reed warbler	Migratory	• The species has been recorded off the Dampier Peninsula in WA and off the coast of Darwin in the NT. • It is a non-breeding species in Australia. • Habitat mainly includes beds of reed beside lakes, coastal marshes, estuaries and along rivers (DoEE 2019a).	Given the preferred coastal habitat, the species is unlikely to be present in the Operational Area. Higher population densities may be encountered in the coastal waters of the EMBA.
Oriental plover	Migratory	• The oriental plover is a non-breeding visitor to Australia, where the species occurs in both coastal and inland areas, mostly in northern Australia. • The oriental plover is a migratory species, breeding in the Northern Hemisphere and flying south for the boreal winter (Dement'ev and Gladkov 1951; Lane 1987; Marchant and Higgins 1993; Wiersma 1996). • Internationally important sites in Australia includes Roebuck Bay, approximately 750 km southeast of the Operational Area (DoEE 2019a). • Oriental plovers usually forage among short grass or on hard stony bare ground, but also on mudflats or among beachcast seaweed on beaches. • In Australia, the species typically inhabits coastal habitats such as estuarine mudflats and sandbanks, on sandy or rocky ocean beaches or nearby reefs, or in near-coastal grasslands.	Given the preferred coastal habitat, the species is unlikely to be present in the Operational Area. Higher population densities may be encountered in the coastal waters of the EMBA.
Oriental pratincole	Migratory	• Within Australia, the oriental pratincole is widespread in northern areas, especially along the coasts of the Pilbara Region and the Kimberley Division in WA, the Top End of the NT, and parts of the Gulf of Carpentaria.	Given the preferred coastal habitat, the species is unlikely to be present in the Operational Area. Higher population densities may be encountered in the coastal waters of the EMBA.

Species	Protection status	Distribution, habitat and life stages	Presence in the Operational Area and EMBA
		• In non-breeding grounds in Australia, the species usually inhabits open plains, floodplains or short grassland (including farmland or airstrips), often with extensive bare areas. • The species does not breed in Australia (DoEE 2019a).	
Wedge-tailed shearwater	Migratory	• The wedge-tailed shearwater is widespread across the Indian and Pacific Oceans. • In Australia, the species breeds on the east and west coasts of Australia and on offshore islands, including the Ashmore Reef. • The West Island, Ashmore Reef supports a small colony of breeding wedge-tailed shearwaters, with an estimated 30 active burrows in 2002 (Swan 2005). • The foraging areas of wedge-tailed shearwaters that breed at Ashmore Reef are unknown.	The closest breeding area for Wedge-tailed shearwater is 389 km away of the Operational Area (Figure 3-12). Given the preferred coastal habitat, the species is unlikely to be present in the Operational Area. Higher population densities may be encountered in the coastal waters of the EMBA, particularly in waters surrounding Ashmore Reef.
White-tailed tropicbird	Migratory	• The white-tailed tropicbird breeds on islands throughout the tropics of the northern Indian Ocean, including Ashmore Reef and Rowley Shoals off the northern coast of WA (Johnstone and Storr 1998; Marchant and Higgins 1993). • The white-tailed tropicbird is a rather scarce breeding species at Ashmore Reef, and it is estimated that up to two pairs nest within the reserve each year (Clarke 2010). • The species forages up to 89 km from the nest site when breeding, and further when not breeding, and are surface foragers that occasionally take shallow dives (Marchant and Higgins 1990).	The closest breeding area for White-tailed tropicbird is 392 km away of the Operational Area (Figure 3-12). Given the preferred coastal habitat, the species is unlikely to be present in the Operational Area. Higher population densities may be encountered in the coastal waters of the EMBA, particularly in waters surrounding Ashmore Reef.

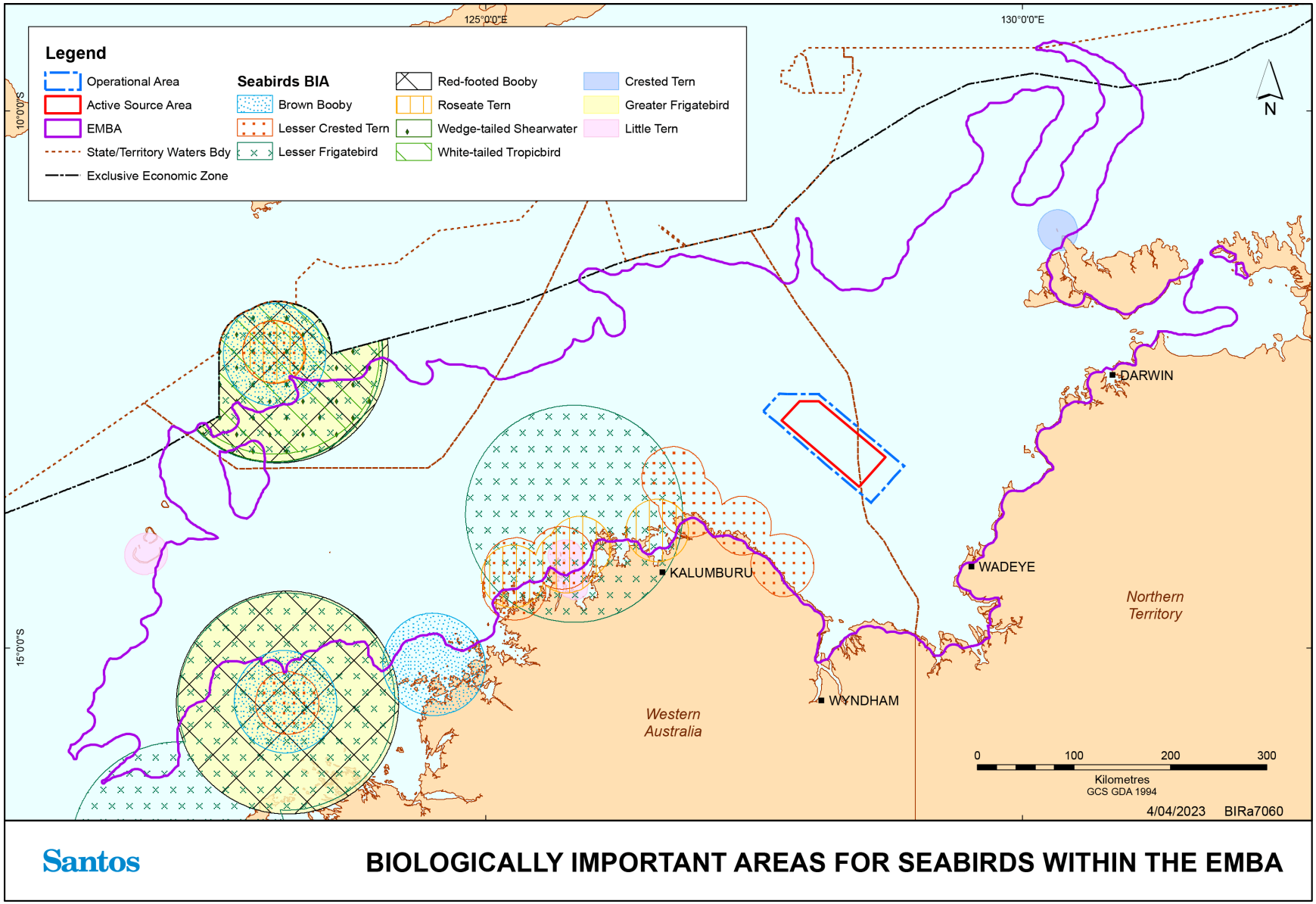


Figure 3-12: BIAs for seabird and migratory shorebirds in the EMBA

3.8 Socio-economic and cultural features

The section describes the socio-economic values within the EMBA including commercial fisheries, shipping, recreational fishing, oil and gas industry, tourism, cultural heritage, and defence activities. Particular focus is however given to commercial fishers as active and socio-economically important co-users of the marine environment within the operational area and surrounds.

3.8.1 Commercial fisheries

3.8.1.1 Commonwealth-managed fisheries

The Australian Fisheries Management Authority (AFMA) manages Australian fisheries on behalf of the Commonwealth Government from 3 nm to the edge of the Australian fishing Zone (AFZ). AFMA carry out objectives that are listed in the *Fisheries Administration Act 1991* and the *Fisheries Management Act 1991*. Commonwealth-managed fisheries with management boundaries that overlap with the Operational Area and EMBA include:

- Northern Prawn Fishery
- North West Slope Trawl Fishery
- Western Tuna and Billfish Fishery
- Southern Bluefin Tuna Fishery
- Western Skipjack Fishery.

These fisheries are further described in Table 3-18.

Table 3-18: Relevant Commonwealth-managed fisheries

Fishery	Management area		Description[1, 2]	Fishing effort reported within the Operational Area	Relevance to EP
	Operational Area	EMBA			
Northern Prawn Fishery (NPF)	✓	✓	**Extent**: Operates from the JBG across the top end to the Gulf of Carpentaria. **Effort:** In 1981, fishing effort peaked at 40,000 fishing days and more than 250 vessels. Three decades later, it has reduced to around 8,000 days of effort and 52 fishing permits. The majority of fishing is conducted in coastal waters. The main fishing area for the NPF is the Gulf of Carpentaria, with relatively low intensity within the JBG. The NPF operates during two seasons. The first season is from 1 April to 15 June, and during this time banana prawns are mainly caught. In the second season (1 August – 1 December) tiger prawns are predominantly caught. Either season has the potential to end early if catch rates fall below pre-set trigger levels. However, a closure area was introduced in 2021 for the JBG region (an area south of latitude 13°S) and includes a significant portion of the Operational Area. The closure area excludes fishing in the JBG during the first season (1 April to 15 June). During consultation, it was advised that spawning in the NPF occurs between August and October. Annual catches tend to vary year to year because of natural variability in the banana prawn component of the fishery. Total landed catch in 2022 was 5,526 t, including 4,029 t banana prawns, 924 t tiger prawns and 372 t endeavour prawns. During the 2021 season, a total of 3,618 t of banana prawns, 1,014 t of tiger prawns and 436 t of endeavour prawns were caught. During the 2020 season, a total of 2,905 t of banana prawns, 1,366 t of tiger prawns and 358 t of endeavour prawns were caught. **Resource**: Key species include banana prawns (*Penaeus indicus* and *Penaeus merguiensis*), tiger prawns (*Penaeus esculentus* and *Penaeus semisulcatus*), and endeavour prawns (*Metapenaeus endeavouri* and *Metapenaeus ensis*), as well as others (squid, bugs and scampi). **Method:** Otter trawl gear.	✓	The Operational Area overlaps 0.15% of this fishery. Fishing takes place in waters 35–70 m deep, with most fishing effort between 50 and 60 m. Water depths within the Active Source Area range between 67 m to 111 m (generally outside of the main fishing depths). Based on 2010–2020 fishing data, fishing intensity within the JBG in any given year is usually low (<0.1 days/km^2) although in some years there has been medium (0.1-0.25 days/km^2) or high (0.25-0.55 days/km^2) intensity fishing effort. The low intensity fishing area in the JBG overlaps with the southern corner of the Operational Area and border of the Active Source Area (Figure 3-14). Therefore, there is potential for interaction with the Eos 3D MSS.
Western Skipjack Tuna Fishery (STF)	✓	✓	**Extent**: The STF covers the entire sea area around Australia, out to 200 nm from the coast. It is split into two sectors: the Eastern Skipjack Tuna Fishery and the Western Skipjack Tuna Fishery. **Effort:** There has been no fishing effort in the STF since the 2008-09 season. **Resource**: Indian Ocean skipjack tuna (*Katsuwonus pelamis*) and Western and central Pacific Ocean skipjack tuna (*Katsuwonus pelamis*). Skipjack tuna are known to spawn throughout the continental shelf and slope waters of the Indian Ocean.	X	The fishery is currently not in operation. There is no potential for interaction with the Activity and therefore, the fishery is not considered further in this EP.

Fishery	Management area		Description[1, 2]	Fishing effort reported within the Operational Area	Relevance to EP
	Operational Area	EMBA			
			Method: Predominantly purse-seine gear is used. A small amount of pole and line effort.		
Southern Bluefin Tuna Fishery (SBTF)	✓	✓	**Extent**: Fishery includes all waters of Australia, out to 200 nm from the coast. Juvenile fish move from spawning grounds in the north-east Indian Ocean into the Australian EEZ and southward along the WA coast (Patterson et al. 2021). During consultation for this EP, Tuna Australia raised concerns regarding potential overlaps between the seismic survey and spawning timeframes for Yellowfin Tuna. In Zudaire et al (2013), the main spawning season for this species was November to February, with a secondary peak in June. **Effort**: No current effort in the JBG, fishing activity is concentrated in the Great Australian Bight and off South-east Australia. The fishery had 85 SFRs (permits) in the 2020-21 season with seven active purse seine vessels. **Resource**: Key species is the Southern Bluefin tuna (*Thunnus maccoyii).* Migration pathways are outside of the Operational Area and EMBA. A potential overlap exists for the spawning grounds and the western-most portion of the EMBA. Southern bluefish spawn in tropical waters during the spring and summer months (AFMA 2023b). Only one spawning ground has been identified, in the north-eastern Indian Ocean south of Java (AFMA 2023b). **Method**: Most of the Australian catch has been taken by purse seine, targeting juvenile tuna (2–4 years of age) in the Great Australian Bight. Australian domestic longliners operating along the east coast catch some tuna and there is some recreational fishing for the species.	X	There is no effort currently reported in WA or the NT. There is no potential for interaction with the Activity and therefore, the fishery is not considered further in this EP.
Western Tuna and Billfish Fishery (WTBF)	✓	✓	**Extent**: The WTBF covers the sea area west from the tip of Cape York in Queensland, around Western Australia, to the border between Victoria and South Australia. Fishing occurs in both the Australian Fishing Zone and adjacent high seas. **Effort**: Since 2005, there has been fewer than five vessels active in the fishery, down from 50 active vessels in 2000. In recent years, fishing effort has concentrated off south-west WA and South Australia with no current effort on the NWS There were 94 boat SFRs (permits) and only two active pelagic longline vessels for both the 2021 and 2020 seasons. **Resource**: Key species include Bigeye tuna (*Thunnus obesus*), yellowfin tuna (*T. albacares*), striped marlin (*Tetrapturus audux*) and swordfish (*X. gladius)* . These species are known to spawn throughout the continental shelf and slope waters of the Indian Ocean.	X	There is no potential for interaction with the Eos 3D MSS and therefore, the fishery is not considered further in this EP.

Fishery	Management area		Description[1, 2]	Fishing effort reported within the Operational Area	Relevance to EP
	Operational Area	EMBA			
			Method: The main fishing gear in the WTBF is pelagic longline, with low levels of minor-line fishing.		
North West Slope Trawl Fishery (NWSTF)	X	✓	**Extent**: The NWSTF is located in deep water from the coast of the Prince Regent National Park to Exmouth between the 200 m depth contour to the outer limit of the Australian Fishing Zone. A large area of the Australia–Indonesia memorandum of understanding box (an area off north-western Western Australia where Indonesian fishers may operate using only traditional methods) falls within the northern extent of the NWSTF management area. **Resource**: The primary species is Australian scampi (*Metanephrops australiensis*), with smaller quantities of velvet scampi (*M. velutinus*), Boschma's scampi (*M. boschmai*) and mixed scampi (*Metanephrops spp.* and *Nephropsis spp.*) also landed. **Effort**: Total catch in 2021–22 was 85.8 t, and in 2020–2021 was 86.9 t. Total effort was 196 days in 2021–22 and 233 days in 2020–21. There were seven fishing permits and three active vessels during the 2021–22 season. **Method**: Bottom trawl	X	There is no potential for interaction with the Eos 3D MSS and therefore, the fishery is not considered further in this EP.

[1] *Butler et al 2023*

[2] *AFMA 2023a, b, c, d and e*

Northern Prawn Fishery

The NPF operates off Australia's northern coast from Cape York (QLD) to Cape Londonderry (WA) (AFMA 2018d). The NPF is restricted to 52 fishing permits and around 8,000 days of effort. The overlap of the NPF with the Operational Area is shown in Figure 3-13. Most of the trawling activity and harvest comes from within the Gulf of Carpentaria (GoC), with the westernmost region of the fishery (i.e. Bonaparte and JBG area in particular) seeing much less effort.

Figure 3-15 shows the main areas of fishing activity in the JBG for 2010–2020, based on available fishing intensity data provided by ABARES.

The following information on the NPF is sourced from the ABARES 2023 Fishery Status Report (Butler et al 2023) except where noted. Information relating to the activities of the NPF within the JBG has been sourced from:

- Australian Maritime College (AMC) (2021)
- Loneragan et al. (2002)
- AFMA (2023e)
- Laird (2018)
- Jarrett et al. (2015)
- Information obtained from NPFI during stakeholder consultation for this EP and previous seismic surveys in the JBG.

The NPF is managed through a combination of input controls (limited entry, seasonal closures, permanent area closures, gear restrictions and operational controls) that are implemented under the Northern Prawn Fishery Management Plan 1995 (amended 2012).

The NPF uses otter trawl gear to target a range of tropical prawn species. In recent years, many vessels have transitioned from using twin gear to mostly using a quad rig comprising four trawl nets—a configuration that is more efficient.

Advice from the NPFI during the development of the Santos Fishburn EP (2017) is that prawn species reach a commercial size at six months and can live for up to two years. Larger sized prawns have a higher price tag. Growth rates vary considerably between species and sexes, with females generally growing faster and to a larger size than males. During consultation for this EP the NPFI advised that spawning occurs in the NPF between August and October.

The status (health) of target species populations in the NPF is reported annually in the Fishery Status Reports compiled by the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES). In 2022, all target species were considered not subject to overfishing and not overfished.

The NPF operates during two seasons. The first season is from 1 April to 15 June, and during this time banana prawns are mainly caught. Conversely, during the second season (1 August – 1 December) tiger prawns are predominantly caught. Either season has the potential to end early depending on the total catch.

The total catch in the NPF in 2022 was 5,325 t at a value of $87.6 million, and in 2021 was 5,390 t at a value of $76.6 million. Annual catches tend to be quite variable from year to year because of natural variability in the banana prawn component of the fishery.

White banana prawn, redleg banana prawn and two species of tiger prawn (brown and grooved) account for approximately 93% of the landed catch. White banana prawn (*Penaeus merguiensis*) is mainly caught during the day on the eastern side of the Gulf of Carpentaria, whereas redleg banana prawn (*P. indicus)* is caught during both day and night, mainly in the JBG. Tiger prawns (*P. esculentus* and *P. semisulcatus*) are caught at night (daytime trawling has been prohibited in all areas during the tiger prawn fishing season). Most tiger prawn catches come from the southern and western Gulf of Carpentaria, and along the Arnhem Land coast. Tiger prawn fishing grounds may be close to those of banana prawns, but the highest catches come from areas near coastal seagrass beds, the nursery habitat for tiger prawns (Butler et al. 2023; Patterson et al. 2020).

By-product species include bugs (Thenus spp.), cuttlefish, saucer scallops (*Amusium spp.),* scampi (*Metanephrops spp.*) and squids

The JBG comprises approximately 60,000 km^2 of the westernmost portion of the NPF (Figure 3-13). Catch in the JBG is comprised primarily of banana prawns (mainly *P. indicus* and some *P. merguiensis*), with a very minor catch of tiger and endeavour prawns (Laird 2017). This is consistent with confidential fishing data provided by NPFI during consultation in 2019 and 2021, which shows that tiger prawns typically make up a significantly smaller proportion of catch and effort in the JBG than banana prawns.

Fishing for the banana prawns is permitted day and night in both NPF fishing seasons. Fishing takes place in waters 35–70 m deep, with most fishing effort between 50 and 60 m. The trawling regime for this species is similar

to the tiger prawn sub-fishery in other regions of the NPF, where the total duration of individual trawls is usually long (~3 h). Although the JBG fishery comprises less than 5% of the area of the NPF, it contributes about 65% of the NPF redleg banana prawn catch and around 20% of the NPF total banana prawn catch (combined *P. merguensis* and *P. indicus*) (Loneragan et al. 2002).

Due to the large tidal range in the JBG and its reputed influence on prawn abundance in the region, *P. indicus* are fished on the neap tides, when tidal range and currents are minimal (Tonks et al. 2008). Thus, over a tide cycle, fishing effort is high on the late spring-neap, neap and early neap-spring tides, and low to non-existent at other times when the fleet moves to fishing grounds north of Melville Island and Port Essington, outside the JBG. The extra steaming time that this fishing pattern generates, together with the remoteness of the JBG and the lower price of *P. indicus* in comparison to other species of prawns, makes the JBG a less attractive area to fish than other parts of the NPF. As a result, the annual fishing effort in the JBG fishery is mostly dependent on the catch levels elsewhere in the NPF; if catches are good elsewhere, effort in JBG is low (Loneragan et al. 2002).

Prior to 2021, a seasonal closure area for the NPF in the JBG existed which excluded fishing from nearshore banana prawn nursery habitats in the southern part of the JBG to protect small juvenile banana prawns as they migrate offshore to deeper waters in the south-western JBG, where the adults are targeted during the trawling operations. The closure area applied during the 1 April to 15 June fishing season each year, which, in combination with the closure periods across the fishery, protected the juvenile migration. Any catch south of the seasonal closure line was taken in the second fishing season only (1 August – 1 December) when the less-fished tiger prawns in the JBG were targeted, whereas catch taken north of the closure line was taken during both the first and second seasons.

While the pre-2021 seasonal closure area was outside the Operational Area, a new closure area, recommended by the NPF Resource Assessment Group (NPRAG), was introduced in 2021 and applies to the whole of the JBG south of latitude 13°S, including a significant portion of the Operational Area (Figure 3-16). The closure area excludes fishing in the JBG during the first season (1 April to 15 June) for better management of the redleg banana prawn stock of the JBG. The new closure area effectively means that no fishing will take place, including for banana prawns, in the JBG between 1 April to 15 June and only fishing during the 1 August to 1 December tiger prawn season is now permitted in the JBG. The new closure area will be reviewed in five years (2026) to determine its effectiveness on improving the JBG stock (AFMA 2021).

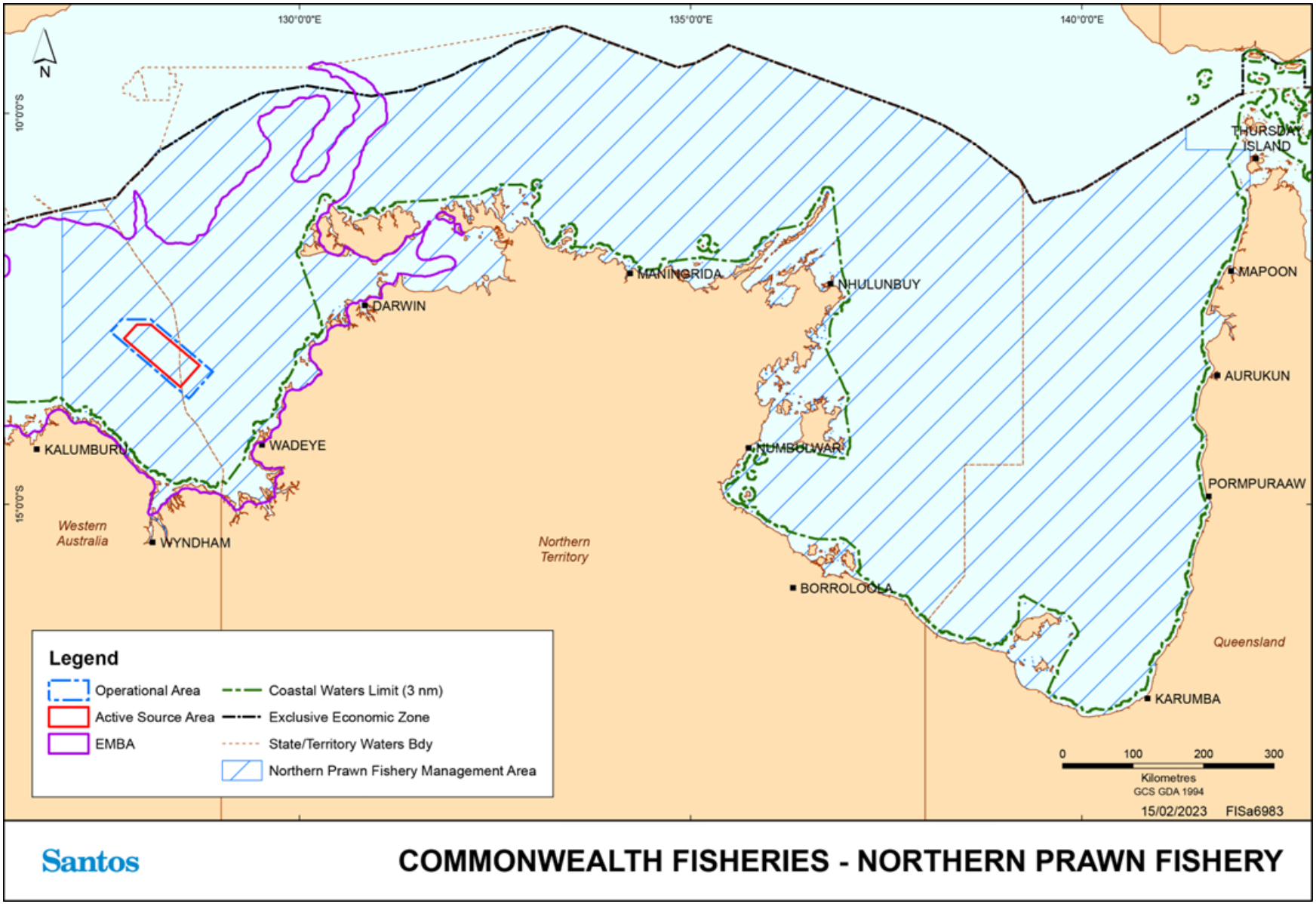


Figure 3-13: Northern Prawn Fishery management area

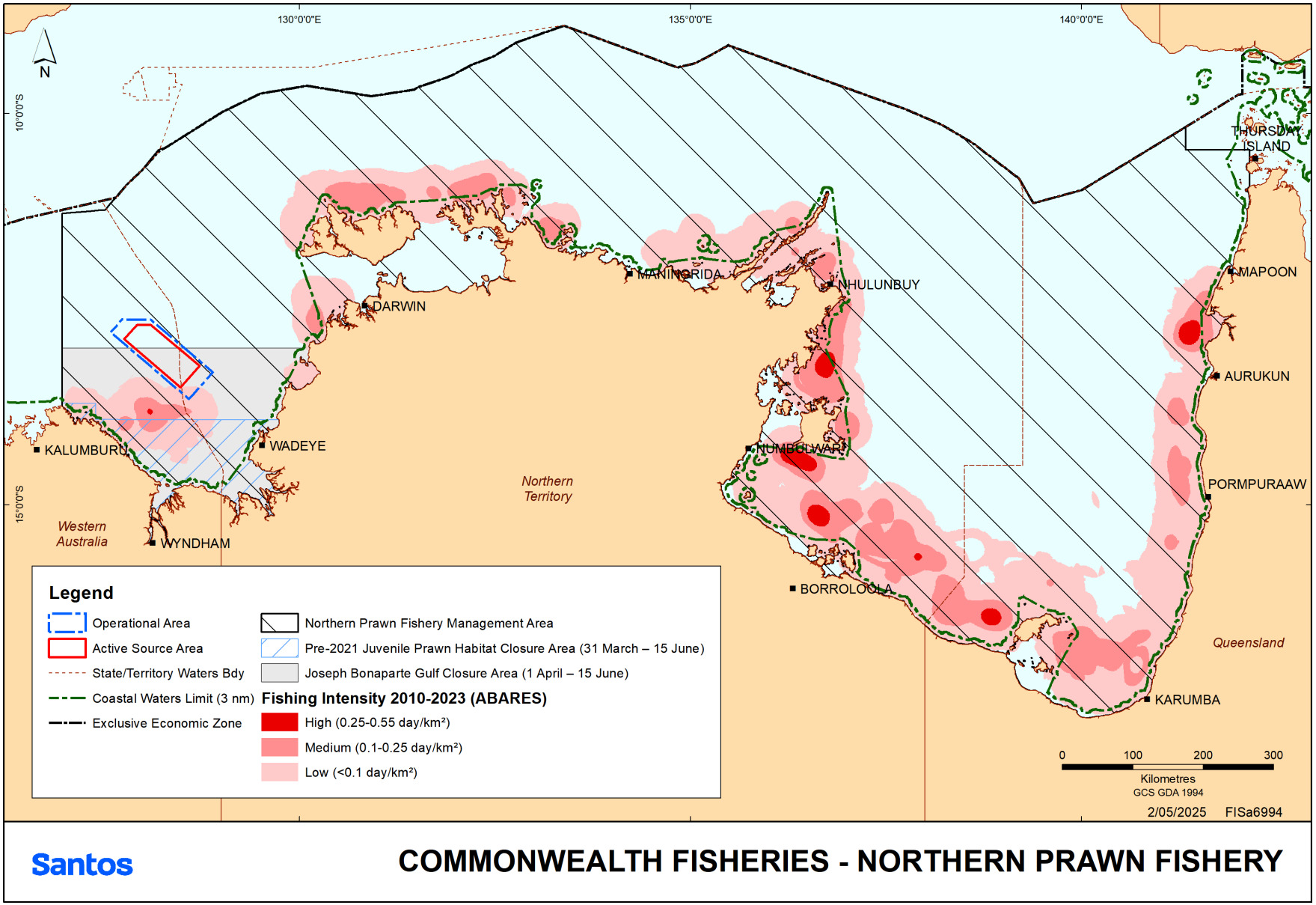
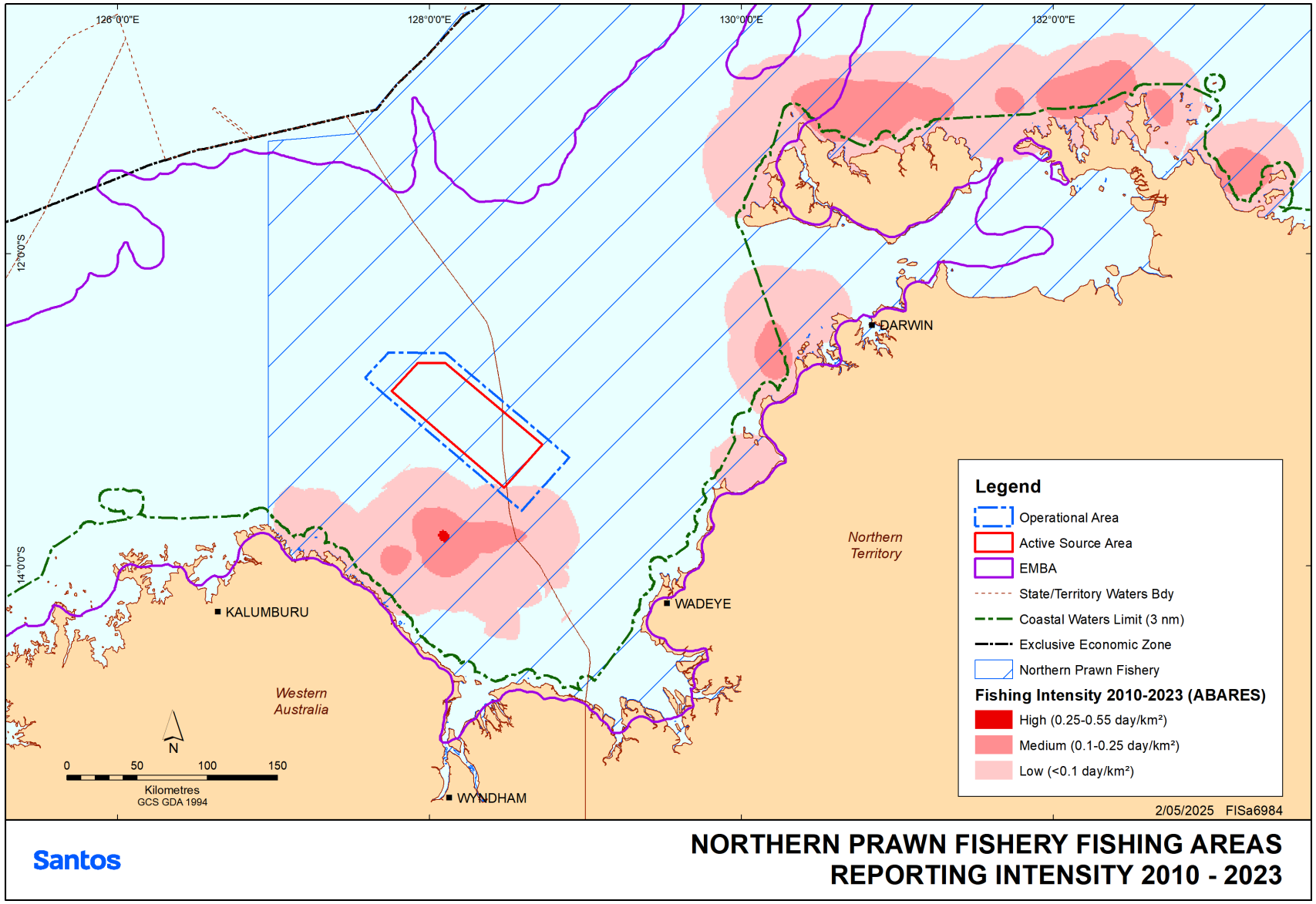


Figure 3-14: Areas fished and relative fishing intensity in the Northern Prawn Fishery (2010–2023)



Source: ABARES 2021

Figure 3-15: NPF fishing areas reporting low, medium and high intensity (<0.1–0.55 day/km^2) fishing in the JBG (2010–2023)

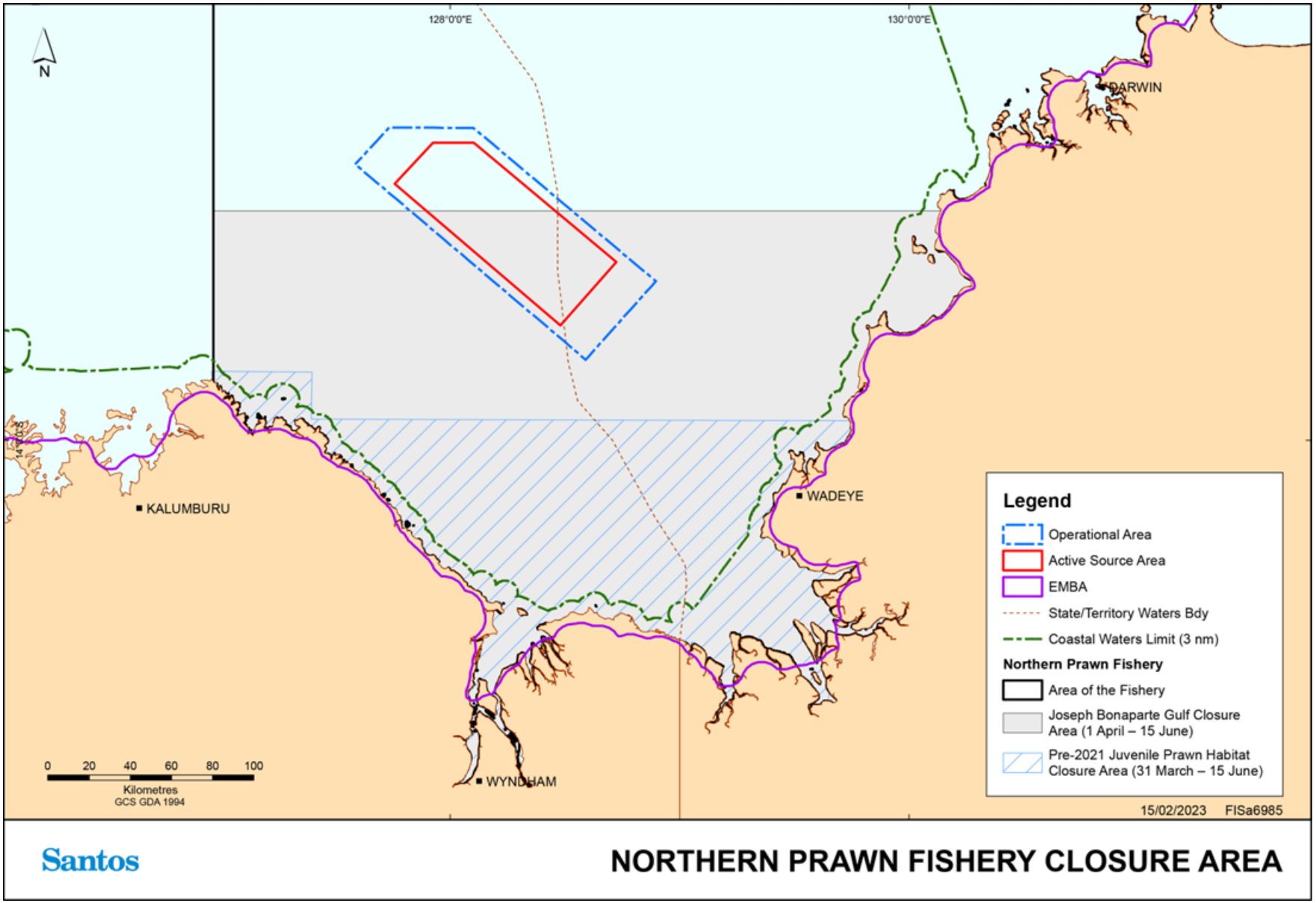


Figure 3-16: Northern Prawn Fishery seasonal closure area

3.8.1.2 Western Australian managed fisheries

WA State commercial fisheries are managed by the WA Department of Primary Industries and Regional Development (DPIRD) under the *Fish Resources Management Act 1994*, Fisheries Resources Management Regulations 1995, relevant gazetted notices and licence conditions and applicable Fishery Management Plans. WA managed fisheries with management boundaries that overlap with the Operational Area and EMBA include:

- Abalone Managed Fishery (AMF)
- Broome Prawn Managed Fishery (BPMF)
- Kimberley Crab Managed Fishery (KCMF)
- Kimberley Gillnet and Barramundi Fishery (KGBF)
- Kimberley Prawn Managed Fishery (KPMF)
- Mackerel Managed Fishery (MMF)
- Marine Aquarium Fish Managed Fishery (MAFMF)
- Northern Demersal Scalefish Managed Fishery (NDSMF)
- North Shark Fisheries (Joint Authority Northern Shark Fishery and WA North Coast Shark Fishery) (NSF)
- Pearl Oyster Managed Fishery (POMF)
- South West Coast Salmon Managed Fishery (SWCSMF)
- Specimen Shell Managed Fishery (SSMF)
- West Australian Sea Cucumber Fishery (WASCF)
- West Coast Deep Sea Crustacean Managed Fishery (WCDSCMF).

These fisheries are further described in Table 3-19.

Catch and effort data

Santos requested annual catch and effort data (FishCube data) from WA DPIRD for fisheries understood to operate within or near to the Operational Area. Data was assessed for 10 nm x 10 nm Catch and Effort System (CAES) blocks, and where data was unavailable, the 60 nm x 60 nm CAES blocks were assessed as the next available scale for the following:

- Catch and effort data for the most recent 11 years (2013–2023, aggregated)
- Annual catch and effort data for each of the most recent 11 years (2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022 and 2023).
- Data was assessed to identify where the greatest fishing effort in each fishery occurred and the relative importance of waters within the Operational Area.
- Data provided by DPIRD included:
- Weight (kg) – a measure of fish catches per CAES block during the period of interest
- Vessel Count – a measure of the number of vessels that fished in a CAES block during the period of interest
- Fishing Day Count – a measure of fishing effort, represented by the number of days when one or more vessels fished in a CAES block during the period of interest.

Due to confidentiality reasons, DPIRD do not release catch and effort data for CAES blocks where less than three vessels fished during the period of interest (i.e. less than three vessels per year or less than three vessels over the complete 10-year period). Where this applies, the Vessel Count is marked ‘Less than 3’, while Weight and Fishing Day Count are marked as ‘N/A’. CAES blocks where the results are provided in this way confirm that fishing effort did occur within the block during that period, but the associated catch and effort values are not available. CAES blocks where no fishing is recorded do not return any data.

Santos acknowledges that the State of WA is the owner of the copyright of this information.

As presented in Table 3-19, the NDSMF and MMF are the only WA-managed commercial fisheries that have activity within the Operational Area. The following subsections provide additional information and present the FishCube data that has been mapped for the two fisheries.

Table 3-19: Relevant Western Australian-managed fisheries

Fishery	Overlap with management area		Description[1, 2]	Fishing effort reported within the Operational Area	Relevance to EP
	Operational Area	EMBA			
Abalone Managed Fishery (AMF)	✓	✓	**Extent:** The AMF operates in all shallow coastal waters of the Southern Ocean, Indian Ocean and Timor Sea between the Western Australian / Northern Territory Border and the Western Australian / South Australian border (i.e. all the waters of the state). **Catch and Effort:** The recorded catch effort for the AMF is reported separately for different species of abalone with Roe's abalone recording 29.7 t for 2021 and greenlip and brownlip abalone recording 39 t (25.9 t and 13.1 t respectively). **Resources:** Roe's abalone (*Haliotis roei*), Greenlip abalone (*Haliotis laevigata*), and Brownlip abalone (*Haliotis conicopora*) **Method:** Hand collection (either wading or diving)	X	FishCube data (2013-2023) did not show activity for this fishery within the Operational Area or EMBA. Therefore, there is no potential for interaction with the Eos 3D MSS.
Broome Prawn Managed Fishery (BPMF)	X	✓	**Extent:** One of four prawn fisheries operating in the North Coast Bioregion. The BPMF in particular operates off Broome. **Catch and Effort:** Minimal fishing occurred in 2021 with only trial fishing activities undertaken by three vessels to investigate whether catch rates were sufficient for commercial fishing. A 'negligible' catch effort reported. **Resources:** Western King Prawns (*Penaeus latisulcatus*), Brown tiger prawns (*Penaeus esculentus*), and Blue endeavour prawns (*Metapenaeus endeavouri*) **Method:** Otter prawn trawl	X	FishCube data (2013-2023) did not show activity for this fishery within the Operational Area or EMBA. Therefore, there is no potential for interaction with the Eos 3D MSS.
Kimberley Crab Managed Fishery (KCMF)	✓	✓	**Extent:** The boundaries of the KCMF is between Broome and the Cambridge Gulf. **Catch and Effort:** The commercial catch for this fishery is reported as part of the North Coast Crab Resource which also includes the Pilbara Crab Managed Fishery. The total catch for 2021 was 9.7 t which was an increase from 2.1 t caught in 2020. **Resources:** Blue Swimmer Crab (*Portunus pelagicus*) and Mud crabs (*Scylla serrata*) **Method:** Crab traps	X	FishCube data (2013-2023) for 10 nm CAES blocks did not show activity for this fishery within the Operational Area or EMBA. The 60 nm CAES blocks were assessed as the next available scale and while activity for up to three vessels was observed throughout areas of the EMBA, no activity is reported overlapping the operational area.

Fishery	Overlap with management area		Description[1, 2]	Fishing effort reported within the Operational Area	Relevance to EP
	Operational Area	EMBA			
					Therefore, there is no potential for interaction with the Eos 3D MSS.
Kimberley Gillnet and Barramundi Fishery (KGBF)	X	✓	**Extent:** The KGBF operates in the nearshore and estuarine zones of the North Coast Bioregion. That is from the WA / NT border to the northern end of Eighty Mile Beach, south of Broome. The coastal area in proximity to the operational area and EMBA is closed from 1 November to 31 January each year. **Catch and Effort:** The total reported catch of all species in the KGBF in 2021 was 100 t. Of this, 67.2 t were barramundi which was the highest recorded catch since 1990. **Resources:** Barramundi (*Lates calcarifer*), King threadfin (*Polydactylus macrochir*), and Blue threadfin (*Eleutheronema tetradactylum*) **Method:** Gillnets to take any fish in inshore waters while barramundi can be taken by any means.	X	FishCube data (2013-2023) for 10 nm CAES blocks did not show activity for this fishery within the Operational Area or EMBA. The 60 nm CAES blocks were assessed as the next available scale and showed activity overlapping the operational area in one block for less than three vessels on one occasion (April 2019). However, this block is noted to overlap with the WA coastline where the KGBF is known to operate. It can be assumed that the reported activity is outside the operational area boundary. Therefore, there is no potential for interaction with the Eos 3D MSS.
Kimberley Prawn Managed Fishery (KPMF)	✓	✓	**Extent:** The KPMF operates off the north of the state between Koolan Island and Cape Londonderry. The KPMF abuts the western boundary of the Commonwealth Northern Prawn Fishery. There are two fishing periods for the season (April to mid-June, then from August to the end of November) with around 74% of the total landings taken in the first fishing period. **Catch and Effort:** The total prawn landings in 2021 for the KPMF were 203.9 t. The catch was primarily banana prawns (186.8 t), with 12.6 t of brown tiger prawns and 4.4 t of blue endeavour prawns also taken. **Resources:** Key species include the banana prawn, however endeavour prawns, king prawns and tiger prawns are also taken. **Method:** High opening otter trawl systems are used when targeting banana prawns and low opening otter trawl systems are also used.	X	While FishCube data (2013-2023) shows activity from the KPMF of up to 11 vessels within the EMBA, there was no activity within the Operational Area. Therefore, there is no potential for interaction with the Eos 3D MSS.
Marine Aquarium Fish Managed Fishery (MAFMF)	✓	✓	**Extent:** The MAFMF operates in WA state waters from the NT border in the north through to the South Australian border in the south. However, the fishery is typically more active in waters south of Broome with	X	The fishery occurs in WA State waters and is typically more active in waters between Esperance and Broome with higher levels of effort around the

Fishery	Overlap with management area		Description[1, 2]	Fishing effort reported within the Operational Area	Relevance to EP
	Operational Area	EMBA			
			higher levels of effort around the Capes region, Perth, Geraldton, Exmouth, Dampier and Broome. MAFMF operates across a number of aquatic ecosystems including coral reefs, lagoons, coastal embayments and intertidal areas (DPIRD 2018). Fishing operations are heavily weather-dependent due to the small vessels used and the potentially hazardous conditions (e.g. waves and swell) encountered (DPIRD 2018). In addition, human constraints (i.e. physiological effects of decompression) limit the amount of effort exerted in the fishery, including the depth of water (generally <30 m deep) and the offshore extent where collections can occur (DPIRD 2018). **Catch and Effort:** There were eleven out of the twelve licences that were active in the MAFMF in 2021. The total catch in the MAFMF in 2021 was 92,227 fishes (including fish, syngnathids, invertebrates and sponges), 27.97 t of coral, live rock and living sand and 42 L of marine plants and live feed. **Resource:** The MAFMF resource potentially includes more than 1,500 species of marine aquarium fishes, under the Marine Aquarium Fish Managed Fishery Management Plan 2018. Operators in the MAFMF are also permitted to take coral, live rock, algae, seagrass and invertebrates. **Method:** Primarily hand catch but fishing line also used.		Capes region, Perth, Geraldton, Exmouth and Dampier (Fletcher et al. 2017). While FishCube data (2013-2023) shows activity from the MAFMF of less than three vessels within the EMBA, there was no activity within the Operational Area. Therefore, there is no potential for interaction with the Eos 3D MSS.
Mackerel Managed Fishery (MMF)	✓	✓	**Extent:** The fishery encompasses the entire coastline of WA from the Northern Territory border to Cape Leeuwin in the south-west. However, the fishery mainly operates between Geraldton and the WA-NT border (Lewis et al. 2021). It comprises of three areas: Area 1 – Kimberley, Area 2 – Pilbara and Area 3 – Gascoyne/West Coast (Fletcher et al. 2017). **Catch and Effort:** Fishing effort occurs year round but typically takes place between May and November and is concentrated in waters less than 70 m. The total	✓	FishCube data for the period 2013-2023 indicates that the one 10 nm block overlapped by the Operational Area was fished by less than three vessels in July 2021 only. Areas that are more regularly and intensively fished are located to the north and west of Kalumburu. Up to four vessels were active in the EMBA. The activity within the EMBA is predominantly less than three vessels or three vessels based on 2013-2023

Fishery	Overlap with management area		Description[1, 2]	Fishing effort reported within the Operational Area	Relevance to EP
	Operational Area	EMBA			
			catch of Spanish mackerel in the 2019/20 season was291 t (Lewis et al. 2021). **Resource:** Target species comprise Spanish and grey mackerel. Spanish mackerel are an offshore, pelagic (surface-dwelling) fish, which inhabit offshore and coastal reefs. **Method**: Trolling or handline. Near-surface trolling gear from vessels in coastal areas around reefs, shoals and headlands (Lewis et al. 2021).		data with four vessels only recorded in November 2019 and November 2020 across four reporting blocks. While there is potential for interaction between the fishery and the Eos 3D MSS, fishing effort in the Operational Area is expected to be low, and interactions infrequent.
Northern Demersal Scalefish Managed Fishery (NDSMF)	✓	✓	**Extent:** North-west coast of WA in the waters east of longitude 120°E to the edge of the AFZ. The fishery is divided into two fishing areas: an inshore sector (Area 1) and an offshore section (Area 2). Area 2 is further divided into zones. Zone A is an inshore area, Zone B comprises the area with most historical fishing activity and Zone C is an offshore deep slope area representing waters deeper than 200 m (Newman et al. 2020). **Catch and Effort:** Total catch in 2019 was 1,507 t (Newman et al. 2021a). **Resource:** Demersal scale fish, primarily red and blue spotted emperors and goldband snapper, with a number of species of snappers, cods and emperors. **Method:** Primarily trap, some line including handline and dropline.	✓	The Operational Area is located in Zone A of Area 2 of the NDSMF, noting that the NDSMF primarily targets deeper waters in Zone B of Area 2 of the fishery. FishCube data from 2013-2023 shows less than three vessels active within the Operational Area and up to four vessels active within the EMBA. The activity within the EMBA is predominantly less than three vessels or three vessels based on 2013-2023 data with four vessels only recorded on one occasion (May 2020). While there is potential for interaction between the fishery and the Eos 3D MSS, fishing effort in the Operational Area is expected to be low, and interactions infrequent.
North Shark Fisheries (Joint Authority Northern Shark Fishery and WA North Coast Shark Fishery)	✓	✓	**Extent:** Covers the Pilbara and eastern and western Kimberley. **Catch and Effort:** Limited to no fishing activity has been recorded in both fisheries since 2008–2009 as they do not have a Wildlife Trade Operation (WTO) accreditation that allows export of product from the fishery thus making the fishery unprofitable. **Resource:** Sandbar shark, blacktip shark **Method:** Line fishing	X	The fishery is currently inactive. If fishing does recommence, there is the potential for interaction with the Eos 3D MSS. However, given the range of target species, fishing effort in the Operational Area is expected to be low, and interactions infrequent.

Fishery	Overlap with management area		Description[1, 2]	Fishing effort reported within the Operational Area	Relevance to EP
	Operational Area	EMBA			
Pearl Oyster Managed Fishery (POMF)	✓	✓	**Extent**: Quota based dive fishery operating in shallow coastal waters of the North Coast Bioregion. The fishery is split into three zones (previously four zones) with DPIRD proposing, as part of the Aquatic Resource Management Paper No.5: Draft Aquatic Resource Management Strategy for the *Pinctada maxima* (2023) to restructure these current zones. Zone 1, Zone 2 (previously Zone 2/3) and a Kimberley Development Zone (previously Zone 4) where no commercial fishing is permitted. **Catch and Effort:** Pearl oyster shell fishing has not been reported in Zone 1 from 2017–2021. In 2021, catch was taken in Zones 2 and 3 (with the number of wild caught pearl oysters totally 590,064. This comprised of 539,612 culture shells and 50,452 Mother of Pearl shells over 8,175 dive hours. **Resource**: Indo-Pacific, silver-lipped pearl oysters. **Method**: Drift diving, harvesting oysters by hand.	X	The Operational Area is located within the actively fished Zone 3. However, the Operational Area is located away from the Kimberley coastline where pearling leases are located, and where pearl fishing/diving occurs (<50 m depth). FishCube data for the period 2013-2023 confirms that there has been no fishing activity within the Operational Area, and less than three vessels in October 2015 within the EMBA in the last 11 years. Therefore, there is no potential for interaction with the Eos 3D MSS.
South West Coast Salmon Managed Fishery (SWCSMF)	✓	✓	**Extent:** The area for the SWCSMF extends most of the WA state waters, however the fishery operates on various beaches south of the Perth metropolitan area. In Western Australia, Salmon are predominantly found in cooler southern waters, but can also be common in waters north of Perth metropolitan area during winter months. **Catch and Effort:** The commercial catch for this fishery is reported as part of the West Coast Nearshore and Estuarine Finfish Resource which encompasses five other fisheries. The total catch for 2021 was 318.3 t with the Western Australian salmon species contributing 88.5 t. **Resources:** Western Australian salmon (*Arripis truttaceus*) **Method:** Beach seine nets and gill nets	X	FishCube data (2013-2023) did not show activity for this fishery within the Operational Area or EMBA. Therefore, there is no potential for interaction with the Eos 3D MSS.
Specimen Shell Managed Fishery (SSMF)	✓	✓	**Extent**: The fishing area includes all WA waters between the high-water mark and the 200 m isobath, with some concentration of effort in areas adjacent to population centres such as Broome, Karratha, Shark Bay, metropolitan Perth, Mandurah, the Capes area and Albany.	X	Collection typically occurs in shallow waters (outside of the Operational Area), however exception permits allow for the use of remote controlled underwater vehicles up to a depth of 300 m.

Fishery	Overlap with management area		Description[1, 2]	Fishing effort reported within the Operational Area	Relevance to EP
	Operational Area	EMBA			
			Effort: This is a limited entry fishery with 30 licences in the fishery. A maximum of four divers are allowed in the water per licence at any one time . In 2021, the total number of specimen shells collected was 5,443 distributed over 200 species. This is based on 100% of submitted catch returns. In the past 5 years, more than 435 separate species of molluscs have been collected, with an average of more than 200 species per year – the majority in low numbers per individual species. **Resource:** There is some focus of effort on mollusc families most popular with shell collectors, such as cowries, cones, murexes and volutes. Cypraeidae or cowries are noted for their localised variations in both shape and colour, making them attractive to collectors. **Method:** The main method of specimen shell collection is by hand collection by a small group of divers operating from small boats in shallow coastal waters or by wading along coastal beaches below the high-water mark or, in some instances, by use of ROV.		While FishCube data (2013-2023) shows activity of less than three vessels on two occasions from the SSMF within the EMBA, there was no activity within the Operational Area. Therefore, there is no potential for interaction with the Eos 3D MSS.
West Australian Sea Cucumber Fishery (WASCF)	✓	✓	**Extent:** While the fishery is permitted to operate throughout WA waters, fishing occurs mostly in the northern half of the State from Exmouth Gulf to the Northern Territory border, and Shark Bay was fished for the second time in 2021. **Catch and Effort:** In 2021, the total catch was 41.3 t and comprised 31.5 t of sandfish (*Holothuria scabra*), 8.8 t of deepwater redfish (*Actinopyga echinites*) and 0.8 t of black teatfish (*Holothuria whitmaei*). **Resources:** WASCF targets two main species: sandfish (*Holothuria scabra*) and redfish (*Actinopyga echinites*). **Method:** Primarily caught by diving and a small amount by wading.	X	While FishCube data (2013-2023) shows activity from the WASCF of less than three vessels within the EMBA, there was no activity within the Operational Area. Therefore, there is no potential for interaction with the Eos 3D MSS.
West Coast Deep Sea Crustacean Managed Fishery (WCDSCMF)	✓	✓	**Extent:** The WCDSCMF operates off the west coast of Western Australia (WA), on the seaward side of the 150 m isobath out to the extent of the Australian Exclusive Economic Zone (EEZ; 200 nm boundary). The fishery covers three WA management bioregions: North Coast, Gascoyne Coast and West Coast,		The operational area is inside the prohibited fishing area for this fishery and FishCube data (2013-2023) did not show activity for this fishery within the EMBA. Therefore, there is no potential for interaction with the Eos 3D MSS.

Fishery	Overlap with management area		Description[1, 2]	Fishing effort reported within the Operational Area	Relevance to EP
	Operational Area	EMBA			
			however, the majority of fishing activities are centred in the Gascoyne and West Coast Bioregions. **Catch and Effort:** In 2021 the total catch was 154 t and comprised predominantly of 139.9 t of crystal crab (90.1%), 14 t champagne crab and 0.1 t of giant crab. **Resources:** Crystal crab (*Chaceon albus*), Champagne crab (*Hypothalassia acerba*), and Giant crab (*Pseudocarcinus gigas*) **Method:** Baited pots operated from a long-line.		

[1] *WAFIC 2023*

[2] *Newman et al. 2023*

Northern Demersal Scalefish Managed Fishery

In the Kimberley, the NDSMF operates off the WA coast in waters east of 120° E longitude (Figure 3-17). The NDSMF is managed primarily through input controls in the form of an annual fishing effort capacity, with supplementary gear controls and area closures.

The fishery is permitted to use hand lines, droplines and fish traps, although the NDSMF has essentially operated as a trap-based fishery since 2002. The NDSMF principally targets red emperor and goldband snapper, with a number of species of snappers (*Lutjanidae*), cods (*Epinephelidae*) and emperors (*Lethrinidae*) comprising the majority of the remainder of the catch (Newman et al. 2020).

The fishery is further divided into two fishing areas: an inshore sector (Area 1) and an offshore sector (Area 2). The Northern Demersal Scalefish Managed Fishery Management Plan 2000 was amended in 2013 to formalise the previous voluntary industry agreement which further divides the offshore sector (Area 2) into three zones; A, B and C. Zone B comprises the area with most of the historical fishing activity. Zone A is an inshore developmental area and Zone C is an offshore deep slope developmental area representing waters deeper than 200 m (Newman et al 2020). The Eos 3D MSS is located within Area 2, Zone A, where fishing effort is limited.

In 2021 the total catch for the NDSMF was reported at 1,544 t, down from 1,570 in 2019/20 (Newman et al 2023), above the catch tolerance levels of 903–1,332 t per year set by DPIRD in the fishery's harvest strategy (DPIRD 2017). The majority of the catch was landed from Zone B, with a catch of 1,406 t in 2021 (Newman et al. 2023), up from 1,313 t in 2019. The level of catch in Zone B is the highest reported since zoning was implemented (Newman et al. 2021a). The total catch of goldband snapper in 2021 in the NDSMF (627.3 t) was greater than that reported in 2019 (602 t) (Newman et al 2020, 2021, 2023). The last five years have seen high reported landings for this species, continuing an overall trend of increasing catches since 2005. The total catch of red emperor in 2021 was 167.2 t, which is slightly lower than the red emperor catch levels reported in 2019 (192 t) (Newman et al 2020, 2021a, 2023).

Analysis of FishCube data (10 nm grid blocks) shows that the Operational Area and Active Source Area overlap with the activity of less than three vessels during the 2013–2023 period (refer to Figure 3-18).

Mackerel Managed Fishery

The MMF is divided into three zones, Area 1 – Kimberley (121°E to WA-NT border), Area 2 – Pilbara (114°E to 121°E) and Area 3 – Gascoyne (27°S to 114°E), which encompass the entire coastline of WA from the NT border to Cape Leeuwin in the south-west (Fletcher and Santoro 2015) (Figure 3-17).

The primary target species of the MMF is the Spanish mackerel (*Scomberomorus commerson*), which is fished commercially between Geraldton and the NT border.

The MMF was made a fully managed fishery in 2012 and operates under an Individual Transferable Quota (ITQ) system, which includes the setting of Total Allowable Commercial Catches (TACCs) for each area of the fishery, allocation of the entitlement to take quota in the form of units, and establishment of minimum unit holding requirements to operate in the Fishery.

Licence holders may only fish for mackerel by trolling or handline. There are currently only 14 licences in the Kimberley management area. A total of 15 vessels operated across the entire MMF during the 2019/20 season (Lewis et al. 2021).

The total catch of Spanish mackerel in the 2021 season was 238 t, down from the 2019–2021 season which recorded 291 t (Lewis and Bray 2020; Lewis et al. 2021). This is a return to the low level of catch reported in 2018. Prior to 2018–2019, the catch throughout the MMF had been relatively stable at 270–320 t since quotas were introduced in 2006 (Lewis et al. 2021). The low catch can be partially attributed to one of the four main Kimberley vessels not fishing and another hitting a reef and sinking during the season along with continued low effort in the other fishing areas (Newman et al. 2023). It may also be due to widespread environmental changes in Northern Australia, with catches also declining in other states (Lewis and Bray 2020; Newman et al. 2023). The nominal catch rates in the Kimberley and Pilbara management areas of the MMF are generally decreasing suggesting that the overall spawning stock may be declining, possibly due to the effects of marine heatwaves (Lewis and Bray 2020, Lewis et al. 2021). The 2021 catch is just below the target commercial catch range for Spanish mackerel in the MMF of 246–430 t ,however, in the Kimberley area the 2021 Spanish mackerel catch of 157 t is within the catch range (110–225 t) (Newman et al. 2023).

Analysis of FishCube data shows that the Operational Area overlaps one reporting block (10 nm) located in the southern half of the Operational Area, within the Active Source Area (refer to Figure 3-19). The activity for this reporting grid block shows less than three vessels active during the 2013–2023 period.

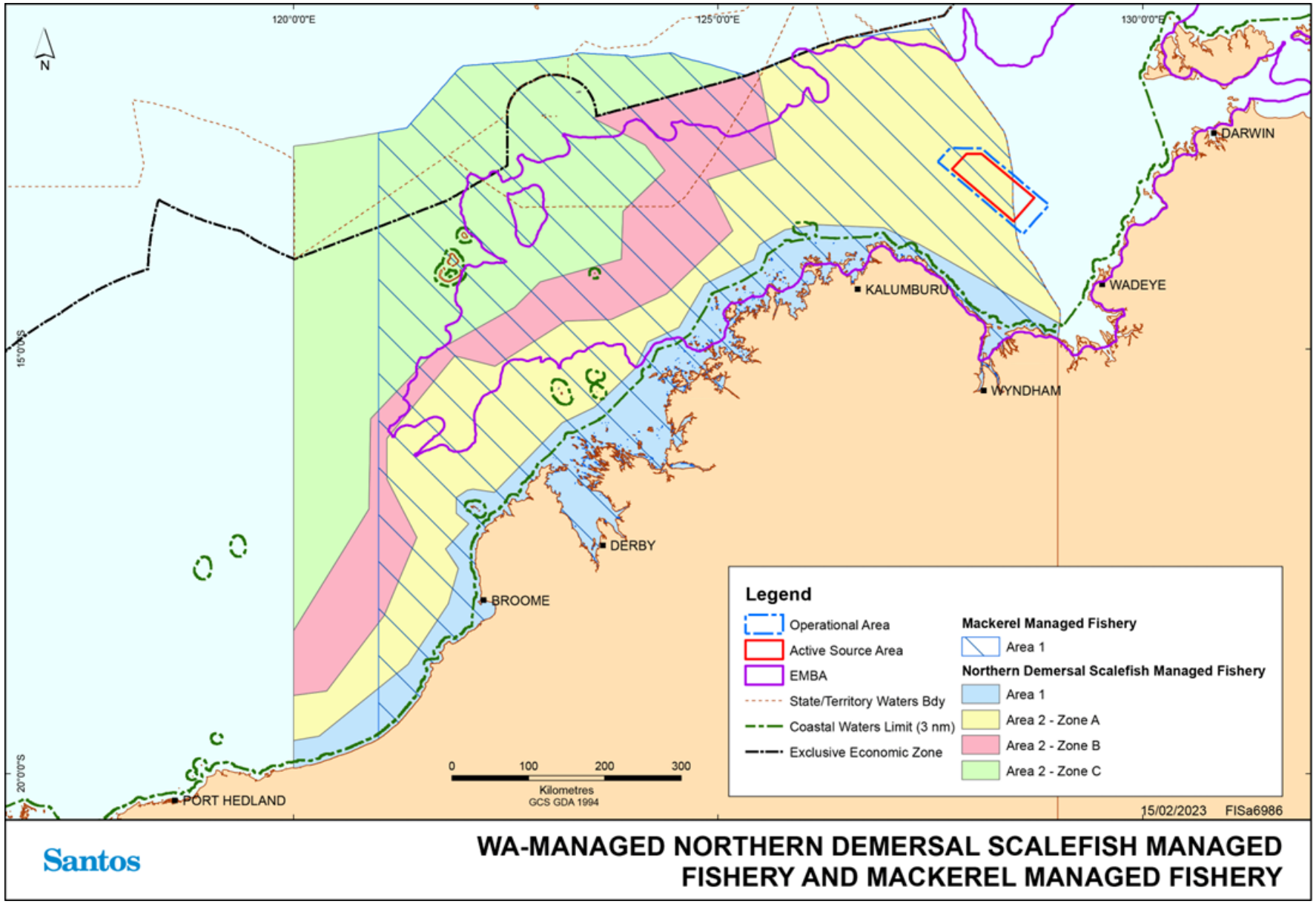


Figure 3-17: Relevant Western Australian-managed fisheries

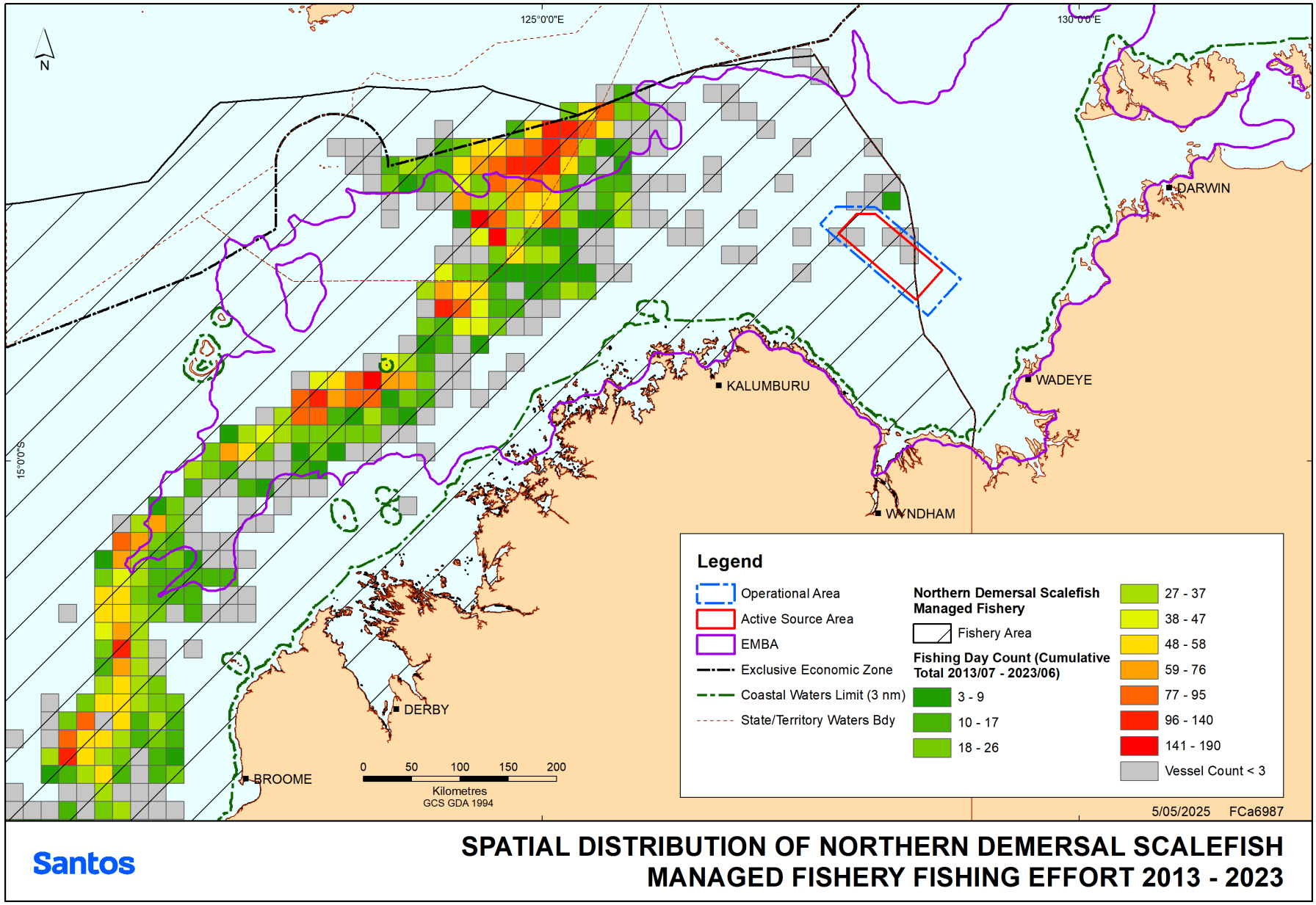


Figure 3-18: Northern Demersal Scalefish managed fishery total fishing day count (2013–2023)

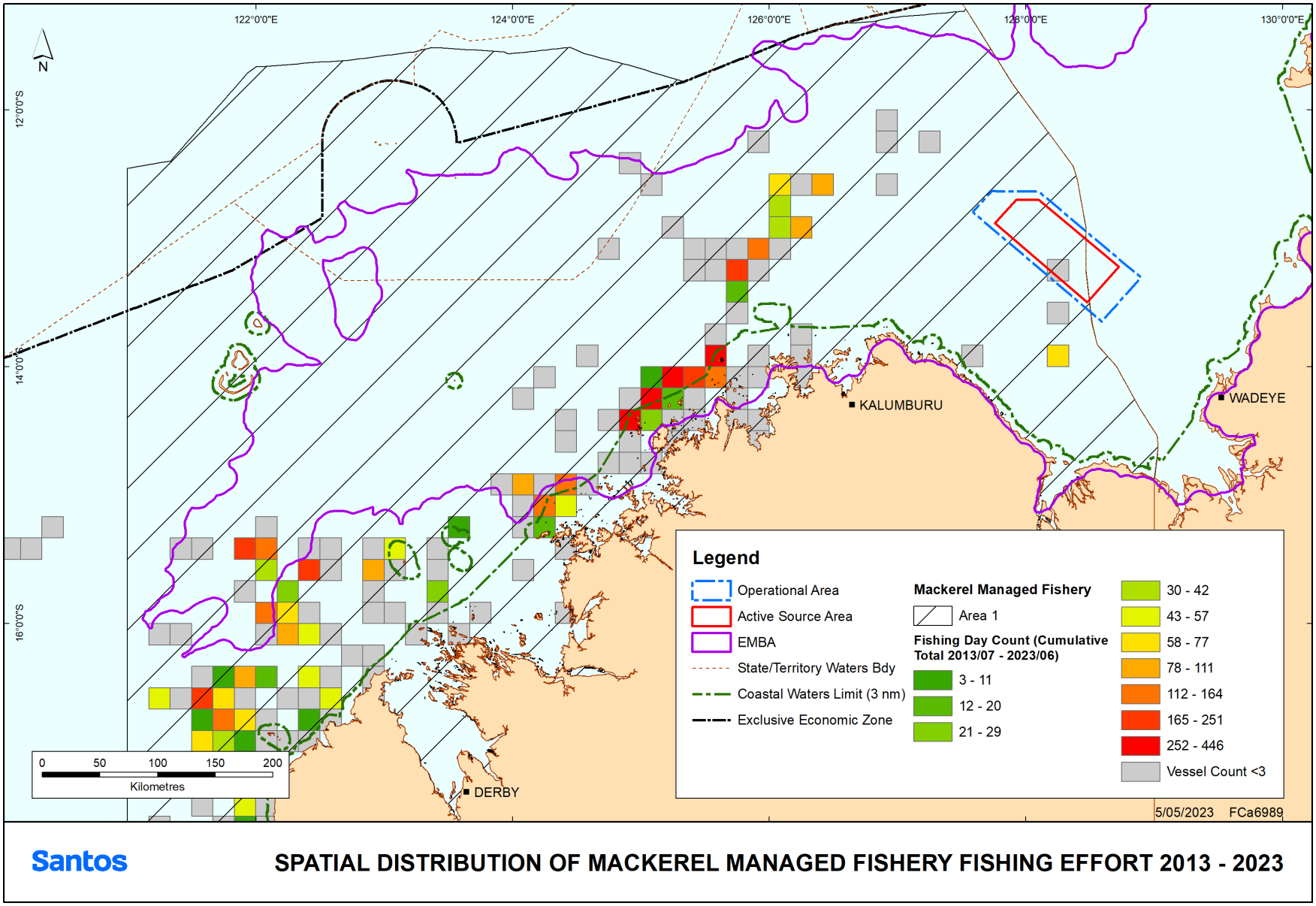


Figure 3-19: Mackerel Managed Fishery total fishing day count (2013–2023)

3.8.1.3 Northern Territory managed fisheries

Northern Territory fisheries are managed by the NT Department of Industry, Tourism and Trade (NT DITT), formerly known as NT Department of Primary Industry and Resources (NT DPIR). Wild harvest fisheries are managed under the *Fisheries Act 1988* and Fisheries Regulations 1992 and management plans. NT managed fisheries with management boundaries that overlap with the Operational Area and EMBA include:

- Demersal Fishery (DF)
- Spanish Mackerel Fishery (SMF)
- Offshore Net and Line Fishery (ONLF)
- Aquarium Fishery (AF)
- Barramundi Fishery (BF)
- Coastal Line Fishery (CLF)
- Trepang Fishery (TF)
- Development – Small Pelagic (DSP)
- Timor Reef Fishery (TRF)
- Coastal Net Fishery (CNF).

These fisheries are further described in Table 3-20. The information presented in this section has predominantly been sourced from recent NT DITT fisheries reports.

Catch and effort data

Santos requested annual catch and effort data from NT DITT. Annual catch and effort data was available for each of the most recent 5 years (2016–2020).

Data was assessed for 60 nm × 60 nm blocks to identify where the greatest fishing effort in each fishery occurred and the relative importance of waters within the Operational Area. Block resolution finer than 60 nm x 60 nm was not available.

Data provided included:

- Weight (kg) – a measure of fish catches per block during the period of interest
- Licence Count – a measure of the number of licences that fished in a CAES block during the period of interest
- Sum of Hook Hours – a measure of fishing effort, represented by the number of hours fished in a block during the period of interest.

Due to confidentiality reasons, NT DITT was unable to release catch and effort data for blocks where less than five licences fished during the period of interest. Blocks where the results are provided in this way confirm that fishing effort did occur within the block during that period, but the associated catch and effort values are not available. Blocks where no fishing is recorded do not return any data.

The following subsections provide additional information on the relevant NT managed fisheries and presents the fishing catch and effort data that has been mapped for the fisheries.

Table 3-20: Relevant Northern Territory-managed fisheries

Fishery	Overlap with management area		Description	Fishing effort reported within the Operational Area	Relevance to EP
	Operational Area	EMBA			
Demersal Fishery (DF)	✓	✓	**Extent:** Demersal fishing is allowed from 15 nm from the low water mark to the outer boundary of the Australian fishing zone, excluding the area of the Timor Reef Fishery. Effort: There are currently 18 licences issued for the DF and in 2017, the reported catch was 3,389 t (DPIR 2019f), including, red snapper (70.8%) and goldband snapper (10.1%). **Resource:** Goldband snapper, red snapper, saddletail snapper and crimson snapper. **Method**: Vertical lines, drop lines, finfish long-lines, baited fish traps and semi-demersal trawl nets in two multi-gear areas.	✓	Catch effort data for 2016–2020 shows the DF was active for approximately 662 days across two reporting blocks overlapping the Operational Area. Therefore, there is potential for interaction with this fishery and the Eos 3D MSS. The EMBA also showed fishing activity for up to 16 licence holders of the TF across 12 reporting blocks for a total of approximately 1,938 days fished.
Spanish Mackerel Fishery (SMF)	✓	✓	**Extent:** Commercial fishing for Spanish mackerel is permitted from the high water mark to the outer boundary of the AFZ. **Effort:** The SMF is a limited entry fishery, with catch managed via input controls (DPIR 2019b). There are currently 15 active licences. Total catch was 290 t in 2017 (DPIR 2019f). Most Spanish mackerel are caught off the western and eastern mainland coasts and near islands including Bathurst Island, Groote Eylandt and the Wessel Islands. Fishing generally takes place around reefs, headlands and shoals. **Resource:** Spanish mackerel **Method**: Troll lines, floating hand lines and rods.	✓	Catch effort data for 2016–2020 shows the SMF was active for approximately 12 days across two reporting blocks overlapping the Operational Area. Therefore, there is potential for interaction with this fishery and the Eos 3D MSS. The EMBA also showed fishing activity for up to 39 licence holders of the SMF across 16 reporting blocks for a total of approximately 3,295 days fished.
Offshore Net and Line Fishery (ONLF)	✓	✓	**Extent:** The Offshore Net and Line Fishery is a quota managed fishery. Fishing is permitted from the low water mark to the outer boundary of the AFZ to the extent the waters are waters relevant to the NT. **Effort:** 641 t in 2017 (DPIR 2019f). Including, grey mackerel (73%) and blacktip shark (11%). **Resource:** Black-tip sharks and grey mackerel are the primary species, however other shark species caught include hammerhead, bull, tiger, pigeye, lemon and winghead sharks and dusky whalers. **Method**: Demersal long lines, pelagic long lines, and pelagic nets.	✓	Catch effort data for 2016–2020 shows the ONLF was active for approximately seven days across two reporting blocks overlapping the Operational Area. Therefore, there is potential for interaction with this fishery and the Eos 3D MSS. The EMBA also showed fishing activity for up to 30 licence holders of the ONLF across 13 reporting blocks for a total of approximately 2,007 days fished.

Fishery	Overlap with management area		Description	Fishing effort reported within the Operational Area	Relevance to EP
	Operational Area	EMBA			
Aquarium Fishery (AF)	✓	✓	**Extent:** The NT Aquarium Fishery is a small-scale, multi-species fishery. It includes freshwater, estuarine and marine habitats to the outer boundary of the AFZ, which is 200 nm offshore. **Effort:** According to the NTSC, the fishery has 11 licences and around three boats are active each year (NTSC 2017). Total catch in 2017 was 2 t. Freshwater and estuarine species are generally collected between the Adelaide and Daly rivers, while most marine species are collected within 100 km of Nhulunbuy and Darwin. **Resource:** Aquarium fishes, including rainbowfish, catfish and scats. Invertebrates including hermit crabs, snails, whelks and hard/soft corals. Plants are also taken. **Method**: AF licence holders can use barrier, cast, scoop, drag and skimmer nets, hand pumps, freshwater pots and hand-held equipment to collect aquarium species.	✓	Information obtained from the Chair of the Aquarium Fishery Licence Committee during the consultation process for the nearby Santos Bethany 3D MSS confirmed that licence holders typically scuba dive to a maximum of 30 m. It was also confirmed that one operator operates at Evan Shoal, east of Lyndoch Shoal, Blackwood Shoal and Money Shoal in Arafura Sea and within the Timor Reef Fishery Area. Catch effort data for 2016–2020 shows the AF was active for approximately three days across three reporting blocks overlapping the Operational Area. Therefore, there is potential for interaction with this fishery and the Eos 3D MSS. The EMBA also showed fishing activity for up to 31 licence holders of the AF across 16 reporting blocks for a total of approximately 1,015 days fished.
Timor Reef Fishery (TRF)	X	✓	**Extent:** Commercial fishing is allowed north-west of Darwin to the WA / NT border and to the outer boundary of the Australian fishing zone, 200 nm offshore. The fishery has an area of approximately 8,400 square nautical miles. **Effort:** There are 15 licences currently issued in the TRF, however, there are no restrictions on the number of licences in the fishery. **Resource:** Goldband snapper is the primary species taken. Other key species include saddle-tail snapper, crimson snapper, red emperor and cods. **Method:** Vertical lines, drop lines attached to or free from a vessel, finfish long-lines, and baited fish-traps are all used in the TRF.	X	Although activity is recorded in one grid block overlapping the Operational Area, the Timor reef fishery is unlikely to be active within or close to the Operational Area. Given the 60 nm × 60 nm extent of the grid block, the boundary of the TRF has been captured along with a small portion of the Operational Area, however these boundaries do not overlap each other (refer to Figure 3-20). Therefore, the recorded 1.8 days of activity by this fishery within this grid block is not representative of activity within the Operational Area.

Fishery	Overlap with management area		Description	Fishing effort reported within the Operational Area	Relevance to EP
	Operational Area	EMBA			
					While the EMBA showed fishing activity for up to 25 licence holders of the TRF across 11 reporting blocks for a total of approximately 2,630 days fished, there is no potential for interaction with the Eos 3D MSS and the fishery is not considered further in this EP.
Barramundi Fishery (BF)	X	✓	**Extent:** Commercial fishing for barramundi is allowed from the high water mark to three nautical miles seaward of the low water mark. The fishing area is restricted to waters seaward from the coast, river mouths and legislated closed lines. The annual commercial barramundi fishing season in the NT is from 1 February to 30 September. **Effort:** The fishery is restricted to 14 licences which can be bought, sold and leased. **Resource:** Barramundi and king threadfin are the primary species taken in the BF. **Method**: Commercial operators fish over tidal mud flats and inside a restricted number of rivers using monofilament gill nets.	X	The fishery is located within the EMBA with up to 18 licences showing activity across four reporting blocks for a total of 2,201 days. There is no potential for interaction with the Eos 3D MSS and therefore, the fishery is not considered further in this EP.
Coastal Line Fishery (CLF)	X	✓	**Extent:** Coastal NT waters between the high-water mark and 15 nautical miles out from the low water mark. No fishing is permitted in reef fish protected areas. **Effort:** The fishery is restricted to 52 licences. **Resource:** Black jewfish and golden snapper are the main species taken in the coastal line fishery. **Method**: Vertical lines, cast nets, scoop nets or gaffs can be used from the high-water mark out to 15 nautical miles from the low water mark. Drop lines and up to five fish traps can be used from two to 15 nautical miles out from the low water mark (however not in the western zone). Up to five hooks per vertical line and up to 40 hooks per drop line are allowed.	X	The fishery is located within the EMBA with up to 1 licences showing activity across eight reporting blocks for a total of approximately 1,977 days. There is no potential for interaction with the Eos 3D MSS and therefore, the fishery is not considered further in this EP.
Trepang Fishery (TF)	X	✓	**Extent:** Trepang is more commonly known as sea cucumber in the Northern Territory (NT). Commercial fishing for sea cucumber is allowed from the high-water mark to three nautical miles seaward from the territorial sea baseline. However, most sea cucumbers are	X	The fishery is located within the EMBA with up to two licences showing activity across three reporting blocks for a total of approximately seven days. There is

Fishery	Overlap with management area		Description	Fishing effort reported within the Operational Area	Relevance to EP
	Operational Area	EMBA			
			collected along the Arnhem Land coast, mainly around the Cobourg Peninsula and Groote Eylandt. **Effort:** The fishery is restricted to six licences which can be bought, sold and leased. All are currently allocated. **Resource:** Sandfish are the primary species of sea cucumber taken. **Method**: Trepang are harvested by hand either on foot or by diving, usually on neap tides during the dry season when the water is clearer.		no potential for interaction with the Eos 3D MSS and therefore, the fishery is not considered further in this EP.
Development – Small Pelagic (DSP)[2]	X	✓	Development Fishery Licences are issued to existing fisheries intending to trial new fishing gear, fishing methods and / or catch new target species. Fishers who wish to conduct development trials are required to lodge written applications providing detailed information about their proposed activities. Performance criteria are assigned to each permit so that the feasibility of the trials may be assessed. Development licences may be issued to approved applicants for up to one licensing year and may be renewed a maximum of four times. Where licence holders meet all performance criteria and remain able to demonstrate that the fishery and/or gear is both ecologically and economically sustainable, the fishery and/or gear in question may progress to a managed fishery.	X	Development fishing activity is located within the EMBA with up to six licences showing activity across four reporting blocks for a total of approximately 105 days. There is no potential for interaction with the Eos 3D MSS and therefore, the fishery is not considered further in this EP.
Coastal Net Fishery (CNF)	X	✓	**Extent:** The fishery extends from the high-water mark to 3 nautical miles out from the low water mark. The fishery is divided into regions with fishers only permitted to fish in the region or regions nominated on their licence. The regions include: • Darwin – from Cape Hotham to Native Point and Cape Ford to Cape Dooley • Gove – between Cape Arnhem and Cape Wilberforce • Borroloola – from Bing Bong Creek and Pelican Spit. **Effort:** This fishery is restricted to 5 licences, all of which are allocated. **Resource:** Mullet is the primary species taken in the CNF. **Method**: Nets that are up to 300 m long, have a maximum drop of 5 m, a mesh size of 65 mm or less and are anchored at one end only.	X	The fishery is located within the EMBA with up to 13 licences showing activity across two reporting blocks for a total of approximately 275 days. There is no potential for interaction with the Eos 3D MSS and therefore, the fishery is not considered further in this EP.

[1] *NT Gov 2019*

[2] *DPIF 2012*

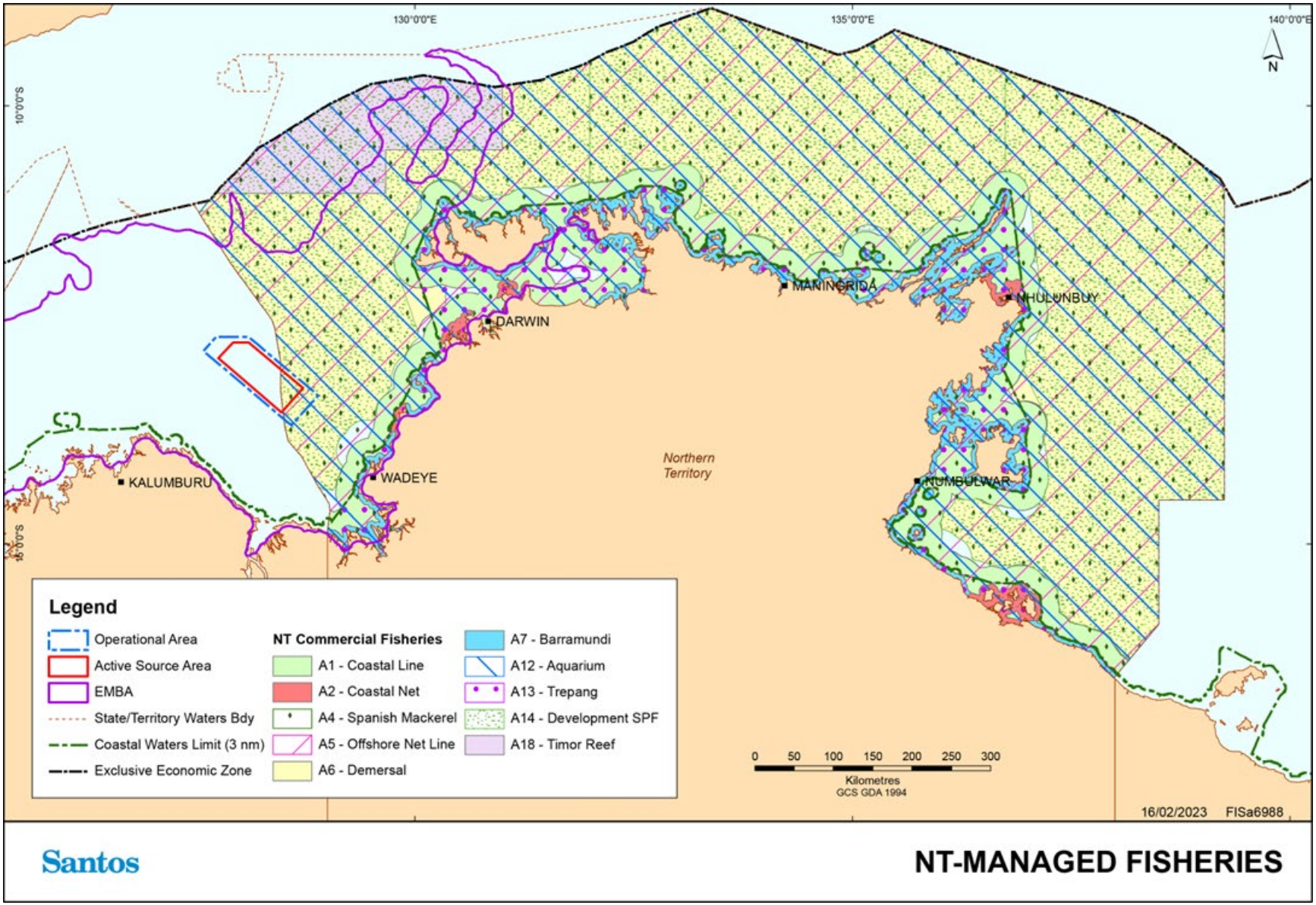


Figure 3-20: Northern Territory-managed fisheries

Demersal Fishery

The NT DF extends from 15 nm from the low water mark to the outer limit of the AFZ (excluding the area of the Timor Reef Fishery) and targets a range of tropical snappers (*Lutjanus spp.* and *Pristipomoides spp*.).

The harvest by the DF is limited through a set of total allowable catches (TACs) applied to goldband snappers (*Pristipomoides spp*.) (400 t), red snappers (*L. malabaricus* and *L. erythropterus*) (2,500 t) and a 'grouped fish' category (915 t). The latter group includes all fishes other than barramundi (Lates calcarifer), king threadfin (*Polydactylus macrochir*), Spanish mackerel, shark and mud crabs (*Scylla spp*.) (DPIR 2019a).

DF licensees harvested 3,389 t of fishes in 2017 (DPIR 2019f). Red snappers and goldband snappers formed the bulk of the harvest (70.8% and 10.1%, respectively) with painted sweetlip (*Diagramma labiosum*) being the primary by-product species (5.7%) along with redspot emperor (2.8%). Reported bycatch (by weight) during 2017 was less than 1% of the dropline and trap harvest and the average bycatch recorded by observers for the trawl harvest in 2016 was 27.4% (DPIR 2019f).

In 2016, the total commercial catch of goldband snapper was 535.2 t, of which 340.7 t was taken by the DF. The status of goldband snapper from the Arafura and Timor seas was assessed using data up to 2016 using a stochastic Stock Reduction Analysis (SRA) model. The outputs of this model estimated egg production to be around 65–70% of unfished levels and the current harvest rate is below that required to achieve maximum sustainable yield. This level of fishing mortality is well above conventional target levels and is unlikely to cause the stock to be recruitment overfished (DPIR 2019a).

The fishery permits the use of different fishing methods in certain areas of the fishery, either line and fish-trap gear are permitted and demersal trawls nets are excluded, or where line, fish-trap and finfish trawl gear are all permitted.

Traps used in the fishery are set on the seabed with an identifying float on the sea surface. The fishery is monitored primarily through logbook returns, which operators are required to fill out on a daily basis during fishing operations. The logbooks provide detailed catch and effort information, as well as information on the spatial distribution of the fishing operations.

Catch and effort for trap vessels varies from year to year. The NT Government (2014) states that the substantial variability in trap effort since 2009 generally reflects movement between the DF and the nearby Timor Reef Fishery. The NT Government (2014) states that Stock Reduction Analysis evidence suggests that this is not due to changes in fish abundance or sustainability concerns that the fluctuating CPUE reflects the small number of operators and their developing knowledge of the fishery.

Analysis of catch and effort data shows that the fishing effort for the DF was approximately 662 days within the Operational Area for the period between 2016 and 2020 (refer to Figure 3-21).

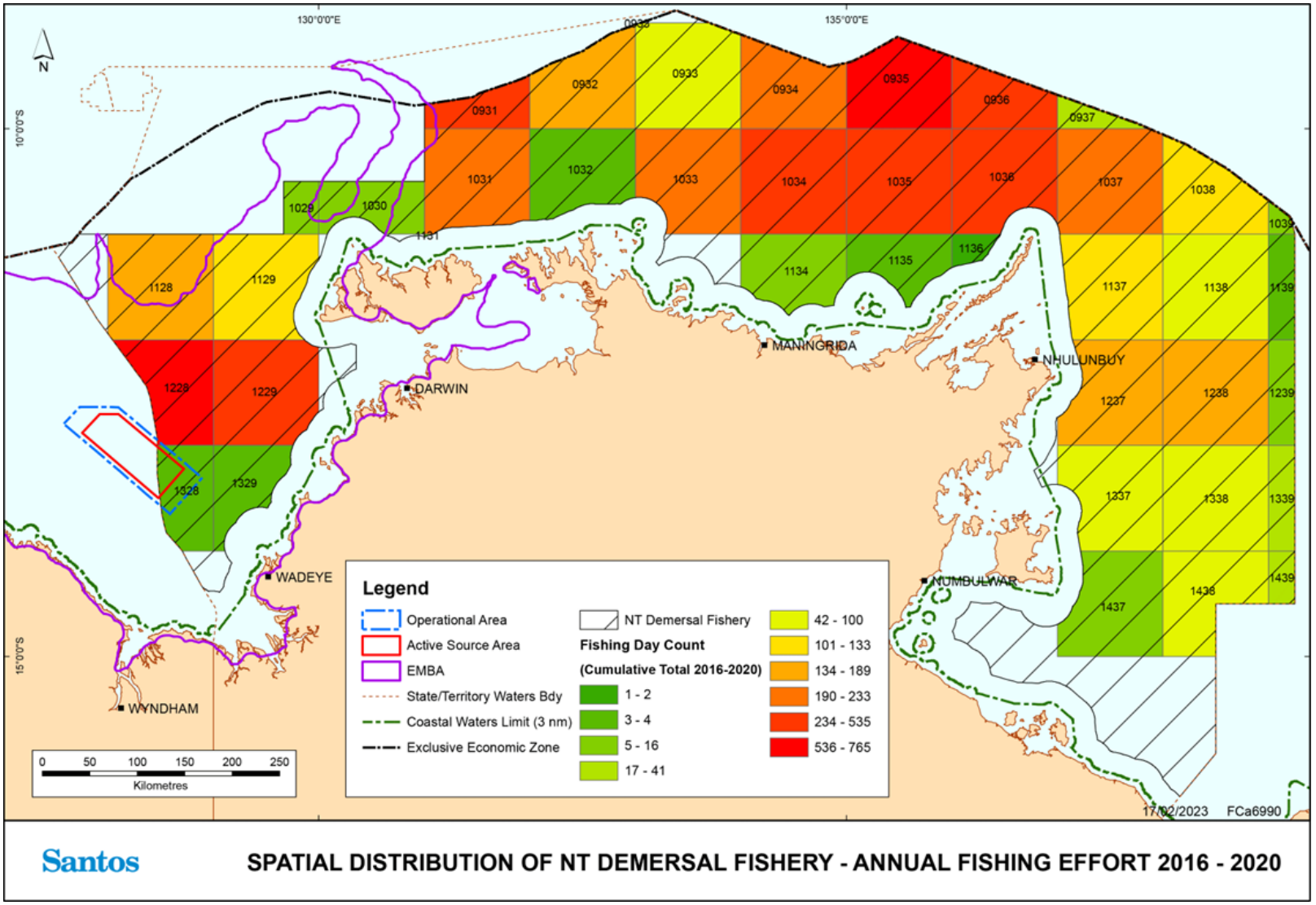


Figure 3-21: Demersal Fishery total fishing day count (2016–2020)

Spanish Mackerel Fishery

The NT SMF extends seaward from the high-water mark to the outer limit of the AFZ and targets Spanish mackerel (*Scomberomorus commerson*) using trolled lures or baited lines. The primary fishing grounds include waters near Bathurst Island, New Year Island, the Wessel Islands around to Groote Eylandt and the Sir Edward Pellew Group of islands.

Licensees typically fish from a mother ship and dories, with a maximum of two dories permitted per licence. They may use any number or combination of troll lines, floating hand lines or rods. Operators generally troll two to four lines behind a dory and up to eight lines from a mother boat.

Commercial catches and catch rates of Spanish mackerel gradually increased from 1986–2006, before declining to an average catch of about 350 t per annum and a catch rate of 300 kg per day. Both commercial catches and catch rates of the commercial sector of the Spanish Mackerel Fishery have since increased to peak at their highest level of 446.5 t (2016) and 389 kg per day (2012).

A total of 390.6 t of fish were harvested by SMF licensees in 2017, with all but 0.7 t being Spanish mackerel and the remaining, reported as grey mackerel (DPIR 2019f).

Current biomass levels are well within sustainable limits and suggest that this stock is not considered to be recruitment overfished and the current level of fishing mortality is unlikely to cause the stock to become recruitment overfished. The NT Spanish Mackerel stock is classified as a sustainable stock.

Analysis of catch and effort data for the SMF was limited at approximately 12 days within the Operational Area for the period between 2016 and 2020 (refer to Figure 3-22).

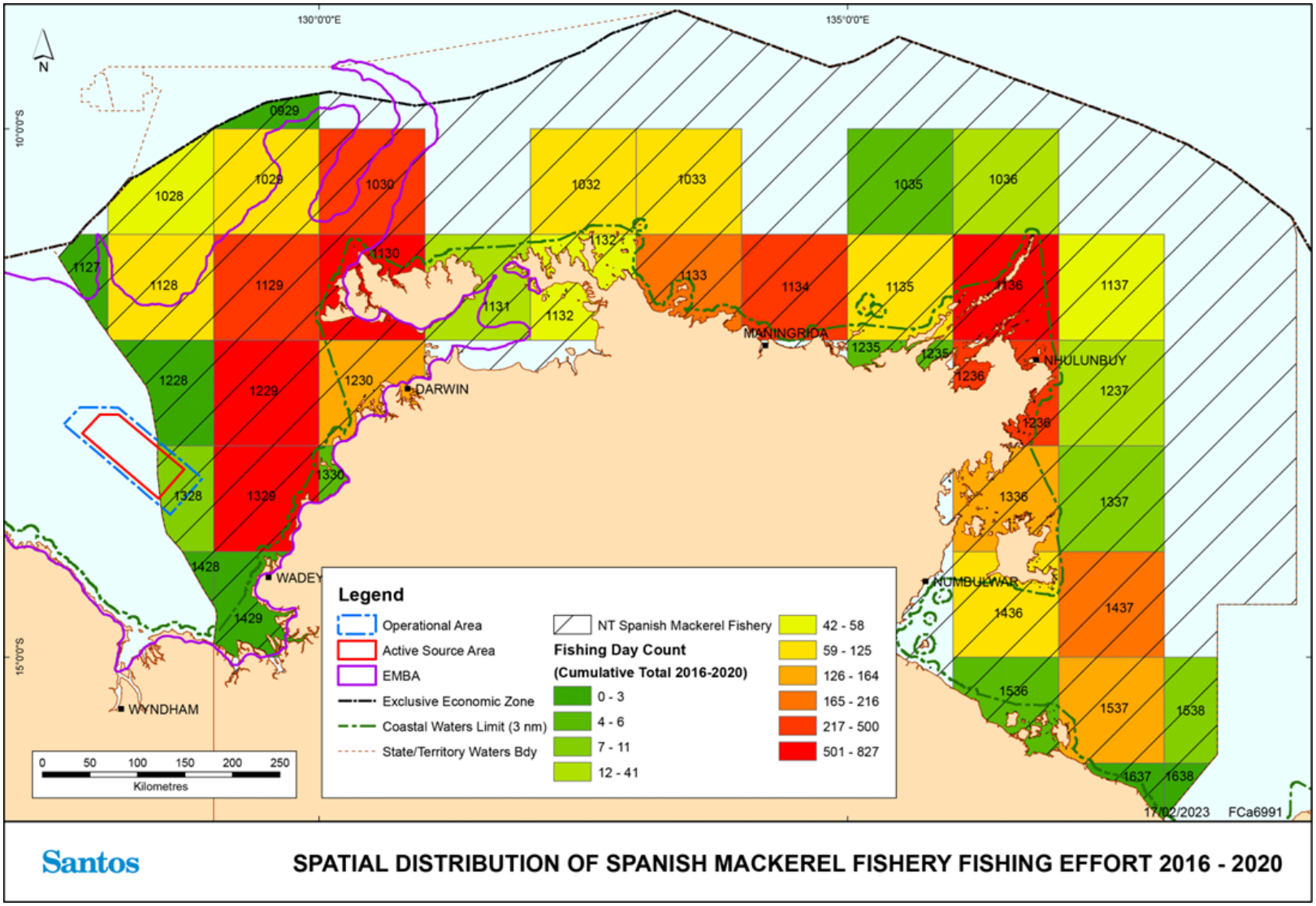


Figure 3-22: Spanish Mackerel Fishery total fishing day count (2016–2020)

Offshore Net and Line Fishery

The NT ONLF is a quota managed fishery operating in the NT waters seaward from the low-water mark to the outer limit of the AFZ. The fishery targets Australian blacktip sharks (*Carcharhinus tilstoni*), common blacktip sharks (*C. limbatus*) and grey mackerel (*Scomberomorus semifasciatus*) using demersal long lines, pelagic long lines and pelagic nets.

The NT and Commonwealth via the Northern Territory Fisheries Joint Authority (NTFJA) share responsibility for the management of the ONLF with the Fisheries Division of the Department of Primary Industry and Resources (Fisheries) undertaking day-to-day management of the fishery (DPIR 2018). While there are no restrictions on the number of licences issued in this fishery, vessels must hold a licence to fish commercially. In order to manage sustainability, address environmental impacts of the fishery, and to enhance fisheries economic viability, a Total Allowable Commercial Catch (TACC) Quota was approved.

Licensees harvested 640.8 t of fishes in 2017 (DPIR 2019f). Grey mackerel formed the bulk of the harvest (73.2%) followed by the blacktip shark group (11.8%) and Spanish mackerel (3.1%). The primary by-product species were hammerhead sharks (3%), tuna (2.1%) and queenfish (2%). Bycatch (by weight) was less than 1% of the harvest in 2017 (DPIR 2019f).

Analysis of catch and effort data for the ONLF was limited at approximately seven days within the Operational Area for the period between 2016 and 2020 (refer to Figure 3-23).

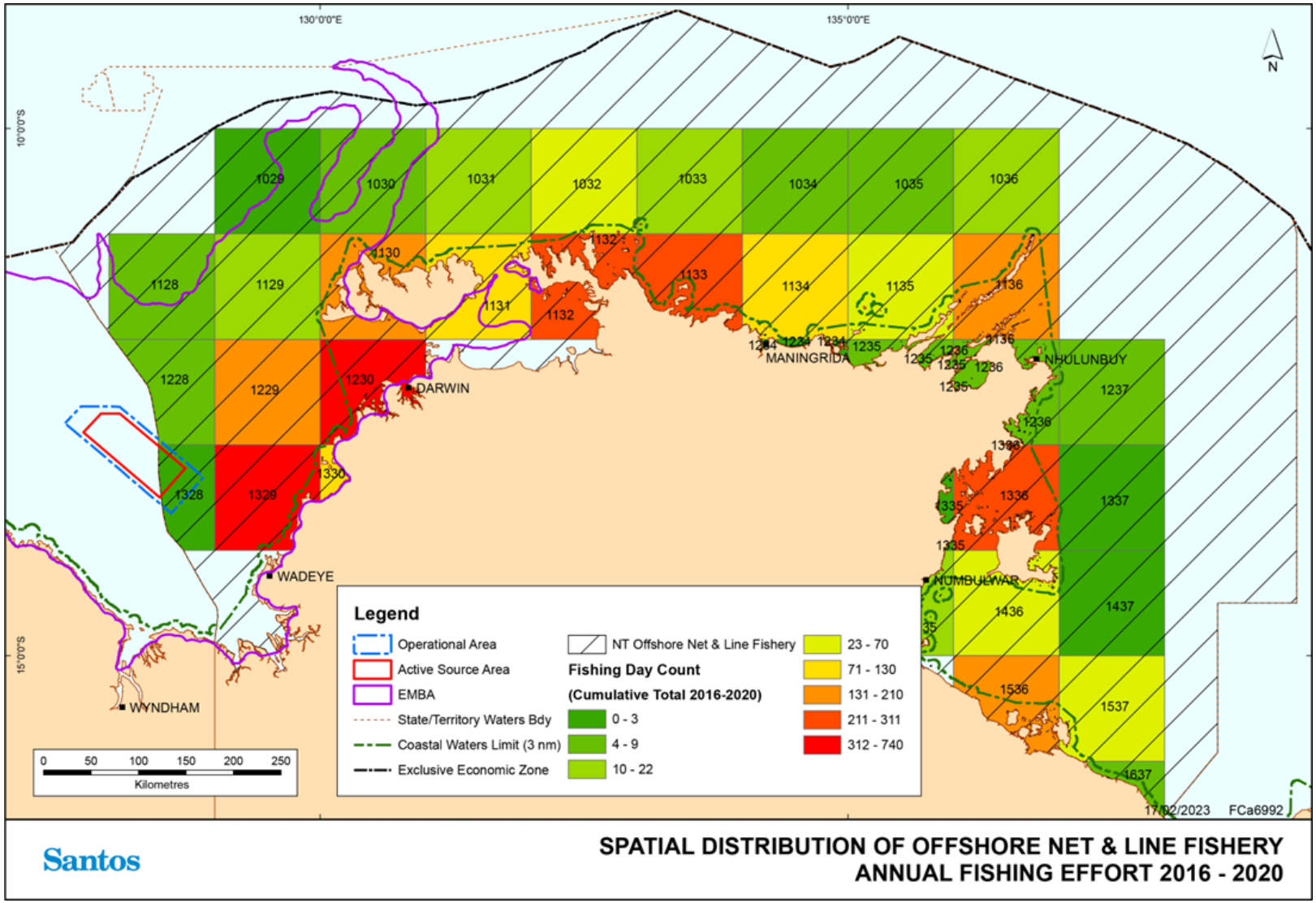


Figure 3-23: Offshore Net and Line Fishery total fishing day count (2016–2020)

Aquarium Fishery

The AF is a small-scale, multi-species fishery that prospects freshwater, estuarine and marine habitats to the outer boundary of the Australian Fishing Zone (AFZ). The fishery supplies a wide range of aquarium fishes and invertebrates to local, interstate and international pet retailers, wholesalers, and public aquariums (DCCEEW 2022).

Fishing may occur in all inland, estuarine and marine waters to the outer boundary of the AFZ using a variety of methods including barrier, cast, scoop, drag and skimmer nets, hand pumps, freshwater pots and hand-held equipment to collect aquarium species (NT 2019). Freshwater and estuarine species are generally collected between the Adelaide and Daly rivers, while most marine species are collected within 100 km of Nhulunbuy and Darwin (NT Gov 2019).

The fishery is managed through the issuing of licences and a licence is required to collect, sell or publicly display marine life in the NT. Therefore, there are different licence categories and licence limits for the AF, the categories include aquarium fishing / display licence, trader licence, and display licence. Of the 12 available licences, 11 have been allocated (DCCEEW 2022).

Information obtained from the Chair of the Aquarium Fishery Licence Committee during the consultation process for the nearby Santos Bethany 3D MSS confirmed that licence holders typically scuba dive to a maximum of 30 m. It was also confirmed that one operator operates at Evan Shoal, east of Lyndoch Shoal, Blackwood Shoal and Money Shoal in Arafura Sea and within the Timor Reef Fishery Area.

Analysis of catch and effort data was limited at approximately three days across three reporting blocks within the Operational Area for the period between 2016 and 2020 (refer to Figure 3-24).

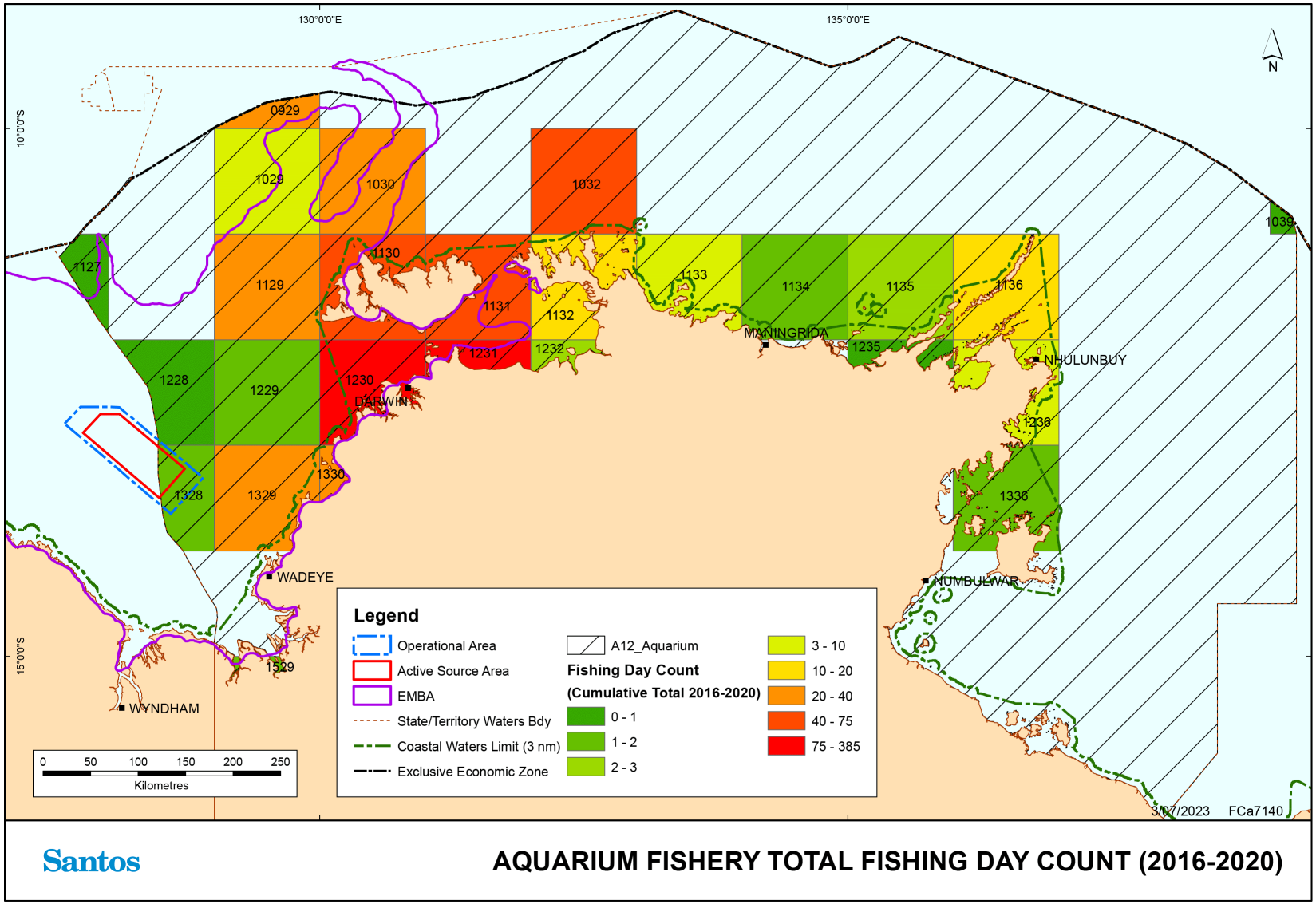


Figure 3-24: Aquarium Fishery total fishing day count (2016–2020)

3.8.1.4 Key commercial finfish and shellfish species

Stock information for key commercial finfish and shellfish species targeted commercial fisheries in the Operational Area and was sourced from the Fisheries Research and Development Corporation (FRDC) (2021) Status of Australian Fish Stocks Reports and supplemented with information from the WA DPIRD. ABARES and AFMA monitor Commonwealth-managed fisheries, including the NPF. The prawn stocks within the NPF are considered as a single stock and management unit.

The species described in the following subsections are referred to by the fishery management authorities as indicator species and are relevant to the management of commercial fish stocks. Indicator species are selected from the suite of commercially targeted finfish (based on their inherent vulnerability, management importance and overall risk to sustainability) for assessing the status of the overall resource.

3.8.1.5 Key Prawn Species

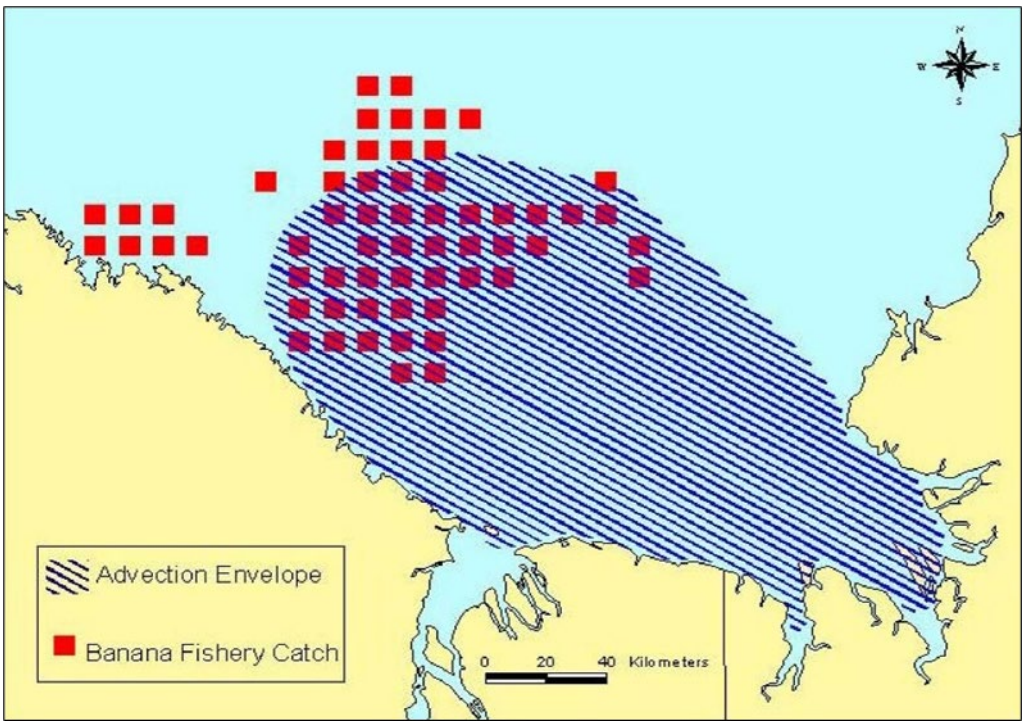
Based on information from the Northern Prawn Fishery Industry Pty Ltd (NPFI) and NPF fishery publications, the NPF indicator prawn species (banana prawns and tiger prawns), as well as endeavour prawns may spawn within the Operational Area. During consultation for this EP the NPFI advised spawning occurs between August and October. The biology of these species is described below and summarised in Table 3-21, as published by AFMA (2023a), Parsa et al. (2020), and the FRDC online Status of Australian Fish Stocks Reports (Butler et al. 2020).

Banana prawns inhabit tropical and subtropical coastal waters. They are found over muddy and sandy bottoms in coastal waters and estuaries. Juveniles inhabit small creeks and rivers in sheltered mangrove environments. White banana prawns can generally be found at depths of 16–25 m but can occur to depths of 45 m. Red-legged banana prawns are found at depths of 35–90 m (AFMA 2023a).

Advice provided to industry by the NPFI in relation to other marine seismic surveys in the region (i.e. Santos Fishburn 3D MSS, Santos Beehive 3D MSS and Polarcus Petrelex 3D MSS), is that *P. indicus* spawn offshore in proximity to the fishing area throughout the year. Two spawning peaks have been identified: the late dry season (September-November) and the late wet season (March-May). The larvae move inshore and then wash out as juveniles with the wet season floods. A twelve-month-old female can produce hundreds of thousands of eggs at a single spawning and may spawn more than once in a season. The eggs sink to the bottom after release, where they hatch into larvae within about 24 hours. Less than 1% of these offspring survive the 2–4 week planktonic larval phase to reach suitable coastal nursery habitats where they may settle. After one to three months on the nursery grounds, the young prawns move offshore onto the fishing grounds.

As described in Loneragan et al. (2002), the offshore fishery for red-legged banana prawns (*P. indicus*) takes place in the western offshore waters of the JBG (in water depths of 50–80 m). The juvenile phase of *P. indicus* is found in estuarine habitats up to 120 km south and 240 km east-southeast of the southern and eastern limits of the JBG *P. indicus* fishing grounds. The juvenile phase of *P. merguiensis* is found in estuarine habitats in the western JBG, about 50 km to the south-west of the offshore fishing grounds. Although these mangrove habitats are the closest inshore habitats to the fishery, they are not used by *P. indicus*. These results suggest that the larvae of *P. indicus* resulting from spawning in the fishing area of the JBG, are advected large distances to the south and east to their nursery habitats (Figure 3-25). They also imply that the emigrating juveniles and sub-adults migrate from the mangrove nursery habitats, north and west, across shallower sand substrates (30–40 m deep) to the deeper-water fishery (on mud substrates about 50–80 m deep).

The migration of juvenile *P. indicus* in the JBG appears to be split into two periods, with the migration of the main cohort occurring between November and March, with a possible second cohort migrating from April to June (Neil Loneragan, CSIRO Division of Marine Research, pers. comm., April 2000). The migration of juveniles is thought to be triggered by rainfall and river discharge.



Source: Loneragan et al. 2002

Figure 3-25: Size of the probable advection envelope for post larval *P. indicus* in the JBG

Tiger prawns inhabit shelf waters to depths of 200 m. Adult brown tiger prawns are found over coarse sediments. Adult grooved tiger prawns are found in fine mud sediments. Juvenile tiger prawns are found in shallow waters, often in association with seagrass beds, and sometimes on top of coral reef platforms. Spawning occurs throughout the year, in both inshore and offshore areas for brown tiger prawns and in offshore areas for grooved tiger prawns. Brown tiger prawns have a spawning peak between July and October. Grooved tiger prawns have a spawning peak in August-September, with a secondary peak in February (AFMA 2023a).

Endeavour prawns inhabit tropical coastal waters. Blue endeavour prawns can be found over sandy or mud-sand substrates to depths of about 60 m. Red endeavour prawns prefer muddy substrates and have been found to depths of 95 m. Juvenile blue endeavour prawns are commonly associated with seagrass beds in shallow estuaries, while juvenile red endeavour prawns are more widely distributed across seagrass beds, mangrove banks, mud flats and open channels. Spawning occurs throughout the year. Blue endeavour prawns have spawning peaks in March and September. Red endeavour prawns have a spawning peak in September to December (AFMA 2023a).

Table 3-21: Key prawn species relevant to the survey

Species	Habitat	Stock structure and distribution	Reproduction and recruitment	Stock assessment	Relevance to EP
Banana prawns Redleg banana prawn *P. indicus* White banana prawn *P. merguiensis*	Tropical and subtropical coastal waters. Muddy and sandy bottoms in coastal waters and estuaries. Juveniles inhabit small creeks and rivers in sheltered mangrove environments. White banana prawns can generally be found at depths of 16–25 m but can occur to depths of 45 m. Redleg banana prawns are found at depths of 35–90 m. Schooling species that sometimes form dense aggregations near the surface called 'boils'.	Banana prawns are found across northern Australia, from WA to QLD. The biological stock structure of banana prawn is uncertain. There is some evidence that there may be separate biological stocks of banana prawn within the Northern Prawn Fishery, however, the boundaries of the biological stocks are unknown. Stocks in WA and QLD are widely separated, but it is not known whether these are completely independent stocks. In the JBG, a single separate stock is assumed for stock assessment purposes, although stock status for the species is reported at the management unit level–- Northern Prawn Fishery.	Spawn offshore near the fishing grounds throughout the year with two spawning peaks: the late dry season (September–November) and the late wet season (March–May). Banana prawns are serial spawners. Each female lays several egg batches each year. Females produce 100,000–450,000 eggs per year. The eggs sink to the bottom and hatch into larvae within 24 hours. Less than 1% of larvae survive the 2–4 week planktonic larval phase to reach suitable coastal nursery habitats where they may settle. After 1–3 months on the nursery grounds, the young prawns migrate offshore. Migration of the main cohort occurs November-March. A possible second cohort migrates April–June. Reach sexual maturity at approximately 6 months, lifespan 1–2 years. Recruitment in the NPF is highly variable due to seasonal environmental conditions, particularly rainfall. Annual recruitment (as evidenced by catches) has been maintained and continued a pattern of high natural variability from year-to-year.	**Sustainable** A stock–recruitment relationship is not established and no formal stock assessment is conducted. Status determination is instead based on a weight-of-evidence approach. The harvest strategy in the NPF is designed to ensure adequate remaining spawning biomass and prevent overfishing by controlling the timing of the fishing seasons and closure of the seasons when catch rates fall below a catch-rate trigger level. The species has shown resilience to fishing pressure, with strong subsequent recruitment following historical high levels of catch. The above evidence indicates that the stock biomass is unlikely to be depleted and that recruitment is unlikely to be impaired.	White banana prawns are likely to occur in waters shallower than 45 m (i.e. shallower than the Active Source Area and Operational area). Redleg banana prawns may occur in the southern part of the Operational Area in water depths shallower than 90 m, as indicated by the main area of historical NPF fishing effort in the JBG, which targets the species here. The juvenile migration in the JBG takes place from coastal waters to the south of the Operational Area.
Tiger prawns Brown tiger prawn, *P. esculentus* Grooved tiger prawn, *P. semisulcatus*	Tiger prawns inhabit coastal waters to depths of 200 m. Adult brown tiger prawns are found over coarse sediments. Adult grooved tiger prawns are found in fine mud sediments. Juvenile tiger prawns are found in shallow	Brown tiger prawns are endemic to tropical and subtropical waters of Australia, while Grooved Tiger Prawns have a wider Indo–West Pacific distribution. There is some genetic evidence of separation of brown tiger prawn stocks from the east and west coasts of Australia.	Spawning occurs throughout the year, in both inshore and offshore areas for brown tiger prawns and in offshore areas for grooved tiger prawns. Brown tiger prawns have a spawning peak between July and October. Grooved tiger prawns have a spawning peak in in August-September, with a secondary peak in February.	**Sustainable** The harvest strategy in the NPF is designed to ensure adequate remaining spawning biomass and prevent overfishing by controlling the timing of the fishing seasons and closure of the seasons when catch rates fall below a catch-rate trigger level.	Tiger prawns may occur throughout the Operational Area.

Species	Habitat	Stock structure and distribution	Reproduction and recruitment	Stock assessment	Relevance to EP
	waters, often in association with seagrass beds, and sometimes on top of coral reef platforms.	Assessment of stock status is undertaken at the management unit level–- Northern Prawn Fishery.	Females produce about 186,000 eggs (brown tiger prawns) and 365,000 eggs (grooved tiger prawns) per year. Eggs hatch within 24 hours of fertilisation. Reach sexual maturity at approximately 6 months, lifespan 2 years.	The NPF management unit is not considered to be recruitment impaired. The brown tiger prawn and grooved tiger prawn stocks in the NPF management unit are classified as sustainable.	
Endeavour prawns Blue endeavour prawn, *M. endeavouri* Red endeavour prawn, *M. ensis*	Endeavour prawns inhabit tropical coastal waters. Blue endeavour prawns can be found over sandy or mud-sand substrates to depths of about 60 m. Red endeavour prawns prefer muddy substrates and have been found to depths of 95 m. Juvenile blue endeavour prawns are commonly associated with seagrass beds in shallow estuaries, while juvenile red endeavour prawns are more widely distributed across seagrass beds, mangrove banks, mud flats and open channels.	Little is known about the biological stock structure of the populations of blue and red endeavour prawns. Assessment of stock status is undertaken at the management unit level–- Northern Prawn Fishery.	Spawning occurs throughout the year. Blue endeavour prawns have spawning peaks in March and September. Red endeavour prawns have a spawning peak in September–December. Females produce about 296,000 eggs per year.	**Sustainable** (*M. endeavouri*) **Undefined – no current stock assessment** (*M. ensis*)	Blue endeavour prawns are likely to occur in waters shallower than 60 m and, therefore, may occur in the shallower parts of the Operational Area and in waters shoreward of here. Red endeavour prawns may occur in the southern part of the Operational Area in water depths shallower than 95 m.

Sources:

AFMA 2023 https://www.afma.gov.au/fisheries-management/species/prawns

Butler et al. 2021 https://fish.gov.au/report/272-BANANA-PRAWNS-2020

Patterson et al. 2022 https://www.agriculture.gov.au/abares/research-topics/fisheries/fishery-status#sections

Key Demersal and Pelagic Finfish Species

The WA and NT state-managed commercial fisheries target a range of demersal and pelagic finfish species. The two demersal indicator species for the WA NDSMF are red emperor (*Lutjanus sebae*) and goldband snapper (*Pristipomoides multidens*) (Newman et al. 2023). Spanish mackerel (*Scomberomorus commerson*) are the principal target pelagic species and indicator species for the WA MMF (Newman et al. 2023) and NT SMF (Grubert et al. 2013).

Demersal indicator species for the NT DF include goldband snapper (*Pristipomoides multidens*), saddle-tail snapper (*Lutjanus malabaricus*), and crimson snapper (*L. erythropterus*) (FRDC 2018). Grey mackerel; is an indicator species of the NT ONLF (FRDC 2021a).

The FRDC (2021) assesses the status of key indicator fish species in terms of genetic stock structure and fishery management units in their Status of Australian Fish Stocks (SAFS) reports. The genetic stocks refer to the geographic areas where genetic homogeneity is maintained by the dispersal of pelagic eggs and larvae within and between regions (Newman et al. 2000; Department of Fisheries 2004). The level of mixing from egg and larval dispersal is influenced by the spatial-temporal patterns of spawning relative to the prevailing oceanographic currents, the duration of the spawning period and the periodicity of spawning. For example, a species that spawns over a large portion of the continental shelf for a protracted period will very likely have a high level of egg and larval dispersal resulting in a wide spatial stock extent (Gaughan et al. 2018). This is the case with all of the key indicator fish species in northern WA, which spawn throughout their ranges and on multiple occasions during protracted spawning periods (Gaughan et al. 2018).

The eggs and larvae released by spawning adult demersal fish in the region may disperse for several days or weeks and may travel for hundreds of kilometres or more before settling on the seabed (Newman et al. 2000; Mackie et al. 2010; Marriott et al. 2012; Berry et al. 2012; Gaughan et al. 2018). The genetic stocks, therefore, represent the area where the exchange of larvae and subsequent recruitment of juvenile fish to the stocks occurs over many years (Martin et al. 2014; Gaughan et al. 2018).

Table 3-22 summarises the indicator fish species that are relevant to the Operational Area, the spatial extent of their biological stocks, and their reproductive biology, based on information provided in SAFS reports by FRDC (2021) as well as other published literature on the fisheries and fish species.

Note that fish stocks may also be considered in terms of smaller more discrete fisheries ‘management units’, which are adopted by fisheries management authorities for the purposes of fisheries management and monitoring. The management units consider the genetic stock and larval settlement, but also take into account the smaller ranges and localised movements of adult and juvenile fish, as well as the extent of the fisheries that target the stocks. Consequently, the fisheries management units are typically smaller than the extent of the genetic stocks. Application of management units provides a more conservative approach to managing the resource (Gaughan et al. 2018). The North Coast Fisheries Bioregion of WA, defined by DPIRD, is divided into two management units, the Pilbara and the Kimberley management units, which also inform the FRDC (2021) stock assessments.

Table 3-22: Key indicator finfish species relevant to the survey

Species	Distribution and habitat	Biological stock range	Principal depth range	Reproduction and recruitment	Stock status	Spawning season	Relevance to EP
Demersal species							
Goldband snapper (*Pristipomoides multidens*)	Goldband snapper occur around offshore reefs, shoals, and areas of hard flat bottom with occasional benthos or vertical relief. Juveniles typically occur on uniform sedimentary habitat with no relief (Newman et al. 2008). Goldband snapper are widely distributed throughout northern Australia, from the Gascoyne region of WA to SE Queensland (Trinnie et al. 2021).	Australian populations of goldband snapper are likely to form a single biological stock with mitochondrial DNA data revealing no genetic difference among Australian locations, except for the northern Kimberley location that exhibited restricted gene flow (Trinnie et al. 2021). In 2018, Saunders et al. were able to identify separate biological stocks in the JBG, Timor Sea, Arafura Sea and Gulf of Carpentaria. Therefore, the JBG biological stock is relevant to the Operational Area.	50–200 m (DPIRD 2019).	Goldband snapper are highly fecund, serial, broadcast spawners and they can produce several million eggs per season (Newman et al. 2008). They spawn throughout their range (DPIRD 2019). Goldband snapper can spawn approximately every three days / every week during the spawning period (Santos 2020a). Juveniles remain in offshore waters with the adult spawning biomass, but are found in association with different habitat (Newman et al. 2008). Fish are estimated to reach maturity after approximately 4.6 years (Saunders et al. 2018).	Undefined status for the stock within the JBG (Trinnie et al. 2021)	October–May (extended peak spawning period) (DPIRD 2019).	Given the known distribution and habitat depths, goldband snapper are likely to occur and may spawn within the Operational Area.
Red emperor (*Lutjanus sebae*)	Distribution of red emperor in Australia encompasses the entire northern coastline from Cape Naturaliste in WA, around to the east coast, occasionally extending as far south as Sydney in New South Wales (Newman et al. 2021c). Red emperor are widely distributed across the continental shelf and associated with reefs, lagoons, epibenthic communities, limestone sand flats and gravel patches (Newman et al. 2008).	The reproductive biology of red emperor results in a very broad distribution of eggs and larvae, which shows in genetic connectivity over a wide geographic range, i.e. eastern and western Australian populations of Red Emperor form a single biological stock (Gaughan et al. 2018; Newman et al. 2021c). There is no evidence of discrete breeding populations between regions in WA (Gaughan et al 2018).	10–180 m (DPIRD 2019).	Red emperor are highly fecund, serial, broadcast spawners. Females release numerous batches of eggs over an extended spawning period. (Newman et al. 2008; Gaughan et al 2018). They spawn throughout their range (DPIRD 2019). Juvenile fish are more common in nearshore waters and move offshore and recruit to the stock as they mature (Newman et al. 2008; van Herwerden et al. 2009). Fish are estimated to reach maturity after approximately 4–6 years (Newman et al. 2018).	Undefined status for the stock within the JBG (Newman et al. 2021c)	The species spawns for 10–12 months of the year on the north coast of WA (Gaughan et al. 2018). DPIRD (2019) advise that the main spawning season is September – June (with bimodal peaks September–November and January–March).	Given the known distribution and habitat depths, red emperor are likely to occur and may spawn within the Operational Area.

Species	Distribution and habitat	Biological stock range	Principal depth range	Reproduction and recruitment	Stock status	Spawning season	Relevance to EP
		Relevant to the Operational Area is the stock belonging to the JBG.					
Saddle-tail snapper (*Lutjanus malabaricus*)	Saddle-tail snapper are widely distributed throughout the Indo-Pacific region (Saunders et al. 2021). In Australian waters, they are found from Shark Bay in WA, across northern Australia to the east coast of Queensland over a wide depth range, from coastal to offshore areas (Saunders et al. 2021a).	Genetic studies indicate that three biological stocks occur across the species' Australian range: the North Coast Bioregion biological stock, the Northern Australian biological stock (including the Timor Sea, Arafura Sea and the Gulf of Carpentaria) and the East coast of Queensland biological stock (Saunders et al. 2021a). However, in 2018, Saunders et al. identified a separate biological stock in the JBG, Timor and Arafura seas, and Gulf of Carpentaria. Relevant to the Operational Area is the stock belonging to the JBG.	The depth distribution for this species has not been well defined in the NT. This species is expected to be found between 5 m and 100 m (Salini et al. 2006).	Saddle-tail snapper reach reproductive maturity at about 9 years and have a lifespan of about 30 years (FRDC 2018; Fry et al. 2009). There is a distinct difference in length at first maturity between the sexes, with male saddle-tail snappers first reaching sexual maturity at around 240 mm whereas females began maturing between 250 and 300 mm. Published data available on the reproductive characteristics of tropical lutjanides indicate that most species are highly fecund, serial spawners with a protracted spawning season (Davis and West 1993; Grimes 1987; Kritzer 2004; Marriot et al. 2007; Shimose 2005). Northern Australian populations of saddle-tail snapper show a single-modal cycle in their reproductive activity (Fry et al. 2009). The species has been recorded producing up to 997,000 oocytes per batch (Fry et al. 2009). Preferred spawning depths have not been identified for this species in the region.	Sustainable status for the stock within the JBG (Saunders et al. 2021a)	Spawning occurs throughout the year, with a peak between September and March (Fry et al. 2009).	Given the known distribution and likely habitat depths, saddle-tail snapper may occur in the Operational Area and may spawn throughout their range, particularly during their peak spawning times.
Crimson snapper (*Lutjanus erythropterus*)	Crimson snapper are widely distributed throughout the Indian Ocean and the tropical parts of the Western	Research on the biological stock structure of this species in Australian waters has only occurred in northern Australia; including	The depth distribution for this species has not been well	Male crimson snapper reach reproductive maturity at about 240 mm whereas females begin maturing between 250 and 300 mm. The species has	Undefined status for the stock within the JBG	Spawning occurs throughout the year, with a peak between July and	Given the known distribution and likely habitat depths, crimson snapper may

Species	Distribution and habitat	Biological stock range	Principal depth range	Reproduction and recruitment	Stock status	Spawning season	Relevance to EP
	Pacific Ocean (Saunders et al. 2021b). In Australian waters, they are found from Shark Bay in WA to central NSW over a wide depth range, from coastal to offshore areas (NT Government 2018).	the Timor Sea, the Arafura Sea and the Gulf of Carpentaria where a single genetic stock was found across this region (Saunders et al. 2021b). However, in 2018, Saunders et al. identified a separate biological stock in the JBG, Timor and Arafura seas, and Gulf of Carpentaria. Relevant to the Operational Area is the stock belonging to the JBG.	defined in the NT. This species is expected to be found between 5 m and 100 m (Salini et al. 2006).	a lifespan of about 40 years (FRDC 2018; Fry et al. 2009). Published data available on the reproductive characteristics of tropical lutjanids indicate that most species are highly fecund, serial spawners with a protracted spawning season (Davis and West 1993; Grimes 1987; Kritzer 2004; Marriot et al. 2007; Shimose 2005). Northern Australian populations of crimson snapper show a single-modal cycle in their reproductive activity (Fry et al. 2009). The species has been recorded producing up to 676,100 oocytes per batch (Fry et al. 2009).	(Saunders et al. 2021b)	December (Fry et al. 2009).	occur in the Operational Area and may spawn throughout their range, particularly during their peak spawning times.
Pelagic species							
Spanish mackerel (*Scomberomorus commerson*)	Spanish mackerel are a pelagic species that are widely distributed throughout Indo-West Pacific waters. In Australia, Spanish mackerel are found from approximately Geraldton in WA to Northern NSW (Langstreth et al. 2018). Adult movements in Australian waters occur over ranges of 100–300 km (Mackie et al. 2010).	Spanish mackerel in northern Australia form three distinct genetic stocks (Roelofs et al. 2021a). However, evidence from additional research indicates that there are likely to be a number of smaller biological stocks with limited interaction (Roelofs et al. 2021a). WA biological stock has been assessed under the Mackerel Managed Fishery (management unit level) and NT biological stock under the NT jurisdictional level.	1–50 m (DPIRD 2019).	Form spawning schools around inshore reefs in north coast bioregion (Mackie et al. 2010; Lewis and Jones 2018). Spanish mackerel spawning occurs in coastal waters. They are serial spawners and alongshore dispersal of eggs maintains genetic homogeneity (Mackie et al. 2010). Females are capable of producing a batch of hundreds of thousands of eggs every 1-3 days during the spawning season, though a spawning frequency of 1.9–5.9 days has also been reported (McPherson 1993; Mackie et al. 2010).	**Sustainable** status for stock within the Mackerel Managed Fishery unit level and NT jurisdictional level (Roelofs et al. 2021a)	September–December (peak spawning) (DPIRD 2019).	Given the known distribution and habitat depths, Spanish mackerel are unlikely to occur in the Operational Area given the preferred water depth ranges are less than 50 m. The minimum water depth in the Operational Area is 60 m.

Species	Distribution and habitat	Biological stock range	Principal depth range	Reproduction and recruitment	Stock status	Spawning season	Relevance to EP
				Larvae are commonly associated with reef lagoonal areas, before juveniles move to estuary and foreshore nursery and feeding grounds where they tend to remain for the first year of life (McPherson 1993; Begg et al. 2006; Mackie et al. 2010). Fish are estimated to reach maturity after approximately 2 years (Langstreth et al. 2018).			
Grey mackerel (*Scomberomorus semifasciatus*)	Grey mackerel have a restricted distribution and are confined to the waters of southern Papua New Guinea and around northern Australia from the Houtman Abrolhos Islands on the west coast to northern NSW on the east coast (NT Government 2020; Roelof et al. 2021b). Adult grey mackerel are known to commonly occur in turbid tropical and subtropical waters at approximately 3–30 m depth. This is usually in the vicinity of bottom structure in close proximity to headlands and reefs and on sandy mud and muddy sand substrates (NT Government 2020).	There are at least five Grey Mackerel biological stocks across northern Australia, with a possible additional stock in the north-east Gulf of Carpentaria (Roelof et al. 2021b). Stock status is presented at the biological stock level. Relevant to the Operational Area is the stock belonging to Western Australia and the North West Northern Territory.	Grey mackerel are usually found in water depths of about 3–30 m (NT Government 2020d).	Grey mackerel have a lifespan of about 14 years, with females reaching maturity at around 2 years while males reach maturity between 1–2 years (Cameron and Begg 2002; Department of Agriculture and Fisheries 2016). Grey mackerel grow rapidly and are highly fecund, producing approximately 250,000 oocytes per spawning (NT Government 2020). They form spawning schools that are predictable enough both spatially and temporally to be targeted by fisheries (NT Government 2020). Once hatched, larvae of this species move to the inner margins of coastal bays and also into estuaries (Jenkins et al. 1985). Juveniles grow rapidly in estuarine habitats and move into coastal environments as they mature.	Sustainable status across all jurisdictions (Roelof et al. 2021b)	August–January, though this is thought to be temperature dependent and potentially extended in northern regions (Welch et al. 2009)	Given the known distribution and habitat depths, grey mackerel are unlikely to occur in significant numbers within the Operational Area where water depths are >60 m. Therefore they are also unlikely to spawn within the Operational Area.

3.8.2 Shipping

The proximity of the Darwin Port to Southeast Asia makes the surrounding area a key shipping region. Vessel traffic data (provided by Australian Maritime Safety Authority [AMSA]) within and surrounding the Operational Area between May 2024 and April 2025 is illustrated in Figure 3-26.

The figure shows high traffic shipping volumes in close proximity to Darwin Harbour, around operating petroleum fields (i.e. Blacktip platform) and along key shipping routes to and from South-east Asia. There is also vessel traffic that passes through the southern part of the Operational Area between Darwin and Kalumburu, and through the northern part of the Operational Area between Darwin and the INPEX Ichthys and Shell Prelude offshore LNG facilities.

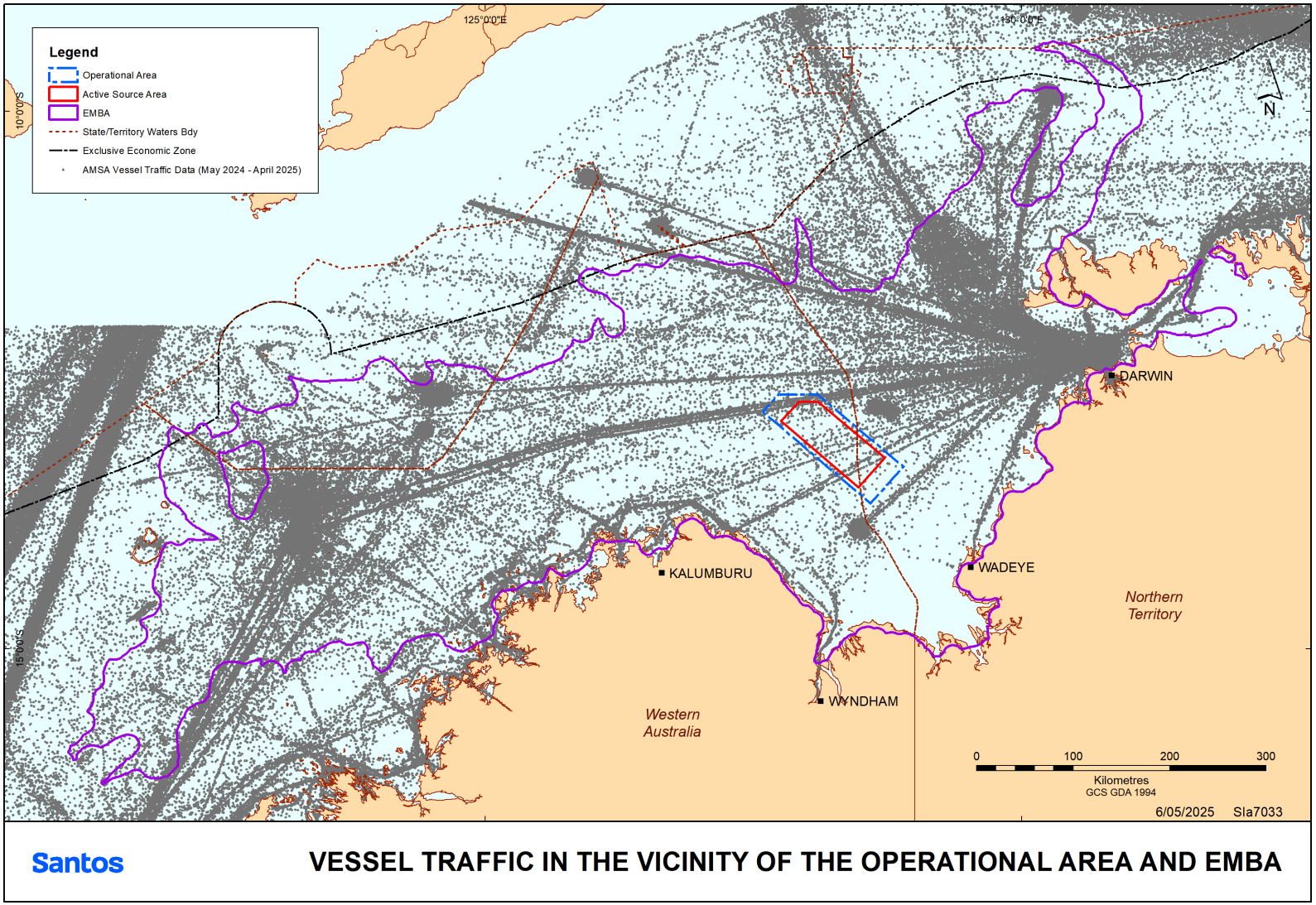


Figure 3-26: Vessel traffic within and surrounding the Operational Area (May 2024 to April 2025)

3.8.3 Oil and gas activities

The Bonaparte Basin is an established hydrocarbon province with a number of commercial operations, including the Blacktip production platform and pipeline operated by Eni Australia B.V., located approximately 21 km south from the Operational Area. Petroleum titleholders with titles within the Operational Area are listed in Table 3-23 and shown in Figure 3-27.

In addition to petroleum titles there are two greenhouse gas assessment permits in the Bonaparte Basin. One is G-11-AP, which is the title instrument for the Eos 3D MSS, and the other is G-7-AP, which is directly to the east and held by INPEX Browse E&P Pty Ltd, Total Energies CCS Australia Pty Ltd and Woodside Energy Ltd. The Operational Area overlaps the southwest corner of G-7-AP.

Table 3-23: Oil and gas permits within 150 km of the Operational Area

Permit	Permit type	Operator	Distance from the Operational Area
WA-548-P	Exploration Permit	Neptune Energy Bonaparte P/L	Overlaps
NT/P88	Exploration Permit	Neptune Energy Bonaparte P/L	Overlaps
WA-6-R	Retention Licence	Neptune Energy Bonaparte P/L	Overlaps
NT/RL1	Retention Licence	Neptune Energy Bonaparte P/L	Overlaps
WA-27-R	Retention Licence	Bonaparte Gas & Oil P/L	Overlaps
WA-33-L	Production Licence	Eni Australia B.V.	21 km S
WA-488-P	Exploration Permit	EOG Resources Australia Block WA-488 Pty Ltd	23 km SW
WA-544-P	Exploration Permit	MEO International Pty Limited	48 km SE
NT/P87	Exploration Permit	MEO International Pty Limited	51 km SE

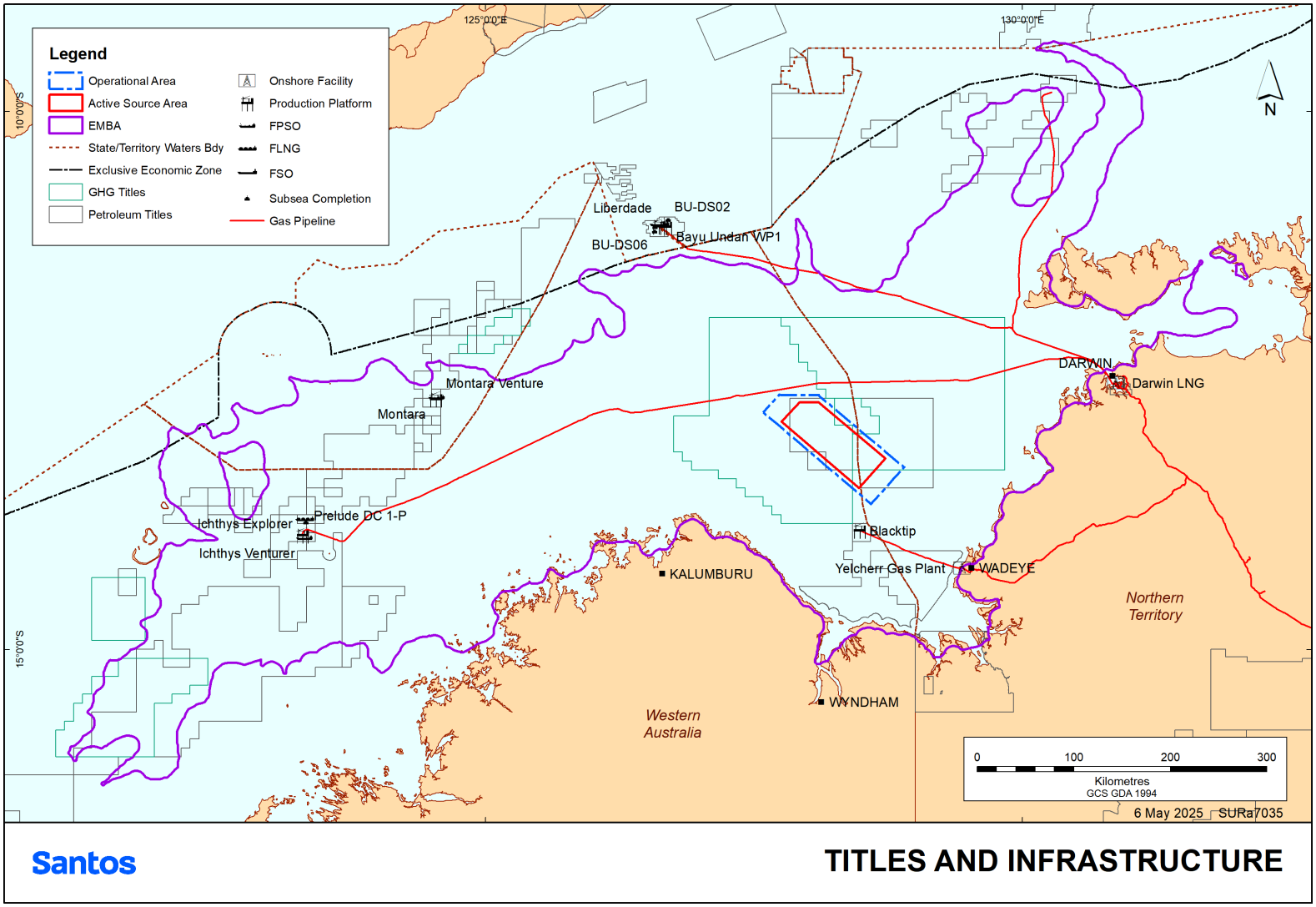


Figure 3-27: Petroleum titles and infrastructure

3.8.4 Tourism and recreation

Most recreational and tourism activities in the region occur predominantly in State/Territory waters adjacent to population centres, such as Broome and Darwin. Tourism in the region typically peaks during the dry season (May–October), which includes activities such as recreational fishing, diving, snorkelling, wildlife watching and boating (DEWHA 2008a).

Santos has consulted with WA Tourism, the WA Boating Industry, the NT Guided Fishing Association and a number of specific tourism operators regarding tourism and recreational charter vessel operations in the JBG (see Section 4). A number of luxury cruise operators access Kimberley coastal waters, including Kimberley Quest, Silversea and True North, which operate from late February/March to October/early November to avoid the wet season. Some Kimberley cruises extend to the coastal waters of the JBG, sailing from Wyndham and visiting coastal locations such as Cambridge Gulf, Berkeley River, Reveley Island, King George River and Cape Bernier, all of which are approximately 109 km or more from the Operational Area. Activities are either land-based, or take place in rivers, estuaries or within a few kilometres from the coast. Cruise itineraries do not include offshore waters, although operators may occasionally transit through the Operational Area between Darwin and the Kimberley coastline (Kimberley Quest 2024; Silversea 2024; True North 2024).

Onshore tourism operations in the Kimberley include Berkeley River Lodge. The camp closes during October and reopen during March following the wet season. Charter fishing, site-seeing tours and other excursions are located within a few kilometres from the coast, and mainly in estuarine waters.

No scuba diving or snorkelling sites or dive shops or clubs have been identified in the JBG or adjacent townsites. The presence of saltwater crocodiles and other potentially dangerous fauna generally makes these waters unsuitable for such activities and some tourism operators clearly specify this on their websites (e.g. Berkeley River Lodge). Swimming tends to be limited to guided excursions to freshwater pools and waterfalls on land. Known dive sites in the wider Kimberley region are near Broome, the Lacepede Islands and the Rowley Shoals.

Recreational fishing occurs in the JBG; however, fishing tends to take place in estuaries (e.g. barramundi fishing) or in coastal waters. Interactions in the Operational Area are considered unlikely due to the remoteness and predominantly deep offshore waters of the Operational Area. Charter vessels may occasionally transit through the Operational Area and EMBA between Darwin and the northern Kimberley coastline.

3.8.5 Defence

Australian Border Force and Australian Defence Force vessels undertake civil and maritime surveillance within the region with the primary purpose of monitoring the passage of illegal entry vessels and illegal fishing activity within these areas. Refugees seeking asylum in Australia are also known to use the area, travelling between Indonesia and Australia.

The Operational Area overlaps with practice and training areas that comprise the North Australian Exercise Area (NAXA), a maritime military zone administered by the Australian Defence Force, as well as restricted airspace (Figure 3-28). The NAXA is used by the Royal Australian Air Force and the Royal Australian Navy for military operations including live weapons and missile firings.

Defence advised that unexploded ordinance (UXO) may be present on and in the sea floor of the Operational Area. According to the Defence UXO Database, the south-east portion of the Operational Area is located within a Defence Practice Area and may be affected by UXOs. The north-west section of the Operational Area overlaps a Defence Air to Air Refuelling (AAR) and Airborne Early Warning and Control area (DoD 2023) (Figure 3-28).

Defence advised during consultation that the proposed activities would have minimal impact on their capabilities.

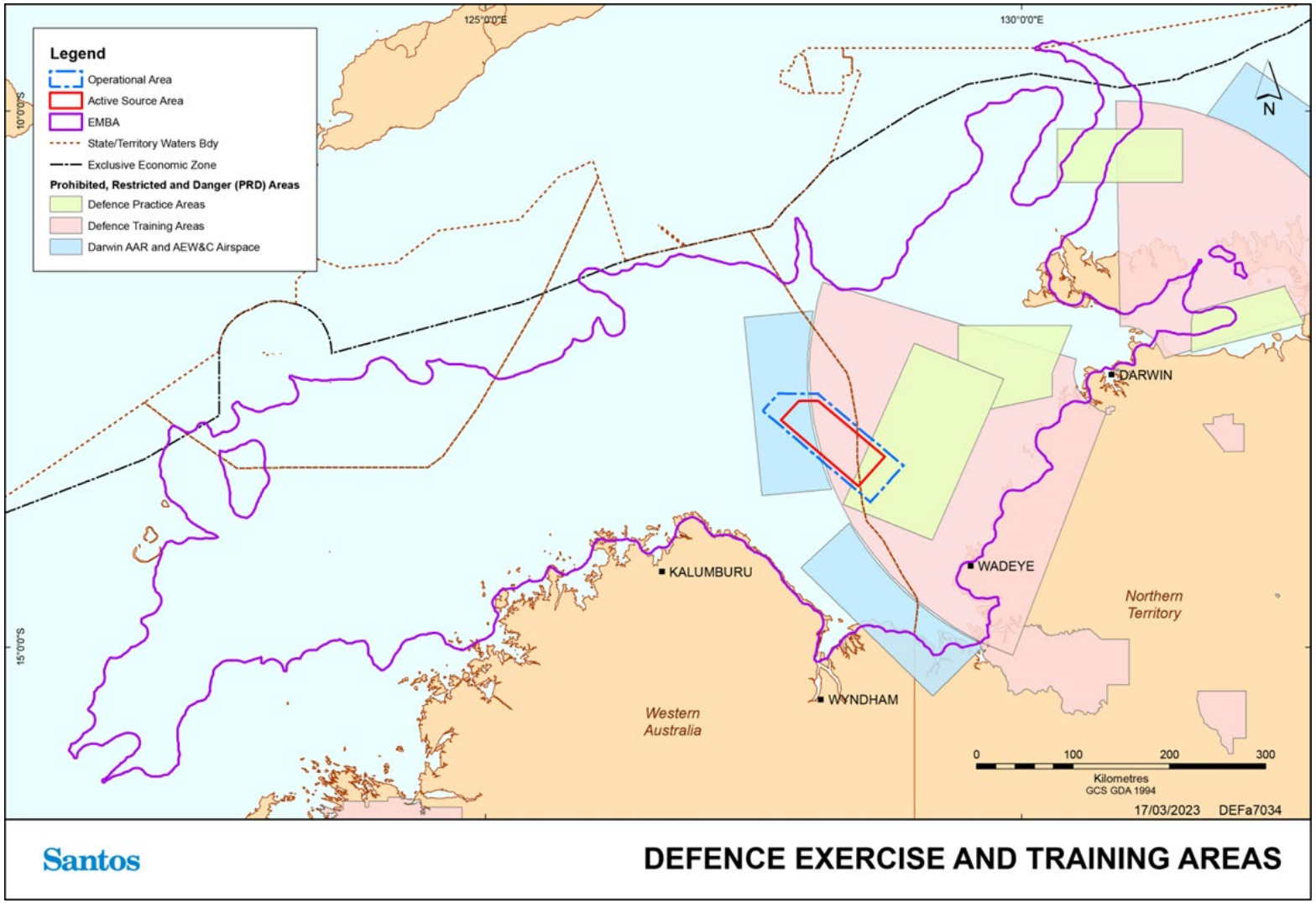


Figure 3-28: Defence exercise and training areas

3.8.6 Maritime heritage

Historic shipwrecks and sunken aircraft are recognised and protected under the *Underwater Cultural Heritage Act 2018* that protects historic wrecks, sunken aircraft and associated relics. Under the Act, all wrecks and sunken aircraft more than 75 years old are protected, together with their associated relics regardless of whether their actual locations are known. The Commonwealth minister responsible for the environment can also make a declaration to protect any historically significant wrecks or articles and relics that are less than 75 years old.

A search of the Australasian Underwater Cultural Heritage Database confirms that there are no protected shipwrecks or sunken aircraft located within the Operational Area. The closest shipwreck to the Operational Area (approximately 11 km north-east) is the Sedco Helen, wrecked in 1970, located in depths of approximately 100 m.

3.8.7 Cultural features

Santos acknowledges the tradition of the First Nations people of Australia includes a cultural and spiritual connection to their land and waters, including sea country. These connections are rooted in their traditional communal beliefs and practices. First Nations people view their land and waters as integral to their identity, culture, and spirituality and they have a deep respect for the natural world.

The cultural heritage of First Nations peoples includes a vast array of tangible and intangible cultural artifacts, practices and beliefs. The protected heritage of First Nations peoples is also of cultural value to Australia and the global community. The cultural value of First Nations protected heritage to Australia is evidenced and given force by a range of factors, including the laws, regulations and institutions established across Australia that are designed specifically to protect First Nations rights and interests in relation to sacred sites and other aspects of First Nations cultural heritage including the *Native Title Act 1993* (Cth) (NT Act), *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cth) (ATSIHP Act), *Underwater Cultural Heritage Act 2018* (Cth) (UCH Act).

Country is an important concept to First Nations people and the term is often to describe family origins and associations with particular parts of Australia, both land and sea (Smyth, 2007). The expressions Country and Sea Country are used to refer to the land and waters which constitute Aboriginal traditional areas as ancestrally distinct and linguistically bounded geographic areas (Kearney et al, 2023 p106).

Country is inclusive of many environments that are ecologically, geographically, ancestrally and socially configured (Kearney et al 2023). For First Nations Indigenous People, Country is a combination of the land, sea, rivers and islands and all that they contain and sustain. ‘Country refers to more than just a geographical area: it is shorthand for all the values, places, resources, stories and cultural obligations associated with that geographical area.’ (Smyth, 2007).

First Nations people in northwest WA continue to rely on coastal and marine environments and resources of the region for their cultural identity, health and wellbeing, and their domestic and commercial economies (Smyth, 2007).

Numerous different Indigenous groups have connections to different parts of Country. These family groups are representative of many different Indigenous language groups.

Submerged archaeological landscapes have recently been identified in WA through combined evidence of terrestrial ecology, coastal and marine geomorphology and sea-level studies (Benjamin et al 2020; McCarthy et al 2022). There is a potential for the existence of submerged landscapes with associated Aboriginal heritage values due to strong cultural connections between Traditional Owners and the sea (McCarthy et al 2022).

3.8.7.1 Sea Country

The Australian Marine Parks North-west Marine Parks Network Management Plan 2018 defines sea country as “the areas of the sea that Aboriginal and Torres Strait Islander groups are particularly affiliated with through their traditional lore and customs”. Sea country is valued for Aboriginal cultural identity, health and wellbeing. Aboriginal people of north-western Australia have been sustainably using and managing their sea country for tens of thousands of years, in some cases since before rising sea levels created these marine environments (DNP, 2018b).

A common feature of coastal Aboriginal cultures is the connectedness of land and sea: together they form a country of significant cultural sites and dreaming tracks of the creation ancestors (NOO, 2002). As a result, coastal environments are an integrated cultural landscape/seascape that is conceptually different from the broader Australian view of land and sea (NOO, 2002).

Animals can be totems for Aboriginal people. Aboriginal people share the land and water with animals and their relationship with totem animals is fundamental to continued practice and cultural responsibility; for food, health, shelter, cultural expression and spiritual wellbeing (VAHC, 2021). Caring for plants, animals and their habitats is therefore seen as a key way of expressing culture (VAHC, 2021).

Aboriginal people use and actively manage the coastal and marine environments as a resource and to maintain cultural identity, health and wellbeing. Fishing, hunting and the maintenance of culture and heritage through ritual, stories and traditional knowledge continue as important uses of nearshore and adjacent areas.

Sea country is described in both State, Territory and Commonwealth Marine Park Management Plans. The Australian Marine Park Management Plans include the objective to provide for the protection and conservation of biodiversity and other natural, cultural and heritage values of marine parks. The plans define cultural values as 'living and cultural heritage recognising Indigenous beliefs, practices and obligations for country, places of cultural significance and cultural heritage sites' (DNP, 2018b). Australian Marine Park Management Plans list the Aboriginal people who have responsibilities for sea country in the Marine Parks, and the Native Title Representative Body for the region.

The EMBA of this EP overlaps marine parks that are covered by the North and North-west Marine Parks Network Management Plans 2018 (DNP, 2018a; DNP, 2018b), and notes the various groups that have responsibilities for sea country within those marine parks, which are outlined below.

There is limited information about the cultural significance of the Oceanic Shoals Marine Park.

- The Miriuwung, Gajerrong, Doolboong, Wardenybeng and Gija and Balanggarra people have responsibilities for sea country in the Joseph Bonaparte Gulf Marine Park. Miriuwung Gajerrong Aboriginal Corporation is the Registered Native Title Body Corporate (RNTBC) responsible for the management of the Miriuwung, Gajerrong, Doolboong, Wardenybeng and Gija Native Title claim, and Balanggarra Aboriginal Corporation is the RNTBC responsible for the Balanggarra peoples' claim.
- The land and sea country of the Balanggarra people extends from Napier-Broome Bay to Cambridge Gulf and Wyndham in the JBG. In the past, the Balanggarra people speared fish along the rocky shoreline and in shallow waters.
- Saltwater fish, turtles, dugong, mud crabs and cockles continue to be important food sources for the Balanggarra people today (DPaW 2016a).
- The Wunambal Gaambera, Dambimangari, Mayala, Bardi Jawi and the Nyul Nyul people's sea country extends into the Kimberley Marine Park. The Wunambal Gaambera people's country includes daagu (deep waters), with about 3400 km2 of their sea country located in the Marine Park.
- The Wunambal Gaambera, Dambimangari, Mayala, Bardi Jawi and the Nyul Nyul people have an unbroken connection to their sea country, having deep spiritual connection through Wunggurr (creator snakes) that still live in the sea.

Staple foods of living cultural value include saltwater fish, turtles, dugong, crabs and oysters. Access to sea country by families is important for cultural traditions, livelihoods and future socio-economic development opportunities. In addition to the above, various groups have responsibilities for sea country within the marine parks identified in Section 3.5.2.

- The long-standing connections, rights and interests of traditional owners have been recognised through native title determinations for the lands and waters in and adjacent to the North Kimberley Marine Park for the Wunambal Gaambera, Balanggara and Miriuwung Gajerrong people.
- The Niiwalarra Islands and Lesueur Island are situated within Balanggarra 'blue water' country.
- The Lalang-gaddam Marine Park has been formed from the amalgamation of four marine parks in Dambeemangarddee (Dambimangari) Sea Country, including the Lalang-garram / Camden Sound Marine Park and the North Lalang-garram Marine Park.
- Cobourg Aboriginal people refer to the Coburg Marine Park as sea country. They are connected to this sea country through Aboriginal tradition and law and this connection remains an intimate part of their existence.

These people/groups have been consulted, in some case via representative prescribed body corporates, as outlined in Section 4.

3.8.7.2 Indigenous Land use Agreements

An 'Indigenous land use agreement' (ILUA) is a voluntary, legally binding agreement about the use and management of land or waters, made between one or more native title groups and non-native title interest holders in the ILUA area (such as grantee parties, pastoralists or governments).

The Register of Indigenous Land Use Agreements is kept by the Native Title Registrar in accordance with s199A of the NTA and includes a description of the ILUA area, the parties' names, the term of the ILUA and other information as the Registrar considers is appropriate (s199B of the NTA).

Registration confers a contractual effect on the ILUA and binds all persons holding native title regardless as to whether they are already parties to the ILUA (s24EA of the NTA).

A search of the Native Title Register found the following ILUAs within the EMBA.

Name	Type
BAC KSCS Indigenous Land Use Agreement (WA)	Body Corporate
Ord Final Agreement	Area Agreement
Kenbi ILUA (NT)	Area Agreement
Cox Peninsula Water Supply ILUA (NT)	Area Agreement

3.8.7.3 Indigenous Protected Areas

Indigenous Protected Areas (IPAs) are areas of land and sea that Traditional Owners have agreed to manage for biodiversity conservation. IPAs represent more than 50% of National Reserve System.

The Sea Country Indigenous Protected Areas Program seeks to increase the area of sea in IPAs to strengthen the conservation and protection of Australia's unique marine and coastal environments, while creating employment and economic opportunities for Indigenous Australians.

A search of the Native Title Register identified three IPAs within the Operational Area or EMBA as listed below.

Name	International Union for the Conservation of Nature Categories
Balanggarra (WA)	VI – Protected area with sustainable use of natural resources
Uunguu (WA)	VI – Protected area with sustainable use of natural resources
Marri-Jabin (Thamurrurr – Stage 1) (NT)	IV – Habitat/Species Management Areas

3.8.7.4 Aboriginal Cultural Heritage Inquiry System (WA)

The Department of Planning, Lands and Heritage (DPLH) Aboriginal Cultural Heritage Inquiry System (ACHIS) provides information about Aboriginal sites (as defined under the *Aboriginal Heritage Act 1972* (WA)) in Western Australia. To identify Aboriginal sites that may be affected by the Activities, a search of the ACHIS was completed for the EMBA. The results of this search are appended in Appendix D.

The ACHIS search identified that there were:

No known sites of Aboriginal Heritage significance located within the Operational Area

108 Aboriginal sites were identified within the EMBA, 49 lodged and 57 registered sites. None of these Aboriginal sites will be disturbed by planned activities. In the unlikely event of a hydrocarbon release, which is assessed as low risk (refer Section 7.1), it is not anticipated that shoreline impact to cultural features would arise.

Santos has consulted with First Nations groups within the EMBA and no feedback or concerns regarding impacts to Aboriginal sites within the Operational Area or EMBA were raised.

3.8.7.5 Regions of Sacred Sites in the Northern Territory

Sacred sites are places within the landscape that have a special meaning or significance under Aboriginal tradition. Hills, rocks, waterholes, trees, plains, lakes, billabongs and other natural features can be sacred sites. In coastal and sea areas, sacred sites may include features which lie both above and below the water.

Sacred sites derive their status from their association with particular aspects of Aboriginal social and cultural tradition. This body of tradition is mainly concerned with the activities of ancestral beings, collectively known as 'Dreamings' whose travels across the land and sea created the physical and social world that people now inhabit.

Aboriginal sacred sites are recognised and protected as an integral part of the Northern Territory's and Australia's cultural heritage, under the *Aboriginal Land Rights (Northern Territory) Act 1976* (Land Rights Act) and the *Northern Territory Aboriginal Sacred Sites Act 1989* (Sacred Sites Act).

Four registered sacred sites were identified on the Tiwi Islands, 58 sites in the Daly River region and 206 sites in the Darwin Hinterland. Although these regions have coastlines that are either within or adjacent to the EMBA, they also cover large inland areas with limited potential for interaction with activities (unplanned) associated with this EP. However, some sites located directly on the coast or on offshore islands that have values associated with plant resources, water sources, hunting places/camps and spiritual and cultural history may be affected in the event of an emergency condition. Sacred sites on the Roche Reefs and Quail Island are located on the perimeter of the EMBA. The Quail Island Region is traditionally significant to Aboriginal groups, who have long used the area for fishing, foraging, and cultural practices tied to the mangrove forests and intertidal mudflats (Noble et al. 2020).

Stakeholder consultation with the Aboriginal Areas Protection Authority (AAPA) highlighted that sacred sites are present along the Northern Territory coastline that intersect the Eos EMBA however, no specific site names and locations were provided. We have consulted with First Nations groups within the EMBA and no feedback or concerns regarding impacts to sacred sites within the Operational Area or EMBA were raised.

3.9 Submarine cables

A network of submarine cables extends from Darwin through the Timor Sea and offshore waters of the Kimberley, linking Northern Australia with South-East Asia. None of these cables intersects the Operational Area.

The nearest are the Northwest Cable System, which heads north-west out of Darwin Harbour, passes north of the JBG and travels west around the Kimberly to Port Headland, WA, and the Asia Connect Cable-1 and Hawaiki Nui Cable, both of which head north / northwest out of Darwin Harbour. The Asia Connect Cable-1 commenced construction in 2023 and will be ready for service in 2026 (Inligo Networks 2023). While the construction of the Hawaiki Nui Cable is set to commence in 2024 and is also expected to be ready for service in 2026 (BW Digital 2023).

3.10 Periods of peak sensitivity or activity

Timing of peak sensitivity or activity for threatened species and other relevant, significant sensitivities that may occur within or in proximity to the Operational Area is provided in Table 3-24.

Table 3-24: Timing of key sensitivities relevant to the Operational Area

Proposed survey timing Anytime from EP acceptance until December 2027	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Environmental Sensitivity													**Source**
Marine Turtles													
Foraging: Loggerhead, olive ridley, green and flatback turtles													DAWE 2020
Commercial Prawn and Indicator Fish Species Spawning													
Banana prawn spawning													AFMA 2020
Juvenile banana prawn migration	Main cohort			Possible 2nd cohort							Main cohort		Longeran et al. 2002
Brown tiger prawn spawning													AFMA 2020
Grooved tiger prawn spawning													AFMA 2020
Blue endeavour prawn spawning													AFMA 2020
Red endeavour prawn spawning													AFMA 2020
Red endeavour prawn													DPIRD 2019
Goldband snapper													DPIRD 2019
Spanish mackerel (Kimberley stock)													DPIRD 2019
Commercial Fisheries													
Northern Prawn Fishery: Fishing Season	Closed season			Mainly banana prawns *New closure area for JBG applies*			Closed season	Mainly tiger prawns				Closed season	Butler et al. 2023 AFMA 2021
WA Northern Demersal Scalefish Managed Fishery													Newman et al. 2020
WA Mackerel Managed Fishery													Mackie et al. 2010
NT Demersal Fishery													NT Gov 2015
NT Spanish Mackerel Fishery													
NT Offshore Net and Line Fishery													NTSC 2012a
NT Aquarium Fishery													NTSC 2012b

Proposed survey timing Anytime from EP acceptance until December 2027	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Environmental Sensitivity													**Source**
Defence													
NAXA military exercises– Timing unknown in 2024-26													
Tourism and Recreation													
Luxury cruises, lodges, wilderness camps and ecotours													
Key:													
Sensitivity/activity occurs													
Peak period													
Peak fishing activity													
Extended peak spawning period													
Peak spawning/migration period													

4. Stakeholder consultation

4.1 Consultation background

Santos has undertaken consultation with relevant persons for this EP in compliance with OPGGS(E)R consultation requirements, applicable case law and applicable guidance (e.g. NOPSEMA guidance issued in May 2023 and subsequent guidance in May 2024).

Consultation with relevant persons under section 25 of the OPGGS(E)R for proposed activities commenced in September 2023, building on Santos' history of consultation in the region for exploration, operations and decommissioning activities.

For this EP consultation activities were undertaken in three broad phases:

+ **Preliminary consultation** through sharing of consultation information to allow authorities, persons and organisations opportunities to self-identify as Relevant Persons and directly contacting potential Relevant Persons.
+ **Consultation** including seeking feedback from Relevant Persons to inform development of this EP.
+ **Further consultation** with authorities, persons and organisations following the consultation phase given the need to communicate a change in the earliest commencement date of proposed activities.

A summary report of the consultation carried out under Section 25 is included at Table 4-9.

Section 8.15.2 includes Santos' post acceptance consultation implementation strategy for the Activities covered by this EP in accordance with Section 22(15) of the OPGGS(E)R.

4.2 Regulatory requirements

Table 4-1 outlines the applicable regulatory requirements for consultation with relevant persons for this EP.

Table 4-1: Consultation requirements under the OPGGS(E)R

OPGGS(E)R 2023 Requirements
Section 24. Other information in the environment plan
The environment plan must contain the following: b. a report on all consultations under section 25 of any relevant person by the titleholder, that contains: i. a summary of each response made by a relevant person; and ii. an assessment of the merits of any objection or claim about the adverse impact of each activity to which the environment plan relates; and iii. a statement of the titleholder's response, or proposed response, if any, to each objection or claim; and iv. a copy of the full text of any response by a relevant person.
Section 25. Consultation with relevant authorities, persons and organisations, etc
(1) In the course of preparing an environment plan (including a revised environment plan referred to in Division 5) a titleholder must consult each of the following (a ***relevant person***): a. each Commonwealth, State or Northern Territory agency or authority to which the activities to be carried out under the environment plan may be relevant; b. if the plan relates to activities in the offshore area of a State—the Department of the responsible State Minister; c. if the plan relates to activities in the Principal Northern Territory offshore area—the Department of the responsible Northern Territory Minister; d. a person or organisation whose functions, interests or activities may be affected by the activities to be carried out under the environment plan; e. any other person or organisation that the titleholder considers relevant. (2) For the purpose of the consultation, the titleholder must give each relevant person sufficient information to allow the relevant person to make an informed assessment of the possible consequences of the activity on the functions, interests or activities of the relevant person. (3) The titleholder must allow a relevant person a reasonable period for the consultation. (4) The titleholder must tell each relevant person the titleholder consults that: a. the relevant person may request that particular information the relevant person provides in the consultation not be published; and

OPGGS(E)R 2023 Requirements
b. information subject to such a request is not to be published under this Part.
Section 26. Submission of environment plan
Form of environment plan (8) All sensitive information (if any) in an environment plan, and the full text of any response by a relevant person to consultation under section 25 in the course of preparation of the plan, must be contained in the sensitive information part of the plan and not anywhere else in the plan. Note: Subparagraph 24(b)(iv) requires the plan to contain a copy of the full text of any response by a Relevant person to consultation under section 25 in the course of preparation of the plan.
Section 28. Publishing environment plan and associated information
(1) If NOPSEMA's provisional decision under section 27 is that the environment plan includes material apparently addressing all the provisions of Division 2 (Contents of an environment plan), NOPSEMA must publish on NOPSEMA's website as soon as practicable: a. the plan with the sensitive information part removed; and b. the name of the titleholder who submitted the plan; and c. a description of the activity or stage of the activity to which the plan relates; and d. the location of the activity; and e. a link or other reference to the place where the accepted offshore project proposal (if any) is published; and f. details of the titleholder's nominated liaison person for the activity.

4.3 Government and industry guidance

Santos has considered the following NOPSEMA guidance in developing its consultation activities and approach:

GL2086 – Consultation in the course of preparing an environment plan (EP Consultation Guideline) (NOPSEMA, 2023; 2024)

GN1847 – Responding to public comment on Environment Plans (NOPSEMA, 2022a)GL1887 – Consultation with Commonwealth agencies with responsibilities in the marine area (NOPSEMA, 2024)

GL1721 – Environment plan decision making (NOPSEMA, 2024c)

GN1344 – Environment plan content requirement (NOPSEMA, 2024b)

GN1488 – Oil Pollution Risk Management (NOPSEMA, 2021)

Petroleum activities and Australian Marine Parks: A guidance note to support environmental protection and effective consultation (Australian Government, 2024) jointly released by NOPSEMA and Parks Australia

Supporting cooperative coexistence of seismic surveys and commercial fisheries in Australia's Commonwealth marine area (Australian Government, 2022) jointly released by NOPSEMA, the Commonwealth Department of Agriculture, Fisheries and Forestry (DAFF), the Commonwealth Department of Industry, Science and Resources (DISR), and the Australian Fisheries Management Authority (AFMA).

Santos has also considered other government and industry guidance, including:

International Standards Organisation

- *ISO14001:2015 Environmental Management Systems*

Australian Fisheries Management Authority

- *Petroleum industry consultation with the commercial fishing industry*

Australian Heritage Commission

- *Ask First – A guide to respecting Indigenous heritage places and values*

Commonwealth Department of Agriculture, Fisheries and Forestry

- *Fisheries and the Environment – Offshore Petroleum and Greenhouse Gas Act 2006*
- *Offshore Installations Biosecurity Guide*

Commonwealth Department of Climate Change, Energy, the Environment and Water

- *Interim Engaging with First Nations People and Communities on Assessments and Approvals under the Environment Protection and Biodiversity Conservation Act 1999*

Commonwealth Ministerial Council on Mineral and Petroleum Resources

- *Principles for Engagement with Communities and Stakeholders*

International Association for Public Participation

- *Quality Assurance Standard for Community and Stakeholder Engagement*

WA Department of Primary Industries and Regional Development

- *Guidance statement for oil and gas industry consultation with the Department of Fisheries*

WA Department of Transport

- *Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements*
- *WA Incident Management Plan: Marine Oil Pollution, September 2023*

Western Australian Fishing Industry Council

- *Commercial Fishing Consultation Framework for the Offshore Oil and Gas Sector*
- *Consultation approach for unplanned events*

4.4 Applicable case law and guidance

In addition to considering the regulatory requirements and guidance set out above, in developing this EP Santos has considered the judgments of

- Justice Bromberg in *Tipakalippa v National Offshore Petroleum Safety and Environmental Management Authority (No. 2) [2022] FCA 112*
- the Full Federal Court in *Santos NA Barossa Pty Ltd v Tipakalippa [2022] FCAFC 193 (Appeal Judgement)*
- Justice Calvin in *Cooper v National Offshore Petroleum Safety and Environmental Management Authority (No 2) [2023] FCA 1158*.
- Justice Charlesworth in *Munkara v Santos NA Barossa Pty Ltd (No 3) [2024] FCA 9.*

The EP Consultation Guideline referred to above provides a summary of the Full Federal Court's interpretation of 'functions', 'activities' and 'interests' referenced in Section 25(1)(d), adopted by NOPSEMA to assist in informing who may be a relevant person and how relevant persons may be identified, as defined in Table 4-2.

Table 4-2: Relevant person terms and definitions

Term	Definition
Functions	Refers to 'a power or duty to do something'
Activities	To be read broadly and is broader than the definition of 'activity' in Section 5 of the OPGGS(E)R and is likely directed to what the relevant person is already doing
Interests	To be construed as conforming with the accepted concept of 'interest' in other areas of public administrative law Includes 'any interest possessed by an individual whether or not the interest amounts to a legal right or is a proprietary or financial interest or relates to reputation'

Santos has also had regard to the purpose of consultation as outlined in the Appeal Judgment and EP Consultation Guideline (NOPSEMA, 2024), the emphasis that superficial or tokenistic consultation is not sufficient and that:

consultation must be appropriate and adapted to the nature of each relevant person;

- for each relevant person, the appropriate manner and method of consultation (including the nature of information, time periods for consultation and mode of communication) may differ; and
- there is good reason to adopt pragmatic and practical approaches to consultation conducted in accordance with section 25 of the OPGGS(E)R.

4.5 Santos' consultation methodology

4.5.1 Overview

Santos consults to ensure that any activity it is proposing under an EP is carried out in a manner:

- consistent with the principles of ecologically sustainable development set out in section 3A of the EPBC Act; and
- by which the environmental impacts and risks of the Activity will be reduced to ALARP and to an acceptable level.

The consultation process is designed to assist Santos to further ascertain, understand and assess values and sensitivities of the environment (including ecosystems, including people and communities, natural and physical resources, the qualities and characteristics of locations, places and areas and the heritage value of places) that may be affected by a proposed activity, and the potential environmental impacts and risks, through information obtained during consultations.

Santos may then refine or change its proposed control measures to address potential environmental impacts and risks of the activity based on that information or any claims or objections raised through consultation.

Santos' consultation methodology and process adopted in developing this EP comprised the following key steps:

- Identifying Relevant Persons, as outlined in Section 4.5.2
- Implementing a public awareness campaign and providing opportunities for Relevant Persons to identify themselves if they wished to be consulted, as outlined in Section 4.5.5
- Consultation planning, preliminary consultation and consultation activities, as outlined in Section 4.5.7
- Assessing the merits of claims or objections made by Relevant Persons about alleged adverse impacts of each activity to which the EP relates and providing responses to queries, requests and feedback, as summarised in Section 4.6.

As described in Section 3, Santos considered the spatial extent of the environment that may be affected (EMBA) and the particular aspects of the environment as part of its process for identifying Relevant Persons. As the EMBA represents the greatest geographical extent that could be affected by hydrocarbons in the event of a spill scenario (see Section 3.1.2), the EMBA is Santos' starting point in identifying potential Relevant Persons.

Santos notes that there is no reasonable possibility that planned impacts from the Activity (undertaken within the Operational Area) will have any consequences on functions, interests or activities concerning areas at the extremities of the EMBA.

The only potential consequence for functions, interests or activities at the extremities of the EMBA is as a result of the risk of an unplanned release of hydrocarbons, described in Sections 7.6 and 7.7 of this EP.

The likelihood of an unplanned released given the mitigation and management controls in place, and the residual risk is Low. There is an even lower likelihood of an unplanned hydrocarbon release affecting a person or organisation's functions, interests or activities where these relate to the extremities of the EMBA. This is because there is significant conservatism associated with the EMBA extents given the EMBA:

- is determined from the combination of 300 individual modelled spill scenarios across all seasons
- is based on low exposure values (as described in Section 3.1.1) which represent the maximum potential extent of hydrocarbon contact with environmental receptors, and primarily used to inform Santos preparedness for potential spill response; and
- does not take into account any spill response activities by Santos (as described in the Eos Operations Oil Pollution Emergency Plan (OPEP)) which would be implemented in event of a spill and reduce the EMBA extent.

The modelling itself represents the potential extent of detection of a spill in the environment rather than the geographical extent of environmental impact on receptors in the environment. Further, there is no single event that could ever result in the whole EMBA being affected at the same time.

When considering the remote possibility of any major unplanned spill event, and the inherent conservatism of the EMBA, the likelihood of there being persons or organisations along the Northern Australia NT/Western Australia (WA) coastline having an interest that may be affected by the proposed activities becomes increasingly unlikely with increasing distance from the OA, where planned activities will occur. By way of example, the easternmost boundary of the EMBA is more than 300 km from the OA and westernmost boundary of the EMBA is more than 600 km from the OA.

In considering this, while Santos has still identified and consulted with Relevant Persons whose functions, interests or activities may only be affected by unplanned events (the likelihood of which is remote), Relevant Persons identification steps and direct consultation effort has tended to focus more closely on those most proximate to the OA, such as commercial fishers.

Santos' methodology demonstrates a very broad capture of potential Relevant Persons, including providing ample opportunities, as outlined in Section 4.5.5, for Relevant Persons to self-identify and provide input to the development of the EP if they consider they may be impacted by the proposed activities.

4.5.2 Identifying relevant persons

Table 4-3 summarises the preliminary steps adopted by Santos to identify Relevant Persons, noting that the identification of Relevant Persons is an iterative process.

Table 4-3: Preliminary identification methodology

Process steps
1. Identify the impacts of the planned activities and the risks and impacts of unplanned events.
2. Consider the spatial extent of the EMBA by the Activity for assessment of impacts and risks.
3. Consider and identify aspects of the environment that may be affected, having regard to: a. ecosystems and their constituent parts, including people and communities b. natural and physical resources c. the qualities and characteristics of locations, places and areas d. the heritage value of places e. the social, economic and cultural features of the matters mentioned in paragraphs (a), (b), (c) and (d).
4. Identify relevant person categories, having regard to: a. aspects of the environment identified at Item 3 b. the departments or agencies of Commonwealth, State and Territory governments that could therefore be relevant c. the kinds of functions, interests or activities of people or organisations that could therefore be affected d. submissions received in response to Santos' advertisements asking relevant persons to identify themselves if they wished to be consulted e. any other person or organisation that the titleholder considers relevant. Update during consultation based on new information, if appropriate.
5. Identify relevant persons within relevant person categories, having regard to Items 1–4 above.

Table 4-4 outlines the environmental aspects within the EMBA (described in detail in Section 3). Santos considered these aspects for the purpose of identifying Relevant Person categories.

Table 4-4: Environmental aspects considered for Relevant Person category identification

Aspects of the environment	EP reference
Physical environment	Section 3.4
Provincial Bioregions	Section 3.3.2
Benthic habitats	Section 3.6.2.3
Australian marine parks and state marine parks, management areas, reserves	Sections 3.5.1 and 3.5.2
Key Ecological Features	Section 3.6.1
Commonwealth Heritage Areas (Indigenous and Non- Indigenous)	Section 3.8
Wetlands of International and National Significance	Sections 3.5.5 and 3.5.6
Biologically Important Areas and Critical Habitat	Section 3.7.2
Recovery Plans	Section 3.7
Commercial fisheries	Section 3.8.1
Energy industry	Section 3.8.3
Telecommunication cables	Section 3.9
Defence activities	Section 3.8.5
Shipping	Section 3.8.2
Recreation and tourism	Section 3.8.4
Indigenous and Non-Indigenous Heritage	Section 3.8
Cultural Features	Section 3.8.7

Consideration of the above environmental aspects resulted in the identification of the following relevant person categories:

Section 25(1)(a)(b)(c) of the OPGGS(E)R:

- Commonwealth Government agency or authority,
- NT Government agency or authority, and
- WA Government agency or authority.

Section 25(1)(d)(e) of the OPGGS(E)R

- Academic and research organisations
- Commercial fishing (Commonwealth-managed)
- Commercial fishing (Northern Territory-managed)
- Commercial fishing (Western Australian-managed
- Energy industry titleholders / operators
- Environmental conservation organisations
- First Nations peoples and groups, including recognised community reference/liaison groups
- Infrastructure operators
- Industry associations
- Local government and recognised community reference/liaison groups
- Recreational fishing
- Shipping
- Tourism operators

Table 4-5 outlines actions used by Santos to identify Relevant Persons within those categories.

Table 4-5: Actions for identifying Relevant Persons by category

Relevant person Category	Actions to identify relevant persons
All relevant person categories	• Review of relevant regional historical consultation by Santos in the region • Review of identified relevant persons in publicly available EPs submitted by other Titleholders that may be relevant to proposed activities to be managed under this EP • Public awareness campaign as outlined in Table 4-6 • Review of information provided by or claims made by or on behalf of organisations who claimed to be relevant persons • Review of published NOPSEMA guidance relevant to consultation.
Section 25(1)(a) of the OPGGS(E)R	
Commonwealth agency or authority to which the activities to be carried out under the environment plan may be relevant	• Review of government agency websites and directories to understand agency roles, functions and responsibilities • Review of government agency guidance on consultation expectations
Section 25(1)(b) and (c) of the OPGGS(E)R	
State and Territory Departments/Agencies	• Review of government agency websites and directories to understand agency roles, functions and responsibilities • Review of NOPSEMA and government agency guidance on consultation expectations
Section 25(1)(d) and (e) of the OPGGS(E)R	
Academic and research organisations	• Conducting key-word searches of publicly available online search engines, review media coverage and review organisation websites to identify organisations with reasonably ascertainable functions, interests or activities that may be affected, having regard to the region, activities or risks/impacts under this EP

Relevant person Category	Actions to identify relevant persons
Commercial fishing	• Review of Commonwealth and WA Government commercial fishing catch and effort data in the Operational Area • Review of fisheries entitled to fish in the EMBA
Energy industry	• Review of EMBA overlap with petroleum, greenhouse gas and any other National Offshore Petroleum Titles Administrator (NOPTA) issued titles.
Environmental conservation organisations	• Conducting key-word searches of publicly available online search engines, review media coverage and review organisation websites to identify organisations with reasonably ascertainable functions, interests or activities that may be affected, having regard to the region, activities or risks/impacts under this EP
First Nations people and groups	• Review of the Judgment and the Appeal Judgment • Review of EMBA overlap with Native Title determined areas and claims, Indigenous land use agreements (ILUAs), land rights and Indigenous Protected Areas (IPAs). • Review of Representative Aboriginal/Torres Strait Island Bodies (RATSIBs) and Native Title Representative Bodies (NTRBs) on Native Title website. • Review of Prescribed Bodies Corporate on Native Title website, where relevant. • Conducting searches of public cultural heritage databases relevant to the EMBA. • Review of marine park management plans relevant to the EMBA. • Engagement with government departments/agencies with relevant knowledge or relevant responsibilities. • Engagement with representative bodies under the *Native Title Act 1993* (NT Act) and the *Aboriginal Land Rights (Northern Territory) Act 1976* (ALR Act). • Engagement with other representative organisations in areas of potential relevance to proposed activities such as liaison committees and First Nations Consultative Committees (FNCCs). • Engagement with third party consultants to assist with identification of potential First Nations Relevant Persons.
Infrastructure operators	• Review of EMBA overlap with offshore and onshore infrastructure, such as submarine telecommunications cables or ports
Industry associations	• Review of industry representation of the following relevant person groups: – commercial fishing – local government authorities – local industry – recreational fishing – shipping – tourism operators
Local government and recognised community reference/liaison groups	• Review of EMBA overlap with boundaries of local government areas
Recreational fishing	• Review of EMBA overlap with areas of interest to recreational fishing • Review of potential presence of recreational fishing club members in the EMBA • Review of website information of relevant agencies/organisations that represent recreational fishing interests
Tourism operators	• Review of EMBA overlap with areas of interest to charter and tourism operators • Review of potential presence in the EMBA • Review of website information of relevant operators/organisations that represent commercial tourism interests with reasonably ascertainable functions, interests or activities that may be affected, having regard to the region, activities or risks/impacts under this EP

4.5.3 Identification and consultation of First Nations peoples and groups

Santos has developed a comprehensive process for identifying and undertaking effective consultation with First Nations Relevant Persons.

As with Santos' process for identifying Relevant Persons generally, this is an iterative process with multiple avenues of enquiry including, but not limited to, the following actions:

+ Consideration of known cultural features of the environment;
+ Active steps to identify First Nations people and groups as per actions outlined in Table 4-5, directed to identifying First Nations Relevant Persons with functions, interests or activities that may be affected;
+ Making sustained efforts to engage and build relationships with identified NTRBs and PBCs/RNTBCs through a range of appropriate communication methods;
+ Asking identified Relevant Persons, including identified First Nations Relevant Persons, if there are other persons or organisations who may be a Relevant Person;
+ Conducting a public awareness and advertising campaign targeted at increasing awareness of the activities proposed in this EP; to ensure that Relevant Persons not otherwise identified by Santos' examination of the EMBA, are given the opportunity to self-identify; and
+ Encouraging any persons or organisations who consider they have functions, interests or activities that may be affected by the activities in this EP to contact Santos (see Section 4.5.5).

Santos' process also involved engaging a third-party consultant to assist Santos in identifying First Nations groups, clans and/or organisations along the NT/WA coastline in the vicinity of the EMBA.

Santos proceeded to consult with a number of First Nations groups identified through the above processes as potential Relevant Persons, with a view to ascertaining during consultation sessions what, if any, functions, interests or activities they had that may be affected by the activities proposed in this EP. Santos has taken a broad approach and considers that these First Nations people or groups are Relevant Persons for the purposes of consultation on this EP (and therefore they have been included in Table 4-8 and Table 4-9) notwithstanding that in some cases, no potentially affected functions, interests or activities were ultimately ascertained.

Santos was not directed to any other First Nations groups or organisations (other than those Santos had identified) in response to Santos' invitation in its consultation materials for Relevant Persons to notify Santos of other potentially Relevant Persons for Santos to consider consulting about this EP.

As mentioned, Santos used the public awareness campaign outlined in Section 4.5.5 to help identify other First Nations groups with interests (such as connection with sea country) that may be affected by the Activity, that were not identified through other identification steps described above and in Table 4-5.

While Santos recognises that the obligation to identify Relevant Persons lies on the titleholder, and titleholders cannot rely solely on a process of public notification and self-identification, Santos considers its public awareness campaign to be an appropriate and sufficient measure to promote comprehensive identification of First Nations (and other) Relevant Persons, particularly having regard to the remoteness of the activity, the remote possibility of a major unplanned spill event, the inherent conservatism in spill modelling used to inform the EMBA and the difficulty in ascertaining whose functions, interests or activities may be affected in remote offshore waters.

4.5.4 International persons

With regard to the location of the proposed activities, there are no impacts from planned activities that may affect the functions, interests or activities of international Relevant Persons (see Section 5).

However, the worst-case credible spill scenario modelled for this EP indicates a possibility that international waters could be in contact with residual entrained hydrocarbons.

As stated in Section 4.5.1 there is significant conservatism associated with the depiction of the EMBA based on low exposure values that Santos has applied and especially given the modelling process (Section 3.1.2) which combines a large number of individual unmitigated spill simulations and the low likelihood of occurrence given the planned engineering prevention measures (Sections 7.6 and 7.7).

In addition, the modelling at low exposure values is primarily used to inform Santos' preparedness for potential spill response and does not take into account the suite of mitigations described in the Operations OPEP that would be implemented and reduce the EMBA extent in the unlikely event of a spill.

As a result, Santos has consulted the Department of Foreign Affairs and Trade (DFAT) which has a function in coordinating and facilitating communication between Australia and international governments.

4.5.5 Public awareness campaign and self-identification opportunities

In addition to undertaking the process for identification of potential Relevant Persons, as described above, Santos has undertaken a range of activities to promote opportunities for other organisations or individuals to self-identify as potential Relevant Persons if they considered that their functions, interests or activities may be affected. These promotional activities include widespread public information campaigns using a range of appropriate media, including, radio, print media and targeted social media. Details of the public awareness campaign for this EP are included in Table 4-6 and a schedule of advertising is included in Table 4-7.

Santos also has an online self-nomination form on its Consultation Hub website, where fact sheets and other consultation materials are published and available for download.

The media and advertising campaign had a regional focus, noting the remoteness of First Nations and other communities in Northern Australia. Regional radio advertising, particularly in the Kimberley region, was seen as a useful tool to raise awareness in First Nations communities proximate to the OA about the proposed Activity and associated consultation opportunities and to invite potentially affected persons to contact Santos.

Such activities provide a more than reasonable opportunity for organisations and individuals to self-identify as a Relevant Person for the purpose of OPGGS(E)R section 25 consultation, where they consider themselves to have interests, functions or activities that may be affected by the planned activities and for Relevant Persons to provide their input.

Santos' process includes opportunities for the self-identification or nomination of others as Relevant Persons, having regard to consultation information and materials shared directly to known and potential Relevant Persons, and/or indirectly during Santos' public awareness campaign. Santos' process involves the provision of reasonable timeframes for the self-identification or nomination of others as Relevant Persons, for Relevant Persons to consider consultation information, ask questions and give their input and for Santos' consideration and assessment of the merits of objections and claims.

Table 4-6: Public awareness campaign overview

Activity	Purpose	Timing
Preliminary Consultation		
Website Website content and activity fact sheets developed and made available at https://www.santos.com/offshoreconsultation/	**Provide:** • Information about Santos' consultation obligations and approach. • Descriptions of proposed activities, including potential activity impacts and risks, and proposed management measures. • Contact information to enable relevant persons to provide feedback. • Information about how to self-identify as a relevant person, including an online nomination form. • Details about how feedback will be managed, including provision of Santos' offshore Western Australia and Northern Territory privacy notice.	From 26 September 2023
Advertising Advertisements in these publications: • The West Australian • NT News • Broome Advertiser • Kimberley Echo Advertisements on these radio stations: • Hit 101.3 Broome • Hit WA FM • Kimberley Aboriginal Media Radio • 6GME Radio Goolarri 99.7FM	Promote awareness of proposed activities to create opportunities for relevant persons to self-identify and seek feedback from relevant persons in addition to those identified by Santos as part of its initial public review process.	From 19 September 2003 (publication details are included in Table 4-7).
Consultation materials • Email to identified relevant persons with a link to the fact sheet for this EP	Provide relevant persons with details on proposed Activities and establish consultation expectations.	From 26 September 2023

Activity	Purpose	Timing
One-to-one meetings • Meetings held with authorities, persons and organisations		From 20 September 2023
Consultation		
Consultation email: Email to identified Relevant Persons and potential Relevant Persons advising of the commencement of the formal consultation period.	Reminder to Santos' identified Relevant Persons and potential Relevant Persons of the commencement and closing dates for the formal consultation period.	From 27 October 2023
Advertising Advertisements in the following publications: • The West Australian • NT News • Broome Advertiser • Kimberley Echo Advertisements on the following radio stations: • Kimberley Aboriginal Media Radio • 6GME Radio Goolarri 99.7FM	Promote awareness of proposed activities and seek feedback from relevant persons	From 30 October 2023 (additional publication details are included in Table 4-7)
Consultation email • Reminder email to identified relevant persons advising pending closure of consultation period	Reminder to Santos identified relevant persons of the closing dates for consultation	From 3 November 2023
Consultation email Email to identified Relevant Persons advising of a change to the earliest survey commencement date.	Opportunity to provide additional feedback further to consultation opportunities provided in 2023.	From 16 April 2025

Table 4-7: Targeted advertising campaign details (September–November 2023)

Publication date	Advertising type	Towns / Communities	Reach
Preliminary consultation			
19 Sep 2023	Press ad – NT News	NT-wide	20,000
20 Sep 2023	Press ad – The West Australian	WA-wide	348,000
21 Sep 2023	Press ad – Broome Advertiser	Broome, Derby and Fitzroy Crossing	11,117
21 Sep 2023	Press ad – Kimberley Echo	Broome, Derby and Fitzroy Crossing	1,600
25–29 Sep 2023	Radio ad – Hit 101.3 Broome	Broome and surrounds	NA
25–29 Sep 2023	Radio ad – Hit WA FM	Broome and surrounds	NA
25–29 Sep 2023	Radio ad – Kimberley Aboriginal Media Radio	Kimberley towns and communities, focusing on remote communities	NA
25–29 Sep 2023	Radio ad – 6GME Radio Goolarri 99.7FM	Kimberley towns and communities, focusing on remote communities	NA
Consultation			
30 Oct 2023	Press ad – NT News	NT-wide	24,000
30 Oct 2023	Press ad – The West Australian	WA-wide	415,000
2 Nov 2023	Press ad – Broome Advertiser	Broome, Derby and Fitzroy Crossing	11,117
2 Nov 2023	Press ad – Kimberley Echo	Broome, Derby and Fitzroy Crossing	1,600
30 Oct–3 Nov 2023	Radio ad – Kimberley Aboriginal Media Radio	Kimberley towns and communities, focusing on remote communities	NA
30 Oct–3 Nov 2023	Radio ad – 6GME Radio Goolarri 99.7FM	Kimberley towns and communities, focusing on remote communities	NA

4.5.6 Relevant persons

A list of potential relevant persons was developed through application of the above methodology for the purposes of undertaking preliminary consultation to confirm consultation expectations.

This consultation phase was supported by the public awareness campaign outlined in Table 4-7 to raise public awareness about the proposed Activity and provide opportunities for authorities, persons or organisations to identify themselves if they wished to be consulted.

Relevant persons consulted for this EP are listed in Table 4-8.

Table 4-8: Relevant persons for this EP

Relevant Person	Summary of relevance
Section 25(1)(a): Departments or agencies of the Commonwealth to which the activities to be carried out under the environment plan may be relevant	
Australian Communications and Media Authority (ACMA)	ACMA is responsible for the regulation of communications and media services in Australia. ACMA is a relevant agency because the Activity has the potential to impact future proposed subsea communications cable installations.
Australian Fisheries Management Authority (AFMA)	AFMA is responsible for managing Commonwealth fisheries and is a relevant agency where the Activity has the potential to impact on fisheries resources in AFMA managed fisheries. AFMA expects petroleum operators to consult directly with fishing operators about all activities and projects which may affect day to day fishing activities. AFMA also provides industry association contacts for petroleum operators to use when consultation with fishing operators is required.
Australian Hydrographic Office (AHO)	AHO is responsible for maintaining and disseminating nautical charts, including the distribution of Notice to Mariners.
Australian Institute of Marine Science (AIMS)	AIMS is Australia's tropical marine research agency and is established under the *Australian Institute of Marine Science Act 1972* (AIMS Act).
Australian Maritime Safety Authority (AMSA) – Maritime Safety and Marine Pollution	AMSA is the statutory and control agency for maritime safety and vessel emergencies in Commonwealth Waters. AMSA is a relevant agency when proposed offshore activities may impact on the safe navigation of commercial shipping in Australian waters.
Department of Agriculture, Fisheries and Forestry (DAFF) – Biosecurity	DAFF administers the *Biosecurity Act 2015* (Cth) (Biosecurity Act). DAFF is a relevant agency for consultation because the Activity involves the movement of aircraft or vessels between Australia and offshore petroleum activities either inside or outside Australian territory.
Department of Agriculture, Fisheries and Forestry (DAFF) – Fisheries	DAFF (fisheries) has primary policy responsibility for promoting the biological, economic and social sustainability of Australian fisheries. The Department is the relevant agency where the Activity has the potential to negatively impact fishing operations and/or fishing habitats in Commonwealth waters.
Department of Climate Change, Energy, the Environment and Water (DCCEEW) – Underwater Cultural Heritage	The Department of Climate Change, Energy, the Environment and Water protects Australia's natural environment and heritage sites, helps Australia respond to climate change and carefully manages water and energy resources.
Department of Defence (DoD)	DoD manages the development, maintenance and disposal of the Defence estate, including unexploded ordinance (UXO).
Department of Foreign Affairs and Trade (DFAT)	DFAT promotes and protects Australia's interests internationally and contributes to global stability and economic growth. The modelled EMBA for this EP extends beyond Australia's territory. DFAT is a relevant agency for consultation as the proposed Activity poses a hydrocarbon spill risk that could result in impacts extending to other international jurisdictions, and where persons or organisations in international jurisdictions may be affected by the proposed Activity.
Department of Home Affairs and Australian Border Force (ABF)	The Department of Home Affairs is an Australian Government department responsible for overseeing migration, national security and resilience, and border-related functions. Australian Border Force (ABF) is an operationally independent body within the Home Affairs portfolio. ABF is Australia's border law enforcement agency and customs service. ABF's vessels undertake patrols as part of its

Relevant Person	Summary of relevance
	surveillance and response activities throughout an offshore maritime area of almost 45.1 million square kilometres. This area includes the EMBA.
Department of Industry, Science and Resources (DISR)	DISR responsibilities include offshore oil and gas development and safety, and greenhouse gas storage.
Director of National Parks (DNP)	DNP is the statutory authority responsible for administration, management and control of Commonwealth marine reserves (CMRs). The DNP is a relevant person for consultation where: • the Activity or part of the Activity is within the boundaries of a proclaimed Commonwealth marine reserve • activities proposed to occur outside a reserve may impact on the values within a Commonwealth marine reserve; and / or • an environmental incident occurs in Commonwealth waters surrounding a Commonwealth marine reserve and may impact on the values within the reserve.
National Indigenous Australians Agency (NIAA)	NIAA is an Australian Government agency responsible for whole-of-government coordination of policy development, program design and service delivery for Indigenous Australians.
Section 25(1)(b): Departments or agencies of Northern Territory to which the activities to be carried out under the environment plan may be relevant	
Aboriginal Areas Protection Authority (AAPA)	The Aboriginal Areas Protection Authority supports development while safeguarding Aboriginal sacred sites. Under the Northern Territory *Aboriginal Sacred Sites Act*, the Aboriginal Areas Protection Authority is responsible for overseeing the protection of Aboriginal sacred sites on land and sea across the whole of Australia's Northern Territory. The Act also gives the Authority the power to prosecute people and organisations that damage sacred sites.
Darwin Harbour Advisory Committee	The Darwin Harbour Advisory Committee provides advice to the Northern Territory (NT) Government through the Minister for Environment, Parks and Water Security (the Minister) on the effective management of Darwin Harbour and its catchment.
NT Department of Lands, Planning and Environment (DLPE)	The Department of Lands, Planning and Environment (DLPE) was established by the NT Government on 10 September 2024. This new department combined the functions of the previous Department of Environment, Parks and Water Security and Lands and Planning from the former Department of Infrastructure, Planning and Logistics (DIPL). The government established the department to combine many of the key functions that foster and protect the environment and natural resources in the NT. This includes water, land resource management, environmental issues and the parks and wildlife functions.
NT Environment Protection Authority (NT EPA)	The NT EPA is an independent authority established under the Northern Territory *Environment Protection Authority Act 2012*. The NT EPA consists of between four and seven members appointed by the Administrator of the Northern Territory and the Chair of the NT Planning Commission. Appointed members to the NT EPA are required to collectively provide knowledge and experience in a broad range of environmental, scientific, business and social disciplines.
NT Department of Industry, Tourism and Trade (DITT) – Fisheries – Aquatic Biosecurity Section	The Aquatic Biosecurity Unit of Northern Territory Fisheries monitors and manages the risk of new marine pests arriving in the Territory. The unit monitors for early detection of aquatic pests; coordinates inspections and treatment of high-risk vessels entering Darwin; responds to reported sightings of invasive freshwater and marine pests; and educates the public about the impacts, prevention and management of aquatic pests. It also monitors natural changes in native marine fouling species and represents the NT in national forums on the prevention and management of introduced aquatic species.
NT Department of Industry, Tourism and Trade (DITT) – Fisheries Division	NT DITT has functions in relation to NT-managed fisheries. The Operational Area overlaps NT-managed fisheries.
NT Department of Infrastructure, Planning and Logistics (DIPL) – Transport Division	NT DIPL is responsible for marine safety in NT coastal waters.
NT Dept of Territory Families, Housing and Communities – Heritage Branch	The NT Department of Territory Families, Housing and Communities' Heritage branch has a role in protecting the maritime heritage of the Northern Territory.
Parks and Wildlife Commission of the Northern Territory	Parks and Wildlife Commission of the Northern Territory is the Northern Territory Government agency responsible for tasks including the establishment of 'parks,

Relevant Person	Summary of relevance
	reserves, sanctuaries and other land', the management of these and the 'protection, conservation and sustainable use of wildlife.
Tourism NT	Tourism NT is the government statutory authority responsible for promoting tourism in the Northern Territory, including potential activity by NT-based operators in the EMBA.
Section 25(1)(b): Departments or agencies of Western Australia to which the activities to be carried out under the environment plan may be relevant	
Department of Biodiversity, Conservation and Attractions (DBCA)	DBCA is a relevant State agency responsible for the management of State marine parks and reserves and protected marine fauna and flora.
Department of Jobs, Tourism, Science and Innovation (JTSI)	JTSI is a Western Australian Government statutory authority responsible for promoting Western Australia as a holiday destination.
Department of Planning, Lands and Heritage (DPLH)	DPLH is responsible for WA state level land use planning and management, and oversight of Aboriginal cultural heritage and built heritage matters.
Department of Primary Industries and Regional Development (DPIRD)	DPIRD is responsible for managing West Australian fisheries.
Department of Transport (DoT) – Marine Pollution	DoT is the control agency for marine pollution emergencies in Western Australian State waters.
Department of Water and Environmental Regulation (DWER)	DWER is responsible for environment and water regulation.
Kimberley Development Commission (KDC)	KDC is a Western Australian Government statutory authority dedicated to the economic and social development of the Kimberley region.
Kimberley Ports Authority (KPA)	The KPA head office is located in Broome and is responsible for the Ports of Derby, Yampi Sound and Wyndham and directly manages the Port of Broome which is the principal deepwater port servicing the Kimberley region.
Western Australian Museum (WAM)	WAM maintains a database of shipwrecks off the Western Australian coast.
Section 25(1)(c): Department of the responsible Northern Territory Minister	
NT Department of Industry, Tourism and Trade (DITT) – Energy	NT DITT is the department of the responsible Territory Minister and is required to be consulted under subregulation 11A(1)(c) of the OPGGS(E)R.
Section 25(1)(b): Department of the responsible Western Australian Minister	
WA Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	DEMIRS is the department of the relevant State Minister and is required to be consulted under subregulation 11A (1) of the Environment Regulations.
Section 25(1)(d): Persons or organisations whose functions, interests or activities may be affected by the activities to be carried out under the Environment Plan, or the revision of the Environment Plan	
Academic and Research Organisations	
Australian Marine Sciences Association (WA Branch) (AMSA)	Marine research organisation.
Charles Darwin University (CDU)	Marine research organisation.
Commonwealth Scientific and Industrial Research Organisation (CSIRO)	Marine research organisation.
Geoscience Australia (GA)	Marine research organisation.
University of Tasmania – Marine Biodiversity Hub (UTAS)	Marine research organisation.
University of Western Australia (UWA)	Marine research organisation.
Western Australian Marine Science Institution (WAMSI)	Marine research organisation.
Commercial fishing – Commonwealth managed	
Commonwealth fisheries that spatially overlap the Operational Area: • North West Slope Trawl Fishery • Northern Prawn Fishery	Licence holders in this fishery have been active in the Operational Area: • Northern Prawn Fishery As such there is potential for interaction with licence holders in this fishery who should be consulted.

Relevant Person	Summary of relevance
• Southern Bluefin Tuna Fishery • Western Skipjack Tuna Fishery • Western Tuna and Billfish Fishery	
Commercial fishing – Northern Territory managed	
NT fisheries that spatially overlap the Operational Area: • Aquarium Fishery • Bait Net Fishery • Barramundi Fishery • Coastal Line Fishery • Coastal Net Fishery • Demersal Fishery • Development (Small Pelagic) • Mud Crab Fishery • Offshore Net and Line Fishery • Pearl Oyster Fishery • Spanish Mackerel Fishery • Timor Reef Fishery • Trepang Fishery	Licence holders in these fisheries have been active in the Operational Area: • Aquarium Fishery • Demersal Fishery • Offshore Net and Line Fishery • Spanish Mackerel Fishery As such there is potential for interaction with licence holders in these fisheries who should be consulted.
Commercial fishing – Western Australian managed	
WA fisheries that spatially overlap the Operational Area: • Abalone Managed Fishery • Broome Prawn Managed Fishery • Kimberley Crab Managed Fishery • Kimberley Gillnet and Barramundi Fishery • Kimberley Prawn Managed Fishery • Mackerel Managed Fishery • Marine Aquarium Fish Managed Fishery • Northern Demersal Scalefish Managed Fishery • North Shark Fisheries (Joint Authority Northern Shark Fishery and WA North Coast Shark Fishery) • Pearl Oyster Managed Fishery • South West Coast Salmon Managed Fishery • Specimen Shell Managed Fishery • West Australian Sea Cucumber Fishery • West Coast Deep Sea Crustacean Managed Fishery	Licence holders in these fisheries have been active in the Operational Area: • Northern Demersal Scalefish Managed Fishery • Mackerel Managed Fishery As such there is potential for interaction with licence holders in these fisheries who should be consulted.
Energy industry – Petroleum titleholders and GHG permit holders	
Arafura Oil	Titleholder within the EMBA.
Carnarvon Energy	Titleholder within the EMBA.
Eni Australia	Titleholder within the EMBA.
EOG Resources Australia	Titleholder within the EMBA.
INPEX	Titleholder within the EMBA and OA.

Relevant Person	Summary of relevance
IPB WA	Titleholder within the EMBA.
Melbana Energy (previously MEO International)	Titleholder within the EMBA.
Neptune Energy	Titleholder within the OA.
NT Gas Australia	Titleholder within the EMBA.
Total Energy	Titleholder within the EMBA (Consulted via INPEX who are the contact titleholder)
Shell Australia	Titleholder within the EMBA.
Vulcan Exploration	Titleholder within the EMBA.
Woodside Energy	Titleholder within the EMBA.
Environmental conservation organisations	
Australian Conservation Foundation (ACF)	ACF is a peak conservation body with an interest in activities that may affect the marine environment.
Australian Marine Conservation Society – NT (AMCS)	According to its website: • AMCS-NT is a grassroots independent environmental conservation organisation and charity that works to protect ocean wildlife along the Northern Territory coastline, waters and seas. • Its members work to protect marine animals and critical ocean ecosystems. • It advocates for evidence-based solutions to conservation activity and works closely with marine research centres. Its interests for the purposes of this EP relate to marine parks and sanctuary zones within the EMBA for threatened and at-risk species.
Conservation Council of WA (CCWA)	CCWA is a peak conservation body with an interest in activities that may affect the marine environment.
Environment Centre Northern Territory (ECNT)	According to its website, ECNT is a not-for-profit incorporated association whose objects include protection of all aspects of the natural environment, conducting campaigns to protect the natural environment, environmental research, and public education and information about the natural environment.
Environs Kimberley	Environs Kimberley is the peak environmental NGO for the Kimberley region and is dedicated to looking after the health of the land and waters of the region.
Greenpeace Australia Pacific (GAP)	GAP is a peak conservation body with an interest in activities that may affect the marine environment.
International Fund for Animal Welfare (IFAW)	IFAW is a peak conservation body with an interest in activities that may affect the marine environment.
Keep Top End Coasts Healthy	According to its website, KTECH is an alliance of environment groups including the Australian Marine Conservation Society (AMCS) and the Environment Centre of the Northern Territory (ECNT).
Save the Kimberley	STK is a volunteer, not-for-profit organisation that is involved in protecting the terrestrial and marine environment of the Kimberley.
Sea Turtle Foundation	According to its website, the Sea Turtle Foundation is a non-profit, non-government group based in Australia with a stated interest in protecting sea turtles through research, education and action.
The Wilderness Society	TWS is a peak conservation body with an interest in activities that may affect the marine environment.
World Wide Fund For Nature (WWF)	WWF is a peak conservation body with an interest in activities that may affect the marine environment.
First Nations peoples and groups	
The following groups may have interests that intersect the EMBA. Information was provided to these organisations during formal consultation to help identify and consult groups or individuals whose spiritual or cultural connections to land and sea country in accordance with Indigenous tradition may be affected by proposed activities. In addition, targeted regional advertising was conducted during formal consultation to provide opportunity for individuals whose functions, interests and activities may be affected by the proposed activity to self-identify as relevant persons. Information was provided during further consultation to representative organisations and consultative committees to communicate a change in the earliest commencement date of proposed activities. Information was provided to these	

Relevant Person	Summary of relevance
organisations as the most effective way to communicate the activity update, noting the inherently conservative nature of the EMBA and the low likelihood of a spill reaching Northern Territory coastal areas. No groups or individuals self-identified as relevant persons and none were identified via consultation with the following organisations.	
Representative organisations – Northern Territory	
Larrakia Nation Aboriginal Corporation (LNAC)	Larrakia Nation is one of Darwin's leading community service organisations. Larrakia Nation Aboriginal Corporation was set up in 1997 through the Northern Land Council to provide a corporate identity for Larrakia people to uphold Native Title claims. In 20 years, it has grown to represent the Traditional Owners of the Darwin region and to speak on behalf of Larrakia people while delivering community and outreach services to the broader Darwin community.
Northern Land Council (NLC)	NLC is the Native Title Representative Body for the Northern Region, including sea country. Its functions are prescribed under the NT Act. NLC also has statutory obligations under the ALR Act and is authorised to perform certain functions under the NT Act. NLC's area of interest includes sea country where non-exclusive native title rights and interests may exist, including within the EMBA.
Tiwi Land Council (TLC)	TLC is governed under the ALR Act. The Tiwi Aboriginal Land Trust was also established under the ALR Act and the TLC is the only body with authority to direct the Trust. The authority of the TLC does not extend into Commonwealth offshore waters, although the sea country interests of Tiwi Island clans do, including within the EMBA.
Wickham Point Deed Liaison Committee (WPDLC)	The objective of the WPDLC is to strengthen the dialogue between Santos and the Larrakia people and support the delivery of the parties' commitments under the Wickham Point Deed entered into between Darwin LNG and the Northern Land Council on 29 April 1999. Santos coordinates quarterly meetings with the Wickham Point Deed liaison committee, which includes representatives from Larrakia family groups, the functions of which are set out in the Wickham Point Deed and include making recommendations to Santos on various matters such as environmental, cultural heritage, employment and business opportunities.
First Nations Consultative Committees and coastal clan groups	
Agalda Clan	The Agalda clan estate is located over the western parts of the Cobourg Peninsula, including coastal areas and adjacent sea country.
Daly River / Port Keats FNCC	Daly River / Port Keats FNCC represents the Yek Yedere, Rak Kinmu, Yek Nangu, Yek Maninh, Kura Thipma and Kuy clans. The named clan estates are located on the coastal areas of the Port Keats / Daly River Aboriginal Land Trust and adjacent sea country.
Djulidki Consultative Committee (formerly Bradshaw Liaison Committee)	The Bradshaw Field Training Area (Bradshaw) is a major Australian Defence Force and joint Australian and United States (US) military training facility located near the township of Timber Creek in the Victoria River region of the Northern Territory. The facilities at Bradshaw are regularly used for combined training operations between Australian and US forces. An Indigenous Land Use Agreement (ILUA) for Bradshaw was struck in 2003 between the Native Title Claimants, the Northern Land Council and the Commonwealth Department of Defence. In implementing the ILUA, the Bradshaw Liaison Committee (BLC) was established to support the relationship between the ADF and the Bradshaw Native Title Holders. The BLC meet regularly to discuss the ILUA and to receive briefings on matters that may affect BLC members, including in relation to third-party activities being undertaken in the Bradshaw vicinity. First Nations BLC members have interests, including cultural connections, in Bradshaw and adjacent sea country.
Larrakia People	The Larrakia people are the traditional owners of the Darwin region. Larrakia country runs from Cox Peninsula in the west to Gunn Point in the north, Shoal Bay in the east and down to the Manton Dam area southwards. The Larrakia People consist of between eight to fourteen family groups, depending on how families are grouped.
Mulyurrud Consultative Committee (MCC)	The Mulyurrud Consultative Committee speaks for Croker Island, including the Gadura-Minaga, Mangalarra and Mandilarri clan estates, and the adjacent sea country, including several islands to the east and north east of Croker Island and the Ildugidj clan estate located on the mainland coastline (south from Croker Island). This Committee's area includes the southern portion of the Arafura Marine Park.
Rak Badjalarr Consultative Committee (RBCC)	The Rak Bajalarr Consultative Committee speaks for country extending north from the Daly River to the Cox Peninsula, and adjacent coastal sea country, including the Peron Islands and the Dum In Mirrie, Beer Eeetar, Windirr and Grose, Quail and

Relevant Person	Summary of relevance
	Indian Islands. It includes the western part of the Darwin harbour and associated waterways, and represents the Kenbi, Emmiyangal, Mendheyangal, Kiyuk, Wadigany, Murranungu, Malak Malak and Marriamu clans located over the coastal areas from the Cox Peninsula to the Daly River.
Tiwi Island Clan Groups and Traditional Owners	The Tiwi Islands are located approximately 80 km north of Darwin in the Arafura Sea. There are three major communities on the Tiwi Islands. The largest community is Wurrumiyanga (on Bathurst Island), with smaller communities of Milikapiti and Pirlangimpi located on Melville Island. There are eight landowning groups (clans) on the islands, Mantiyupwi, Munupi, Yimpinari, Malawu, Wulirankuwu, Wurankuwu, Mirrikawuyanga and Jikilaruwu (or Tikalaru). Members of the Mantiyupwi clan also speak for the Vernon Islands, which are located between the Tiwi Islands and mainland NT.
Wulna clan	The Wulna clan estate is located on coastal areas and adjacent sea country from the Gunn Point area in the west and extending east from the Adelaide River.
Representative organisations – Western Australia	
Balanggarra Aboriginal Corporation	The Ballengarra Aboriginal Corporation, based in Wyndham, is the Registered Native Title Body Corporate (RNTBC) for the Ballengarra People and manages their native title determination
Bardi and Jawi Niimidiman Aboriginal Corporation (RNTBC)	The Bardi and Jawi Niimidiman Aboriginal Corporation, based in Broome, is the RNTBC for the Bardi and Jawi Niimidiman People and manages their native title determination.
Dambimangari Aboriginal Corporation	The Dambimangari Aboriginal Corporation, based in Derby, is the Aboriginal corporation nominated by the Wanjina Wunggurr RNTBC, (which holds the larger native title determination over the area) to manage the southern part of the determination.
Kimberley Land Council (KLC)	The KLC is the Native Title Representative Body for the Kimberley region in WA. Its primary role is to provide native title services to Kimberley Aboriginal people. KLC's area of interest includes sea country where non-exclusive native title rights and interests may exist, including within a section of Commonwealth waters within the EMBA. The KLC is also named in several Marine Park Management Plans off the Kimberley coast.
Mayala Inninalang Aboriginal Corporation	The Mayala Inninalang Aboriginal Corporation, based in Broome, is the RNTBC for Mayala Inninalang people, and manages their determination.
Miriuwung Gajerrong Aboriginal Corporation	Native Title Prescribed Body Corporate that represents Miriuwung, Gajerrong, Doolboong, Wardenybeng and Gija Native Title holders The Miriuwung, Gajerrong, Doolboong, Wardenybeng and Gija peoples have responsibilities for sea country in the Joseph Bonaparte Gulf Marine Park. The Marine Park is outside of the OA but is intersected by the EMBA.
Nyul Nyul Aboriginal Corporation	Native Title Prescribed Body Corporate that represents Native Title holders. Nyul Nyul people's sea country extends into the Kimberley Marine Park. The Marine Park is outside of the OA but is intersected by the EMBA.
Wanjina-Wunggurr Aboriginal Corporation	Native Title Prescribed Body Corporate that represents Native Title holders. The EMBA intersects the Uunguu Part A Native Title determined area.
Wunambal Gaambera Aboriginal Corporation	Aboriginal Corporation that represents northern group of Native Title holders who are part of the larger Wanjina-Wunggurr Native Title determination. Wunambal Gaambera people's sea country extends into the Kimberley Marine Park.
Industry associations – Commercial fishing	
Australian Southern Bluefin Tuna Industry Association (ASBTIA)	ASBTIA represents the interests of the Southern Bluefin Tuna Fishery and Western Skipjack Fishery.
Commonwealth Fisheries Association (CFA)	CFA represents the interests of commercial fishers with licences in Commonwealth waters.
Northern Territory Seafood Council (NTSC)	NTSC is the peak representative body for the wild catch, aquaculture and trader/processor seafood sectors in the Northern Territory.
Northern Prawn Fishing Industry (NPFI)	NPFI represents the interests of the interests of commercial fishers in the Northern Prawn Fishery.
Tuna Australia (TA)	TA represents the interests of the Western Tuna and Billfish Fishery.

Relevant Person	Summary of relevance
Western Australian Fishing Industry Council (WAFIC)	WAFIC represents the interests of the WA commercial fishing, pearling and aquaculture sector.
Industry associations – Energy industry	
Australian Energy Producers (AEP)	AEP represents the interests of oil and gas explorers and producers in Australia.
Industry associations – Local government	
Local Government Association of the Northern Territory (LGANT)	The Local Government Association of the Northern Territory (LGANT) is the peak body representing the local government sector in the NT. It represents 16 of the 17 local government councils. Membership consists of four municipals, three shires, nine regional councils, and one associate member (Nhulunbuy Corporation).
Western Australian Local Government Association (WALGA)	WALGA is an independent, member based, not for profit organisation representing and supporting the WA Local Government sector.
Industry associations – Local industry	
Broome Chamber of Commerce and Industry	Regional representative organisation representing the interests of local business.
Cambridge Gulf Limited	CGL is a small micro-cap public unlisted company that is proud to be part of Northern Australia's diverse economy as well as the various local communities that it operates within. CGL is one of the biggest employers in Wyndham, Western Australia and the Board of Directors are all based in the East Kimberley region.
Chamber of Commerce Northern Territory (CCNT)	Regional representative organisation representing the interests of local business.
Derby Chamber of Commerce and Industry	Regional representative organisation representing the interests of local business.
East Kimberley Chamber of Commerce and Industry	Regional representative organisation representing the interests of local business.
Industry associations – Recreational fishing	
Amateur Fishermen's Association of the Northern Territory (AFANT)	AFANT is the peak body representing NT recreational fishers whose interests may intersect the EMBA.
Recfishwest	Recfishwest represents the interests of Western Australia's recreational fishing sector.
WA Game Fishing Association (WAGFA)	WAGFA co-ordinates the activities of game fishing throughout Western Australia, maintains State game fishing records and data concerning open game fishing tournaments of its member clubs. WAGFA members are: • Broome Fishing Club • Cockburn Power Boats • Exmouth Game Fishing Club • Fremantle Sailing Club • Geraldton and District Offshore Fishing Club • King Bay Gamefishing Club • Marmion Angling and Aquatic Club • Naturaliste Game and Sports Fishing Club • Nor-West Game Fishing Club • Perth Game Fishing Club
Industry associations – Commercial shipping	
Maritime Industry Australia Ltd (MIAL)	MIAL is Australia's national shipping industry peak body.
Industry Associations – Tourism	
Australian Tourism Industry Council (ATIC)	ATIC is the national representative body for tourism.
Northern Territory Guided Fishing Industry Association (NTGFIA)	NTGFIA is the peak body responsible for promoting, developing, and maintaining the guided fishing industry in the Northern Territory. It represents professional fishing guides and operators. Interests may intersect the EMBA.
Tourism Council of Western Australia (TCWA)	TCWA is the peak body representing tourism businesses, industries and regions in Western Australia.

Relevant Person	Summary of relevance
Marine Tourism WA (MTWA)	The MTWA is an association made up of charter industry owners and operators.
Tourism Top End	Tourism Top End is the Regional Tourism Association, a non-profit entity serving businesses, individuals and organisations involved in tourism activities in the Northern Territory. Interests may intersect the EMBA.
Western Australian Indigenous Tourism Operators Council (WAITOC)	WAITOC is the peak representative for Aboriginal tours and experiences in Western Australia.
Infrastructure operators	
BW Digital	BW Digital is a privately-owned, carrier-neutral and innovative to deliver optimal customer service. It develops, builds and operates a digital ecosystem, specialising in data transport, compute and storage to connect countries across oceans sustainably.
Darwin Port	Private consortium responsible for the management of shipping and other commercial activities requiring use of Darwin Harbour. Santos contracted vessels plan to use Darwin Harbour.
Inligo Networks	Inligo Networks is focused on developing strategic, low latency and high-capacity subsea and terrestrial cable networks across South-East Asia, Australasia and the Pacific to address the large and growing capacity needs in these rapidly developing regions.
NT Port and Marine	Private consortium that owns and operates the commercial port at Port Melville on the Tiwi Islands.
Telstra	Telstra Group Limited is an Australian telecommunications company that builds and operates telecommunications networks and markets related products and services.
Vocus	Operator of the following telecommunications cables: • Darwin-Jakarta-Singapore Cable (DJSC). • North West Cable System (NWCS)
Local Government Authorities – Northern Territory	
City of Darwin	The City of Darwin includes the central business district of the capital, Darwin City, and represents two-thirds of its metropolitan population. The Council's area includes NT coastline within the EMBA.
Litchfield Council	Litchfield Council represents people living in some of Darwin's outer rural suburbs. The Council's area includes NT coastline within the EMBA.
Tiwi Islands Regional Council	The Tiwi Islands Regional Council provides a range of local government and other services to Bathurst and Melville Islands and the communities of Wurrumiyanga, Wurankuwu, Milikapiti (Snake Bay) and Pirlangimpi (Garden Point), as well as several smaller outstations. The Council's area includes NT coastline within the EMBA.
Victoria Daly Regional Council	Victoria Daly Regional Council services the communities of Nauiyu/Daly River, Pine Creek, Timber Creek, Yarralin Walangeri and Kalgkarindji Daguragu. The Council's area includes NT coastline within the EMBA.
Wagait Shire Council	The Wagait Shire Council services community on the Cox Peninsula west of Darwin. The Council's area includes NT coastline within the EMBA.
West Arnhem Regional Council	West Arnhem Regional Council services the communities of Gunbalanya, Jabiru, Maningrida, Minjilang, Warruwi, as well as outstations. The Council's area includes NT coastline within the EMBA.
West Daly Regional Council	West Daly Regional Council services the communities of Wadeye, Palumpi and Peppimenarti. The Council's area includes NT coastline within the EMBA.
Local Government Authorities – Western Australia	
Shire of Derby-West Kimberley	The Shire of Derby-West Kimberley is a local government area in the Kimberley region of Western Australia.
Shire of Wyndham-East Kimberley	The Shire of Wyndham-East Kimberley is a local government area in the Kimberley region of Western Australia.
Recreational fishers	
NT and WA fishers	Recreational fishers active within the EMBA have been consulted via their representative organisations – AFANT and Recfishwest.

Relevant Person	Summary of relevance
Tourism operators	
NT and Kimberley based operators • DNA Barra Fishing, Darwin • Absolute Clean Charters • Berkeley River Lodge • Broome Adventure Company – Turtle Kayak • Broome Billfish Charters • Kimberley Pearl Charters • Kuri Bay Sport Fishing Tours • Phat Time Fishing • Reel Teaser Fishing Adventures • Slick Fishing Charters • Smithy's Seaside Adventures • West Kimberley Fishing Tours • Munupi Wilderness Lodge • Alure Fishing Charters • Anglers Advantage Fishing Charters • Angler's Choice Fishing Safaris • Arafura Bluewater Charters • Barra Fishing Charters • Bayview Marina • Clearwater Island Lodge and Munupi Wilderness Lodge • Compass T-L • Crab Claw Island Resort • Cullen Bay Fishing Charters • Cullen Bay Marina • Darwin Bara Fishing Tours • Darwin Dive Academy • Darwin Fish Seeker Charters • Darwin Harbour Cruises • Darwin Harbour Fishing Charters • Darwin Red Devil Fishing Charters • Darwin Sailing Club • Darwin Trailer Boat Club • Dinah Beach Cruising Yacht Club • Dreamers Dive Academy Timor • Dundee Beach Fishing Charters • Equinox Fishing Charters • Estuary Escapes Fishing Charters • Fish the Top End Fishing Charters • FNA Sports Fishing • Humbug Fishing • NT Indigenous Tours • Obsession Fishing Safaris • Offshore Boats Fishing Charters • Palmerston Game Fishing Club • Reel Screamin Barra Fishing • Sail Darwin	Marine tourism operator active within the EMBA.

Relevant Person	Summary of relevance
• Saltwater Cultural Tours • Sea Darwin • Shoal Bay Sportfishing Tours • Spring Tide Safaris • Streeter Cruises • Territory Guided Fishing • Tiwi Island Adventures • Tiwi Island Retreat • Top End Barra Fishing Tours • Top End Seafaris • Vision Sport Fishing • Yknot Fishing Charters	

4.5.7 Consultation planning, preliminary and consultation activities

Santos acknowledges that consultation processes need to have sufficient flexibility to adapt to the "nature of the interests of the Relevant Persons[22]".

For this EP consultation activities were generally undertaken in three broad phases:

Preliminary consultation (from 27 September 2023) – this included:

- activities to allow authorities, persons and organisations opportunities to self-identify as Relevant Persons and provide feedback about consultation methods and information needs via a portal and form available on its website. [refer to Section 4.6.4]; and
- directly contacting Relevant Persons and potential Relevant Persons to:
  - inform them about the consultation for this EP, including sharing information about the EP activity and associated environmental impacts and risks;
  - seek information to better understand if the person contacted was from a relevant government Department or agency, or was a person (or organisation) whose functions, interests or activities may be affected by the activities proposed to be carried out under this EP; and, if so, the nature of those potentially affected functions, interests or activities; and to
  - share information about titleholder responsibilities and opportunities to provide guidance for consultation expectations.

Formal consultation (from 27 October 2023) – this included seeking feedback from Relevant Persons to inform development of this EP during or following exchanges that involved the provision of sufficient information and a reasonable period of time (refer to Section 4.6.6).

Further consultation (from 16 April 2025) – this included seeking feedback on a change to earliest commencement date for proposed activities.

In developing this EP Santos has sought to work with authorities, persons and organisations on pragmatic and practical approaches to Section 25A consultation.

Santos sought feedback about consultation methods and information needs in its correspondence and via consultation meetings. Santos also sought information as to functions, interests or activities that may be affected by the Activity.

This approach has included:

- Providing relevant persons access to information using different mediums and platforms, including by telephone, email, website, electronic materials, in person and virtual meetings.
- Making information about proposed activities to be managed under this EP available on the Santos website at www.santos.com/offshoreconsultation. Hyperlinks to this website were included in consultation emails.
- Recognising WAFIC's published guidance that petroleum titleholders consult directly with those Western Australian fishery licence holders that have been historically active in Operational Areas, while providing a list

[22] *Santos NA Barossa Pty Ltd v Tipakalippa [2022] FCAFC 193 at paragraph [104]*

of all entitled fisheries that overlap the EMBA. This approach acknowledges previous feedback from WAFIC regarding consultation fatigue among Western Australia's estimated 1500 fishing boat licence holders.

+ Application of this activity-centric approach has been applied to consultation with respect to commercial and recreational fishing, given the significant geographic extent of some of commercial fisheries and the location of historical catch and effort by commercial and recreational fishers relative to the proposed petroleum activity. This approach considers:

+ Advice from a representative organisation, the Northern Prawn Fishery Industry, that it will pass along any information to its members where it is required and relevant.

+ Using a Tuna Australia fee-for-service arrangement to obtain activity specific reports on behalf of licence holders.

+ Using a WAFIC fee-for-service arrangement to circulate Santos' consultation information via email to licence holders and making information available to potentially affected commercial fishing licence holders in Western Australian managed fisheries on the WAFIC website at https://www.wafic.org.au/what-we-do/access-sustainability/oil-gas/consultationhubtrial/ for the duration of the consultation period.

+ Recognising previous feedback from Recfishwest that petroleum titleholders consult directly with those fishing clubs with regional proximity to Operational Areas, while providing information on activity EMBA's that may have broader implications for recreational fishers. This approach acknowledges DPIRD's estimated 620,000 recreational fishers in Western Australia.

All authorities, persons and organisations engaged during the preliminary consultation and consultation phases were provided a link to the NOPSEMA brochure: Consultation on offshore petroleum environment plans.

A schedule of consultation activities is included in Table 4-9 and a schedule of advertising is included in Table 4-7.

4.5.7.1 Consultation with First Nations people and groups

For this EP, Santos has provided consultation opportunities and supporting information to organisations and clan groups listed in Table 4-8, acknowledging the use of a highly conservative EMBA (as described in Section 3) for the purpose of assisting to identify potentially relevant persons.

This conservative approach has ensured a very broad capture of potential interested relevant persons and provided them an opportunity to provide input if they feel they may be impacted.

Consultation with Existing Representative Organisations

Consultation effort for existing representative organisations in the Northern Territory has focused on providing opportunities for land councils and Aboriginal Corporations during formal consultation to provide their input, principally the following groups given their representative roles within the EMBA:

+ Northern Land Council.

+ Tiwi Land Council.

+ Larrakia Nation Aboriginal Corporation.

+ Wickham Point Deed Liaison Committee.

Consultation effort for existing representative organisations in Western Australia has focused on providing opportunities for the Kimberley Land Council and RNTBCs and in the Kimberley region where the EMBA intersects their respective Native Title determined areas. Further details about these RNTBCs are included in Table 4-8.

These groups, and First nations consultative committees, were also engaged during further consultation to communicate a change in the earliest commencement date of proposed activities. Information was provided to these organisations as the most effective way to communicate the activity update, noting the inherently conservative nature of the EMBA and the low likelihood of a spill reaching Northern Territory coastal areas.

Consultation with Tiwi Islands Clans and Individuals

For this EP Santos implemented the following tailored and culturally considered consultation approach for Tiwi Islands people and individuals given the nature and scale of proposed activities and the low likelihood of being impacted by a worst-case credible spill given the conservative nature of the EMBA:

+ A total of eight individual clan consultation sessions were held for Tiwi people from December 2023 to February 2024.

+ Consultation activities were conducted face-to-face in the form of clan sessions held at two locations on Bathurst Island, and one location on Melville Island, collectively known hereon in as the Tiwi Islands.

- Scheduling of consultation sessions was undertaken in conjunction with Clan Trustees/Traditional Owners, the Tiwi Land Council, Tiwi Recourses and Tiwi Enterprises to ensure no clashes with community events, cultural ceremony or “Sorry Business”.
- Ensuring appropriate permissions from the Tiwi Land Council were obtained to allow Santos personnel to visit the Tiwi Islands.
- A Welcome/ Acknowledgement to Country was performed at each consultation session by the appropriate senior Clan Traditional Owner/Elder/Senior. This person also opened meetings in language, thanked people for their attendance and encouraged attendees to listen, ask questions and provide feedback.
- Consultation sessions were arranged for clans independent of one another and at a location convenient for that clan. Nevertheless, the attendance and representation at each designated clan session varied for a multitude of reasons. At times clans came together in one meeting in entirety and/or, there was diversified clan representation. Where clans came together in entirety, this was with the agreeance of the clans’ trustees. For the latter, this was managed between the individuals present.
- Consultation session attendance by qualified interpreters.

Hard copy consultation materials were produced made available at the consultation sessions to support informed discussion. Material included, but was not limited to, copies of the Activity Fact Sheet and the *NOPSEMA community information brochure: Consultation on offshore petroleum environment plans*.

At the end of each session, Santos SMEs were also available to speak with individuals who had additional questions, concerns or wished to discuss matters that may not have been raised during the open forum.

Consultation with Larrakia People

For this EP Santos implemented the following tailored and culturally considered consultation approach for Larrakia people and individuals given the nature and scale of proposed activities and the low likelihood of being impacted by a worst-case credible spill given the conservative nature of the EMBA:

Consultation opportunities for existing representative organisations with a dedicated Larrakia focus, these being Northern Land Council, Wickham Point Deed Liaison Committee and Larrakia Nation Aboriginal Corporation;

One face-to-face meeting with the Wickham Point Deed Liaison Committee on 28 November 2023.

Two face-to-face Larrakia People Consultation Sessions coordinated by Santos and held 19 December 2023.

Hard copy consultation materials were produced made available at the Larrakia People consultation sessions to support informed discussion. Material included, but was not limited to, copies of the Activity Fact Sheet and the NOPSEMA community information brochure: Consultation on offshore petroleum environment plans.

At the end of each session, Santos SMEs were also available to speak with individuals who had additional questions, concerns or wished to discuss matters that may not have been raised during the open forum.

Consultation with First Nations Consultative Committees

Santos notes that there are remote areas of coastal Northern Australia where formal mechanisms for consultation are few or non-existent.

To support consultation in these areas for this EP, Santos engaged a consultant to support the establishment of First Nations Consultative Committees (FNCCs) with the intention that these be self-nominating and self-governing, and independent of government or industry. The intended purpose of these committees is to provide a forum to allow for culturally appropriate consultation with First Nations peoples represented through FNCCs, and to serve as a means for those peoples to provide feedback to third parties on matters on which the FNCC is consulted.

The FNCC establishment process is led by cultural advisors, comprising a team of First Nations leaders with extensive knowledge and experience in relation to First Nations cultures of Northern Australia, and who possess deep cultural connections to First Nations peoples of the region. The FNCC establishment process commences with the identification by the cultural advisers of First Nations clans and associated persons who may have functions, interests or activities that may be affected by activities Santos proposes to carry out under an environment plan.

The cultural advisors then contact the identified First Nations persons to discuss the FNCC concept. Santos understands that this includes meetings with Elders and other First Nations leaders who speak for coastal and sea country that may be affected by project activities. Where an interest to participate in the FNCC process is expressed, the cultural advisers support the relevant clan group to establish their own FNCC and to self-determine its functions and operations, including in relation to committee membership, leadership and governance arrangements and desired level and method of consultation.

This process involves the cultural advisors sharing knowledge and experience in relation to their participation on established committees and supporting the identified clan members to determine their own rules and processes for

committee decision-making, membership and the nomination of chairs. Once determined, these matters are formally documented in charters adopted by the FNCCs. Santos has been provided with copies of charters of FNCCs consulted for this EP, which include details about the FNCCs' purposes, membership and procedures.

Once established, and subject to the wishes of FNCC members, the external cultural advisors may provide ongoing support to the FNCCs, including administrative and advisory services. Santos engaged a consultant to support FNCC establishment and operations. This consultant maintains regular contact with FNCCs and Clan groups to facilitate Santos' consultation with these groups.

The activities of these committees are complementary to the functions and responsibilities of representative organisations, such as Land Councils or other formal bodies, with the intention that they be in a position to represent First Nations peoples.

FNCC activities are understood to include disseminating consultation information to First Nations community members of relevance.

Santos acknowledges the establishment and operation of these committees in response to the growing need for a means for First Nations voices to be heard and considered. This need is particularly relevant along the NT coastline where formal consultative mechanisms are typically not in existence, in contrast with the WA coastline Prescribed Bodies Corporate (PBCs) which provide an avenue for consulting First Nations people who have been recognised by Australian law as holding rights and interests to traditional land and waters.

Santos has consulted FNCCs with representative functions across the EMBA for this Activity, providing a broad coverage of any potential sea country interests within the EMBA. Eleven FNCCs were consulted in the preparation of this EP given the expanded geographical coverage of the spill EMBA. Consultation sessions for FNCC members were notified via provision of a specific meeting invitation. Table 4-9 includes a chronology of consultation with FNCCs.

Consultation with other clans

In some instances, Santos consulted individual clan groups with NT coastal interests, where FNCCs or other representative bodies are not established. For this EP, Santos consulted members of the Agalda clan and the Wulna clan.

4.5.8 Provision of sufficient information

Santos provided relevant persons with sufficient information so they can make an informed assessment about the possible consequences of the Activity on their functions, interests or activities. Santos provided relevant persons with information regarding:

- The Activity proposed under this EP.
- The environment that may be affected by the Activity, including depictions of the modelled EMBA and explaining how the EMBA is determined.
- The potential environmental impacts and risks of the Activity and proposed control measures.
- The environmental approval process.
- The purpose of consultation, who may be a relevant person and how to self-nominate as a potential relevant person.
- The titleholder's obligations during consultation in the course of preparing an environment plan, including the obligation of the titleholder not to publish particular information if so requested by the relevant person.
- How to provide feedback.
- At a minimum, this information was available on the Santos website and also included in the factsheets which Santos sent to relevant persons by email or made available during consultation sessions.
- Relevant persons were provided access to information using different mediums and platforms, including by telephone, email, website (www.santos.com/offshoreconsultation), hard copy and electronic materials, and in person and virtual meetings.

For this EP, this included a commercial fisher fact sheet providing additional information of relevance to fishers, including proposed activities to support on water deconfliction, sound source volume, active source area, line orientation and sail line timing, as well as likely presence of commercial fisheries that are active in the operational area and those that are licenced to fish in the EMBA. The fisher fact sheet was provided to all relevant Commonwealth, Northern Territory and WA Government fishery authorities as well as representative organisations on behalf of licence holders that are active in the operational area and those that are licenced to fish in the EMBA.

Examples of the consultation materials used are included in Appendix E.

4.5.9 Reasonable period for consultation

Santos directly contacted relevant persons notifying them of the consultation process and consultation period. Emails were sent to relevant persons to invite feedback for the EP, confirming the date by which feedback was sought.

Santos' process involves the provision of reasonable timeframes for the self-identification or nomination of others as Relevant Persons, for Relevant Persons to consider consultation information, ask questions and give their input, for Santos' consideration and assessment of the merits of objections and claims.

Santos provided approximately 30 days for each consultation phase from the date of providing consultation information for review and response. In some cases, more time was provided. Santos generally considered input provided by relevant persons outside of the consultation periods also sought to accommodate reasonable requests for additional time.

4.5.10 Consultation opportunities

Santos offered multiple avenues and mediums for consultation, including:

- Provision of a toll free 1800 number
- Dedicated email address
- In-person or virtual meetings, as appropriate.

Attempts were made to follow up contact and a response if/where no response was received.

4.5.11 Ongoing consultation

Santos carries out ongoing consultation during the life of an EP, including after an EP has been accepted by NOPSEMA.

Santos' post EP acceptance consultation implementation strategy is described in Section 8.15 and Activity notifications are outlined in Table 8-4.

If, during the course of post acceptance consultation, Santos receives information demonstrating a new or increased environmental impact or risk that is not provided for in this EP, (as in force at the time) Santos will apply its Management of Change process outlined in Section 8.9.

4.6 Consultation report

A summary report including the outcomes of consultation with Relevant Persons, including any objections or claims and Santos' assessment of them, satisfying the requirements of section 24(b)(i)-(iii) of the OPGGS(E)R, is provided in Table 4-9. The full records of Relevant Persons consultation, as required by section 24(b)(iv) of the OPGGS(E)R, is provided in the Sensitive Information Report.

Table 4-9: Summary of consultation activities

Section 25(1)(a): Departments or agencies of the Commonwealth to which the activities to be carried out under the environment plan may be relevant			
Australian Communications and Media Authority (ACMA)			
• On 28 September 2023 Santos emailed ACMA to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2462] • On 3 November 2023 Santos emailed ACMA further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2577] • On 8 November 2023 ACMA emailed Santos advising it had reviewed consultation information and noted that activities may be in the vicinity of the North-West Cable System which is owned and operated by Vocus. It encouraged Santos to engage with the operator of any submarine cable in the vicinity of its activities if it has not already done so. It also noted there is continuing demand for additional submarine cables to be installed in offshore Northern Australia, meaning there is possibility for future cable installations to traverse the EMBA.. ACMA noted that it may be relevant for Santos to engage with the owners of two forthcoming submarine cable projects with proposed landings in Darwin: Hawaiki Nui cable by BW Digital; and Asia Connect Cable System by Inligo Networks. ACMA had no additional comments. [Con-2642] • On 21 November 2023 Santos emailed ACMA acknowledging feedback that the proposed activities may be in the vicinity of the North-West Cable system owned by Vocus. Santos confirmed it had contacted Vocus on these proposed activities. Santos also confirmed it had reached out to BW Digital and Inligo Networks as part of its consultation activities . Santos acknowledged ACMA has no objection or further comments regarding Santos' proposed activities and that a summary of ACMA's response would be included in the relevant Environment Plans for respective proposed activities. [Con-2723] • On 16 April 2025 Santos notified ACMA of an update to the proposed activity timeline, noting the earliest possible commencement was now anticipated in Q1 2026. Santos informed ACMA that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6157] • On 17 April 2025, ACMA advised that the EMBA was not located near any existing protection zones declared by the ACMA. It also noted that Santos was aware of Vocus' North-West Cable System, a submarine telecommunications cable situated within the EMBA. [Con-6158] • No further correspondence or feedback was received from ACMA.			
Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
ACMA provided feedback on contacting the operators of telecommunications cables with regional interests.	Santos notes ACMA's feedback in relation to the North-West Cable System. Santos notes ACMA's feedback in relation to proposed new cable projects.	Santos has consulted Vocus, BW Digital and Inligo Networks on proposed activities.	Section 3.9

	Santos notes ACMA had no comments on proposed activities.		
ACMA provided feedback during further consultation that the EMBA was not located near any existing declared protection zones and noted Santos' awareness of the presence of Vocus' North-West Cable System in the EMBA.	Santos notes feedback from AFMA.	Santos has consulted Vocus regarding its North-West Cable System, which is present in the EMBA.	Section 3.9

Australian Fisheries Management Authority (AFMA)

- On 6 October 2023 Santos emailed AFMA to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2518]
- On 19 October 2023 AFMA emailed Santos advising it had no comments on the proposed Bonaparte Basin activities. AFMA noted seismic activity was a particularly sensitive issue for the fishing industry. AFMA encouraged Santos to contact relevant fishing industry associations as follows [Con-2544]:
  - Northern Prawn Fishery Industry
  - Commonwealth Fisheries Association
  - Tuna Australia
  - WAFIC
- On 31 October 2023 Santos emailed AFMA acknowledging AFMA had no comments regarding the proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2600]
- On 16 April 2025 Santos notified AFMA of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed AFMA that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6212]
- On 29 April 2025 AFMA emailed Santos, thanking Santos for the update regarding timing of the proposed activities. AFMA recommended that Santos contact the representatives of the identified fisheries directly for their input. AFMA confirmed that it did not have any further comments on the amendment to the activity timing. AFMA also informed Santos for future correspondence and consultation requests are to be sent to OffshoreEnergy@afma.gov.au. [Con-6258]
- On 12 May 2025 Santos responded to AFMA outlining the consultation approach Santos has taken for this Environment Plan. Santos confirms that: [Con-6259]
  - There are four Commonwealth managed fisheries overlapping the Activity Operational Area, with only the Northern Prawn Fishery having proximate fishing effort in recent years, this being in the southern corner of the Operational Area.
  - Feedback received from commercial fishing representative organisations will be summarised in the EP.
  - It notes AFMA's request to update AFMA's contact details and that that AFMA does not have any further comments.
  - No further correspondence or feedback was received from AFMA.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
AFMA provided feedback to contact relevant fishing industry associations.	Santos notes AFMA's feedback. Associations identified by Santos for consultation in relation to Commonwealth managed fisheries are: Northern Prawn Fishery Industry; Commonwealth Fisheries Association; Tuna Australia; WAFIC.	Santos has consulted affected fishing entitlement holders via fishing industry associations as per AFMA guidance.	Not applicable.

Australian Hydrographic Office (AHO)

- On 28 September 2023 Santos emailed AHO to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2462]
- On 3 November 2023 Santos emailed AHO further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2577]
- On 3 November 2023 AHO emailed Santos advising the email had been received by the AHO. AHO advised that data supplied would be registered, assessed, prioritised and validated in preparation for updating Navigational Charting products. AHO advised the activities must adhere to International and Australian Charting Specifications and standards, noting that these standards may result in some data generalisation or filtering due to the scale of existing charts, proximity to other features, and the level of risk a reported feature presents to mariners. [Con-2619]
- On 16 April 2025 Santos notified AHO of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed AHO that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6159]
- On 16 April 2025, AHO emailed Santos to acknowledge receipt of the email and advised it will assess and prioritise the submitted data for potential inclusion in navigational charts, in accordance with international and Australian charting standards. [Con-6160]
- No further correspondence or feedback was received from AHO.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
AHO provided its standard response on activity notifications that is issued to an operator developing an EP.	Santos notes feedback from AHO.	As per advice from AMSA, Santos will notify the AHO no less than four weeks before operations commence where practicable. Santos will notify AHO on any changes to the intended operations.	AHO activity notifications are included in Table 8-4.

Australian Institute of Marine Science (AIMS)

- On 28 September 2023 Santos emailed AIMS to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2462]
- On 6 October 2023 AIMS emailed Santos advising that no AIMS operational activity would be impacted by the proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2516]

- On 31 October 2023 Santos emailed AIMS acknowledging AIMS feedback that proposed Bonaparte Basin activities would not impact AIMS' operational activities. [Con-2597].
- On 16 April 2025 Santos notified AIMS of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed AIMS that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6161]
- No further correspondence or feedback was received from AIMS.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
AIMS advised that no AIMS operational activity would be impacted by proposed activities	Santos notes feedback from AIMS.	No response required.	Not applicable.

Australian Maritime Safety Authority (AMSA) – Maritime Safety

- On 28 September 2023 Santos emailed AMSA – Maritime Safety to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2462]
- On 17 October 2023 AMSA – Maritime Safety emailed Santos requesting the AMSA Joint Rescue Coordination Centre (JRCC) to be notified for promulgation of radio-navigation warnings 24–48 hours before operations commence. AMSA requested that the AHO should also be contacted no less than four working weeks before operations commence for the promulgation of related notices to mariners. AMSA also requested Santos to evaluate and implement adequate anti-collision measures. [Con-2542]
- On 3 November 2023 Santos emailed AMSA – Maritime Safety to acknowledge AMSA's request of 17 October 2023 and confirm Santos' compliance with AMSA's requests, including anti-collision measures. [Con-2614]
- On 16 April 2025 Santos notified AMSA – Maritime Safety of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed AMSA – Maritime Safety that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6162]
- On 16 April 2025 AMSA – Maritime Safety responded with standard notification related to the standing arrangements with Santos regarding radio-navigation warning, and procedures to contact AHO for the promulgation of related notices to mariners. AMSA – Maritime Safety advised that vessels must display appropriate lights, shapes, and AIS status in line with COLREGs, especially when operations restrict manoeuvrability. AMSA – Maritime Safety advised that Santos should also assess and implement suitable anti-collision measures. [Con-6163]
- No further correspondence or feedback was received from AMSA.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
AMSA requested Santos to notify AMSA's Joint Rescue Coordination Centre (JRCC) for promulgation of radio-navigation warnings 24–48 hours before operations commence and provided AMSA JRCC's communications expectations.	Santos notes feedback from AMSA.	Santos will notify AMSA's Joint Rescue Coordination Centre (JRCC) through rccaus@amsa.gov.au for promulgation of radio-navigation warnings 24–48 hours before operations commence.	AMSA JRCC notifications are included in: Table 8-4.

AMSA requested Santos to contact the Australian Hydrographic Office no less than four working weeks before operations commence for related notices to mariners.	Santos notes feedback from AMSA.	Santos will contact the Australian Hydrographic Office through datacentre@hydro.gov.au no less than four working weeks before operations commence for the promulgation of related notices to mariners.	AHO notifications are included in: Table 8-4.
AMSA advised that vessels should exhibit appropriate lights and shapes to reflect the nature of operations, noting Santos' obligation to comply with the International Rules for Preventing Collisions at Sea (COLREGs), in particular, the use of appropriate lights and shapes. AMSA requested that vessels also ensure their navigation status was set correctly in the ship's AIS unit.	Santos notes feedback from AMSA.	Santos will ensure vessels exhibit appropriate lights and shapes to reflect the nature of operations – we are aware of the obligation to comply with the International Rules for Preventing Collisions at Sea (COLREGs), in particular, the use of appropriate lights and shapes to reflect the nature of operations (e.g. restricted in the ability to manoeuvre). Vessels will also ensure navigation status is set correctly in the ship's AIS unit.	Lighting and navigation controls are included in: • CM-1-EPS-2 • CM-2-EPS-1 • CM-28-EPS-1
AMSA advised that Santos should evaluate and implement adequate anti-collision measures, noting that collision risk mitigation measures may include: additional warnings and/or lights; offshore guard vessel/s.	Santos notes feedback from AMSA.	Santos will review and assess the merit of the proposed mitigation strategies and anti-collision measures as per our standard approach to all vessel activities.	Additional anti-collision measures are considered in: Section 6.2 – Control measures evaluation for interaction with other marine users.

Australian Maritime Safety Authority (AMSA) – Marine Pollution

- On 23 October 2023 Santos emailed AMSA – Marine Pollution to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2558]
- On 3 November 2023 Santos emailed AMSA – Marine Pollution further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2577]
- On 21 November 2023 Santos emailed AMSA – Marine Pollution further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2703]
- On 16 April 2025 Santos notified AMSA – Marine Pollution of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed AMSA – Marine Pollution that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6164]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from AMSA – Marine Pollution.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from AMSA – Marine Pollution	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met	No response required.	Not applicable.

Department of Agriculture, Fisheries and Forestry (DAFF) – Biosecurity

- On 28 September 2023 Santos emailed DAFF – Biosecurity to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2462]
- On 29 September 2023 DAFF – Biosecurity emailed Santos in response to its preliminary consultation email regarding proposed Bonaparte Basin activities. It requested several items to be reviewed, completed and responded to, to ensure an assessment can be completed. [Con-2442]
- On 29 September 2023 DAFF – Biosecurity advised it can support the vessel's visit into Australian territory, regarding the proposed Bonaparte Basin activities. It advised there are a number of regulatory obligations under the *Biosecurity Act 2015*. [Con-2443]
- On 21 November 2023 Santos emailed DAFF – Biosecurity in response to its email from 29 September 2023, advising Santos will review and comply with DAFF requirements, and relevant control measures will be included in the Environment Plan. Santos reminded DAFF – Biosecurity to please let Santos know by 27 November 2023 if DAFF – Biosecurity had any other feedback regarding the proposed activities. [Con-2713]
- On 16 April 2025 Santos notified DAFF – Biosecurity and trade of an update to the proposed activity timeline. The earliest possible commencement is now anticipated in Q1 2026. Santos informed DAFF – Biosecurity and trade that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6165]
- On 16 April 2025 Santos received an auto-generated email confirming receipt of notification and advising of a response within 10 business days. [Con-6166]
- No further correspondence or feedback was received from DAFF – Biosecurity.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
DAFF requested that Santos review the Offshore Installations webpage and attached Offshore Installations Biosecurity Guide.	Santos notes feedback provided by DAFF – Biosecurity.	Santos will review and comply with DAFF requirements, and relevant control measures will be included in the Environment Plan.	No changes made to the EP. The DAFF comment is regarding a different Bonaparte activity outside the scope of this EP.
DAFF request Santos to review Australian ballast water and biofouling requirements and pre-arrival reporting using the Maritime and Aircraft Reporting System (MARS).	Santos notes feedback provided by DAFF – Biosecurity.	Santos will review and comply with DAFF requirements, and relevant control measures will be included in the Environment Plan.	No changes made to the EP. The DAFF comment is regarding a different Bonaparte activity outside the scope of this EP.

DAFF advised that to have biosecurity risk status assessed, offshore installation projects must apply to DAFF at least two months prior to project commencement.	Santos notes feedback provided by DAFF – Biosecurity.	Santos will review and comply with DAFF requirements, and relevant control measures will be included in the Environment Plan.	No changes made to the EP. The DAFF comment is regarding a different Bonaparte activity outside the scope of this EP.
DAFF provided a web link to a questionnaire to support the assessment of biosecurity risk.	Santos notes feedback provided by DAFF – Biosecurity.	Santos will review and comply with DAFF requirements, and relevant control measures will be included in the Environment Plan.	DAFF Biosecurity notifications are included in Table 8-4.
DAFF advised that to further assess the assessment it required a Biosecurity Management Plan explaining how all the biosecurity risks will be managed.	Santos notes feedback provided by DAFF – Biosecurity.	Santos will review and comply with DAFF requirements, and relevant control measures will be included in the Environment Plan.	Compliance with the *Biosecurity Act 2015* and DAFF requirements are included in: Section 7.7 Introduction of Invasive Marine Species.

Department of Agriculture, Fisheries and Forestry (DAFF) – Fisheries

- On 28 September 2023 Santos emailed DAFF – Fisheries to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2462]
- On 06 October 2023 Santos emailed DAFF – Fisheries and AFMA to advise it of consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2518]
- On 22 December 2023 Santos emailed DAFF – Fisheries to follow up on any feedback regarding the proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-3011]
- On 3 January 2024 DAFF – Fisheries emailed Santos advising it has no further comments beyond those provided by AFMA regarding the proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-3013]
- On 16 April 2025 Santos notified DAFF – Fisheries of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed DAFF – Fisheries that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6214]
- On 16 April 2025 Santos received an automated email advising receipt of notification. [Con-6216]
- No further correspondence or feedback was received from DAFF – Fisheries.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
DAFF advised it had no further comments beyond those provided by AFMA.	Santos notes feedback provided by DAFF – Fisheries.	No response required.	Not applicable.

Department of Climate Change, Energy, the Environment and Water (DCCEEW) – Underwater Cultural Heritage

- On 26 October 2023 Santos emailed DCCEEW – Underwater Cultural Heritage to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2565]
- On 3 November 2023 Santos emailed DCCEEW – Underwater Cultural Heritage further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2577]
- On 21 November 2023 Santos emailed DCCEEW – Underwater Cultural Heritage further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2707]
- On 16 April 2025 Santos notified DCCEEW – Underwater Cultural Heritage of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed DCCEEW – Underwater Cultural Heritage that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6167]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from DCCEEW.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from DCCEEW.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Department of Defence (DoD)

- On 28 September 2023 Santos emailed DoD to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2462]
- On 29 September 2023 DoD emailed Santos acknowledging that DoD would like to be consulted on each of the proposed Bonaparte Basin activities advising email communication is preferred. [Con-2438]
- On 31 October 2023 Santos advised it looks forward to receiving feedback from DoD and if more information was needed to let Santos know. [Con-2592]
- On 7 December 2023 Santos emailed DoD to follow up on correspondence from 31 October 2023 seeking comments and feedback regarding the proposed Bonaparte Basin activities. [Con-2846]
- On 8 December 2023 DoD emailed Santos advising it would provide feedback by 15 December 2023 regarding the proposed Bonaparte Basin activities. [Con-2861]
- On 11 December 2023 DoD emailed Santos and advised it would not be able to provide feedback on the proposed Bonaparte Basin activities until COB 5 February 2024. [Con-2869]
- On 15 December 2023 Santos emailed DoD acknowledging DoD had advised it is unable to provide feedback to Santos by 5 February 2024. [Con-2886]
- On 15 December 2023 Santos emailed DoD further to the previous email on 15 December 2023, noting that in the absence of DoD advice prior to EP submission, Santos will defer to previous feedback provided by DoD for other proposed activities, noting DoD's expectations for pre-start and end of activities, as well as Operator responsibilities with respect to the location, identification, removal or damage to equipment from UXOs. Santos also advised it would confirm restricted air space status with DoD as part of its commencement of activity notification. Santos will contact DoD four weeks prior to the start of proposed activities, and upon activity completion. Santos also acknowledges DoD's previous advice in regard to location, identification, removal or damage to equipment from UXOs. [Con-2887]

- On 21 December 2023 DoD emailed Santos advising that Air Force had advised there may be conflicts with the proposed activities that may not be supported. DoD acknowledged its previously provided feedback. [Con-2969]
- On 31 January 2024 Santos emailed DoD by way of reminder that it committed to providing feedback by 5 February 2024 and provided an update on the planned EP submission date. [Con-3108]
- On 26 March 2024 Santos called DoD following up on Santos' email of 22 March 2024. [Con-3527]
- On 28 March 2024 DoD emailed Santos and advised it was following up on feedback for activities to be managed under this EP. [Con-3534]
- On 3 April 2024 Santos called and emailed DoD to seek clarification on information provided on 28 March 2024 (following up DoD email of 28 March 2024). [Con-3535]
- On 4 April 2024 DoD called and emailed Santos acknowledging Santos' telephone call and provided engagement opportunities to provide clarification. [Con-3558]
- On 4 April 2024 Santos responded by email and sent a meeting invitation for 5 April 2024. [Con-3559]
- On 5 April 2024 Santos met with DoD to clarify information provided to Santos on 28 March 2024 and emailed DoD to confirm discussions. [Con-3536]
- On 5 April 2024 DoD emailed Santos and confirmed responses from Navy, Estate Planning and Air Force would be collated in the week beginning 8 April 2024. [Con-3560]
- On 11 April 2024 DoD emailed Santos and advised that proposed activities would have minimal impact on DoD capability and requested Santos to contact the AHO prior to the commencement of activities. [Con-3601]
- On 16 April 2024 Santos emailed DoD and confirmed DoD's request for AHO activity notifications. [Con-3602]
- On 06 May 2025 Santos notified DoD of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed DoD that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6217]
- No further correspondence or feedback was received from DoD.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
DoD advised that proposed activities would have minimal impact on DoD capability. DoD requested Santos contact AHO prior to the start of activities.	Santos notes DoD's feedback and request.	Santos will contact DoD at least four weeks prior to the start of proposed activities, and upon activity completion.	DoD and AHO notifications are included in: Table 8-4.

Department of Foreign Affairs and Trade (DFAT)

- On 27 October 2023 Santos emailed DFAT to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2572]
- On 13 November 2023 Santos emailed DFAT further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities. [Con-2665]
- On 21 November 2023 Santos emailed DFAT further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2708].
- On 22 April 2025, Santos notified Department of Foreign Affairs and Trade (DFAT) of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. However, the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. Any feedback already provided will be included in the EP unless otherwise instructed. [Con-6168]

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
Santos notes advice previously provided by DFAT for other proposed activities, noting contact details provided should country-to-country engagement be required.	The likelihood of an unmitigated spill reaching the territorial lands and waters of other countries is low for this activity. Santos has established communications channels and protocols in the event of an emergency that would require country-to-country engagements. Santos also notes that response planning and prioritisation of areas for protection outside of Australian territorial waters would be undertaken by the respective country under its respective spill response arrangements.	Santos will include contact details previously provided by DFAT in its contacts directory in the event that country-to-country engagement is required for emergency response planning. Santos acknowledges the role that DFAT would play more broadly in country-to-country discussions in the event that a marine pollution incident had implications for other nation's interests.	Not applicable.

Department of Home Affairs and Australian Border Force (ABF)

- On 28 September 2023 Santos emailed ABF to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2462]
- On 3 November 2023 Santos emailed ABF further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2577]
- On 21 November 2023 Santos emailed ABF further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2707].
- On 16 April 2025 Santos notified ABF of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed ABF that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. Con-6171]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from ABF.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from ABF.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Department of Industry, Science and Resources (DISR)

- On 28 September 2023 Santos emailed DISR to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2462]
- On 3 November 2023 Santos emailed DISR further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2577]
- On 21 November 2023 Santos emailed DISR further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2707]
- On 16 April 2025 Santos notified DISR of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed DISR that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6173]"
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from DISR.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from DISR.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met	No response required.	Not applicable.

Director of National Parks (DNP)

- On 28 September 2023 Santos emailed DNP to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2462]
- On 3 November 2023 Santos emailed DNP further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2579]
- On 21 November 2023 Santos emailed DNP further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2707]
- On 16 April 2025, Santos notified DNP of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed DNP that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6174]
- On 3 June 2025 DNP emailed Santos and confirmed they have no comments on the updated proposed timing of the Eos 3D MSS. DNP also confirmed they should be made aware of oil/gas pollution incidences which occur within a marine park or are likely to impact on a marine park as soon as possible and preferable within 24 hours to the Marine Compliance Duty Officer. [Con-6365]
- On 30 June 2025 Santos emailed DNP to acknowledge they have no comments on the updated activity timing. Santos acknowledged the DNPs requirements concerning the notification of any oil or gas pollution incidents that occur within, or are likely to impact, a marine park. [Con-6367]

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
DNP advised that it had no comment on the proposed update to Activity timing, as well as its expectations for notification in the event of a spill that was likely to impact an Australian Marine Park.	Santos notes feedback provided by DNP.	No response required.	DNP notifications are included in Table 8-4.

National Indigenous Australians Agency (NIAA)

- On 28 September 2023 Santos emailed NIAA to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2462]
- On 3 November 2023 Santos emailed NIAA further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2577]
- On 21 November 2023 Santos emailed NIA further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2707]
- On 16 April 2025 Santos notified NIAA of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed NIAA that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6175]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from NIAA.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from NIAA.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Section 25(1)(b): Departments or agencies of Northern Territory to which the activities to be carried out under the environment plan may be relevant

Aboriginal Areas Protection Authority (AAPA)

- On 26 October 2023 Santos emailed AAPA to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2566]
- On 6 November 2023 Santos emailed AAPA further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2586]
- On 7 November 2023 AAPA emailed Santos advising it considers itself an Interested Person under the NOPSEMA guidelines on the basis that the development may affect the functions or responsibilities of our organisation. AAPA advised its role was to protect Aboriginal sacred sites through the issuing of Authority Certificates that state the activities that can occur

within or in the vicinity of a sacred site. AAPA noted that a spill from Santos' operations had the potential to damage sacred sites along the coastline where Santos' modelling predicts the environment may be affected (EMBA). AAPA advised it had recently has been in consultation with the Territory Emergency Management Council (TEMC) on how to manage a spill to the coastline in a culturally sensitive way to protect sacred sites. APPA advised that the AEP (formerly APPEA) Oil Spill Working Group met with TEMC where Authority Certificates and the certificate process were discussed. AAPA recommended that Santos contact AEP for an update and details of the meeting. AAPA advised it will be meeting with TEMC in future on how best to incorporate culturally sensitive practices into a hydrocarbon spill emergency response. [Con-2641]

- On 20 November 2023, Santos received meeting minutes from the AEP Oil Spill Working Group and TEMC meeting which took place on 20 June 2023. [Con-2734]
- On 21 November 2023 Santos emailed AAPA based on the meeting minutes between the AEP Oil Spill Working Group and TEMC, acknowledging that the NT Government has arrangements for obtaining Authority Certificates from the Aboriginal Areas Protection Authority, and that these Authority Certificates will be formalised in the NT Oil Spill Contingency Plan (OSCP) and response plans. [Con-2717]
- On 16 April 2025 Santos notified AAPA of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed AAPA that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6188]
- No further correspondence or feedback was received from AAPA.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
AAPA advised Santos to contact AEP and obtain the process agreed by TEMC (NT Government) to acquire the Authority Certificate to manage potentially impacted cultural sites in the event of a spill. AAPA advised that it will be meeting with TEMC (NT Government) to identify the best approach to incorporate culturally sensitive practices into the response strategies of the NT OSCP.	Santos notes feedback provided by AAPA.	Santos acknowledges that the NT Government will, through its NT OSCP and response plans, obtain the necessary Authority Certificates in the event of a spill that has potential to impact Aboriginal cultural heritage.	Not applicable.

Darwin Harbour Advisory Committee

- On 28 September 2023 Santos emailed Darwin Harbour Advisory Committee to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2509]
- On 3 November 2023 Santos emailed Darwin Harbour Advisory Committee further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2580]
- On 21 November 2023 Santos emailed Darwin Harbour Advisory Committee further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2714]
- On 16 April 2025 Santos notified Darwin Harbour Advisory Committee of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Darwin Harbour Advisory Committee that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6198]

- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Darwin Harbour Advisory Committee.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from Darwin Harbour Advisory Committee.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

NT Department of Lands, Planning and Environment (DLPE) (formerly Department of Parks and Water Security (DEPWS))

- On 28 September 2023 Santos emailed DLPE (then DEPWS) to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2509]
- On 23 October 2023 Santos emailed DLPE (then DEPWS) to advise it of consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2559]
- On 21 November 2023 Santos emailed DLPE (then DEPWS) further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2714]
- On 16 April 2025 Santos notified DEPWS of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed DEPWS that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6199]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from DEPWS.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from DEPWS.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

NT Environment Protection Authority (NT EPA)

- On 26 October 2023 Santos emailed NT Environment Protection Authority to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2566]
- On 6 November 2023 Santos emailed NT Environment Protection Authority further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2586]
- On 21 November 2023 Santos emailed NT Environment Protection Authority further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2714]

- On 16 April 2025 Santos notified NT Environment Protection Authority of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed NT Environment Protection Authority that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6200]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from EPA.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from EPA.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

NT Department of Industry, Tourism and Trade (DITT) – Fisheries – Aquatic Biosecurity Section

- On 26 October 2023 Santos emailed DITT – Fisheries – Aquatic Biosecurity Section to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2566]
- On 6 November 2023 Santos emailed DITT – Fisheries – Aquatic Biosecurity Section further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2586]
- On 21 November 2023 Santos emailed DITT – Fisheries – Aquatic Biosecurity Section further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2716]
- On 16 April 2025 Santos notified DITT – Fisheries – Aquatic Biosecurity Section of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed DITT – Fisheries – Aquatic Biosecurity Section that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6203]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from DITT – Fisheries – Aquatic Biosecurity Section.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from DITT – Fisheries – Aquatic Biosecurity Section.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

NT Department of Industry, Tourism and Trade (DITT) – Fisheries Division

- On 28 September 2023 Santos emailed DITT – Fisheries Division to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2509]

- On 3 November Santos emailed DITT – Fisheries Division further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2580]
- On 21 November 2023 Santos emailed DITT – Fisheries Division further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2716]
- On 23 November 2023 DITT – Fisheries Division emailed Santos advising it considers itself a relevant person in relation to these activities. DITT – Fisheries Division advised its main areas of interest for Santos' proposed activities would be acoustic disturbance, physical presence and interaction with other marine users, operational discharges, habitat disturbance and Invasive Marine Species. [Con-2792]
- On 29 November 2023 Santos emailed NT DITT – Fisheries Division seeking feedback specific to the proposed Bonaparte Basin activities. [Con-2789]
- On 29 November 2023 NT DITT – Fisheries Division advised it had no specific questions in relation to the activities. It would like to receive regular project updates via email. [Con-2794]
- On 29 November 2023 Santos emailed NT DITT – Fisheries Division confirming it had no objections or feedback to the proposed activities. Santos confirmed it would send activity updates via email. [Con-2795]
- On 16 April 2025 Santos notified NT DITT – Fisheries Division of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed NT DITT – Fisheries Division that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6215]
- On 16 April 2025 Santos received an automated email advising receipt of notification. [Con-6219]
- No further correspondence or feedback was received from NT DITT – Fisheries Division.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
DITT – Fisheries Division requested activity notifications.	Santos notes feedback from DITT – Fisheries Division.	Activity Notifications will be sent to DITT – Fisheries Division.	DITT notifications are included in Table 8-4

Department of Infrastructure, Planning and Logistics (DIPL) – Transport Division

- On 28 September 2023 Santos emailed DIPL – Transport Division to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2509]
- On 3 November 2023 Santos emailed DIPL – Transport Division further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2580]
- On 21 November 2023 Santos emailed DIPL – Transport Division further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2714]
- On 16 April 2025 Santos notified DIPL – Transport Division of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed DIPL – Transport Division that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6204]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from DIPL – Transport Division.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from DIPL – Transport Division.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.
Department of Territory Families, Housing and Communities (DTHFC) – Heritage Branch			
• On 28 September 2023 Santos emailed DTHFC to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2509] • On 13 October 2023 DTHFC emailed Santos and advised it would like to be consulted for the proposed Bonaparte Basin activities, including activities to be managed under this EP, as it administers the Commonwealth *Underwater Cultural Heritage Act 2018* and the NT *Heritage Act 2011*. [Con-2541] • On 31 October 2023 Santos emailed DTHFC acknowledging it would like to be consulted on the proposed Bonaparte Basin activities. Santos asked if DTHFC if it would like to meet and requested a suitable date and time. [Con-2599] • On 14 November 2023 DTHFC emailed Santos advising it had previously spoken to Santos about proposed Bonaparte Basin activities, asking if there had been any developments or changes since the last discussion. [Con-2669] • On 14 November 2023 Santos emailed DTHFC to clarify the proposed Bonaparte activities, including those proposed under this EP, were new and had not been provided to relevant persons for consultation. Santos asked if DTHFC wanted more information or to meet. [Con-2671] • On 27 November 2023 DTHFC emailed Santos requesting Santos provide activity information and advised it would be happy to meet online. [Con-2783] • On 29 November 2023 Santos emailed DTHFC with information about proposed activities and confirmed it could arrange a call should NTDTHFC want more information. [Con-2790] • On 29 November 2023 DTHFC emailed Santos and recommended a meeting date of 5 December 2023. [Con-2802] • On 5 December 2023 Santos met with DTHFC to discuss proposed activities. [Con-2829] • On 5 December 2023 Santos emailed DTHFC a copy of the presentation from the meeting. [Con-2830] • On 7 December 2023 Santos emailed DTHFC following up seeking feedback comments on proposed activities. [Con-2847] • On 8 December 2023 DTHFC emailed Santos with feedback for Eos 3D MSS (as per below). [Con-2862] • On 21 December 2023 Santos emailed NT Dept of Territory Families, Housing and Communities – Heritage Branch to answer a query regarding the proposed Eos 3D MSS. [Con-2973] • On 16 April 2025 Santos notified NT Department of Lands, Planning and Environment, (previously DTHFC – Heritage Branch) of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed NT Department of Lands, Planning and Environment, (previously DTHFC – Heritage Branch) that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6205] • On 7 May 2025, NT Department of Lands, Planning and Environment, (previously DTHFC – Heritage Branch), emailed Santos requesting Shapefiles for the proposed activities. The department also advised that a generic email asking for feedback is not an appropriate means of consultation with the Heritage Branch. [Con-6248] • On 12 May 2025 Santos emailed NT Department of Lands Planning and Environment – DLPE, (previously DTHFC – Heritage Branch) and supplied Shapefiles for both the Operational Area and the Active Source Area, corresponding to the Eos 3D proposed works as requested. [Con-6251]		

- On 20 May 2025 Santos emailed NT Department of Lands Planning and Environment – DLPE, (previously DTHFC – Heritage Branch) to check if the Shapefiles for both the Operational Area and the Active Source Area, corresponding to the Eos 3D proposed works had been received. Santos also asked that any feedback or requests for further information be made by 26 May 2025, as the EP was scheduled to be submitted to the regulator in the coming weeks. [Con-6263]
- No further correspondence or feedback was received from NT Department of Lands Planning and Environment – DLPE.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
DTHFC requested additional information on the conduct of seismic surveys, including confirmation seismic techniques would be non-invasive.	Santos notes this information request from DTHFC.	Santos advised that during the survey: • A seismic survey vessel will tow a seismic source array and a series of streamers within the Operational Area, as defined in Section 2.3 of the Eos EP. • The seismic source will emit pulses of low-frequency sound, which once reflected from the underlying rock layers beneath the seabed are recorded by the towed streamers. • The survey is estimated to take up to 50 days to complete including the deployment of in-sea equipment prior to the survey commencing and the recovery of in sea equipment prior to the vessel demobilising at the end of the survey.	Section 2 – Activity Description
DTHFC requested during further consultation Shapefiles for both the Operational Area and the Active Source Area.	Santos acknowledged the request from DTHFC. Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	Santos provided the Shapefiles of the Operational Area and the Active Source Area. Santos followed up by email with DTHFC to confirm receipt and requested feedback additional to that provided during consultation by DTHFC.	Not applicable.

Parks and Wildlife Commission of the Northern Territory

- On 28 September 2023 Santos emailed Parks and Wildlife Commission of the Northern Territory to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2509]
- On 3 November 2023 Santos emailed Parks and Wildlife Commission of the Northern Territory further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2580]
- On 21 November 2023 Santos emailed Parks and Wildlife Commission of the Northern Territory further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2714]
- On 16 April 2025 Santos notified Parks and Wildlife Commission of the Northern Territory of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Parks and Wildlife Commission of the Northern Territory that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6206]

- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Parks and Wildlife Commission of the Northern Territory.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from Parks and Wildlife Commission of the Northern Territory.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Tourism NT

- On 28 September 2023 Santos emailed Tourism NT to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2509]
- On 3 November 2023 Santos emailed Tourism NT further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2580]
- On 21 November 2023 Santos emailed Tourism NT further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2714]
- On 16 April 2025 Santos notified NT Departments of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed NT Departments that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6207]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Tourism NT.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from Tourism NT.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Section 25(1)(b): Departments or agencies of Western Australia to which the activities to be carried out under the environment plan may be relevant

Department of Biodiversity, Conservation and Attractions (DBCA)

- On 28 September 2023 Santos emailed DBCA to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2510]
- On 2 October 2023 DBCA emailed Santos advising it considers itself a relevant stakeholder for the Eos 3D MSS activities, advising it would like to be consulted. It advised all future notifications and correspondence to be sent to EMBAdmin@dbca.wa.gov.au. [Con-2460]

- On 31 October 2023 Santos emailed DBCA acknowledging it would like to be consulted for the proposed Eos 3D MSS activities and asked if DBCA would like to meet to discuss the proposed activities. [Con-2596]
- On 1 November 2023 DBCA emailed Santos advising DBCA considers the opportunity to comment on EPs (email notification with associated factsheets) sufficient consultation. [Con-2603]
- On 3 November 2023 Santos emailed DBCA seeking confirmation it had provided sufficient information for DBCA to provide feedback on proposed activities. [Con-2615]
- On 10 November 2023 DBCA emailed Santos with feedback regarding its proposed Eos 3D MSS activities (as per table below). [Con-2655]
- On 21 November 2023 Santos emailed DBCA addressing its feedback comments from 10 November 2023 (as per table below). [Con-2729]
- On 16 April 2025 Santos notified DBCA of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed DBCA that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6220]
- On 19 May 2025 DBCA emailed Santos noting that DBCA has already received responses from Santos in relation to its previous advice. DBCA informed Santos that it would like to reiterate its comments in this instance in relation to the marine parks, island national park and nature reserves, and biologically important areas which are located within the area of the environment that may be affected by the proposed activities (as identified through Santos' modelling).
- DBCA stated it would welcome any additional information in relation to its monitoring or oil spill response preparedness for information the proposed activities. DBCA also noted that Santos should be aware that any activities requiring access to reserves managed by DBCA under the CALM Act or requiring the taking / disturbance of threatened fauna listed under the BC Act in State waters may require additional approvals under this legislation, and recommended Santos to consult early with DBCA on these matters. [Con-6267]
- On 26 May 2025 Santos responded to DBCA, noting that in response to this consultation activity that DBCA would like to reiterate its comments provided in 2023 as part of initial consultation for the proposed activities. Santos acknowledged that the protected areas and species noted by DBCA are considered in the environmental impact assessment presented in the Eos MSS EP. Santos also informed DBCA that should any additional information become available in relation to its monitoring or oil spill response preparedness for these activities, Santos will provide it to DBCA for information. [Con-6268]

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
DBCA noted that baseline values of the EMBA should be understood and documented prior to any operations commencing that have the potential to lead to hydrocarbon releases.	Santos notes feedback provided by DBCA.	Santos acknowledges there are ecologically important areas located in the vicinity of the proposed operations, and within the wider EMBA. The values and sensitivities are documented in Section 3 (Existing Environment) of the EP which provides the state of environment to inform the risk and impacts of the proposed activities. In addition, the potential area that could be affected by an unplanned hydrocarbon release are risk and impact assessed in Sections 7.1 (Marine diesel oil (MDO) release from vessel collision (surface) and 7.2 (Minor hydrocarbon release) of the EP, with appropriate measures applied to reduce the potential risk and impacts to ALARP and acceptable levels.	Section 3 – Existing Environment Section 7.1 – Marine diesel oil (MDO) release from vessel collision (surface) Section 7.2 – Minor hydrocarbon release
DBCA recommended that Santos assess what baseline information was required commensurate with the level of risk associated with the proposed activities and identify suitable sources/methods to	Santos notes feedback provided by DBCA.	Santos acknowledges DBCA's comments in relation to baseline survey data. Our existing baseline data is reviewed every two years. In areas where limited baseline data is available, post spill pre-impact monitoring for the relevant receptors will be carried out in line with Santos' Operational and Scientific Monitoring Plan (OSMP). However, the ability to undertake this monitoring will depend on the arrival time for the oil to contact the sensitive	Section 5 – Environmental Risk and Impact Assessment Section 7.1 – Marine diesel oil (MDO) release from vessel collision (surface) Section 7.2 – Minor hydrocarbon release

attain that information such that Santos can ensure any impacts on ecological values and recovery of these values can be clearly identified, monitored and remediated.		receptors. The predicted arrival time for oil to contact key sensitive receptors is outlined in Sections 7.1 (Marine diesel oil (MDO) release from vessel collision (surface) and 7.2 (Minor hydrocarbon release) of the EP. Section 5 (Environmental Risk and Impact Assessment) of the EP outlines the process Santos follows to identify and manage the potential risk and impact of an activity to ALARP and Acceptable levels. Further, Sections 7.1 (Marine diesel oil (MDO) release from vessel collision (surface) and 7.2 (Minor hydrocarbon release) of the EP details the risk and impact assessment on High Environment Value areas and the OPEP identifies Priority Protection Areas for response arrangements in the event of an unplanned hydrocarbon release. Santos is confident that its risk and impact assessment process, baseline survey data review, and OSMP, addresses potential impacts on ecological values and recovery of these values.	
DBCA advised that published DBCA marine park monitoring may not be suitable to provide all baseline information required for oil spill risk assessment and management planning. DBCA encouraged Santos to acquire necessary information to implement a Before-After, Control-Impact (BACI) framework in planning and evaluating its management response.	Santos notes feedback provided by DBCA.	Santos acknowledges the monitoring reports available from the DBCA website. Santos notes DBCAs comments in relation to the BACI framework and advise the required responses to satisfy the BACI framework are contained within the Scientific Monitoring Plans attachment included in the OPEP.	OSMP (Operational and Scientific Monitoring Plan) – OPEP attachment
DBCA recommended that Santos refer to the Commonwealth Department of Climate Change, Energy, the Environment and Water's National Light Pollution Guidelines for Wildlife as a best-practice industry standard for managing potential impacts of light pollution on marine fauna.	Santos notes feedback provided by DBCA.	Santos assesses the potential risk and impacts of light emissions within Section 6.5 (Light emissions) and in this case the light assessment boundary of 20 km from the source has been used as the extent of light exposure in accordance with National Light Pollution Guidelines for Wildlife (DCCEEW 2023).	Section 6.5 (Light emissions)

DBCA provided contact details and communications expectations in the event of an actual or impending hydrocarbon release. DBCA also advised it would not implement an oiled wildlife management response on behalf of a petroleum operator except as part of a whole of government response mandated by regulatory decision makers, and any advice or assistance from DBCA would occur on a full cost recovery basis. DBCA recommended Santos commit to the monitoring and clean-up of any DBCA interests affected by an oil spill in consultation with DBCA.	Santos notes feedback provided by DBCA.	Santos confirms in the event of a hydrocarbon release, it will notify DBCA's Pilbara office as soon as practicable on telephone number 08 9182 2000. Santos will also work with the Department of Transport to ensure effective management, monitoring and clean-up of any DBCA interests if affected by an oil spill, in consultation with DBCA. Santos also acknowledges DBCA's advice that it will not implement an oiled wildlife management response on behalf of a petroleum operator except as part of a whole of government response mandated by regulatory decision makers led by DoT (state's Hazard Management Agency) and any advice or assistance from DBCA, at any scale, will occur on a full cost recovery basis. Santos' also commits to consult with DBCA as required on monitoring and clean-up activity in the event of an oil spill and this commitment will be reflected in the OPEP.	DBCA activity notifications are included in Table 8-4.
DBCA commented that Santos should refer to the Department of Transport's (DoT) web content regarding marine pollution and the Offshore Petroleum Industry Guidance Note of September 2018 titled *Marine Oil Pollution: Response and Consultation Arrangements*.	Santos notes feedback provided by DBCA.	Santos has referred to the DoT website regarding marine pollution and the Offshore Petroleum Industry Guidance Note of September 2018 titled *Marine Oil Pollution: Response and Consultation Arrangements*.	Section 4.3 advises that consideration was given to the Offshore Petroleum Industry Guidance Note – *Marine Oil Pollution: Response and Consultation Arrangements* during the consultation phase.
DBCA commented during further consultation that it would welcome any additional information in relation to Santos' monitoring or oil spill response preparedness.	Santos notes feedback provided by DBCA.	Santos advised it will provide to DBCA any additional information that becomes available in relation to its monitoring or oil spill response preparedness for proposed activities.	N/A
DBCA advised during further consultation that activities requiring access to reserves managed by DBCA under the CALM Act or requiring the	Santos notes feedback provided by DBCA.	Santos acknowledged that the protected areas and species noted by DBCA are considered in the environmental impact assessment presented in Section 6 and 7 the EP.	Section 6 and 7.

taking / disturbance of threatened fauna listed under the BC Act in State waters may require additional approvals under this legislation. DBCA recommended Santos to consult early with DBCA on these matters.			

Department of Jobs, Tourism, Science and Innovation (JTSI)

- On 28 September 2023 Santos emailed WA Department of Jobs, Tourism, Science and Innovation (JTSI) to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2511]
- On 3 November 2023 Santos emailed West Australian Departments/Agencies further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2582]
- On 21 November 2023 Santos emailed WA Departments further to previous correspondence to provide a reminder that feedback is being sought by 27 November 2023. [Con-2718]
- On 16 April 2025 Santos notified JTSI of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed JTSI Departments that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6221]
- On 23 April 2025, JTSI emailed Santos thanking Santos for the opportunity to provide feedback and also noting that the Department of Jobs, Tourism, Science and Innovation (JTSI) has no comment on Eos 3D Marine Seismic Survey Environment Plan. [Con-6254]
- On 21 May 2025, Santos emailed the JTSI thanking them for their response and acknowledges that JTSI has no comment on this Environment Plan. [Con-6260]
- No further correspondence or feedback was received from JTSI.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
Santos notes the feedback provided by JTSI that it had no requests for information about proposed activities.	This response does not raise an objection or claim about the activity to which this EP relates.	No response required.	Not applicable.

Department of Planning, Lands and Heritage (DPLH)

- On 28 September 2023 Santos emailed DPLH to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2510]
- On 3 November 2023 Santos emailed DPLH further to previous correspondence to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2581]
- On 21 November 2023 Santos emailed DPLH further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2735]
- On 16 April 2025 Santos notified DPLH of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed DPLH that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6222]

- On 16 April 2025, Santos received an automated email from DPLH confirming receipt of the notification and advising that they would make contact in due course. [Con-6223]
- No further correspondence or feedback was received from DPLH.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from DPLH.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Department of Primary Industries and Regional Development (DPIRD)

- On 28 September 2023 Santos emailed DPIRD to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2510]
- On 3 November 2023 Santos emailed DPIRD further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2581]
- On 21 November 2023 Santos emailed DPIRD further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2735]
- On 16 April 2025 Santos notified DPIRD of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed DPIRD that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6224]
- On 15 May 2025 DPIRD emailed Santos, informing Santos that DPIRD considers itself a relevant person in the proposed activities and requests an extension of the current consultation closing date. [Con-6255]
- On 16 May 2025 Santos emailed DPIRD extending the consultation closing date to the 26 May 2025. Santos has also offered to meet in the interim to discuss any matters DPIRD may have. [Con-6256]
- On 19 May 2025 the DPIRD emailed Santos to thank them for the extension, and advised DPIRD would be back int touch should any questions arise or further information be required. [Con-6368]
- On 26 May 2025 DPIRD emailed Santos and provided input on proposed activities in relation to fishing areas in the area, spill contingency plans, spawning and nursery grounds, biosecurity, matters of national environmental significance, and environmental impact assessment and research. [Con-6369]
- On 27 June 2025 Santos emailed DPIRD and provided responses to the matters as summarised in the table below. [Con-6370]
- No further correspondence or feedback was received from DPIRD.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
DPIRD provided advice on commercial fishing and aquaculture interests in or in proximity proposed activities, including the potential for	Santos notes advice provided by DPIRD on fishing interests that exist in, or are proximal to, the proposed survey area.	Santos advised it had in developing the Environment Plan considered Commonwealth, Northern Territory and Western Australian fisheries that spatially overlap the Operational Area and the EMBA.	Section 3.8.1 – commercial fishing. See Section 4.6 Consultation report for consultation with commercial fishery licence holders in the Northern Demersal Scalefish

customary fishing among local indigenous communities.		Of these fisheries, two WA managed fisheries had historic presence in the Operational Area based on DPIRD FishCube data where vessel interaction was possible, these being the Northern Demersal Scalefish Managed Fishery and the Mackerel Managed Fishery. Licence holders in the fisheries have been consulted in the development of this Environment Plan. Santos also advised that other WA managed fisheries identified by Santos were consistent with DPIRD advice, noting that these fisheries, including nearshore pearling and aquaculture leases, could only be affected in the unlikely event of a spill. The probability of a spill reaching these nearshore areas is extremely low and at very low thresholds. Santos also advised it had consulted First Nations organisations in Western Australia and the Northern Territory who may have interests in or proximal to the EMBA.	Managed Fishery and the Mackerel Managed Fishery. See Section 4.6 Consultation report for consultation with First Nations people and groups.
DPIRD provided contact details for peak fishing sector bodies and guidance on information that required by these bodies.	Santos notes advice provided by DPIRD on peak fishing bodies.	Santos advised that consultation of these organisations was assessed on a case-by-case basis considering activity impacts and risks. For this EP Santos has consulted: • Western Australian Fishing Industry Council • Recfishwest • Marine Tourism WA	See Section 4.6 Consultation report for consultation with commercial fishing representative groups.
DPIRD provided guidance on its expectations to be notified in the event of a spill, including provision of baseline marine data.	Santos notes DPIRD's request with regards to notifications with respect spills.	Santos has included DPIRD notification on spills in the EP.	Eni activity notifications are included in Table 8-4.
DPIRD requested Santos collect baseline marine data when developing the Oil Spill Contingency Plan.	Santos notes DPIRD's request with regards to collection of baseline marine data.	Santos confirmed baseline data was reviewed by Santos every two years. In areas where limited baseline data was available, Santos advised that post spill pre-impact monitoring for the relevant receptors would be carried out in line with Santos' Operational and Scientific Monitoring Plan (OSMP).	Section 16 of the Eos 3D MSS OPEP
DPIRD provided advice on key fish species that may be spawning within the area of the proposed activities and requested Santos to identify and mitigate risks to seabed	Santos notes advice provided by DPIRD on peak fishing bodies.	Santos confirmed that seabed disturbance and underwater noise impacts and risks would be identified and assessed as part of EP development, including proposed mitigation strategies and control measures to ensure any identified impacts and risks are as low as reasonably practicable.	Section 6.3 – noise emissions Planned seabed impacts – N/A

disturbance and underwater noise.			
DPIRD provided information to be forwarded to vessel operators to ensure best practice biofouling management to mitigate the risk if harbouring marine pests and disease.	Santos notes advice provided by DPIRD on marine pests and diseases.	Santos confirmed that the EP would include the identification and assessment of biosecurity risk, with mitigation strategies and control measures proposed to ensure any identified impacts and risks are as low as reasonably practicable.	Section 7.7 – invasive marine species
DPIRD requested that Matters of National Environmental Significance (MNES) under the *Environmental Protection and Biodiversity Conservation Act 1999* found in the area should be considered in the development of the Environment Plan.	Santos notes advice provided by DPIRD on MNES.	Santos confirmed that the EP would include the identification and assessment of potential impacts to MNES, with mitigation strategies and control measures proposed to ensure any identified impacts and risks are as low as reasonably practicable.	Section 3.7 – identification of MNES Section 6 and 7 – assessment of impacts and risks to MNES
DPIRD recommended additional research be undertaken to better understand consequences of the seismic surveys within the local environment where there are knowledge gaps about impacts on key fish species.	Santos notes advice provided by DPIRD on research to support knowledge gaps about impacts on key fish species.	Santos confirmed it would be open to further discussion on supporting an industry wide initiative to determine the impact of seismic surveys on commercial fish stocks.	N/A

Department of Transport (DoT) – Marine Pollution

- On 23 October 2023 Santos emailed DoT to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2557]
- On 30 October 2023 DoT emailed Santos advising if there is a risk of a spill impacting State waters from any of the proposed Bonaparte Basin activities, Santos is to ensure the DoT is consulted as outlined in the DoT Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements (July 2020). [Con-2573]
- On 13 November 2023 Santos emailed DoT advising it would send through required documentation for review in the coming days, relating to the proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2668]
- On 14 November 2023 Santos emailed DoT with the draft OPEP for the proposed Eos 3D MSS activities. [Con-2675]
- On 23 November 2023 DoT emailed Santos advising that they would be review the draft OPEP and revert if there are any queries. [Con-2775]
- On 7 December 2023 DoT emailed Santos thanking Santos for providing it with the Eos 3D Marine Seismic Survey Oil Pollution Emergency Plan (7710-650-EMP-0011-1), Rev C. Given the information that has been provided, detailing the low risk to State waters, a full review has not been deemed necessary at this time. DoT requested Santos send an accepted version of the OPEP once finalised, for its records. [Con-2854]

- On 16 April 2025 Santos notified DoT of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed DoT that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6225]
- On 16 April 2025, Santos received an automated email from Department of Transport (DoT) – Marine Pollution confirming receipt of the notification. [Con-6226]

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
DoT requested Santos send an accepted version of the OPEP once finalised, for its records. [Con-2854]	Santos notes the request from DoT provided by DoT.	Santos will provide DoT an accepted version of the OPEP once finalised.	Table 8-4

Department of Water and Environmental Regulation (DWER)

- On 28 September 2023 Santos emailed DWER to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation. [Con-2511]
- On 3 November 2023 Santos emailed DWER to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2582]
- On 21 November 2023 Santos emailed DWER further to previous correspondence to provide a reminder that feedback is being sought by 27 November 2023. [Con-2718]
- On 16 April 2025 Santos notified DWER of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed DWER that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6227]
- On 16 April 2025, Santos received an automated email from DWER confirming receipt of the notification, which has been logged with a ticket ID. [Con-6228]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from DWER.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from DWER.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Kimberley Development Commission (KDC)

- On 28 September 2023 Santos emailed KDC to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation. [Con-2511]
- On 3 November 2023 Santos emailed KDC to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2582]
- On 21 November 2023 Santos emailed KDC further to previous correspondence to provide a reminder that feedback is being sought by 27 November 2023. [Con-2718]

- On 16 April 2025 Santos notified KDC of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed KDC that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6229]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from KDC.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from KDC.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Kimberley Ports Authority (KPA)

- On 28 September 2023 Santos emailed KPA to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation. [Con-2511]
- On 3 November 2023 Santos emailed KPA to advise that it is now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2582]
- On 21 November 2023 Santos emailed KPA further to previous correspondence to provide a reminder that feedback is being sought by 27 November 2023. [Con-2718]
- On 16 April 2025 Santos notified KPA of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informd KPA that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6230]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from KPA.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from KPA.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Western Australian Museum (WAM)

- On 3 November 2023 Santos emailed WA Museum to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2582]
- On 21 November 2023Santos emailed WA Museum further to previous correspondence to provide a reminder that feedback is being sought by 27 November 2023. [Con-2718]
- On 23 November 2023 WA Museum emailed feedback to the proposed Eos 3D MSS activities (as outlined below). [Con-2776]

- On 18 December 2023 Santos emailed WA Museum with a response to its email from 23 November 2023. [Con-2915]
- On 16 April 2025 Santos notified WA Museum of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed WA Museum that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6231]

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
WA Museum advised that proponents should contact the Department of Climate Change, Energy, the Environment and Water with respect to matters concerning the Commonwealth *Underwater Cultural Heritage Act 2018*.	Santos notes feedback provided by WA Museum.	Santos has provided consultation information to the Department of Climate Change, Energy, the Environment and Water (underwater heritage branch) about proposed activities.	Section 4.6 Consultation report Table 4-9
WA Museum advised that proponents should refer to the Commonwealth Government's: • Underwater Cultural Heritage Guidance for Offshore Developments • Draft Guidelines for Working in the Near and Offshore Environment to Protect Underwater Cultural Heritage	Santos notes feedback provided by WA Museum.	Santos confirms it has considered the following documents in preparing this EP: • Underwater Cultural Heritage Guidance for Offshore Developments • Draft Guidelines for Working in the Near and Offshore Environment to Protect Underwater Cultural Heritage.	Appendix B (Legislative requirements relevant to the activity)
WA Museum stated that proponents planning actions, or developments, in Australian waters that may be subject to Commonwealth or State planning approval must: • Not undertake activities that will have, or are likely to have, direct or indirect adverse impact on protected underwater cultural heritage (UCH) without a permit.	Santos notes feedback provided by WA Museum.	Santos will comply with the *Underwater Cultural Heritage Act 2018*, and will not undertake activities that will have, or are likely to have, direct or indirect adverse impact on protected underwater cultural heritage (UCH) without an appropriate risk assessment and a permit. Santos will observe the requirements of protected zones and obtain a permit to enter or operate in a protected zone if it is required; and will also notify regulators of the discovery of any suspected UCH identified during the planning, development, operation, or decommissioning phases of a project within 21 days of the discovery.	Appendix B (Legislative requirements relevant to the activity) Table 8-4

• Observe the requirements of protected zones and obtain a permit to enter or operate in a protected zone if it is required; and • Notify regulators of the discovery of any suspected UCH identified during the planning, development, operation, or decommissioning phases of a project within 21 days of the discovery.			
WA Museum stated that proponents should consider engaging a suitably qualified and experienced maritime archaeologist to undertake a UCH Desktop Assessment to identify Aboriginal and non-Aboriginal UCH within the project area.	Santos notes feedback provided by WA Museum.	There are no known maritime heritage sites that intersect the operational areas for proposed activities. The existence of any unknown Aboriginal sites or artefacts of significance within the operational areas is considered highly unlikely. As stated previously, Santos will comply with the requirements of the *Underwater Cultural Heritage Act 2018*.	Section 3.8.7 – Cultural Features
WA Museum stated that proponents should consult with Traditional Owners where appropriate.	Santos notes feedback provided by WA Museum.	Santos has provided consultation information to Traditional Owners, where appropriate, for proposed activities.	Section 4.6 Consultation report Table 4-9
Section 25(1)(c): Department of the responsible Northern Territory Minister			
NT Department of Industry, Tourism and Trade (DITT) – Energy			
• On 28 September 2023 Santos emailed NT DITT – Energy to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation. [Con-3116] • On 3 November 2023 Santos emailed NT DITT – Energy to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2583] • On 21 November 2023 Santos emailed NT DITT – Energy further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2719] • On 16 April 2025 Santos notified NT DITT – Energy of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed NT DITT – Energy that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6209] • On 16 April 2025, Santos received an auto-generated email from NT DITT – Energy confirming receipt of correspondence. [Con-6211] • On 22 April 2025, Santos notified an alternative contact at NT DITT – Energy of an update to the proposed activity timeline. The earliest possible commencement is now anticipated in Q1 2026. However, the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to			

previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. Any feedback already provided will be included in the EP unless otherwise instructed. [Con-6213]

- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from NT DITT – Energy

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from NT DITT – Energy.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Section 25(1)(b): Department of the responsible Western Australian Minister

WA Department of Energy, Mines Industry Regulation and Safety (DEMIRS)

- On 28 September 2023 Santos emailed DEMIRS to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation. [Con- 2476]
- On 3 November 2023 emailed DEMIRS to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2584]
- On 21 November 2023 Santos emailed DEMIRS further to previous correspondence to provide a reminder that feedback is being sought by 27 November 2023. [Con-2720]
- On 16 April 2025 Santos notified DEMIRS of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed DEMIRS that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6232]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from DEMIRS.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from DEMIRS.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Section 25(1)(d): Persons or organisations whose functions, interests or activities may be affected by the activities to be carried out under the Environment Plan, or the revision of the Environment Plan

Academic and Research Organisations

Australian Marine Sciences Association (NT Branch) (AMSA)

- On 28 September 2023 Santos emailed AMSA (NT Branch) to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2423]
- On 3 November 2023 Santos emailed AMSA (NT Branch) further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2585]
- On 21 November 2023 Santos emailed AMSA (NT Branch) further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2721]
- On 16 April 2025 Santos notified AMSA (NT Branch) of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed AMSA (NT Branch) (AMSA) that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6170]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from AMSA (NT Branch).

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from AMSA (NT Branch).	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Charles Darwin University (CDU)

- On 28 September 2023 Santos emailed CDU to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con- 2423]
- On 3 November 2023 Santos emailed CDU further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2585]
- On 21 November 2023 Santos emailed CDU further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2721]
- On 16 April 2025 Santos notified CDU of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed CDU that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6172]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from CDU.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from CDU.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Commonwealth Scientific and Industrial Research Organisation (CSIRO)

- On 28 September 2023 Santos emailed CSIRO to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con- 2423]
- On 3 November 2023 Santos emailed CSIRO further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2585]
- On 21 November 2023 Santos emailed CSIRO further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2721]
- On 16 April 2025 Santos notified CSIRO of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed CSIRO that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6176]
- On 16 April 2025 Santos received an auto-generated email confirming receipt of notification and advising of a response within 1–5 business days. [Con-6177]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from CSIRO.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from CSIRO.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Geoscience Australia (GA)

- On 28 September 2023 Santos emailed GA to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con- 2423]
- On 3 November 2023 Santos emailed GA further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2585]
- On 16 April 2025 Santos notified GA of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed GA that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6178]

- On 16 April 2025 Santos received an auto-generated email confirming receipt of notification and advising of a response within 5–10 business days. [Con-6179]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from GA.
-

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from GA.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

University of Tasmania – Marine Biodiversity Hub (UTAS)

- On 28 September 2023 Santos emailed UTAS to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con- 2423]
- On 3 November 2023 Santos emailed UTAS further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2585]
- On 21 November 2023 Santos emailed UTAS further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2721]
- On 16 April 2025 Santos notified UTAS of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed UTAS that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6181]"
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from UTAS.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from UTAS.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

University of Western Australia (UWA)

- On 28 September 2023 Santos emailed UWA to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con- 2423]
- On 3 November 2023 Santos emailed UWA further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2585]

- On 21 November 2023 Santos emailed UWA further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2721]
- On 16 April 2025 Santos notified UWA of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed UWA that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6182]
- On 16 April 2025 Santos received an automated email indicating that the recipient was away on training and unavailable to respond. [Con-6183]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from UWA.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from UWA.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Western Australian Marine Science Institution (WAMSI)

- On 28 September 2023 Santos emailed WAMSI to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2423]
- On 3 November 2023 Santos emailed WAMSI further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2585]
- On 21 November 2023 Santos emailed WAMSI further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2721]
- On 16 April 2025 Santos notified WAMSI of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed WAMSI that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6184]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from WAMSI.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from WAMSI.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Commercial fishing – Commonwealth managed
North West Slope Trawl Fishery
• Santos has consulted the North West Slope Trawl Fishery via representative organisations listed on the AFMA website for this fishery. Consultation information was provided to **Commonwealth Fisheries Association (CFA)** and **Western Australia Fishing Industry Council (WAFIC).** • See consultation entry for ***Industry Associations – Commercial Fishing***
Northern Prawn Fishery
• Santos has consulted the Northern Prawn Fishery via representative organisations listed on the **AFMA** website for this fishery. Consultation information was provided to **Northern Prawn Fishery Industry Pty Ltd.** • See consultation entry for ***Industry Associations – Commercial Fishing***
Southern Bluefin Tuna Fishery
• Santos has consulted the Southern Bluefin Tuna Fishery via representative organisations listed on the AFMA website for this fishery. Consultation information was provided to **Australian Southern Bluefin Tuna Industry Association (ASBTIA)** and **Commonwealth Fisheries Association (CFA)**. • See consultation entry for ***Industry Associations – Commercial Fishing***
Western Skipjack Tuna Fishery
• Santos has consulted the Western Skipjack Tuna Fishery via representative organisations listed on the AFMA website for this fishery. Consultation information was provided **to Australian Southern Bluefin Tuna Industry Association (ASBTIA)** and **Commonwealth Fisheries Association (CFA)**. • See consultation entry for ***Industry Associations – Commercial Fishing***
Western Tuna and Billfish Fishery
• Santos has consulted the Western Tuna and Billfish Fishery via representative organisations listed on the AFMA website for this fishery. Consultation information was provided to **Tuna Australia** and **Commonwealth Fisheries Association (CFA)**. • See consultation entry for ***Industry Associations – Commercial Fishing***
Commercial Fishing – Northern Territory managed
Aquarium Fishery, Bait Net Fishery, Barramundi Fishery, Coastal Line Fishery, Coastal Net Fishery, Demersal Fishery, Development (Small Pelagic), Mud Crab Fishery, Offshore Net and Line Fishery, Pearl Oyster Fishery, Spanish Mackerel Fishery, Timor Reef Fishery and Trepang Fishery
• On 26 October 2023 Santos sent letters to NT fishers to advise them of the consultation regarding proposed Bonaparte Basin activities. [Con-2891] • On November 13, 2023, Santos notified the NT Departments responsible for commercial fishing activities via email, informing them of ongoing consultations regarding the proposed activities in the Bonaparte Basin. [Con-2661]

- On 21 November 2023 Santos emailed NT Departments (relating to commercial fishing activity) further to previous correspondence to provide a reminder that feedback is being sought by 27 November. [Con-2716]
- On 20 December 2023 Santos sent letters to NT fishers to advise them that consultation had closed for the proposed Bonaparte Basin activities, and any feedback was required as soon as possible. [Con-2943]
- On 16 April 2025 Santos notified NT fishers of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed NT fishers that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6218]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from NT fishers.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from NT fishers.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Commercial Fishing – Western Australia managed

Mackerel Managed Fishery and Northern Demersal Scalefish Managed Fishery consulted via the representative organisation Western Australian Fishing Industry Council (WAFIC)

- Santos has consulted the Mackerel Managed Fishery and Northern Demersal Scalefish Managed Fishery via the representative organisation **Western Australian Fishing Industry Council (WAFIC)**.
- •See consultation entry for ***Industry Associations – Commercial Fishing.***

Energy industry – Petroleum titleholders and GHG permit holders

Arafura Oil

- On 28 September 2023 Santos emailed Arafura Oil to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2477]
- On 5 November 2023 Santos emailed Arafura Oil further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2587]
- On 21 November 2023 Santos emailed Arafura Oil further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2724]
- On 16 April 2025 Santos notified Arafura Oil of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Arafura Oil that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6233]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Arafura Oil.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from Arafura Oil.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Carnarvon Energy

- On 28 September 2023 Santos emailed Carnarvon Energy to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2483]
- On 2 October 2023 Carnarvon Energy emailed Santos advising it has no further requests for any information regarding the proposed Bonaparte Basin activities. [Con-2449]
- On 31 October 2023 Santos emailed Carnarvon Energy acknowledging their email of 2 October 2023 regarding the proposed Bonaparte Basin activities. [Con-2595]
- On 16 April 2025 Santos notified Carnarvon Energy of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Carnarvon Energy that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6234]
- No further correspondence or feedback was received from Carnarvon Energy.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
Santos notes the feedback provided by Carnarvon Energy that it had no requests for information about proposed activities.	This response does not raise an objection or claim about the activity to which this EP relates.	No response required.	Not applicable.

Eni Australia

- On 28 September 2023 Santos emailed Eni Australia to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2479]
- On 5 November 2023 Santos emailed Eni Australia further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2590]
- On 21 November 2023 Santos emailed Eni Australia further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2725]
- On 21 November 2023 ENI emailed Santos acknowledging information sent. ENI advised that at this stage they have no concerns with the activities associated with this activity. ENI has asked to be kept informed as and when required. [Con-2731]
- On 21 November 2023 Santos emailed ENI acknowledging ENI has no objection or comments regarding our proposed activities. Santos also informs ENI that a summary of this response will be included in the relevant EP for proposed activities. [Con-2732]

- On 4 April 2024 Santos emailed Eni Australia advising that the proposed Eos 3D marine seismic survey covered portions of Eni Australia's titles. Santos also advised it would be conducting Significant Risk of Significant Adverse Impact workshops in the upcoming months to address any major concerns Eni Australia may have with proposed activities. A location map was provided and input from Eni Australia was sought by 18 April 2024 prior to EP submission. [Con-3481]
- On 30 July 2024 Santos conducted a Significant Risk of Adverse Impact workshop with Eni for the proposed activity. The meeting minutes indicate no subsurface risks were identified in relation to the Eos 3D MSS. The potential for SIMOPs was also discussed during the session. [Con-5929]
- On 16 April 2025 Santos notified Eni Australia Ltd of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Eni Australia Ltd that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6235]
- No further correspondence or feedback was received from Eni Australia.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
Santos notes the feedback provided by Eni Australia that it had no concerns with the activities associated with this activity. Santos notes Eni Australia would like to stay informed as required.	Santos acknowledges that further engagement with Eni is required for the purposes of obtaining Ingress Authority (as anticipated by email of 4 April 2024).	Activity notifications will be sent to Eni.	Eni activity notifications are included in Table 8-4.

EOG Resources Australia

- On 28/09/23 Santos emailed EOG Resources Australia to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2482]
- On 5 November 2023 Santos emailed EOG Resources Australia further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2589]
- On 21 November 2023 Santos emailed EOG Resources Australia further to previous correspondence to provide a reminder that feedback is being sought by 27 November 2023. [Con-2727]
- On 16 April 2025 Santos notified EOG Resources Australia of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed EOG Resources Australia that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6236]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from EOG Resources Australia.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from EOG Australia.	Santos considers it has provided sufficient information and a reasonable period of time for consultation.	No response required.	Not applicable.

	Santos considers Section 25 consultation requirements to have been met.		

INPEX

- On 28 September 2023 Santos emailed INPEX to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2477]
- On 5 November 2023 Santos emailed INPEX further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2587]
- On 21 November 2023 Santos emailed INPEX further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2724]
- On 4 April 2024 Santos emailed INPEX advising that the proposed Eos 3D marine seismic survey covered portions of INPEX's titles. Santos also advised it would be conducting Significant Risk of Significant Adverse Impact workshops in the upcoming months to address any major concerns INPEX may have with proposed activities. A location map was provided and input from INPEX was sought by 18 April 2024 prior to EP submission. [Con-3843]
- On 30 July 2024 Santos conducted a Significant Risk of Adverse Impact workshop with INPEX. [Con-5930]
- On 30 July 2024 Santos conducted a Significant Risk of Adverse Impact workshop with INPEX for the proposed activity. The meeting minutes indicate no subsurface risks were identified in relation to the Eos 3D MSS. The potential for SIMOPs was also discussed during the session. [Con-5930]
- On 16 April 2025 Santos notified INPEX of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed INPEX that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6237]
- On 16 April 2025, Santos received an auto-generated email response advising receipt of notification. [Con-6238]
- No further correspondence or feedback was received from INPEX.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from INPEX in relation to Relevant Person consultation. Note: the Risk of Significant Adverse Impact workshops held in July 2024 were not part of Relevant Person consultation process.	This response does not raise an objection or claim about the activity to which this EP relates. As such, Santos considers the Section 25 consultation requirements to have been met. Santos acknowledges that further engagement with INPEX is required for the purposes of obtaining Ingress Authority (as anticipated by email of 4 April 2024).	No response required.	Not applicable.

IPB WA

- On 28 September 2023 Santos emailed IPB WA to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2482]

- On 5 November 2023 Santos emailed IPB WA further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2589]
- On 6 November 2023 IPB WA emailed Santos advising it had no concerns in relation to the proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2630]
- On 6 November 2023 Santos emailed IPB WA confirming it had no objection or feedback regarding the proposed Bonaparte Basin activities. [Con-2632]
- On 16 April 2025 Santos notified IPB WA of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed IPB WA that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6239]
- No further correspondence or feedback was received from IPB WA.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
Santos notes the feedback provided by IBP WA that it had no concerns about proposed activities.	This response does not raise an objection or claim about the activity to which this EP relates.	No response required.	Not applicable.

Melbana Energy (previously MEO International)

- On 28 September 2023 Santos emailed Melbana Energy to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2482]
- On 4 October 2023 Melbana Energy emailed Santos regarding proposed Bonaparte Basin activities. It advised it has no objections to these activities. It advised it would like to stay informed on activities in the region. [Con-2466]
- On 16 April 2025 Santos notified Melbana Energy of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Melbana Energy that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6240]
- No further correspondence or feedback was received from Melbana Energy.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
Santos notes the feedback provided by Melbana Energy that it had no objections to these activities. Santos notes Melbana would like to stay informed on regional activities.	This response does not raise an objection or claim about the activity to which this EP relates.	Activity notifications will be sent to Melbana.	Melbana activity notifications are included in Table 8-4.

Neptune Energy

- On 28 September 2023 Santos emailed Neptune Energy to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2477]
- On 5 November 2023 Santos emailed Neptune Energy further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2587]
- On 21 November 2023 Santos emailed Neptune Energy further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2724]
- On 4 April 2024 Santos emailed Neptune Energy advising that the proposed Eos 3D marine seismic survey covered portions of Neptune Energy's titles. Santos also advised it would be conducting Significant Risk of Significant Adverse Impact workshops in the upcoming months to address any major concerns Neptune Energy may have with proposed activities. A location map was provided and input from Neptune Energy was sought by 18 April 2024 prior to EP submission. [Con-3842]
- On 16 April 2025 Santos notified Neptune Energy of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Neptune Energy that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6241]
- On 20 April 2025, Santos received an auto-generated email advising of a delivery failure notification. [Con-6242]
- On 22 April 2025, Santos notified Neptune Energy of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. However, the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027.
- In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. Any feedback already provided will be included in the EP unless otherwise instructed. [Con-6243]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Neptune Energy.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Neptune Energy.	The consultation process for this EP has been running for more than six months, since Santos first provided Neptune Energy with information about the Activities, including the Activity location, on 28 September 2023. Santos has provided Neptune Energy with sufficient time and opportunity for Neptune Energy to ask questions and provide its input on the development of the EP. As such, Santos considers the Section 25 consultation requirements to have been met.	No response required.	Not applicable.

NT Gas Australia

- On 28 September 2023 Santos emailed NT Gas Australia to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2477]

- On 5 November 2023 Santos emailed NT Gas Australia further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2587]
- On 21 November 2023 Santos emailed NT Gas Australia further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2724]
- On 22 November 2023 NT Gas Australia emailed Santos and advised it had no issues or concerns with the proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2750]
- On 23 November 2023 Santos emailed NT Gas Australia acknowledging NT Gas Australia had no comments or objections to the proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2757]
- On 16 April 2025 Santos notified NT Gas Australia of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed NT Gas Australia that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6244]
- No further correspondence or feedback was received from NT Gas Australia.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
Santos notes the feedback provided by NT Gas Australia that it had no concerns about proposed activities.	This response does not raise an objection or claim about the activity to which this EP relates.	No response required.	Not applicable.

Shell Australia

- On 28 September 2023 Santos emailed Shell Australia to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2482]
- On 5 November 2023 Santos emailed Shell Australia further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2589]
- On 21 November 2023 Santos emailed Shell Australia further to previous correspondence to provide a reminder that feedback is being sought by 27 November. [Con-2727]
- On 16 April 2025 Santos notified Shell of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Shell that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6245]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Shell Australia.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Shell Australia.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Vulcan Exploration

- On 28 September 2023 Santos emailed Vulcan Exploration to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation. [Con-2483]
- On 5 November 2023 Santos emailed Vulcan Exploration further to previous correspondence, to advise that it is now consulting regarding proposed Bonaparte Basin activities. [Con-2607]
- On 21 November 2023 Santos emailed Vulcan Exploration further to previous correspondence to provide a reminder that feedback is being sought by 27 November 2023. [Con-2730]
- On 16 April 2025 Santos notified Vulcan Exploration of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Vulcan Exploration that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6246]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Vulcan Exploration.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Vulcan Exploration.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Woodside Energy

- On 28 September 2023 Santos emailed Woodside Energy to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2477]
- On 5 November 2023 Santos emailed Woodside Energy further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2587]
- On 21 November 2023 Santos emailed Woodside Energy further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2724]
- On 16 April 2025 Santos notified Woodside Energy of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Woodside Energy that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6247]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Woodside Energy.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Woodside Energy.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Environmental conservation organisations

Australian Conservation Foundation (ACF)

- On 28 September 2023 Santos emailed ACF to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2485]
- On 5 November 2023 Santos emailed ACF further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2609]
- On 21 November 2023 Santos emailed ACF further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2736]
- On 16 April 2025 Santos notified ACF of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed ACF that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6097]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from ACF.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from ACF.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Australian Marine Conservation Society – NT (AMCS)

- On 28 September 2023 Santos emailed AMCS to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2485]
- On 5 November 2023 Santos emailed AMCS further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2609]
- On 21 November 2023 Santos emailed AMCS further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2736]
- On 16 April 2025 Santos notified AMCS of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed AMCS that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6098]
- On 16 April 2025, Santos received an auto-generated email from AMCS noting the contact was on leave through to 25 April 2025 and will respond upon returning. [Con-6100]
- No further correspondence or feedback was received from AMCS.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from AMCS.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Conservation Council of WA (CCWA)

- On 28 September 2023 Santos emailed CCWA to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2486]
- On 5 November 2023 Santos emailed CCWA further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2617]
- On 22 November 2023 Santos emailed CCWA further to previous correspondence to provide a reminder that feedback is being sought by 27 November 2023. [Con-2737]
- On 16 April 2025 Santos notified CCWA of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed CCWA that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6102]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from CCWA.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from CCWA.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Environment Centre Northern Territory (ECNT)

- On 28 September 2023 Santos emailed ECNT to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2485]
- On 14 November 2023 Santos met with ECNT to provide an overview of Santos' proposed Bonaparte Basin activities, including the activities to be managed under this EP. [Con-2702]
- On 15 November 2023 ECNT emailed Santos following up the meeting from 14 November 2023 requesting more information about anticipated noise sources, as well as information on how appropriate disturbance and injury thresholds have been determined for proposed Bonaparte Basin activities. [Con-2676]
- On 23 November 2023 Santos emailed ECNT and cited a number of public information sources and disturbance and injury thresholds. [Con-2779]
- On 2 December 2023 ECNT emailed Santos and requested additional information about noise profiling. [Con-2832]

- On 21 December 2023 Santos emailed ECNT with answers to their queries on the proposed Eos 3D MSS. [Con-2972]
- On 16 April 2025 Santos notified ECNT of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed ECNT that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6105]
- No further correspondence or feedback was received from ECNT.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
ECNT requested a complete profile of anticipated noise sources for the Eos 3D Marine Seismic Survey EP, as well as information on how appropriate disturbance and injury thresholds have been determined for each activity.	Santos notes ECNT's request.	Santos confirmed noise modelling had been completed for the Eos 3D MSS EP.	Section 6.3 – Noise Emissions Appendix G- Eos 3D MSS acoustic modelling
ECNT acknowledged receipt of references used by Santos to determine injury thresholds. ECNT reiterated its request for information regarding the complete noise profile of activities related to the Eos Marine Seismic Survey and requested detail of impact and injury thresholds for species in the activity area.	Santos notes ECNT's feedback.	The Eos 3D seismic survey EP will be submitted to NOPSEMA and will be issued for a public comment period. The EP will include a risk assessment (Section 6), which will include a detailed noise assessment.	Section 6.3 – Noise Emissions

Environs Kimberley

- On 28 September 2023 Santos emailed Environs Kimberley to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2486]
- On 5 November 2023 Santos emailed Environs Kimberley further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2617]
- On 22 November 2023 Santos emailed Environs Kimberley further to previous correspondence to provide a reminder that feedback is being sought by 27 November 2023. [Con-2738]
- On 16 April 2025 Santos notified Environs Kimberley of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Environs Kimberley that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6106]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Environs Kimberley.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from Environs Kimberley.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Greenpeace Australia Pacific (GAP)

- On 28 September 2023 Santos emailed GAP to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2485]
- On 5 November 2023 Santos emailed GAP further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2609]
- On 21 November 2023 Santos emailed GAP further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2736]
- On 16 April 2025 Santos notified GAP of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed GAP that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6107]
- On 16 April 2025, Santos received an auto-generated email from Greenpeace noting the contact was on leave until 24 April 2025, and apologising for any delayed response. [Con-6108]
- No further correspondence or feedback was received from GAP.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from GAP.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

International Fund for Animal Welfare (IFAW)

- On 28 September 2023 Santos emailed IFAW to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2485]
- On 5 November 2023 Santos emailed IFAW further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2609]
- On 21 November 2023 Santos emailed IFAW further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2736]

- On 16 April 2025 Santos notified IFAW of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed IFAW that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6109]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from IFAW.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from IFAW.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Keep Top End Coasts Healthy

- On 28 September 2023 Santos emailed Keep Top End Coasts Healthy to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2485]
- On 5 November 2023 Santos emailed Keep Top End Coasts Healthy further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2609]
- On 21 November 2023 Santos emailed Keep Top End Coasts Healthy further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2736]
- On 16 April 2025 Santos notified Keep Top End Coasts Healthy of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Keep Top End Coasts Healthy that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6110]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Keep Top End Coasts Healthy.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Keep Top End Coasts Healthy.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Save the Kimberley

- On 28 September 2023 Santos emailed Save the Kimberley to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2485]

- On 5 November 2023 Santos emailed Save the Kimberley further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2609]
- On 21 November 2023 Santos emailed Save the Kimberley further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2736]
- On 16 April 2025 Santos notified Save the Kimberley of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Save the Kimberley that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6111]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Save the Kimberley.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Save the Kimberley.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Sea Turtle Foundation

- On 28 September 2023 Santos emailed Sea Turtle Foundation to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2485]
- On 5 November 2023 Santos emailed Sea Turtle Foundation further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2609]
- On 21 November 2023 Santos emailed Sea Turtle Foundation further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2736]
- On 16 April 2025 Santos notified Sea Turtle Foundation of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Sea Turtle Foundation that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6112]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Sea Turtle Foundation.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Sea Turtle Foundation.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

The Wilderness Society

- On 28 September 2023 Santos emailed The Wilderness Society to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2485]
- On 11 December 2023 Santos met with the Wilderness Society to provide information about proposed Bonaparte Basin activities, further to information previously provided. The Wilderness Society asked Santos at the meeting whether it had considered mound springs as part of Environment Plan development. [Con-2884]
- On 21 December 2023 Santos emailed the Wilderness Society in response to its question on mound springs. [Con-2974]
- On 16 April 2025 Santos notified Environmental Conservation Organisations of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Environmental Conservation Organisations that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6113]
- No further correspondence or feedback was received from TWS.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
The Wilderness Society requested Santos to follow up regarding the mound springs in relation to the Eos 3D MSS activity and provide feedback regarding any potential impact and mitigation.	Santos notes The Wilderness Society's feedback. Mound springs are listed threatened ecological communities. The primary threat to these features is reduced groundwater discharge, as well as damage by stock and weed infestation. The closest of these to the EMBA is a cluster of mound springs near the Victoria Bonaparte Coast, on the northern edge of Carlton Hill Station; but all are located several kilometres inland and well beyond the extent of the EMBA for this activity.	There are eleven mound spring sites in WA. Closest to Perth are those of the Swan Coastal Plain in the Bullsbrook area and at Three Springs, near Eneabba. Other sites are in the north of the State. There are sites in the north Pilbara / southern Kimberley (Dragon Tree soak and the Mandora springs) and in the northern and coastal regions of the Kimberley (Bunda Bunda, Lolly Well, Disaster Bay and Big Springs) comprising a group known as the north Kimberley mound springs, the Durack Ranges and the Victoria-Bonaparte Wetlands.	Section 3.5.3 – Threatened Ecological Communities

World Wide Fund For Nature (WWF)

- On 28 September 2023 Santos emailed WWF to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2485]
- On 5 November 2023 Santos emailed WWF further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2609]
- On 21 November 2023 Santos emailed WWF further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2736]
- On 16 April 2025 Santos notified Environmental Conservation Organisations of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Environmental Conservation Organisations that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6114]

- On 16 April 2025 Santos received an automated email confirming receipt of the notification. [Con-6115]
- On 17 April 2025 Santos received an automated email indicating that our enquiry had been forwarded to the conservation team for review. [Con-6116]
- No further correspondence or feedback was received from WWF.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from WWF.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

First Nations People and Groups – Representative Organisations – Northern Territory

Djulidki Consultative Committee (formerly Bradshaw Liaison Committee)

- On 14 November 2023 Santos met with the Djulidki Consultative Committee to consult on the proposed Eos 3D MSS activities. [Con-2922]
- On 16 November 2023 Santos met with the Djulidki Consultative Committee to consult on the proposed Eos 3D MSS activities. [Con-2928]
- On 16 April 2025 Santos emailed its third-party First Nations consultant to facilitate distribution of the Consultation Activity Update for Eos 3D Marine Seismic Survey Environment Plan and fact sheet. [Con-6276] Santos requested its third-party First Nations consultant to distribute the consultation activity update and materials to the following FNCCs/coastal clan groups:
  - Agalda clan
  - Djulidki Consultative Committee (formerly Bradshaw Liaison Committee)
  - Daly River / Port Keats FNCC
  - Mulyurrud Consultative Committee
  - Rak Badjalarr Consultative Committee
  - Wulna clan
- On 29 May 2025 Santos' third-party First Nations consultant provided a report to Santos on the distribution of consultation to the nominated FNCCs/coastal clan groups. [Con 6371]
- On 30 May 2025 Santos' third-party First Nations consultant confirmed that no feedback or input had been received from the FNCCs/coastal clan groups regarding the Consultation Activity Update. [Con 6372]
- No further correspondence or feedback was received from Santos' third-party First Nations consultant.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
A member of the Djulidki Consultative Committee sought clarification from Santos about EMBAs and wind direction.	Santos notes the question from the Committee member.	Santos provided a description at the meeting on typical variables, including wind direction, that Santos considered in the highly unlikely event of a worst-case hydrocarbon spill due to a vessel collision within the Operational Area.	Section 3 – Description of the Environment

A member of the Djulidki Consultative Committee sought clarification from Santos about how long it would take to complete one section of seismic.	Santos notes the question from the Committee member.	Santos advised at the meeting it would take approximately 10 hours.	Section 2 – Activity Description
A member of the Djulidki Consultative Committee requested that Santos advise it when the EP was submitted to NOPSEMA for assessment.	Santos notes the question from the Committee member.	Santos will notify Djulidki Consultative Committee when the EP was submitted to NOPSEMA for assessment.	Table 8-4
A member of the Djulidki Consultative Committee asked if activity stops if a whale is sighted and if activity is timed to avoid known periods of whale movement.	Santos notes the question from the Committee member.	Santos advised that there were exclusion zones for safety reasons, adding that if a whale was sighted during acquisition, then the sound source would be stopped. Santos added that soft starts were also taken as a precautionary measure, with the sound source increasing in intensity. Santos advised it considered whale migration as part of activity planning.	Section 6.3 – Noise Emissions Section 7.6 – Marine Fauna

Larrakia Nation Aboriginal Corporation (LNAC)

- On 21 November 2023 Santos emailed LNAC to advise it of preliminary consultation regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2712]
- On 22 November 2023 LNAC emailed Santos advising the CEO was away and would be back on 27 November 2023 to address the email. [Con-2751]
- On 22 November 2023 Santos emailed LNAC acknowledging the CEO is away and Santos will follow up once he returns. [Con-2752]
- On 7 December 2023 Santos emailed LNAC following up the email from 21 November 2023 on any feedback regarding the proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2853]
- On 8 December 2023 LNAC emailed Santos requesting Santos undertake face to face consultation on 19 December 2023 with Larrakia family groups and advertise in the NT News to promote the consultation opportunity. LNAC confirmed it would promote the consultation opportunity on social media, as well as via a 1800 number. [Con-2865]
- On 19 December 2023 Santos held two consultation sessions for Larrakia families, however no one attended.
- On 16 April 2025 Santos notified LNAC of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed LNAC that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6190]

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from LNAC or Larrakia family groups.	Santos has followed LNAC's direction in seeking to consult Larrakia families.	No response required.	Not applicable.

	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.		

Northern Land Council (NLC)

- On 21 November 2023, Santos emailed NLC to advise it of consultation regarding proposed Bonaparte Basin activities including activities to be managed under this EP. [Con-2710]
- On 21 November 2023 NLC emailed Santos to advise that the consultation information has been forwarded to senior colleagues of the NLC for consideration. [Con-2711]
- On 28 November 2023 NLC emailed Santos advising it does not wish to comment at this stage in its capacity as a relevant person on the proposed Eos 3D MSS activities. [Con-2786]
- On 16 April 2025 Santos notified NLC of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed NLC that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6293]

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
NLC advised it did not wish to provided feedback about proposed activities.	Santos notes feedback provided by NLC.	No response required.	Not applicable.

Tiwi Island Clan Groups and Traditional Owners

- On 13 November 2023 a notice of meeting was published in the NT News regarding upcoming consultation sessions with the Tiwi Island peoples.
- On 14 November 2023 a notice of meeting was published on the Tiwi Noticeboard (Facebook) regarding upcoming consultation sessions with the Tiwi Island peoples.
- On 5 December 2023 Santos met with the Tiwi Islands people (Marrikawuyanga and Yimpinari Clans and Wulirankuwu Clans) to consult on the proposed Eos 3D MSS activities. [Con-2952]
- On 6 December 2023 Santos met with the Tiwi Islands (Jikilaruwu Clan) people to consult on the proposed Eos 3D MSS activities. [Con-2960]
- On 6 December 2023 Santos met with the Tiwi Islands people (Mantiyupwi Clan) to consult on the proposed Eos 3D MSS activities. [Con-2963]
- On 7 December 2023 Santos met with the Tiwi Islands people (Wurankuwu Clan) to consult on the proposed Eos 3D MSS activities. [Con-2964]
- On 7 December 2023 Santos met with the Tiwi Islands people (Malawu Clan) to consult on the proposed Eos 3D MSS activities. [Con-2965]
- On 8 December 2023 a planned consultation meeting for the Munupi Clan was postponed out of respect due to community matters until 2024.
- On 14 December 2023 Santos met with the Tiwi Islands people (Mantiyupwi Clan) to consult on the proposed Eos 3D MSS activities. [Con-2967]
- On 28 December 2023 Santos emailed Tiwi Islands third-party First Nations consultant on behalf of the Munupi Clan requesting it sends on information about upcoming consultation sessions for the proposed Barossa DPD activities. [Con-3045]
- On 6 January 2024 the Trustee of the Munupi Clan emailed Santos, noting that additional meetings consultations were planned for Tiwi people. [Con-3053]

- On 12 January 2024 Santos emailed its Tiwi Islands third-party First Nations consultant to confirm the next round of consultation with the Munupi Clan for 2 February 2024. Santos advised the session would include information about multiple Santos proposed activities, including the Eos 3D MSS. Santos advised that the Eos 3D MSS activities was planned to be submitted in February 2024. [Con-3044]
- On 15 January 2024 Santos' Tiwi Islands third-party First Nations consultant emailed Santos advising the future date for consultation did not clash with any Sorry Business. The Tiwi Islands third-party First Nations consultant also asked if all the information Santos provided in the email be presented to the Munupi families, as well as transport for Munupi Traditional Owners living in other communities to attend a meeting at Milikapiti. [Con-3046]
- On 17 January 2024 Santos emailed its Tiwi Islands third-party First Nations consultant on behalf of the Munupi Clan to confirm all information in the email from 12 January 2024 would be provided to Munupi Clan members on 2 February 2024 and confirmed travel arrangements to ensure sufficient opportunity for Munupi families to addend. [Con-3052]
- On 18 January 2024 the Trustee for the Munupi Clan emailed Santos to acknowledge Santos' email from 17 January 2024 and advise if Santos needs any on ground support. [Con-3054]
- On 2 February 2024 a consultation meeting was held for the Munupi Clan. [Con-3109]
- On 2 March 2024 Santos emailed its third-party First Nations consultant to confirm completeness of consultation with the Mantiyupwi Clan. [Con-3276]
- On 7 March 2024 Santos' third-party First Nations consultant emailed Santos and advised that representatives of the Mantiyupwi Clan had been contacted and confirmed that consultation was complete for proposed activities. [Con-3276]
- On 16 April 2025 Santos notified Tiwi Island Clan Groups and Traditional Owners via the TLC of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed TLC that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6191]

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
A community member at the Marrikawuyanga & Yimpinari & Wulirankuwu Clan meeting asked if the activity disturbed shipwrecks. [Con-2952]	Santos notes the feedback from the community member. The closest shipwreck (the *Sedco Helen*) is situated 11 km from the operational area and will not be disturbed by the activity.	Santos responded that it would avoid any identified shipwrecks, cultural areas, and sensitive areas and this would be covered in the EP.	Section 3.8.6 – Maritime Heritage
A community member at the Marrikawuyanga & Yimpinari & Wulirankuwu Clan meeting asked if the activity was safe so that people in the water would not be hurt. [Con-2952]	Santos notes the feedback from the community member. The sound source is anticipated to dissipate over 100 m so coastal communities are not expected to be impacted. Support vessels are one of the deconfliction measures implemented to prevent vessel interactions.	The Activity will be situated over 100 kilometres from the nearest coastline and therefore is not anticipated to impact people in the water. No scuba diving or snorkelling sites or dive shops or clubs have been identified in the JBG or adjacent townsites.	Section 2 – Activity Description Section 3.8.4 – Tourism and Recreation
No feedback, objections or claims were made by members of the Jikilaruwu Clan. [Con-2960] and [Con-2960]	Santos considers it has provided sufficient time and opportunity for consultation.	NA	Not applicable.

	Santos considers the Section 25 consultation requirements to have been met.		
No feedback, objections or claims were made by members of the Mantiyupwi Clan [Con-2963] and [Con-3276]	Santos considers it has provided sufficient time and opportunity for consultation. Santos considers the Section 25 consultation requirements to have been met.	NA	Not applicable.
A community member at the Wurankuwu Clan meeting asked if there was any drilling associated with the activity. [Con-2964]	Santos notes the feedback from the community member.	Santos clarified there was no drilling associated with this activity.	Section 2 – Activity Description
A community member at the Wurankuwu Clan meeting confirmed the importance of animals to their Clan, particularly crocodiles and turtles. [Con-2964]	Santos notes the feedback from the community member. As discussed in Section 3, crocodiles are expected to be an infrequent occurrence in the operational area and EMBA. An assessment of the activity on Marine Turtles is contained in Section 6.3. This assessment determined that no long term population impacts or widespread disturbances to foraging or internesting populations of marine turtles are predicted to result from the activity.	Santos responded that this feedback is valuable and that it aimed to prevent all impacts.	Section 3.7.4 – Marine Reptiles Section 6.3.2.9 – Marine Reptiles Section 7.6 – Marine Fauna Collisions
A community member at the Wurankuwu Clan meeting sought clarification about prevention of marine pollution.[Con-2964]	Santos notes the feedback from the community member.	Santos responded that protocols and equipment are used to prevent marine pollution occurring.	Section 6.6 – Planned operational discharges Section 7.1 – Marine diesel oil (MDO) release from vessel collision (surface) Section 7.2 – Minor hydrocarbon release Section 7.3 – Spill response operations Section 7.4 – Hazardous and non-hazardous unplanned discharges – liquid Section 7.5 – Hazardous and non-hazardous unplanned discharges – solid

A community member at the Wurankuwu Clan meeting sought clarification about the noise associated with seismic surveys. [Con-2964]	Santos notes the feedback from the community member.	Santos responded that the seismic source projected downwards from the seismic vessel as it moved through the Active Source Area.	Section 6.3 – Noise emissions
A community member at the meeting of the Mantiyupwi Clan with interests in the Vernon Islands asked about vessel collisions. [Con- Con-2967]	Santos notes the feedback from the community member.	Santos responded that the seismic and support vessels communicated with other marine vessels to prevent collisions.	Section 6.2- Interaction with other marine users
A community member at the meeting of the Mantiyupwi Clan with interests in the Vernon Islands asked whether Santos was inviting comment from local communities. [Con-2967]	Santos notes the feedback from the community member.	Santos responded it was talking to First Nations groups more proximate to the activity location.	Section 4 – Stakeholder consultation
A community member at the Manupi Clan meeting asked if Santos could hear marine animals when listening for the seismic response. [Con-3109]	Santos notes the feedback from the community member.	Santos responded that marine animals generate different levels of noise. However, marine animals, such as whales generally moved away when seismic activities are being undertaken.	Section 6.3 – Noise emissions

Tiwi Land Council (TLC)

- On 22 November 2023 Santos emailed TLC to advise it of consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2831]
- On 22 December 2023 Santos emailed TLC to follow up on any feedback regarding the proposed Bonaparte Basin activities. Santos advised the EP for the proposed Eos 3D MSS activities would be submitted in early-mid February. Santos requested feedback by 10 January 2024. [Con-3010]
- On 16 April 2025 Santos notified TLC of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed TLC that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6191]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from TLC.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from TLC.	Santos considers it has provided sufficient information and a reasonable period of time for consultation.	No response required.	Not applicable.

	Santos considers Section 25 consultation requirements to have been met.		

Wickham Point Deed Liaison Committee (WPDLC)

- On 22 November 2023 Santos emailed WPDLC to advise it of consultation regarding proposed Bonaparte Basin activities including activities to be managed under this EP. [Con-2754]
- On 28 November 2023, Santos met with the WPDLC at its quarterly meeting to discuss a range of proposed activities including those to be managed under this EP. [Con-3335].
- On 16 April 2025 Santos notified WPDLC of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed WPD Liaison Committee that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6292].

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
The reference group provided feedback that people with interests in Channel Point and Peron Islands should be consulted on proposed activities.	Santos notes feedback provided by the Reference Group members. People with interests in Channel Point and Peron Islands were consulted as part of First Nations Consultative Committee engagements in November 2023. Members of the Rak Badjalarr and Daly River / Port Keats consultative committees have interests in the Channel Point and Peron Islands area.	No response required.	Not applicable.

First Nations peoples and groups – First Nations Consultative Committees and coastal clan groups

Agalda clan

- On 21 November 2023 Santos met with the Agalda clan to consult on the proposed Eos 3D MSS activities. [Con-2948]
- On 22 November 2023 Santos met with the Agalda clan to consult on the proposed Eos 3D MSS activities. [Con-2949]
- On 23 November 2023 Santos met with the Agalda clan at the Kakadu Crocodile Hotel, Jabiru to consult on the proposed Eos 3D MSS activities. [Con-2950]
- On 16 April 2025 Santos emailed its third-party First Nations consultant to facilitate distribution of the Consultation Activity Update for Eos 3D Marine Seismic Survey Environment Plan and fact sheet. [Con-6276] Santos requested its third-party First Nations consultant to distribute the consultation activity update and materials to the following FNCCs/coastal clan groups:
  - Agalda clan
  - Djulidki Consultative Committee (formerly Bradshaw Liaison Committee)
  - Daly River / Port Keats FNCC
  - Mulyurrud Consultative Committee
  - Rak Badjalarr Consultative Committee

- Wulna clan

- On 29 May 2025 Santos' third-party First Nations consultant provided a report to Santos on the distribution of consultation to the nominated FNCCs/coastal clan groups. [Con-6371]
- On 30 May 2025 Santos' third-party First Nations consultant confirmed that no feedback or input had been received from the FNCCs/coastal clan groups regarding the Consultation Activity Update. [Con-6372]
- No further correspondence or feedback was received from Santos' third-party First Nations consultant.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
A member of the Agalda clan asked how loud the seismic noise is and questioned the impact on turtles and other wildlife.	Santos notes the feedback from the community member.	Santos advised that potential impacts are minimised given marine mammal spotting and the practice of soft starts, allowing marine mammals to move away. Also, the vessel moves very slowly.	Section 6.3 – Noise emissions

Daly River / Port Keats FNCC

- On 1 December 2023 Santos met with the Daly River/Port Keats FNCC to consult on the proposed Eos 3D MSS activities. [Con-2951]
- On 2 March 2024 Santos emailed its third-party First Nations consultant to confirm completeness of consultation with the Daly River/Port Keats FNCC. [Con-3273]
- On 7 March 2024 Santos' third-party First Nations consultant emailed Santos and advised that representatives of the Daly River/Port Keats FNCC had been contacted and confirmed that consultation was complete for proposed activities. [Con-3273]
- On 16 April 2025 Santos emailed its third-party First Nations consultant to facilitate distribution of the Consultation Activity Update for Eos 3D Marine Seismic Survey Environment Plan and fact sheet. [Con-6276] Santos requested its third-party First Nations consultant to distribute the consultation activity update and materials to the following FNCCs/coastal clan groups:
  - Agalda clan
  - Djulidki Consultative Committee (formerly Bradshaw Liaison Committee)
  - Daly River / Port Keats FNCC
  - Mulyurrud Consultative Committee
  - Rak Badjalarr Consultative Committee
  - Wulna clan
- On 29 May 2025 Santos' third-party First Nations consultant provided a report to Santos on the distribution of consultation to the nominated FNCCs/coastal clan groups. [Con-6371]
- On 30 May 2025 Santos' third-party First Nations consultant confirmed that no feedback or input had been received from the FNCCs/coastal clan groups regarding the Consultation Activity Update. [Con-6372]
- No further correspondence or feedback was received from Santos' third-party First Nations consultant.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No feedback, objections or claims were made by members	Santos has confirmed via its third-party First Nations consultant that consultation is complete.	No response required.	Not applicable.

of the Daly River/Port Keats FNCC.	Santos considers Section 25 consultation to have been met.		

Mulyurrud Consultative Committee (MCC)

- On 23 November 2023 a consultation meeting was held for the Mulurryud Consultative Committee at the Kakadu Crocodile Hotel, Jabiru. [Con-2950]
- On 2 March 2024 Santos emailed its third-party First Nations consultant to confirm completeness of consultation with the Mulurryud Consultative Committee. [Con-3274]
- On 7 March 2024 Santos' third-party First Nations consultant emailed Santos and advised that representatives of the Mulurryud Consultative Committee had a been contacted and confirmed that consultation was complete for proposed activities. [Con-3274]
- On 16 April 2025 Santos emailed its third-party First Nations consultant to facilitate distribution of the Consultation Activity Update for Eos 3D Marine Seismic Survey Environment Plan and fact sheet. [Con-6276] Santos requested its third-party First Nations consultant to distribute the consultation activity update and materials to the following FNCCs/coastal clan groups:
  - Agalda clan
  - Djulidki Consultative Committee (formerly Bradshaw Liaison Committee)
  - Daly River / Port Keats FNCC
  - Mulyurrud Consultative Committee
  - Rak Badjalarr Consultative Committee
  - Wulna clan
- On 29 May 2025 Santos' third-party First Nations consultant provided a report to Santos on the distribution of consultation to the nominated FNCCs/coastal clan groups. [Con-6371]
- On 30 May 2025 Santos' third-party First Nations consultant confirmed that no feedback or input had been received from the FNCCs/coastal clan groups regarding the Consultation Activity Update. [Con-6372]
- No further correspondence or feedback was received from Santos' third-party First Nations consultant.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No feedback, objections or claims were made by members of the Mulurryud Consultative Committee.	Santos has confirmed via its third-party First Nations consultant that consultation is complete. Santos considers Regulation25 consultation to have been met.	No response required.	Not applicable.

Rak Badjalarr Consultative Committee (RBCC)

- On 16 November 2023 Santos met with the Rak Badjalarr Consultative Committee to consult on the proposed Eos 3D MSS activities. [Con-2929]
- On 2 March 2024 Santos emailed its third-party First Nations consultant to confirm completeness of consultation with the Rak Badjalarr Consultative Committee. [Con-3275]
- On 7 March 2024 Santos' third-party First Nations consultant emailed Santos and advised that representatives of the Rak Badjalarr Consultative Committee and been contacted and confirmed that consultation was complete for proposed activities. [Con-3275]

- On 16 April 2025 Santos emailed its third-party First Nations consultant to facilitate distribution of the Consultation Activity Update for Eos 3D Marine Seismic Survey Environment Plan and fact sheet. [Con-6276] Santos requested its third-party First Nations consultant to distribute the consultation activity update and materials to the following FNCCs/coastal clan groups:
  - Agalda clan
  - Djulidki Consultative Committee (formerly Bradshaw Liaison Committee)
  - Daly River / Port Keats FNCC
  - Mulyurrud Consultative Committee
  - Rak Badjalarr Consultative Committee
  - Wulna clan
- On 29 May 2025 Santos' third-party First Nations consultant provided a report to Santos on the distribution of consultation to the nominated FNCCs/coastal clan groups. [Con-6371]
- On 30 May 2025 Santos' third-party First Nations consultant confirmed that no feedback or input had been received from the FNCCs/coastal clan groups regarding the Consultation Activity Update. [Con-6372]
- No further correspondence or feedback was received from Santos' third-party First Nations consultant.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No feedback, objections or claims were made by members of the Rak Badjalarr Consultative Committee.	Santos has confirmed via its third-party First Nations consultant that consultation is complete. Santos considers Section 25 consultation to have been met.	No response required.	Not applicable.

Wulna clan

- On 13 December 2023 Santos met with the Wulna clan to consult on the proposed Eos 3D MSS activities. [Con-2966]
- On 16 April 2025 Santos emailed its third-party First Nations consultant to facilitate distribution of the Consultation Activity Update for Eos 3D Marine Seismic Survey Environment Plan and fact sheet. [Con-6276] Santos requested its third-party First Nations consultant to distribute the consultation activity update and materials to the following FNCCs/coastal clan groups:
  - Agalda clan
  - Djulidki Consultative Committee (formerly Bradshaw Liaison Committee)
  - Daly River / Port Keats FNCC
  - Mulyurrud Consultative Committee
  - Rak Badjalarr Consultative Committee
  - Wulna clan
- On 29 May 2025 Santos' third-party First Nations consultant provided a report to Santos on the distribution of consultation to the nominated FNCCs/coastal clan groups. [Con-6371]
- On 30 May 2025 Santos' third-party First Nations consultant confirmed that no feedback or input had been received from the FNCCs/coastal clan groups regarding the Consultation Activity Update. [Con-6372]
- No further correspondence or feedback was received from Santos' third-party First Nations consultant.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
A member of the Wulna clan sought clarification about what boats are required as part of this activity.	Santos notes the feedback from the community member.	One main boat with the sound source which tows the microphones on cables called streamers. Support boats, including chase boats, are also used to keep other boats, such as fishing boats, out of the area for safety reasons. We don't want other marine users getting tangled in the equipment.	Section 2 – Activity Description
A member of the Wulna Clan sought more information about survey impacts.	Santos notes the feedback from the community member.	Impacts from marine seismic surveys are different to other vessel-based activities, primarily noise emissions. We seek to minimise impacts on marine mammals. We start quietly and build the noise. This is called a 'soft start'. Importantly, there are laws in Australia that protect important species, including whales. Other impacts are the same as the other boats, such as lighting, which we need for safety reasons.	Section 6 – Environmental assessment for planned events
A member of the Wulna Clan asked what happened when you see a whale.	Santos notes the feedback from the community member.	We stop making the seismic noise and only start again when the whale has been observed to move away We use soft starts when resuming the survey.	Section 6.3 – Noise emissions Section 7.6 – Marine Fauna Collisions
Representative organisations – Western Australia			
Balanggarra Aboriginal Corporation			

- On 23 October 2023 Santos emailed Balanggarra Aboriginal Corporation to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2554]
- On 26 October 2023 Balanggarra Aboriginal Corporation emailed Santos advising it would send on Santos' email to its CEO. [Con-2564]
- On 8 February 2024 Santos emailed Balanggarra Aboriginal Corporation to follow up on whether the Corporation wished to participate in the consultation process. [Con-3115]
- On 16 April 2025 Santos notified the Balanggarra Aboriginal Corporation of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed the Balanggarra Aboriginal Corporation that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6278]
- No further correspondence or feedback was received from Balanggarra Aboriginal Corporation.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from Balanggarra Aboriginal Corporation.	Santos considers it has provided sufficient information and a reasonable period of time for consultation.	No response required.	Not applicable.

	Santos considers Section 25 consultation requirements to have been met.		

Bardi and Jawi Niimidiman Aboriginal Corporation (RNTBC)

- On 17 November 2023 Santos emailed Bardi Jawi Niimidiman Aboriginal Corporation RNTBC to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2704]
- On 05 December 2023 Santos emailed Bardi and Jawi Niimidiman Aboriginal Corporation RNTBC to follow up on the consultation seeking feedback regarding the proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2840]
- On 9 February 2024 Bardi and Jawi Niimidiman Aboriginal Corporation emailed Santos and advised that the interests of the Bardi and Jawi Niimidiman AC were unlikely to be affected in the event of a worst-case spill for proposed activities based on Santos' spill modelling. Bardi and Jawi Niimidiman Aboriginal Corporation requested to be consulted should modelling change such that the Corporation's interests may be affected. [Con-3120]
- On 9 February 2024 Santos emailed Bardi and Jawi Niimidiman Aboriginal Corporation acknowledging its feedback and committed to consulting the Corporation should modelling change such that Bardi Jawi interests may be affected. [Con-3118]
- On 16 April 2025 Santos notified the Bardi and Jawi Niimidiman Aboriginal Corporation (RNTBC) of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed the Bardi and Jawi Niimidiman Aboriginal Corporation (RNTBC) that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6280]
- No further correspondence or feedback was received from Balanggarra Aboriginal Corporation.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
RNTBC requested consultation should oil-spill modelling change in a way that could affect their interests.	The response does not raise an objection or claim about the adverse impact of the activity to which this EP relates.	No response required.	Not applicable.

Dambimangari Aboriginal Corporation

- On 17 November 2023 Santos emailed Dambimangari Aboriginal Corporation to advise it of consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2700]
- On 05 December 2023 Santos emailed Dambimangari Aboriginal Corporation to follow up on the consultation seeking feedback regarding the proposed Bonaparte Basin activities, including activities to be managed under this EP. Feedback was sought by 22 December 2023. [Con-2841]
- On 16 April 2025 Santos notified the Dambimangari Aboriginal Corporation of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed the Dambimangari Aboriginal Corporation that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6281]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Miriuwung Gajerrong Aboriginal Corporation.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from Dambimangari Aboriginal Corporation.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Kimberley Land Council (KLC)

- On 17 November 2023 Santos emailed KLC to advise it of consultation regarding proposed Bonaparte Basin activities for consultation. Santos also informs KLC that they have contacted the following Prescribed Body Corporates:
  - Balanggarra Aboriginal Corporation
  - Wanjina-Wunggurr (Native Title) Aboriginal Corporation
  - Miriuwung Gajerrong Aboriginal Corporation
- And the following PBCs for their peoples' sea country interests which extend into the Kimberley Marine Park:
  - Wunambal Gaambera Aboriginal Corporation
  - Dambimangari Aboriginal Corporation
  - Mayala Inninalang Aboriginal Corporation
  - Bardi Jawi Niimidiman Aboriginal Corporation RNTBC
  - Nyul Nyul PBC Aboriginal Corporation [Con-2705]
- On 22 November 2023 KLC emailed Santos providing an updated contact person for Santos to liaise with Nyul Nyul PBC Aboriginal Corporation. [Con-2753]
- On 23 November 2023 Santos emailed KLC acknowledging it had a different contact person for Nyul Nyul PBC Aboriginal Corporation. Santos emailed separately the new contact person for Nyul Nyul PBC Aboriginal Corporation (see separate listing below for this PBC). [Con-2759]
- On 16 April 2025 Santos notified the KLC of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed the KLC that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6282]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from KLC.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from KLC.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Mayala Inninalang Aboriginal Corporation

- On 17 November 2023, Santos emailed Mayala Inninalang Aboriginal Corporation to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2699]
- On 5 December 2023 Santos emailed Mayala Inninalang Aboriginal Corporation to follow up on the consultation seeking feedback regarding the proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2838]
- On 5 December 2023 Mayala Inninalang Aboriginal Corporation emailed Santos advising it had forwarded Santos' email to the directors for their consideration and attendances. It advised response turnaround times can often be somewhat timely or delayed due to various factors including (but not limited to) remoteness, opportunities and logistics for directors to meet, PBC governance compliance legislation to permit formal responses, etc; and therefore, patience and understanding is appreciated. [Con-2842]
- On 8 February 2024 Santos emailed KLC as the nominated contact for Mayala Inninalang Aboriginal Corporation to follow up on whether Directors of the Mayala Inninalang Aboriginal Corporation wished to participate in the consultation process. [Con-3113]
- On 16 April 2025 Santos notified the Mayala Inninalang Aboriginal Corporation of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed the Mayala Inninalang Aboriginal Corporation that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6283]
- No further correspondence or feedback was received from Mayala Inninalang Aboriginal Corporation.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Mayala Inninalang Aboriginal Corporation.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Miriuwung Gajerrong Aboriginal Corporation

- On 23 October 2023 Santos emailed Miriuwung Gajerrong Aboriginal Corporation to advise it of consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2553]
- On 22 November 2023 Santos emailed Miriuwung Gajerrong Aboriginal Corporation further to previous correspondence to provide a reminder that feedback is being sought by 27 November 2023. [Con-2741]
- On 16 April 2025 Santos notified the Miriuwung Gajerrong Aboriginal Corporation of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed the Mayala Inninalang Aboriginal Corporation that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6285]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Miriuwung Gajerrong Aboriginal Corporation.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from Miriuwung Gajerrong Aboriginal Corporation.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Nyul Nyul Aboriginal Corporation

- On 17 November 2023 Santos emailed Nyul Nyul Aboriginal Corporation to advise it of consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2698]
- On 5 December 2023 Santos emailed Nyul Nyul Aboriginal Corporation to follow up on the consultation seeking feedback regarding the proposed Bonaparte Basin activities, including activities to be managed under this EP. Feedback was sought by 22 December 2023. [Con-2839]
- On 16 April 2025 Santos notified the Nyul Nyul PBC Aboriginal Corporation of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed the Nyul Nyul PBC Aboriginal Corporation that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6286
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Nyul Nyul Aboriginal Corporation.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from Nyul Nyul Aboriginal Corporation.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Wanjina-Wunggurr Aboriginal Corporation

- On 23 October 2023 Santos emailed Wanjina-Wunggurr Aboriginal Corporation to advise it of consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2555]
- On 22 November 2023 Santos emailed the Wanjina-Wunggurr Aboriginal Corporation further to previous correspondence to provide a reminder that feedback is being sought by 27 November 2023. [Con-2740]
- On 16 April 2025 Santos notified the Wanjina-Wunggurr Aboriginal Corporation of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed the Wanjina-Wunggurr Aboriginal Corporation that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6287]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Wanjina-Wunggurr Aboriginal Corporation.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from Wanjina-Wunggurr Aboriginal Corporation.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Wunambal Gaambera Aboriginal Corporation

- On 17 November 2023 Santos emailed Wunambal Gaambera Aboriginal Corporation to advise it of consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2701]
- On 5 December 2023 Santos emailed Wunambal Gaambera Aboriginal Corporation to follow up on the consultation seeking feedback regarding the proposed Bonaparte Basin activities, including activities to be managed under this EP. Feedback was sought by 22 December 2023. [Con-2837]
- On 16 April 2025 Santos notified the Wunambal Gaambera Aboriginal Corporation of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed the Wunambal Gaambera Aboriginal Corporation that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6288]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Wunambal Gaambera Aboriginal Corporation.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from Wunambal Gaambera Aboriginal Corporation.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Industry associations – Commercial fishing

Australian Southern Bluefin Tuna Industry Association (ASBTIA)

- On 6 October 2023 Santos emailed ASBTIA to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2521]
- On 5 November 2023 Santos emailed ASBTIA further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2622]
- On 22 November 2023 Santos emailed ASBTIA further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2742]

- On 16 April 2025 Santos notified the ASBTIA of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed the ASBTIA that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6193]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from ASBTIA.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from ASBTIA.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Commonwealth Fisheries Association (CFA)

- On 6 October 2023 Santos emailed CFA to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2522]
- On 5 November 2023 Santos emailed CFA further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2628]
- On 22 November 2023 Santos emailed CFA further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2743]
- On 16 April 2025 Santos notified the CFA of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed the CFA that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6194]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from CFA.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from CFA.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Northern Territory Seafood Council (NTSC)

- On 6 October 2023 Santos emailed NTSC to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2519]
- On 5 November 2023 Santos emailed NTSC further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2629]

- On 22 November 2023 Santos emailed NTSC further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2733]
- On 16 April 2025 Santos notified the NTSC of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed the NTSC that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6195]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from NTSC.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from NTSC.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Northern Prawn Fishing Industry (NPFI)

- On 6 October 2023 Santos emailed NPFI to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2520]
- On 27 October 2023 Santos emailed NPFI to coordinate a meeting for 3 November 2023 to discuss the proposed Bonaparte Basin activities. Santos advised it would send through information that may be of interest to the NPFI. [Con-2571]
- On 3 November 2023 Santos met with NPFI to provide an overview on the proposed Bonaparte Basin activities for consultation purposes, including activities to be managed under this EP. [Con-2659]
- On 13 November 2023 Santos emailed NPFI with information, following up from the meeting on 3 November 2023. Santos provided the following:
  - GIS data for proposed activities.
  - EMBA maps for proposed activities.
  - Santos presentation for sharing with members as required.
  - Santos confirmed the seismic streamer in our proposed Eos 3D MSS captures sea surface temperature or temperature where the streamers are located. Santos can provide this data post completion of the survey.
- Santos requested the following from NPFI:
  - NPFI to confirm the approach of engaging with fishers as discussed in the meeting, whereby NPFI advised if the activity occurs during fishing closure period, consultation materials are to be sent directly to NPFI for NPFI to distribute as required to its members.
  - NPFI to provide thoughts on the spawning data table in the fact sheets and if the data is outdated, provide Santos with the recent data, if available.
  - NPFI to confirm details on timing and any areas that are sensitive for prawn (prawn fishing, spawning, recruitment/ migration) to review against timing of the proposed activities.
  - NPFI to provide any feedback on the activities discussed. [Con-2660]
- On 21 November 2023 NPFI emailed Santos that NPFI will respond to email correspondence of 13 November 2023 sometime later in the week. [Con-2696]
- On 23 November 2023 Santos emailed NPFI acknowledging its email. Santos advised it was awaiting answers from NPFI on queries from email on 13 November 2023. [Con-2758]
- On 7 December 2023 Santos emailed NPFI following up on feedback for the proposed Bonaparte Basin activities. [Con-2848]
- On 20 December 2023 NPFI emailed Santos advising it would provide a response in the coming days for the proposed Bonaparte Basin activities. [Con-2944]

- On 20 December 2023 Santos emailed NPFI acknowledging the email. [Con-2945]
- On 15 January 2024 NPFI emailed Santos with feedback on the proposed Eos 3D MSS activities. [Con-3047]
- On 15 January 2024 NPFI emailed Santos advising the NPF data files included as attachments to its email have been provided in strictest confidence to Santos for the purpose of informing Santos of NPF fishery catch and effort and TEP species data of relevance to the proposed Santos Bonaparte Basin projects. This information is not to be published or disseminated outside of the Santos team. [Con-3048]
- On 15 January 2024 NPFI emailed Santos advising it is withdrawing the email sent earlier that day as the email contains incorrect information. NPFI advised a revised email will be sent on 16 January 2024. [Con-3049]
- On 16 January 2024 Santos emailed NPFI advising it has noted that NPFI no longer wish to proceed with the original email regarding the Bayu-Undan GEP activities. Santos asked NPFI if the feedback regarding the Eos 3D MSS and Tern-2 activities was still correct or if they would provide a new email altogether. [Con-3050]
- On 16 January 2024 NPFI emailed Santos with feedback regarding the proposed Eos 3D MSS activities. [Con-3051]
- On 29 January 2024 Santos emailed NPFI in response to their feedback from 16 January 2024 regarding the proposed Eos 3D MSS activities. [Con-3056]
- On 16 April 2025 Santos notified the NPFI of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed the NPFI that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6196]
- No further correspondence or feedback was received from Balanggarra Aboriginal Corporation.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
NPFI expressed concerns about the immediate and future impacts of seismic on prawn stocks given the lack of information on the impact of seismic activities on crustaceans. NPFI requested Santos not undertake activities from August to October (spawning period) and advised that there was a high probability of disruption to NPFI fishing operations should the proposed survey occur between 1 August and 1 December in any year (fishery open to fishers).	Santos notes the feedback from NPFI.	Santos responded that a detailed assessment of the potential impact of the proposed seismic survey on marine species, including plankton, invertebrates, fish, shark and rays has been undertaken, with outcomes to be detailed in the Eos 3D MSS EP (Section 6.3). Santos advised that the assessment found that the potential risk of the seismic survey to commercial prawns was considered to be limited and at an acceptable level. Santos advised it currently planned to undertake the Eos survey in December 2024 at the earliest, with exact timing of the survey subject to vessel availability and a number of other commercial, operational and environmental factors. As such, flexibility was required for the survey window and EP had been prepared to allow the survey to be undertaken throughout the calendar year. Reducing the survey window to avoid the August to October period could prevent Santos from being able to complete the survey or it could mean the survey is not financially feasible.	Section 6.3- Noise Emissions
NPFI noted that there was a limited number of interactions with EPBC Act Threatened, Endangered and Protected (TEP) species (including	Santos notes the feedback from NPFI.	Santos noted the potential for EPBC Act listed species to occur near the proposed area of activity and advised that a detailed assessment of the potential impact of the proposed seismic	Section 6.3- Noise Emissions

sawfish and sea snakes) directly within the proposed area of activity and that there were considerable numbers of interactions in close proximity to the proposed activity area. NPFI expressed concern about potential impacts to four species of sawfish in Australia, all of which inhabit the inshore and offshore waters of the NPF.		survey on marine species, including plankton, invertebrates, fish, shark and rays had been undertaken. Santos advised that the outcomes of this assessment would be detailed in the Eos 3D MSS EP (Section 6.3). Based on the impact assessment, no long term or population impacts to individual fish, sharks, rays or commercial fish stocks were expected to result from the seismic survey.	
NPFI noted that it was possible that the distribution of TEP species was much wider and that there were more TEP species in the proposed activity area than identified in the NPF catch and effort data base. NPFI expressed concerns in relation to the potential impacts of seismic activity on TEP species and urged Santos to take all measures to minimise and mitigate impacts on both NPF fishing operations and prawns stock in the area as much as possible. NPFI also encouraged investment by Santos in research to better understand the impacts of its activities on prawn stocks and TEP species.	Santos notes the feedback from NPFI.	Santos confirmed that the anticipated impact of the seismic survey on marine species had been assessed and would be detailed in the Eos 3D MSS EP (Section 6.3). Santos advised that no significant impacts to invertebrates or fish species were expected to result from the proposed seismic survey. Santos advised it had assessed measures that could be implemented to minimise and mitigate impacts on both NPF fishing operations and prawns stock in the area to as low as reasonably practicable. Santos agreed that further research was warranted and was open to supporting relevant future research proposals in relation to marine seismic survey impacts.	Section 6.3- Noise Emissions
Tuna Australia			
• On 6 October 2023 Santos emailed Tuna Australia to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2523] • On 12 October 2023 Tuna Australia emailed Santos advising it would like to meet to discuss the proposed approach for Bonaparte Basin consultation support. [Con-2528] • On 6 November 2023 Santos emailed Tuna Australia following up on a phone call to identify if it would like to meet to discuss the proposed Bonaparte Basin activities. [Con-2625] • On 21 November 2023, Tuna Australia emailed Santos, requesting a phone call to discuss the activities. [Con-2709] • On 23 November 2023 Santos emailed Tuna Australia advising it had called earlier that day in response to an email received on 21 November 2023. [Con-2763]			

- On 24 November 2023 Santos called Tuna Australia following up an email on 21 November 2023. Tuna Australia advised it had commenced consultation for the proposed Bonaparte Basin activities. It advised it would have a report available regarding any feedback on 10 December 2023. Santos acknowledged this and advised it was looking forward to receiving the report. [Con-2774]
- On 15 December 2023 Santos emailed Tuna Australia to follow up on the feedback report for the proposed Eos 3D MSS activities, as discussed on the phone on 24 November 2023. [Con-2885]
- On 18 December 2023 Tuna Australia emailed Santos requesting an extension to provide the feedback report from their members for the proposed Eos 3D MSS activities. [Con-2904]
- On 20 December 2023 Santos emailed Tuna Australia to advise it would be great to receive the feedback report regarding Eos 3D MSS activities by 10 January 2024. [Con-2942]
- On 20 December 2023 Tuna Australia emailed Santos and advised it would provide the feedback report for the proposed Eos 3D MSS activities by 10 January 2024. [Con-2968]
- On 10 January 2024 Tuna Australia emailed Santos with feedback on the proposed Eos 3D MSS activities (as per below). [Con-3032]
- On 10 January 2024 Santos emailed Tuna Australia acknowledging receipt of the feedback regarding the proposed Eos 3D MSS activities. [Con-3033]
- On 29 January 2024 Santos emailed Tuna Australia with a response to its email providing feedback on 10 January 2024 regarding the proposed Eos 3D MSS activities. [Con-3055]
- On 16 April 2025 Santos notified Tuna Australia of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Tuna Australia that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6197]
- No further correspondence or feedback was received from Tuna Australia.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
Tuna Australia commented that there was a lack of understanding about the impacts of seismic surveys on tuna and billfish species, byproduct species, developing tuna and billfish larvae, and baitfish. Tuna Australia said of greatest concern was the unknown impact of marine seismic surveys on Southern Bluefin Tuna (SBT) larval spawn, noting that two members had witnessed successive years of largescale spawning events of yellowfin tuna immediately south of the proposed operational area. Tuna Australia also commented that the EMBA was adjacent to the single known spawning area for SBT.	Santos notes feedback provided by Tuna Australia.	The anticipated impact of the proposed seismic survey on marine species including plankton, invertebrates, fish, sharks and rays is assessed in detail in the EP (Section 6.3). This includes an assessment of the potential impacts of the seismic survey on the spawning and recruitment of commercially significant fish species not just demersal fish. The assessment is supported by a wide literature review including global research and studies. Potential impacts to spawning and recruitment within commercially significant demersal and pelagic fish stocks are anticipated to be acceptable. This is due to the low likelihood of the survey resulting in any direct reduction in the spawning biomass through fish mortalities and the high fecundity and broadcast spawning characteristics of key demersal and pelagic fish species in the region, which provide for genetic connectivity of the stocks over extensive areas. In addition, the localised short-term behavioural disturbances resulting from a transient seismic source are unlikely to result in a discernible impact to fish populations. This is due to spawning and stock connectivity occurring over significantly larger geographic areas and over protracted spawning periods of several months, involving the production of millions of eggs over multiple spawning events. Santos appreciates the provision of information in regard to spawning events for the Yellowfin tuna and the location of these	Section 6.3– Noise emissions

Tuna Australia further commented that consultation information provided to commercial fishers did not assess potential temporal spawning period overlaps for any of the main Western Tuna and Billfish Fishery target species or SBT. Tuna Australia said that further research was needed to confidently ensure species within the vertical marine ecosystem, including pelagic predator and prey fish, larvae, and phytoplankton, remain unharmed.		events. It is important to note that the EMBA within the factsheet is comprised of the outcomes of numerous oil spill simulations and reflects a maximum oil spill extent. The EMBA does not reflect the potential area of impact associated with noise emissions from the seismic source. The EP (Section 6.3.2) assesses the potential noise impacts (based on modelling and literature research) to plankton (including fish eggs and larvae) communities. These are localised and within approximately 200 m from the acoustic source. Given this area of impact is significantly smaller than the spawning grounds of these fish species, this limited extent of impact is considered adequate to protect against population level impacts. Adult fish stocks comprise fish that are recruited over many years and are unlikely to be affected by seasonal disturbances, even at a regional scale. Therefore, in comparison, the occasional short-term transient and localised disturbances to groups of fish as a result of a seismic survey are not expected to impact recruitment. Given the above, no impacts to the viability of any commercially significant fish stocks are anticipated to result from the proposed seismic survey. Santos acknowledges that Tuna Australia suggest further research is warranted and is open to supporting relevant future research proposals in relation to the environmental impact of marine seismic surveys.	
Tuna Australia said that the compensation framework demonstrated in the EP was inadequate and failed to address longer term and spatially broader impacts to commercial fishers. Tuna Australia added that the framework relied on historical catch records to support ‘evidenced based claims’ and that the prospectivity of fishing areas should also be considered.	Santos notes feedback provided by Tuna Australia.	Santos acknowledges the potential for marine seismic surveys to impact commercial fishing operations. Santos has made an overarching commitment that commercial fishing licence holders will be no worse off as a result of the seismic survey and propose measures that enable commercial fishers to lodge a claim, if applicable, within the EP. ‘Make good’ payments to commercial fishing licence holders will be assessed for loss of catch and relocation expenses should concurrent fishing and seismic vessel operations not be practicable. Santos will also assess requests for administrative support to help fishers collate historical fishing data required for make good payment claims. Santos will assess any payment claims in good faith. Commercial fishers are encouraged to contact Santos should they wish to pursue a claim. Santos considers it to be appropriate for any commercial agreements with commercial fishers to be managed outside of the environmental approval process.	Section 8.6.2 – Commercial fishers payment claim protocol

Tuna Australia said that several members raised the matter of deconfliction of their fishing operations with marine seismic activity. Tuna Australia noted Santos' plans to mitigate entry to the survey area, including the provision of support vessels to manage marine traffic, and requested activity notifications (including a 48-hr look ahead) as a consortium intended to fish in the areas covered by Santos proposed activity in 2024.	Santos notes feedback provided by Tuna Australia.	Santos appreciates the feedback received from Tuna Australia on this matter and advises deconfliction measures relevant to the Eos 3D MSS are detailed within the EP prepared for this activity. Santos is of the view that commercial fishing vessels and seismic survey vessels can undertake activities concurrently, providing the requested 3 nm exclusion (safety) zone around the seismic vessel is observed, and also has an on-water protocol for this. Santos commits to working with relevant commercial fisheries to enable fair and reasonable concurrent operations. Santos advises that the seismic survey will not be undertaken in the first half of 2024, and at this stage Santos anticipates the survey to be undertaken in December 2024 at the earliest, pending acceptance of the Eos EP, availability of a seismic vessel, weather, and operational efficiencies. However, Santos commits to providing a 48-hour look ahead to Tuna Australia prior to the commencement of the seismic survey.	Section 6.1 – Interaction with commercial fisheries Section 6.2– Interaction with other marine users Table 8-4
Tuna Australia commented that several concession holders/owners had raised concerns about cumulative impacts given the substantial amount of activity by the energy sector in the Bonaparte Basin, including potential impacts arising from other activity that overlapped the timeframe and area of the proposed Eos survey.	Santos notes feedback provided by Tuna Australia.	The Eos 3D MSS EP assesses the impact of the proposed seismic survey in relation to historical seismic survey activity. This assessment is detailed in Section 6.4 of the EP. This EP does not assess cumulative impacts from activities that may occur after the Eos 3D MSS. It is not possible to anticipate what surveys will be planned after the Eos 3D MSS and it is the responsibility of future activities to assess the potential cumulative impacts as relevant in their EPs.	Section 6.4 – Cumulative and additive seismic impacts
Tuna Australia suggested that Before After Control Impact (BACI) testing for active fisheries would be the most relevant risk management process to undertake monitoring of potential impacts to fisheries, noting the challenges in getting industry-wide support for a coordinated longitudinal study. In the absence of a BACI analysis, Tuna Australia said	Santos notes feedback provided by Tuna Australia.	Santos would be open to further discussion on supporting an industry wide BACI initiative to determine the impact of seismic surveys on commercial fish stocks. Santos has previously engaged with DPIRD regarding potential studies on the impact of seismic survey on mackerel species but is yet to make progress on this initiative. If Tuna Australia would like to discuss this matter further with industry, Santos is open to participating in these discussions.	Not applicable.

that Santos needed to demonstrate clearly how the environment (pelagic and benthic) would be independently assessed following seismic survey activity.			
Tuna Australia provided information to Santos that during consultation, many cross-endorsements for other tuna fisheries were found but no members advised of concessions held outside of tuna fisheries.	Santos notes feedback provided by Tuna Australia.	Santos notes the potential for cross-endorsements within the State and Commonwealth fishing industry and provides consultation to a broad range of fisheries with commercial interests identified within the activity EMBA, as outlined in the consultation methodology of Section 4 in the Eos 3D MSS EP.	Section 4 – Stakeholder consultation
Tuna Australia requested information of any known impacts that marine seismic arrays and other equipment has on the navigational equipment on other vessels.	Santos notes feedback provided by Tuna Australia.	Santos is not aware of any impacts from marine seismic arrays and related equipment on the navigational equipment on other vessels. Given the temporary nature of the proposed seismic survey and the constant motion of the seismic vessel within the operation area, no significant impacts to navigational equipment onboard other vessels are anticipated. should Santos become aware of such impacts to the navigational equipment on other vessels, this will be considered in the planning of future seismic survey activities.	N/A

Western Australian Fishing Industry Council (WAFIC)

- On 20 September 2023 Santos met with WAFIC to brief it on the proposed Bonaparte Basin activities and to discuss the potential for WAFIC to provide a service to Santos to engage with its members on behalf of Santos regarding these proposed activities. [Con-2453]
- On 22 September 2023 WAFIC emailed Santos in follow-up to the meeting held. WAFIC stated they would be happy to run a similar consultation model as done for Carnarvon Basin activities. WAFIC recommend given interest around seismic surveys to send Eos 3D MSS notification as a separate email. [Con-2457]
- On 22 September 2023, Santos emailed WAFIC the meeting summary from 20 September 2023. [Con-2458]
- On 22 September 2023, WAFIC thanked Santos for the meeting notes and advised it would await Santos' guidance on further action. [Con-2459]
- On 9 October 203 Santos emailed WAFIC to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation. [Con-2524]
- On 24 October 2023 WAFIC emailed commercial fishing licence holders in the Mackerel Managed Fishery – Area 1 and Northern Demersal Scalefish Managed Fishery regarding the proposed Bonaparte Basin activities to be managed under this EP, with links to fact sheets and the WAFIC website requesting feedback on the proposed activities. [Con-2549]
- On 6 November 2023 Santos emailed WAFIC to notify it of consultation for the proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2633]
- On 23 November 2023 Santos emailed WAFIC further to previous correspondence to provide a reminder that feedback for proposed Bonaparte Basin activities is being sought by 27 November 2023. [Con-2777]

- On 23 November 2023 WAFIC emailed a reminder to the commercial fishing licence holders in the Mackerel Managed Fishery – Area 1 and Northern Demersal Scalefish Managed Fishery regarding the proposed Bonaparte Basin activities, with links to fact sheets and the WAFIC website requesting feedback on the proposed activities to be managed under this EP. [Con-2806]
- On 27 November 2023 WAFIC emailed Santos with feedback on the proposed Bonaparte Basin activities. WAFIC asked for information regarding Eos 3D MSS activities (as per below). WAFIC advised it had no feedback or concerns from its members. [Con-2785]
- On 21 December 2023 Santos emailed WAFIC to provide responses to their queries regarding the proposed Eos 3D MSS (as per below). [Con-2971]
- On 16 April 2025 Santos notified WAFIC emailed of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed WAFIC that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6210]
- On 19 May 2025 WAFIC emailed Santos, advising that WAFIC did not receive any feedback from their industry. WAFIC advises that is still stands by its original comments provided on 27 November 2023 [Con-2785]. [Con-6257]
- On 21 May 2025 Santos emailed WAFIC, acknowledging WAFIC's original comments provided on 27 November 2023 and Santos' response provided on 21 December 2023. Santos now considers this consultation closed for this EP. [Con-6269]
- No further correspondence or feedback was received from WAFIC.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
WAFIC asked Santos to provide a summary of the risks associated to the marine environment from carbon injection and storage.	Santos notes WAFIC's feedback.	The Eos 3D MSS EP will specifically assess the risks arising from the seismic survey activity. Any risks or potential impacts associated with CCS would be included in future activity specific Environment Plans, should Santos progress with a CCS project.	Not applicable.
WAFIC asked Santos to provide the cumulative impact assessment of the spatial footprint of previous and known future seismic activity. WAFIC also sought clarification on the related management measures associated with concurrent seismic surveys within commercial fisheries.	Santos notes WAFIC's feedback.	The Risk Assessment (Section 6) of the Eos EP includes the following: • Cumulative and additive impacts refer to situations where successive seismic surveys may be undertaken over the same area, or where concurrent seismic survey activities could occur potentially affecting the same environmental or socio-economic receptors. It is recognised that the effects resulting from multiple seismic surveys, when considered collectively, may result in a greater level of impact or risk than the effects arising solely from the Eos 3D MSS. • Cumulative and additive impacts are assessed in relation to the aspects of underwater noise emissions and the physical interaction of the seismic survey activities with other marine users. Given the time that has elapsed since previous surveys were undertaken in this area, all receptors are expected to have recovered from the effects of previous surveys prior to commencement of the Eos 3D MSS. Therefore, cumulative impacts to ecological receptors are not expected to occur as a	Section 6.4 – Cumulative and additive seismic impacts

		result of any of the identified previous seismic surveys in the region and the proposed Eos 3D MSS. The EP does not assess cumulative impacts from activities that may occur after the Eos 3D MSS. It is not possible to anticipate what surveys will be planned after the Eos 3D MSS and it is the responsibility of future proponents to assess the potential cumulative impacts in their EPs.	
WAFIC stated that it expected Santos' commercial fishers payment claim protocol to align with the NERA commercial fishing industry adjustment protocol.	Santos notes WAFIC's feedback.	Santos is open to ensuring any updates would align accordingly, as this was not taken into account at the time that the protocol was developed.	Not applicable.
WAFIC noted that commercial fishers have a genuine concern regarding the potential impacts seismic surveys have on commercial fishing activity, the commercial fishing resource, the ecosystem that supports the fishery resource and cumulative impacts on fish resources and the general marine environment. WAFIC stated that there were significant gaps in available science related to seismic impacts to commercial fishing species and requested Santos to consider investment in mutually beneficial research.	Santos notes WAFIC's feedback.	Santos is open to undertaking mutually beneficial research with WAFIC and is open to meeting to discuss future opportunities to contribute this research. Please advise a suitable time and date for us to meet. Santos has attempted to reach out to DPIRD to ascertain research opportunities, however DPIRD has not to date provided any appropriate research initiatives for Santos' consideration.	Not applicable.
WAFIC asked if Santos was collecting IP addresses via provision of web site links to consultation information. WAFIC said it was seeking this clarification to better understand commercial fisher interest in proposed activities.	Santos notes WAFIC's feedback.	Currently Santos does not record IP addresses of those who download the fact sheets from our website but could be investigated in the future.	Not applicable.

Industry associations – Energy industry			
Australian Energy Producers (AEP)			
• On 28 September 2023 Santos emailed AEP to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2491] • On 5 November 2023 Santos emailed AEP further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2634] • On 22 November 2023 Santos emailed AEP further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2744] • On 16 April 2025 Santos notified AEP of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed AEP that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6117] • Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from AEP.			
Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from AEP.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.
Industry associations – Local government			
Local Government Association of the Northern Territory (LGANT)			
• On 28 September 2023 Santos emailed LGANT to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2496] • On 5 November 2023 Santos emailed LGANT further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2635] • On 22 November 2023 Santos emailed LGANT further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-3117] • On 16 April 2025 Santos notified WALGA of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed WALGA that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6119] • Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from LGANT.			

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from LGANT.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Western Australian Local Government Association (WALGA)

- On 28 September 2023 Santos emailed WALGA to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2497]
- On 5 November 2023 Santos emailed WALGA further to previous correspondence, to advise that it is now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2636]
- On 22 November 2023 Santos emailed WALGA further to previous correspondence to provide a reminder that feedback is being sought by 27 November 2023. [Con-2476]
- On 16 April 2025 Santos notified WALGA of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed WALGA that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6119] "
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from WALGA.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from WALGA.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Industry associations – Local industry

Broome Chamber of Commerce & Industry

- On 29 September 2023 Santos emailed Broome CCI to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2498]
- On 29 September 2023 Broome CCI emailed Santos advising it would like to be consulted on the proposed Bonaparte Basin activities. Broome CCI requested Santos arrange a time to meet. [Con-2440]
- On 31 October 2023 Santos emailed Broome CCI to confirm it would like to be consulted on the proposed Eos 3D MSS activities and would like to meet. Santos requested Broome CCI advise a suitable meeting time. [Con-2593]

- On 31 October 2023 Broome CCI emailed Santos advising it could meet on Thursday 2 November 2023. [Con-2602]
- On 2 November 2023 Santos emailed Broome CCI to advise it was unable to meet on Thursday 2 November 2023. It asked if Broome CCI was available on Thursday 9 November 2023. [Con-2605]
- On 2 November 2023 Broome CCI emailed Santos advising it nominates a time to meet. [Con-2610]
- On 2 November 2023 Santos emailed Broome CCI to provide some meeting time options. [Con-2611]
- On 2 November 2023 Broome CCI emailed Santos confirming a meeting time. [Con-2612]
- On 9 November 2023 Santos met with Broome CCI to provide an overview of the proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2693]
- On 9 November 2023 following a consultation meeting, Broome CCI emailed Santos with contact information for Cambridge Gulf Limited – a stakeholder who may be a relevant person for the purposes of the proposed Bonaparte Basin activities. [Con-2651]
- On 16 November 2023 Santos emailed Broome CCI in follow up to the meeting on 9 November 2023. Santos provided the presentation and also confirmed the following discussed in the meeting:
  - Santos has added Broome CCI to the Activity Notification List for Eos 3D MSS activities.
  - Santos has added Broome CCI to the Emergency Contact list for Eos 3D MSS activities.
  - Broome CCI has no further comments or feedback regarding Eos 3D MSS activities.
- Santos requested Broome CCI to send through the following, as discussed in the meeting:
  - Confirm if Broome CCI would like Santos to coordinate an oil spill modelling workshop with your local stakeholders in partnership with DoT.
  - Broome CCI to provide information about the heliport business model, outcomes etc at Djarindjin for Santos to share with internal project team members and our social investment team regarding the development of a similar model south of Broome to support Santos' potential future projects. [Con-2694]
- On 16 April 2025 Santos notified CCI of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Broome CCI that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6121]
- No further correspondence or feedback was received from Broome CCI.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
Broome CCI requested activity notifications.	Santos notes feedback from Broome CCI.	Activity notifications will be sent to Broome CCI.	Broome CCI activity notifications are included in Table 8-4.

Cambridge Gulf Limited

- On 14 November 2023 Santos called Cambridge Gulf Limited regarding proposed Bonaparte Basin activities to be managed under this EP and left a voicemail to return the call. [Con-2672]
- On 14 November 2023 Cambridge Gulf Limited called Santos and discussed the proposed Bonaparte Basin activities, including activities to be managed under this EP. Santos advised it would email through some information for review. [Con-2677]
- On 15 November 2023 Santos emailed Cambridge Gulf Limited with consultation information regarding the proposed Bonaparte Basin activities, including links to fact sheets. [Con-2678]
- On 15 November 2023 Cambridge Gulf Limited emailed Santos advising the proposed Eos 3D MSS activities does not represent an issue for Wyndham Port operations. [Con-2683]

- On 16 April 2025 Santos notified Cambridge Gulf Limited of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Cambridge Gulf Limited that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6152]
- No further correspondence or feedback was received from Cambridge Gulf Limited.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
Cambridge Gulf confirmed it had no objection to the proposed Eos activities.	Santos notes feedback from Cambridge Gulf Limited.	No response required.	Not applicable.

Chamber of Commerce Northern Territory (CCNT)

- On 29 September 2023 Santos emailed CCNT to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2499]
- On 5 November 2023 Santos emailed CCNT further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2637]
- On 22 November 2023 Santos emailed CCNT further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2747]
- On 16 April 2025 Santos notified Chamber of Commerce Northern Territory (CCNT) of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed CCNT that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19May 2025. [Con-6123]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from CCNT.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from CCNT.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Derby Chamber of Commerce & Industry

- On 29 September 2023 Santos emailed Derby CCI to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation. [Con-2498]
- On 13 November 2023 Santos emailed Derby CCI further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities. [Con-2638]
- On 22 November 2023 Santos emailed Derby CCI further to previous correspondence to provide a reminder that feedback is being sought by 27 November 2023. [Con-2748]
- On 16 April 2025 Santos notified Derby CCI of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Derby CCI that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6124]

- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Derby CCI.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from Derby CCI.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

East Kimberley Chamber of Commerce & Industry

- On 29 September 2023 Santos emailed East Kimberley CCI to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2498]
- On 5 November 2023 Santos emailed East Kimberley CCI further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2638]
- On 22 November 2023 Santos emailed East Kimberley CCI further to previous correspondence to provide a reminder that feedback is being sought by 27 November 2023. [Con-2749]
- On 16 April 2025 Santos notified East Kimberley CCI of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed East Kimberley CCI that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6125]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from East Kimberley CCI.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from East Kimberley CCI.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Industry associations – Recreational fishing

Amateur Fishermen's Association of the Northern Territory (AFANT)

- On 18 October 2023 Santos emailed AFANT with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2533]
- On 12 December 2023 Santos emailed AFANT further to previous correspondence, to request feedback for its proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2877]

- On 16 April 2025 Santos notified AFANT of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed AFANT that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6126]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from AFANT.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from AFANT.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Recfishwest

- On 5 December 2023 Santos emailed Recfishwest regarding the proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2835]
- On 11 January 2024 Santos emailed Recfishwest to follow up on any feedback for the proposed Eos 3D MSS activities. Santos advised the EP for these activities would be submitted on 2 April 2024 so feedback prior to this date would be appreciated so it could be included in the EP. [Con-3035]
- On 11 January 2024 Recfishwest emailed Santos advising it had no comments on the proposed Eos 3D MSS activities. [Con-3038]
- On 11 January 2024 Santos emailed Recfishwest in response to their email on 11 January 2024, acknowledging it had no comments regarding the proposed Eos 3D MSS activities. [Con-3039]
- On 16 April 2025 Santos notified Recfishwest emailed of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Recfishwest that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6127]
- On 15 May 2025 Recfishwest emailed Santos, advised Santos that given the location of the proposed activities recreational fishing is unlikely to be impacted within and near the Operational Area. However, Recfishwest advised that some charter fishing and fishing from larger vessels takes place within the EMBA, therefore, requests to continue to be included as the activity progresses. [Con-6261]
- On 21 May 2025 Santos emailed Recfishwest, acknowledging Recfishwest's feedback that given the location of the activity it is unlikely for recreational fishing to be impacted within or near the Operational Area. Santos notes from Recfishwest that some charter fishing and fishing from larger vessels may take place within the EMBA. Santos confirms it will add Recfishwest to the activity notifications and update if there are any changes to the activity. Santos now considers this consultation closed for this EP. [Con-6262]
- No further correspondence or feedback was received from Recfishwest.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
Recfishwest requested activity notifications.	Santos notes feedback from Recfishwest.	Activity notifications will be sent to Recfishwest.	Recfishwest activity notifications are included in Table 8-4.

WA Game Fishing Association (WAGFA)

- On 18 October 2023 Santos emailed WAGFA with preliminary consultation information regarding the proposed Bonaparte Basin activities to be managed under this EP, including links to fact sheets. [Con-2534]
- On 11 January 2024 Santos emailed WAGFA to follow up on any feedback for the proposed Eos 3D MSS activities. Santos advised the EP for these activities would be submitted on 2 April 2024 so feedback prior to this date would be appreciated so it could be included in the EP. [Con-3036]
- On 16 April 2025 Santos notified WAGFA of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed WAGFA that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6128]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from WAGFA.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from WAGFA.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Industry associations – Commercial shipping

Maritime Industry Australia Ltd (MIAL)

- On 29 September 2023 Santos emailed MIAL to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2489]
- On 5 November 2023 Santos emailed MIAL further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2639]
- On 22 November 2023 Santos emailed MIAL further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2756]
- On 16 April 2025 Santos notified MIAL of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed MIAL that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6129]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from MIAL.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from MIAL.	Santos considers it has provided sufficient information and a reasonable period of time for consultation.	No response required.	Not applicable.

	Santos considers Section 25 consultation requirements to have been met.		

Industry Associations – Tourism

Australian Tourism Industry Council (ATIC)

- On 29 September 2023 Santos emailed ATIC to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2500]
- On 5 November 2023 Santos emailed ATIC further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2640]
- On 22 November 2023 Santos emailed ATIC further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2762]
- On 16 April 2025 Santos notified ATIC of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed ATIC that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6131]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from ATIC.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from ATIC.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Northern Territory Guided Fishing Industry Association (NTGFIA)

- On 29 September 2023 Santos emailed NTGFIA to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2500]
- On 5 November 2023 Santos emailed NTGFIA further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2640]
- On 22 November 2023 Santos emailed NTGFIA further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2762]
- On 16 April 2025 Santos notified NTGFIA of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed NTGFIA that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6132]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from NTGFIA.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from NTGFIA.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Tourism Council of Western Australia (TCWA)

- On 29 September 2023 Santos emailed TCWA to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2501]
- On 5 November 2023 Santos emailed TCWA further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2680]
- On 22 November 2023 Santos emailed TCWA further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2764]
- On 16 April 2025 Santos notified TCWA of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed TCWA that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6133]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from TCWA.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from TCWA.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Marine Tourism WA (MTWA)

- On 29 September 2023 Santos emailed MTWA to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2501]
- On 5 November 2023 Santos emailed MTWA further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2680]
- On 22 November 2023 Santos emailed MTWA further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2764]
- On 16 April 2025 Santos notified MTWA of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed MTWA that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6134]

- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from MTWA.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from MTWA.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Tourism Top End

- On 29 September 2023 Santos emailed Tourism Top End to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2500]
- On 5 November 2023 Santos emailed Tourism Top End further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2640]
- On 22 November 2023 Santos emailed Tourism Top End further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2762]
- On 16 April 2025 Santos notified Tourism Top End of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Tourism Top End that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6135
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Tourism Top End.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from Tourism Top End.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Western Australian Indigenous Tourism Operators Council (WAITOC)

- On 29 September 2023 Santos emailed WAITOC to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2501]
- On 5 November 2023 Santos emailed WAITOC further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2680]
- On 22 November 2023 Santos emailed WAITOC further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2764]

- On 16 April 2025 Santos notified WAITOC of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed WAITOC that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6136]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from WAITOC.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from WAITOC.	Santos considers it has provided sufficient time and opportunity for consultation. Santos considers the Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Infrastructure operators

BW Digital

- On 18 October 2023 Santos emailed BW Digital with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2538]
- On 11 December 2023 Santos emailed BW Digital to follow up on feedback regarding the proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2866]
- On 16 April 2025 Santos notified BW Digital of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed BW Digital that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6289]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from BW Digital.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from BW Digital.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Darwin Port

- On 29 September 2023 Santos emailed Darwin Port to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2502]

- On 5 November 2023 Santos emailed Darwin Port further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2681]
- On 22 November 2023 Santos emailed Darwin Port further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2765]
- On 16 April 2025 Santos notified Darwin Port of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Darwin Port that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6290]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Darwin Port.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Darwin Port.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Inligo Networks

- On 18 October 2023 Santos emailed Inligo Networks with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2535]
- On 11 December 2023 Santos emailed Inligo Networks to follow up on feedback regarding the proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2867]
- On 12 December 2023 Santos emailed Inligo Networks to follow up on feedback for the proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2870]
- On 16 April 2025 Santos notified Inligo Network of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Inligo Network that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6291]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Inligo Network.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Inligo Network.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

NT Port and Marine

- On 29 September 2023 Santos emailed NT Port and Marine to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2502]
- On 5 November 2023 Santos emailed NT Port and Marine further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2681]
- On 22 November 2023 Santos emailed NT Port and Marine further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2765]
- On 16 April 2025 Santos notified NT Port and Marine of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed NT Port and Marine that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6294]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from NT Port and Marine.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from NT Port and Marine.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Telstra

- On 19 October 2023 Santos emailed Telstra with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2539]
- On 5 November 2023 Santos emailed Telstra further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2681]
- On 22 November 2023 Santos emailed Telstra further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2765]
- On 16 April 2025 Santos notified Telstra of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Telstra that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6295]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Telstra.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Telstra.	Santos considers it has provided sufficient information and a reasonable period of time for consultation.	No response required.	Not applicable.

	Santos considers Section 25 consultation requirements to have been met.		

Vocus

- On 29 September 2023 Santos emailed Vocus to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2502]
- On 5 November 2023 Santos emailed Vocus further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2681]
- On 22 November 2023 Santos emailed Vocus further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2765]
- On 16 April 2025 Santos notified Vocus of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Vocus that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6296]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Vocus.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Vocus.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Local Government Authorities – Northern Territory

City of Darwin

- On 29 September 2023 Santos emailed Darwin City Council to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2503]
- On 5 November 2023 Santos emailed Darwin City Council further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2685]
- On 22 November 2023 Santos emailed Darwin City Council further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2766]
- On 16 April 2025 Santos notified City of Darwin of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed City of Darwin that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6297]
- On 16 April 2025 Santos received an automated email advising correspondence was received and allocated to the appropriate person for action. [Con-6298]
- No further correspondence or feedback was received from City of Darwin.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from City of Darwin.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Litchfield Council

- On 29 September 2023 Santos emailed Litchfield Council to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2507]
- On 6 November 2023 Santos emailed Litchfield Council further to previous correspondence, to advise that it is now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2690]
- On 22 November 2023 Santos emailed Litchfield Council further to previous correspondence to provide a reminder that feedback is being sought by 27 November 2023. [Con-2767]
- On 16 April 2025 Santos notified Litchfield Council of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Litchfield Council that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6299]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Litchfield Council.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from Litchfield Council.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Tiwi Islands Regional Council

- On 29 September 2023 Santos emailed Tiwi Islands Regional Council to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2503]
- On 5 November 2023 Santos emailed Tiwi Islands Regional Council further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2685]
- On 22 November 2023 Santos emailed Tiwi Islands Regional Council further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2766]

- On 16 April 2025 Santos notified Tiwi Islands Regional Council of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Tiwi Islands Regional Council that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6300]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Tiwi Islands Regional Council.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Tiwi Islands Regional Council.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Victoria Daly Regional Council

- On 29 September 2023 Santos emailed Victoria Daly Regional Council to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2506]
- On 6 November 2023 Santos emailed Victoria Daly Regional Council further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2691]
- On 22 November 2023 Santos emailed –Victoria Daly Regional Council further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2768]
- On 16 April 2025 Santos notified Victoria Daly Regional Council of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Victoria Daly Regional Council that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6301]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Victoria Daly Regional Council.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Victoria Daly Regional Council.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Wagait Shire Council

- On 29 September 2023 Santos emailed Wagait Shire Council to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2505]

- On 5 November 2023 Santos emailed Wagait Shire Council further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2685]
- On 22 November 2023 Santos emailed Wagait Shire Council further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2766]
- On 16 April 2025 Santos notified Wagait Shire Council of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Wagait Shire Council that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6302]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Wagait Shire Council.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Wagait Shire Council.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

West Arnhem Regional Council

- On 29 September 2023 Santos emailed West Arnhem Regional Council to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2505]
- On 5 November 2023 Santos emailed West Arnhem Regional Council further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2685]
- On 22 November 2023 Santos emailed West Arnhem Regional Council further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2769]
- On 16 April 2025 Santos notified West Arnhem Regional Council of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed West Arnhem Regional Council that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6303]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from West Arnhem Regional Council.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from West Arnhem Regional Council.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

West Daly Regional Council

- On 29 September 2023 Santos emailed West Daly Regional Council to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2505]
- On 5 November 2023 Santos emailed West Daly Regional Council further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2685]
- On 22 November 2023 Santos emailed West Daly Regional Council further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2766]
- On 16 April 2025 Santos notified West Daly Regional Council of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed West Daly Regional Council that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6304]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from West Daly Regional Council.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from West Daly Regional Council.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Local Government Authorities – Western Australia

Shire of Derby-West Kimberley

- On 29 September 2023 Santos emailed Shire of Derby-West Kimberley to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2508]
- On 6 November 2023 Santos emailed Shire of Derby-West Kimberley further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2686]
- On 6 November 2023 Shire of Derby-West Kimberley emailed Santos advising it had no comments or concerns regarding the proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2623]
- On 16 April 2025 Santos notified Shire of Derby-West Kimberley of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Shire of Derby-West Kimberley that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6305]
- On 16 April 2025 Santos received an automated email advising the recipient was away on leave. [Con-6306]
- No further correspondence or feedback was received from Shire of Derby-West Kimberley.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
Shire of Derby-West Kimberley provided an email to Santos confirming it had no objection to the proposed Eos seismic survey.	Santos notes feedback from Shire of Derby – West Kimberley.	No response required.	Not applicable.

Shire of Wyndham-East Kimberley

- On 29 September 2023 Santos emailed Shire of Wyndham-East Kimberley to advise it of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2508]
- On 6 November 2023 Santos emailed Shire of Wyndham-East Kimberley further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2686]
- On 22 November 2023 Santos emailed Shire of Wyndham-East Kimberley further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2770]
- On 4 December 2023 Shire of Wyndham-East Kimberley emailed Santos advising it had no objection to the proposed Eos 3D MSS activities. [Con-2833]
- On 5 December 2023 Santos emailed Shire of Wyndham-East Kimberley acknowledging it had no objection or feedback regarding the proposed Eos 3D MSS activities. [Con-2843]
- On 16 April 2025 Santos notified Shire of Wyndham-East Kimberley of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Shire of Wyndham-East Kimberley that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6307]
- No further correspondence or feedback was received from Shire of Wyndham-East Kimberley.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
Shire of Wyndham-East Kimberley provided that they had no objection to the proposed Eos seismic survey.	Santos notes feedback from the Shire of Wyndham – East Kimberley.	No response required.	Not applicable.

Recreational fishers

NT and WA Recreational Fishers

- Santos has consulted the NT recreational fishers via representative organisations – Amateur Fishermen's Association of the Northern Territory (AFANT) on 18 October 2023 [Con-2533] and 12 December 2023 [Con-2877].
- Santos has notified the NT recreational fishers of the proposed activity timeline via representative organisations on 16 April 205 – Amateur Fishermen's Association of the Northern Territory (AFANT) [Con-6126]
- Santos has consulted the WA recreational fishers via representative organisations – Recfishwest on 5 December 2023 [Con-2835] and 11 January 2024 [Con-3035], [Con-3038], [Con-3039], [Con-3040], [Con-3041], and Western Australian Game Fishing Association (WAGFA) on 18 October 2023 [Con-2534] and 11 January 2024 [Con-3036].

- Santos has notified the WA recreational fishers of the proposed activity timeline via representative organisations on 16 April 205 – Recfishwest [Con-6127] and Western Australian Game Fishing Association (WAGFA) [Con-6128]

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from NT and WA Recreational Fishers. (See previous table entries for ***Industry associations – Recreation fishing*** for consultation with Recreational Fishing Associations).	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Tourism operators

DNA Barra Fishing, Darwin

- On 26 October 2023 Santos emailed DNA Barra Fishing, Darwin to advise them of preliminary consultation regarding proposed Bonaparte Basin activities for consultation including activities to be managed under this EP. [Con-2567]
- On 8 November 2023 Santos emailed DNA Barra Fishing, Darwin further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2688]
- On 22 November 2023 Santos emailed DNA Barra Fishing, Darwin further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified DNA Barra Fishing, Darwin of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed DNA Barra Fishing, Darwin that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6189]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from DNA Barra Fishing, Darwin.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from DNA Barra Fishing, Darwin.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Absolute Ocean Charters			
• On 26 October 2023 Santos emailed Absolute Ocean Charters to advise them of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2568] • On 6 November 2023 Santos emailed Absolute Ocean Charters further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2692] • On 22 November 2023 Santos emailed Absolute Ocean Charters further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2773] • On 16 April 2025 Santos notified Absolute Ocean Charters of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Absolute Ocean Charters that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6308] • Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Absolute Ocean Charters.			
Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Absolute Ocean Charters.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.
Berkeley River Lodge			
• On 26 October 2023 Santos emailed Berkeley River Lodge to advise them of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2568] • On 6 November 2023 Santos emailed Berkeley River Lodge further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2692] • On 22 November 2023 Santos emailed Berkeley River Lodge further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2773] • On 16 April 2025 Santos notified Berkeley River Lodge of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Berkeley River Lodge that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6309] • Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Berkeley River Lodge.			
Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Berkeley River Lodge.	Santos considers it has provided sufficient information and a reasonable period of time for consultation.	No response required.	Not applicable.

	Santos considers Section 25 consultation requirements to have been met.		

Broome Adventure Company – Turtle Kayak

- On 26 October 2023 Santos emailed Broome Adventure Company – Turtle Kayak to advise them of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2568]
- On 6 November 2023 Santos emailed Broome Adventure Company – Turtle Kayak further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2692]
- On 22 November 2023 Santos emailed Broome Adventure Company – Turtle Kayak further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2773]
- On 16 April 2025 Santos notified Broome Adventure Company – Turtle Kayak of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Broome Adventure Company – Turtle Kayak that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6310]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Broome Adventure Company – Turtle Kayak.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Broome Adventure Company – Turtle Kayak.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Broome Billfish Charters

- On 26 October 2023 Santos emailed Broome Billfish Charters to advise them of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2568]
- On 6 November 2023 Santos emailed Broome Billfish Charters further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2692]
- On 22 November 2023 Santos emailed Broome Billfish Charters further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2773]
- On 16 April 2025 Santos notified Broome Billfish Charters of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Broome Billfish Charters that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6311] "
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Broome Billfish Charters.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from Broome Billfish Charters.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Kimberley Pearl Charters

- On 26 October 2023 Santos emailed Kimberley Pearl Charters to advise them of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2568]
- On 6 November 2023 Santos emailed Kimberley Pearl Charters further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2692]
- On 22 November 2023 Santos emailed Kimberley Pearl Charters further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2773]
- On 16 April 2025 Santos notified Kimberley Pearl Charters of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Kimberley Pearl Charters that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6312]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Kimberley Pearl Charters.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from Kimberley Pearl Charters.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Kuri Bay Sport Fishing Tours

- On 26 October 2023 Santos emailed Kuri Bay Sport Fishing Tours to advise them of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2568]
- On 6 November 2023 Santos emailed Kuri Bay Sport Fishing Tours further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2692]
- On 22 November 2023 Santos emailed Kuri Bay Sport Fishing Tours further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2773]
- On 23 November 2023 Kuri Bay Sport Fishing Tours emailed Santos advising it had responded to the feedback already. [Con-2756]

- On 11 January 2024 Santos emailed Kuri Bay Sport Fishing Tours asking if they had got confused about providing feedback for the proposed Barossa activities, not the Bonaparte Basin activities. Santos advised if Kuri Bay Sport Fishing Tours had feedback or comments for the proposed Eos 3D MSS activities, to please provide this before the EP submission date of 2 April 2024. [Con-3037]
- On 16 April 2025 Santos notified Kuri Bay Sport Fishing Tours of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Kuri Bay Sport Fishing Tours that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6313]

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
Kuri Bay Sport Fishing Tours advised it had already responded with feedback.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	Santos questioned Kuri Bay Sport Fishing Tours if they had got confused about providing feedback for the proposed Barossa activities, not the Bonaparte Basin activities. Santos further asked if Kuri Bay Sport Fishing Tours had feedback or comments for the proposed Eos 3D MSS activities.	Not applicable.

Phat Time Fishing

- On 26 October 2023 Santos emailed Phat Time Fishing to advise them of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2568]
- On 6 November 2023 Santos emailed Phat Time Fishing further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2692]
- On 22 November 2023 Santos emailed Phat Time Fishing further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2773]
- On 16 April 2025 Santos notified Phat Time Fishing of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Phat Time Fishing that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6314]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Phat Time Fishing.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Phat Time Fishing.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Reel Teaser Fishing Adventures

- On 26 October 2023 Santos emailed Reel Teaser Fishing Adventures to advise them of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2568]

- On 6 November 2023 Santos emailed Reel Teaser Fishing Adventures further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2692]
- On 22 November 2023 Santos emailed Reel Teaser Fishing Adventures further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2773]
- On 16 April 2025 Santos notified Reel Teaser Fishing Adventures of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Reel Teaser Fishing Adventures that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6315]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Reel Teaser Fishing Adventures.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Reel Teaser Fishing Adventures.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Slick Fishing Charters

- On 26 October 2023 Santos emailed Slick Fishing Charters to advise them of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2568]
- On 6 November 2023 Santos emailed Slick Fishing Charters further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2692]
- On 22 November 2023 Santos emailed Slick Fishing Charters further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2773]
- On 16 April 2025 Santos notified Slick Fishing Charters of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Slick Fishing Charters that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6316]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Slick Fishing Charters.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Slick Fishing Charters.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Smithy's Seaside Adventures

- On 27 October 2023 Santos emailed Smithy's Seaside Adventures to advise them of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2569]
- On 6 November 2023 Santos emailed Smithy's Seaside Adventures further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2692]
- On 22 November 2023 Santos emailed Smithy's Seaside Adventures further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2773]
- On 16 April 2025 Santos notified Smithy's Seaside Adventures of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Smithy's Seaside Adventures that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6317]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Smithy's Seaside Adventures.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Smithy's Seaside Adventures.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

West Kimberley Fishing Tours

- On 26 October 2023 Santos emailed West Kimberley Fishing Tours to advise them of preliminary consultation regarding proposed Bonaparte Basin activities for consultation, including activities to be managed under this EP. [Con-2568]
- On 6 November 2023 Santos emailed West Kimberley Fishing Tours further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2692]
- On 22 November 2023 Santos emailed West Kimberley Fishing Tours further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2773]
- On 16 April 2025 Santos notified West Kimberley Fishing Tours of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed West Kimberley Fishing Tours that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6318]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from West Kimberley Fishing Tours.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from West Kimberley Fishing Tours.	Santos considers it has provided sufficient information and a reasonable period of time for consultation.	No response required.	Not applicable.

	Santos considers Section 25 consultation requirements to have been met.		

Alure Fishing Charters

- On 23 October 2023 Santos emailed Alure Fishing Charters with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Alure Fishing Charters further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Alure Fishing Charters further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Alure Fishing Charters of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Alure Fishing Charters that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6319]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Alure Fishing Charters.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Alure Fishing Charters.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Anglers Advantage Fishing Charters

- On 23 October 2023 Santos emailed Anglers Advantage Fishing Charters with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Anglers Advantage Fishing Charters further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Anglers Advantage Fishing Charters further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Anglers Advantage Fishing Charters of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Anglers Advantage Fishing Charters that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6320]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Anglers Advantage Fishing Charters.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from Anglers Advantage Fishing Charters.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Angler's Choice Fishing Safaris

- On 23 October 2023 Santos emailed Angler's Choice Fishing Safaris with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Angler's Choice Fishing Safaris further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Angler's Choice Fishing Safaris further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Angler's Choice Fishing Safaris of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Angler's Choice Fishing Safaris that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6321]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Angler's Choice Fishing Safaris.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from Angler's Choice Fishing Safaris.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Arafura Bluewater Charters

- On 23 October 2023 Santos emailed Arafura Bluewater Charters with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Arafura Bluewater Charters further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Arafura Bluewater Charters further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]

- On 16 April 2025 Santos notified Arafura Bluewater Charters of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Arafura Bluewater Charters that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6322]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Arafura Bluewater Charters.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Arafura Bluewater Charters.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Barra Fishing Charters

- On 23 October 2023 Santos emailed Barra Fishing Charters with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Barra Fishing Charters further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Barra Fishing Charters further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Barra Fishing Charters of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Barra Fishing Charters that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6323]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Barra Fishing Charters.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Barra Fishing Charters.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Bayview Marina

- On 23 October 2023 Santos emailed Bayview Marina with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]

- On 6 November 2023 Santos emailed Bayview Marina further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Bayview Marina further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Bayview Marina of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Bayview Marina that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6324]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Bayview Marina.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Bayview Marina.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Clearwater Island Lodge and Munupi Wilderness Lodge

- On 5 December 2023 Santos emailed Clearwater Island Lodge and Munupi Wilderness Lodge regarding the proposed Bonaparte Basin activities including activities to be managed under this EP. The email requested Clearwater Island Lodge and Munupi Wilderness Lodge to provide any feedback by 31 December 2023. [Con-2836]
- On 12 December 2023 Santos emailed Clearwater Island Lodge and Munupi Wilderness Lodge following up on feedback for the proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2878]
- On 19 March 2024 Santos emailed Clearwater Island Lodge and Munupi Wilderness Lodge providing a further opportunity to provide input and requested input by 26 March 2024. [Con-3449]
- On 16 April 2025 Santos notified Clearwater Island Lodge and Munupi Wilderness Lodge of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Clearwater Island Lodge and Munupi Wilderness Lodge that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6325]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Clearwater Island Lodge and Munupi Wilderness Lodge.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Clearwater Island Lodge and Munupi Wilderness Lodge.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Compass T-L

- On 5 December 2023 Santos emailed Compass T-L regarding the proposed Bonaparte Basin activities including activities to be managed under this EP. The email requested Crab Claw Island Resort to provide any feedback by 31 December 2023. [Con-2836]
- On 12 December 2023 Santos emailed Compass T-L following up on feedback for the proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2878]
- On 19 March 2024 Santos emailed Compass T-L providing a further opportunity to provide input and requested input by 26 March 2024. [Con-3449]
- On 16 April 2025 Santos notified Compass T-L of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Compass T-L that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6326]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Compass T-L.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Compass T-L.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Crab Claw Island Resort

- On 5 December 2023 Santos emailed Crab Claw Island Resort regarding the proposed Bonaparte Basin activities including activities to be managed under this EP. The email requested Crab Claw Island Resort to provide any feedback by 31 December 2023. [Con-2836]
- On 12 December 2023 Santos emailed Crab Claw Island Resort following up on feedback for the proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2878]
- On 19 March 2024 Santos emailed Crab Claw Island Retreat providing a further opportunity to provide input and requested input by 26 March 2024. [Con-3449]
- On 16 April 2025 Santos notified Crab Claw Island Resort of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Crab Claw Island Resort that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6327]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Crab Claw Island Resort.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Crab Claw Island Resort.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Cullen Bay Fishing Charters

- On 23 October 2023 Santos emailed Cullen Bay Fishing Charters with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Cullen Bay Fishing Charters further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities. [Con-2689]
- On 22 November 2023 Santos emailed Cullen Bay Fishing Charters further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Cullen Bay Fishing Charters of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Cullen Bay Fishing Charters that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6328]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Cullen Bay Fishing Charters.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Cullen Bay Fishing Charters.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Darwin Bara Fishing Tours

- On 23 October 2023 Santos emailed Darwin Bara Fishing Tours with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Darwin Bara Fishing Tours further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Darwin Bara Fishing Tours further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Darwin Bara Fishing Tours of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Darwin Bara Fishing Tours that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6329]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Darwin Bara Fishing Tours.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Darwin Bara Fishing Tours.	Santos considers it has provided sufficient information and a reasonable period of time for consultation.	No response required.	Not applicable.

	Santos considers Section 25 consultation requirements to have been met.		

Darwin Dive Academy

- On 23 October 2023 Santos emailed Darwin Dive Academy with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Darwin Dive Academy further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Darwin Dive Academy further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Darwin Dive Academy of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Darwin Dive Academy that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6330]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Darwin Dive Academy.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Darwin Dive Academy.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Darwin Fish Seeker Charters

- On 23 October 2023 Santos emailed Darwin Fish Seeker Charters with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Darwin Fish Seeker Charters further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Darwin Fish Seeker Charters further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Darwin Fish Seeker Charters of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Darwin Fish Seeker Charters that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6331]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Darwin Fish Seeker Charters.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from Darwin Fish Seeker Charters.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Darwin Harbour Cruises.

- On 23 October 2023 Santos emailed Darwin Harbour Cruises with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Darwin Harbour Cruises further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Darwin Harbour Cruises further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Darwin Harbour Cruises of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Darwin Harbour Cruises that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6332]
- On 16 April 2025, Santos received an auto-generated email confirming receipt of notification. [Con-6333]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Darwin Harbour Cruises.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from Darwin Harbour Cruises.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Darwin Harbour Fishing Charters

- On 23 October 2023 Santos emailed Darwin Harbour Fishing Charters with preliminary consultation information regarding the proposed Bonaparte Basin activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Darwin Harbour Fishing Charters further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Darwin Harbour Fishing Charters further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]

- On 16 April 2025 Santos notified Darwin Harbour Fishing Charters of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Darwin Harbour Fishing Charters that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6334]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Darwin Harbour Fishing Charters.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Darwin Harbour Fishing Charters.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Darwin Red Devil Fishing Charters

- On 23 October 2023 Santos emailed Darwin Red Devil Fishing Charters with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Darwin Red Devil Fishing Charters further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Darwin Red Devil Fishing Charters further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Darwin Red Devil Fishing Charters of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Darwin Red Devil Fishing Charters that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6335]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Darwin Red Devil Fishing Charters.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Darwin Red Devil Fishing Charters.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Darwin Sailing Club

- On 23 October 2023 Santos emailed Darwin Sailing Club with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]

- On 6 November 2023 Santos emailed Darwin Sailing Club further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Darwin Sailing Club further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Darwin Trailer Boat Club of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Darwin Trailer Boat Club that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6337]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Darwin Sailing Club.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Darwin Sailing Club.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Darwin Trailer Boat Club

- On 23 October 2023 Santos emailed Darwin Trailer Boat Club with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Darwin Trailer Boat Club further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Darwin Trailer Boat Club further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Darwin Trailer Boat Club of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Darwin Trailer Boat Club that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6337]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Darwin Trailer Boat Club.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Darwin Trailer Boat Club.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Dinah Beach Cruising Yacht Club

- On 23 October 2023 Santos emailed Dinah Beach Cruising Yacht Club with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Dinah Beach Cruising Yacht Club further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Dinah Beach Cruising Yacht Club further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Dinah Beach Cruising Yacht Club of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Dinah Beach Cruising Yacht Club that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6338]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Dinah Beach Cruising Yacht Club.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Dinah Beach Cruising Yacht Club.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Dreamers Dive Academy Timor

- On 5 December 2023 Santos emailed Dreamers Dive Academy Timor regarding the proposed Bonaparte Basin activities, including activities to be managed under this EP. The email requested Dreamers Dive Academy to provide any feedback by 31 December 2023. [Con-2836]
- On 12 December 2023 Santos emailed Dreamers Dive Academy Timor following up on feedback for the proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2878]
- On 19 March 2024 Santos emailed Dreamers Dive Academy providing a further opportunity to provide input and requested input by 26 March 2024. [Con-3449]
- On 16 April 2025 Santos notified Dreamers Dive Academy Timor of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Dreamers Dive Academy Timor that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6339]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Dreamers Dive Academy Timor.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Dreamers Dive Academy Timor.	Santos considers it has provided sufficient information and a reasonable period of time for consultation.	No response required.	Not applicable.

	Santos considers Section 25 consultation requirements to have been met.		

Dundee Beach Fishing Charters

- On 23 October 2023 Santos emailed Dundee Beach Fishing Charters with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Dundee Beach Fishing Charters further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Dundee Beach Fishing Charters further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Dundee Beach Fishing Charters of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Dundee Beach Fishing Charters that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6340]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Dundee Beach Fishing Charters.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Dundee Beach Fishing Charters.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Equinox Fishing Charters

- On 23 October 2023 Santos emailed Equinox Fishing Charters with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Equinox Fishing Charters further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Equinox Fishing Charters further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Equinox Fishing Charters of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Equinox Fishing Charters that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6341]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Equinox Fishing Charters.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from Equinox Fishing Charters.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Estuary Escapes Fishing Charters

- On 23 October 2023 Santos emailed Estuary Escape Fishing Charters with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Estuary Escape Fishing Charters further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Estuary Escape Fishing Charters further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Estuary Escapes Fishing Charters of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Estuary Escapes Fishing Charters that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19May 2025. [Con-6342]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Estuary Escapes Fishing Charters.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from Estuary Escapes Fishing Charters.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Fish the Top End Fishing Charters

- On 23 October 2023 Santos emailed Fish the Top End Fishing Charters with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Fish the Top End Fishing Charters further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Fish the Top End Fishing Charters further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Fish the Top End Fishing Charters of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Fish the Top End Fishing Charters that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6343]

- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Fish the Top End Fishing Charters.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from Fish the Top End Fishing Charters.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

FNA Sports Fishing

- On 23 October 2023 Santos emailed FNA Sports Fishing with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed FNA Sports Fishing further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed FNA Sports Fishing further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified FNA Sports Fishing of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed FNA Sports Fishing that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6344]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from FNA Sports Fishing.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from FNA Sports Fishing.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Humbug Fishing

- On 23 October 2023 Santos emailed Humbug Fishing with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Humbug Fishing further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Humbug Fishing further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Humbug Fishing of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Humbug Fishing that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6345]

- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Humbug Fishing.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from Humbug Fishing.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

NT Indigenous Tours

- On 23 October 2023 Santos emailed NT Indigenous Tours with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed NT Indigenous Tours further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed NT Indigenous Tours further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified NT Indigenous Tours of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed NT Indigenous Tours that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6346]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from NT Indigenous Tours.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from NT Indigenous Tours.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Obsession Fishing Safaris

- On 23 October 2023 Santos emailed Obsession Fishing Safaris with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Obsession Fishing Safaris further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Obsession Fishing Safaris further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]

- On 16 April 2025 Santos notified Obsession Fishing Safaris of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Obsession Fishing Safaris that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6347]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Obsession Fishing Safaris.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Obsession Fishing Safaris.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Offshore Boats Fishing Charters

- On 23 October 2023 Santos emailed Offshore Boats Fishing Charters with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Offshore Boats Fishing Charters further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Offshore Boats Fishing Charters s further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Offshore Boats Fishing Charters of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Offshore Boats Fishing Charters that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6348]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Offshore Boats Fishing Charters.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Offshore Boats Fishing Charters.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Palmerston Game Fishing Club

- On 23 October 2023 Santos emailed Palmerston Game Fishing Club with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Palmerston Game Fishing Club further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]

- On 22 November 2023 Santos emailed Palmerston Game Fishing Club further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Palmerston Game Fishing Club of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Palmerston Game Fishing Club that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6349]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Palmerston Game Fishing Club.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Palmerston Game Fishing Club.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Reel Screamin Barra Fishing

- On 23 October 2023 Santos emailed Reel Screamin Barra Fishing with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Reel Screamin Barra Fishing further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Reel Screamin Barra Fishing further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Reel Screamin Barra Fishing of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Reel Screamin Barra Fishing that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6350]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Reel Screamin Barra Fishing.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Reel Screamin Barra Fishing.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Sail Darwin

- On 23 October 2023 Santos emailed Sail Darwin with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]

- On 6 November 2023 Santos emailed Sail Darwin further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Sail Darwin further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Sail Darwin of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Sail Darwin that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6351]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Sail Darwin.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Sail Darwin.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Saltwater Cultural Tours

- On 23 October 2023 Santos emailed Saltwater Cultural Tours with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Saltwater Cultural Tours further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Saltwater Cultural Tours further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Saltwater Cultural Tours of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Saltwater Cultural Tours that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6137]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Saltwater Cultural Tours.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Saltwater Cultural Tours.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Sea Darwin

- On 23 October 2023 Santos emailed Sea Darwin with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Sea Darwin further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Sea Darwin further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Sea Darwin of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Sea Darwin that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6138]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Sea Darwin.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Sea Darwin.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Shoal Bay Sportfishing Tours

- On 23 October 2023 Santos emailed Shoal Bay Sportfishing Tours with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Shoal Bay Sportfishing Tours further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Shoal Bay Sportfishing Tours further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Shoal Bay Sportfishing Tours of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Shoal Bay Sportfishing Tours that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6139]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Shoal Bay Sportfishing Tours.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Shoal Bay Sportfishing Tours.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Spring Tide Safaris

- On 23 October 2023 Santos emailed Spring Tide Safaris with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Spring Tide Safaris further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Spring Tide Safaris further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Spring Tide Safaris of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Spring Tide Safaris that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6140]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Spring Tide Safaris.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Spring Tide Safaris.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Streeter Cruises

- On 24 October 2023 Santos emailed Streeter Cruises with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2547]
- On 6 November 2023 Santos emailed Streeter Cruises further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Streeter Cruises further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Streeter Cruises of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Streeter Cruises that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6141]
- On 16 April 2025 Santos received notification that the respondent was forwarding the notification to its new email address. [Con-6142]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Streeter Cruises.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Streeter Cruises.	Santos considers it has provided sufficient information and a reasonable period of time for consultation.	No response required.	Not applicable.

	Santos considers Section 25 consultation requirements to have been met.		

Territory Guided Fishing

- On 23 October 2023 Santos emailed Territory Guided Fishing with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Territory Guided Fishing further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Territory Guided Fishing further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Territory Guided Fishing of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Territory Guided Fishing that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6144]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Territory Guided Fishing.

Summary of response by relevant person	***Assessment of merits***	***Santos' response statement***	***EP Reference***
No response was received from Territory Guided Fishing.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Tiwi Island Adventures

- On 5 December 2023 Santos emailed Tiwi Island Adventures regarding the proposed Bonaparte Basin activities, including activities to be managed under this EP. The email requested Tiwi Island Adventures to provide any feedback by 31 December 2023. [Con-2836]
- On 12 December 2023 Santos emailed Tiwi Island Adventures following up on feedback for the proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2878]
- On 19 March 2024 Santos emailed Tiwi Island Adventures providing a further opportunity to provide input and requested input by 26 March 2024. [Con-3449]
- On 16 April 2025 Santos notified Tiwi Island Adventures of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Tiwi Island Adventures that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6145]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Tiwi Island Adventures.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from Tiwi Island Adventures.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Tiwi Island Retreat

- On 5 December 2023 Santos emailed Tiwi Island Retreat regarding the proposed Bonaparte Basin activities including activities to be managed under this EP. The email requested Tiwi Island Retreat to provide any feedback by 31 December 2023. [Con-2836]
- On 12 December 2023 Santos emailed Tiwi Island Retreat following up on feedback for the proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2878]
- On 19 March 2024 Santos emailed Tiwi Island Retreat providing a further opportunity to provide input and requested input by 26 March 2024. [Con-3449]
- On 16 April 2025 Santos notified Tiwi Island Retreat of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Tiwi Island Retreat that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6147]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Tiwi Island Retreat.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from Tiwi Island Retreat.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Top End Barra Fishing Tours

- On 23 October 2023 Santos emailed Top End Barra Fishing Tours with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Top End Barra Fishing Tours further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Top End Barra Fishing Tours further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Top End Barra Fishing Tours of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Top End Barra Fishing Tours that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6148]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Top End Barra Fishing Tours.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from Top End Barra Fishing Tours.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Top End Seafaris

- On 24 October 2023 Santos emailed Top End Seafaris with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2547]
- On 6 November 2023 Santos emailed Top End Seafaris further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Top End Seafaris further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Top End Seafaris of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Top End Seafaris that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6149]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Top End Seafaris.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from Top End Seafaris.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Vision Sport Fishing

- On 23 October 2023 Santos emailed Vision Sport Fishing with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Vision Sport Fishing further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Vision Sport Fishing further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 16 April 2025 Santos notified Vision Sport Fishing of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Vision Sport Fishing that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6150]
- Notwithstanding the consultation information provided and the steps described above, no comment or input was received on this EP from Vision Sport Fishing.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
No response was received from Vision Sport Fishing.	Santos considers it has provided sufficient information and a reasonable period of time for consultation. Santos considers Section 25 consultation requirements to have been met.	No response required.	Not applicable.

Yknot Fishing Charters

- On 23 October 2023 Santos emailed Yknot Fishing Charters with preliminary consultation information regarding the proposed Bonaparte Basin activities including activities to be managed under this EP, including links to fact sheets. [Con-2546]
- On 6 November 2023 Santos emailed Yknot Fishing Charters further to previous correspondence, to advise that it was now consulting regarding proposed Bonaparte Basin activities, including activities to be managed under this EP. [Con-2689]
- On 22 November 2023 Santos emailed Yknot Fishing Charters further to previous correspondence to provide a reminder that feedback was being sought by 27 November 2023. [Con-2772]
- On 22 November 2023, Yknot emailed Santos to advise they had no objection to proposed Eos activity. [Con-3112]
- On 16 April 2025 Santos notified Yknot Fishing Charters of an update to the proposed activity timeline. The earliest possible commencement was now anticipated in Q1 2026. Santos informed Yknot Fishing Charters that the activity may take place at any time between the acceptance of the Environment Plan (EP) by the Regulator and the end of December 2027. In addition to previous correspondence, Santos also advised that this is the final opportunity to provide input, with input due by 19 May 2025. [Con-6151]
- No further correspondence or feedback was received from Yknot.

Summary of response by relevant person	*Assessment of merits*	*Santos' response statement*	*EP Reference*
Yknot confirmed it had no objection to the proposed Eos activities.	Santos notes feedback provided by Yknot Fishing Charters.	No response required.	Not applicable.

5. Impact and risk assessment

OPGGS(E)R 2023 Requirements
Section 21. Environmental assessment
Evaluation of environmental impacts and risks 21(5) The environment plan must include: a) details of the environmental impacts and risks for the activity; and b) an evaluation of all the impacts and risks, appropriate to the nature and scale of each impact or risk; and c) details of the control measures that will be used to reduce the impacts and risks of the activity to as low as reasonably practicable and an acceptable level. 21(6) To avoid doubt, the evaluation mentioned in paragraph (5)(b) must evaluate all the environmental impacts and risks arising directly or indirectly from: a) all operations of the activity; and b) potential emergency conditions, whether resulting from accident or any other reason.

Environmental impact and risk assessment refers to a process whereby planned and unplanned events that will or may occur during an activity are quantitatively and/or qualitatively assessed for their impacts on the environment (physical, biological, and socio-economic) at a defined location and specified period of time. In addition, unplanned events are assessed on the basis of their likelihood of occurrence which contributes to their level of risk.

Santos has undertaken environmental impact and risk assessments for the planned events (including any routine, non-routine and contingency activities) and unplanned events in accordance with the OPGGS(E)R.

Provided in this section of the EP is the following information relating to the environmental impact and risk assessment approach:

- Terminology used
- Summary of the approach.

A full description of the process applied in identifying, analysing and evaluating the impacts and risks relating to the planned activity is documented in Santos' *Offshore Division Environmental Hazard Identification and Assessment Procedure* (EA-91-IG-00004 5).

The outcome of the impact and risk assessment process is detailed in Sections 6 and 7.

5.1 Impact and risk assessment methodology

Common terms applied during the impact and risk assessment process and used in this EP are defined in Table 5-1. For a more comprehensive listing of the terms and definitions used in environmental impact and risk assessment, refer to Santos' *Environmental Hazard Identification and Assessment Procedure* (EA-91-IG-00004-6).

Table 5-1: Impact and risk assessment terms and definitions

Term	Definition
Acceptability	Determined for both impacts and risks. Acceptability of events is in part determined by the consequence of the impact following management controls. Acceptability of unplanned events is in part determined from its risk ranking following management controls. For both impacts and risks, acceptability is also determined from a demonstration of the ALARP principle, consistency with Santos Policies, consistency with all applicable legislation and consideration of relevant stakeholder consultation when determining management controls.
Activity	Specific tasks and actions undertaken throughout the life cycle of oil and gas exploration, production and decommissioning.
ALARP	As Low As Reasonably Practicable The term refers to reducing risk to a level that is As Low As Reasonably Practicable. In practice, this means showing through reasoned and supported arguments, that there are no other practicable options that could reasonably be adopted to reduce risks further.
Authorised Person	Person with authority to make the decision or take the action. Examples are Vessel Master, Field Superintendent, Supervisor, Person-in-charge, Company Authorised Representative, and Project Manager.

Term	Definition
Control Measure	Means a system, an item of equipment, a person or a procedure, that is used as a basis for managing environmental impacts and risks[3].
DEMIRS	Department of Environment, Mines, Industry Regulation and Safety
ENVID	Environmental hazard identification workshop.
Environment	Includes natural and socio-economic values and sensitivities, which will or may be affected by the activity. Is defined by NOPSEMA and DEMIRS as: a) ecosystems and their constituent parts, including people and communities; and b) natural and physical resources; and c) the qualities and characteristics of locations, places and areas; and d) the heritage value of places e) the social, economic and cultural features of the matters mentioned in paragraphs (a), (b), (c) and (d).
Environmental consequence	A consequence is the outcome of an event affecting objectives. • Note 1 An event can be one or more occurrences and can have several cases. • Note 2 An event can consist of something not happening. *(Reference ISO 73:2009 Risk Vocabulary)*
Environmental impact	Defined by NOPSEMA[1] as any change to the environment, whether adverse or beneficial, wholly or partly resulting from a planned or unplanned event. Defined by DEMIRS[4] as any change to the environment, whether adverse or beneficial, that wholly or partly results from an activity of an operator.
Environmental risk	Applies to unplanned events. Risk is a function of the likelihood of the unplanned event occurring and the consequence of the environmental impact that arises from that event.
Grossly disproportionate	Where the sacrifice (cost and effort) of implementing a control measure to reduce impact or risk, grossly exceeds the environmental benefit to be gained.
Hazard	A situation with the potential to cause harm.
Impact assessment	The process of determining the consequence of an impact (in terms of the consequence to the environment) arising from a planned or unplanned event over a specified period of time.
Likelihood	The chance of an unplanned event occurring.
Non-routine planned event	An attribute of the planned activity that may occur or will occur infrequently during the planned activity. A non-routine planned event is intended to occur at the time.
Planned activity	A description of the activity to be undertaken including the services, equipment, products, assets, personnel, timing, duration and location and aspect of the activity.
Planned event	An event arising from the activity, which is done with intent (i.e. not an unplanned event) and has some level of environmental impact. A planned event could be routine (expected to occur consistently throughout the activity) or non-routine (may occur infrequently if at all). Air emissions, bilge water discharge and drill cuttings discharge would be examples of planned events.
Receptor	A feature of the environment that may have environmental, social and/ or economic values.
Risk	The effect of uncertainty on objectives.
Risk assessment	The process of determining the likelihood of an unplanned event and the consequence of the impact (in terms of economic, human safety and health, or ecological effects) arising from the event over a specified period of time.
Routine planned event	An attribute of the planned activity that results in some level of environmental impact and will occur continuously or frequently through the duration of the planned activity.
SLT	Senior Leadership Team.
Unplanned event	An event that results in some level of environmental impact and may occur despite preventative safeguards and control measures being in place. An unplanned event is not intended to occur during the activity.

[3] *Defined by the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009*

[4] *Defined by the Guideline for the Development of an Offshore Oil Spill Contingency Plan (2016)*

5.2 Summary of the environmental impact and risk assessment approach

5.2.1 Overview

Santos operates under an overarching Risk Management Policy. The company Risk Procedure (SMS MS1 ST01) underpins the Risk Management Policy and is consistent with the requirements of AS/NZS ISO 31000:2018, Risk Management – Guidelines (ISO 2018).

The key steps to risk management are illustrated in Figure 5-1. The forum used to undertake the assessment is the environmental hazard workshop, referred to as an ENVID, which is described in Section 4 of Santos' *Environmental Hazard Identification and Assessment Procedure* (EA-91-IG-00004_6).

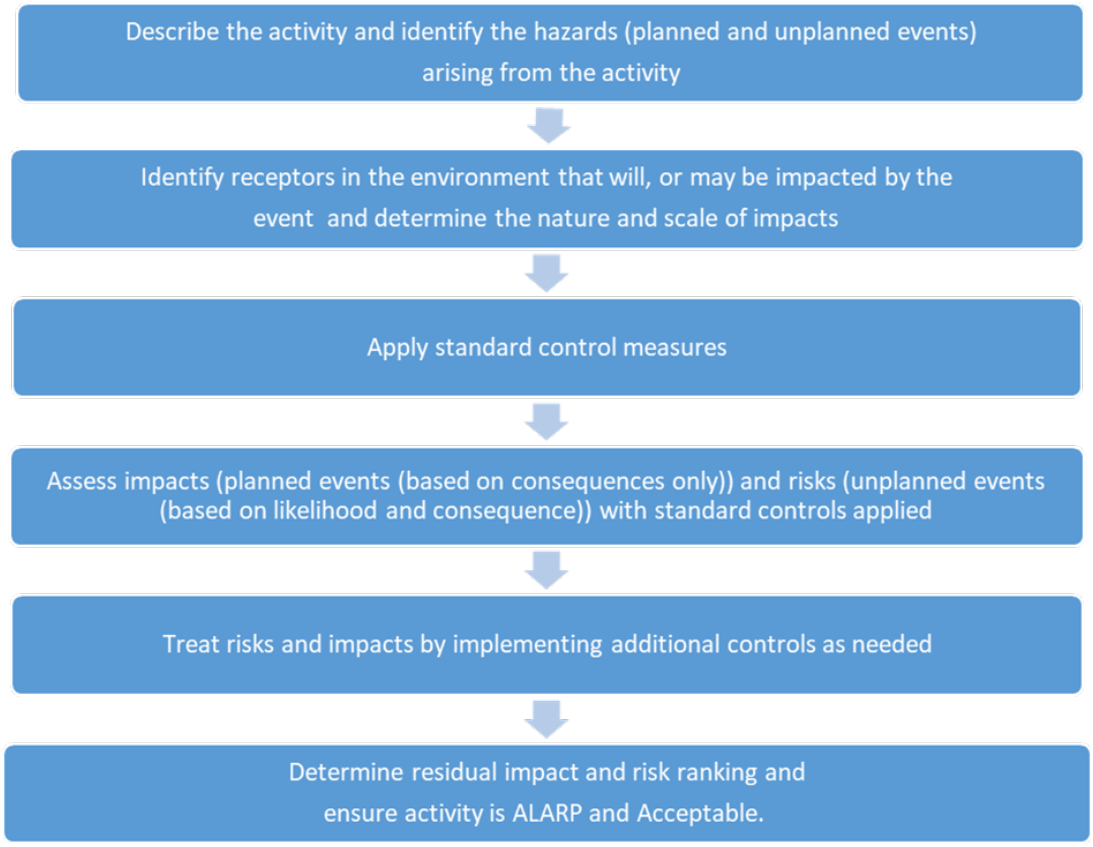


Figure 5-1: Hazard identification and assessment procedure

5.2.2 Context setting

Santos' *Offshore Division Environmental Hazard Identification and Assessment Procedure* (EA-91-IG-00004_5) includes consideration of the following key areas in an impact and risk assessment:

Description of the Activity (including location and timing)

Description of the environment (potentially affected by both planned and unplanned activities)

Identification of relevant persons

Identification of legal requirements ('legislative controls') that apply to the Activity

Santos policy and SMS requirements

Principles of Ecologically Sustainable Development (ESD)

Santos acceptable levels of impact and risk.

These factors are considered in environmental impact and risk assessment workshops in which environmental hazards are identified and assessed (ENVID workshop). The workshop involves participants from Santos' Health, Safety and Environment (HSE), Project and Spill Response departments and specialist environmental consultants

5.2.3 Describe the activity and hazards (planned and unplanned events)

A description of the activity is required in order to determine the planned events that will take place and the credible unplanned events that may occur. The location, timing and scope of the activity must be described in order to determine the impacts from planned events, and the impacts and risks from unplanned events since these have a bearing upon the environment that may be affected by the activity.

The activity is described in Section 2 of this EP. An assessment against the activity was undertaken, and the environmental hazards and aspects were identified. The outcome of this assessment is detailed in the relevant subsections of Sections 6 and 7.

5.2.4 ALARP evaluation

No alternative options to the use of a seismic vessel are possible in order to undertake the Activity. Alternative options to the survey design have been assessed by Santos. In regard to survey design options that affect other marine users, Santos has optimised the survey to minimise the Operational Area size and seismic survey duration.

Stakeholders have been informed of the proposed seismic activity as detailed in Section 4. Santos is committed to continued engagement with relevant stakeholders in the Operational Area.

The area of avoidance requested by Santos around the seismic vessel and streamers in the Operational Area is 3 nm (5.6 km). While this exclusion (safety) zone may temporarily displace marine users, it is required to ensure the safety of the seismic vessel and third-party vessels. Requested exclusion (safety) zones are standard industry practice and Santos has not received any specific objection to the size of the exclusion (safety) zone.

The assessed residual consequence for this potential impact is Minor and cannot be reduced without compromising seismic survey objectives. Without the detailed data this survey will acquire future development activity may be significantly affected resulting in potentially higher capital expenditure on drilling, and delays to drilling programs and any field developments.

No reasonably practicable additional controls were identified in the evaluation of control measures in Section 6.2.3 that would further increase the environmental benefit without a grossly disproportionate cost/sacrifice. Therefore, the proposed control measures for marine user interaction are considered appropriate to manage the consequence to ALARP.

5.2.5 Identify receptors and determine nature and scale of impacts

A description of the environment (natural and socio-economic) within which hazards from the activity will, or may occur, is required. This constitutes a crucial stage of the risk assessment, as an understanding of the environment that will or may be affected is required to determine the type and consequence of impacts from the activity being assessed. The environment must be understood with respect to the spatial and temporal limits of the activity and key resources at risk that will or could be impacted by planned and unplanned events. Santos has developed a *Values and Sensitivities of the Marine and Coastal Environment* (EA-00-RI-10062, Appendix I) reference document which describes the existing environment that may be affected by Santos' activities and is reviewed and updated on an annual basis.

Where the existing environment is being reviewed for regulatory approvals, a comparison shall be made against the *Values and Sensitivities of the Marine and Coastal Environment* (EA-00-RI-10062). A new protected matters search is required to ensure a thorough understanding of the existing environment to ensure all risks are assessed.

The extent of actual impacts from each planned activity or risks from each unplanned activity, are assessed using, where required, modelling (e.g. hydrocarbon spills) and scientific reports. The duration of the event is also described including the potential duration of any impacts should they occur. Receptors identified as potentially occurring within impacted area(s) are detailed in Section 3.2 and Appendix I.

5.3 Describe the environmental performance outcomes and control measures

For each planned and unplanned event, a set of Environmental Performance Outcome(s), Control Measures, Environmental Performance Standards and Measurement Criteria are identified. The definitions of the performance outcomes, control measures, standards and measurement criteria must be consistent with OPGGS(E)R 2023, and the NOPSEMA EP Content Requirements Guidance Note (NOPSEMA 2020).

For any hazard, additional controls, must also be considered and either accepted for use or rejected based on whether the standard controls reduce impacts and risks to levels that are ALARP and acceptable (refer Sections 5.6 and 5.7).

Controls are allocated in order of preference according to Figure 5-2.

Control	Effectiveness	Example
Eliminate		*Removal of the risk.* Refueling of vessels at port eliminates the risks of an offshore refueling.
Substitute		*Change the risk for a lower one.* The use of low-toxicity chemicals that perform the same task as a more toxic additive.
Engineering		*Engineer out the risk.* The use of oil-in-water separator to minimise the volume of oil discharged.
Isolation		*Isolate people or the environment from the risk.* The use of bunding for containment of bulk liquid materials.
Administrative		*Provide instructions or training to people to lower the risk.* The use of Job Hazard Analysis to assess and minimise the environmental risks of an activity.
Protective		*Use of protective equipment.* Containment and recovery of spilt hydrocarbons.

Figure 5-2: Hierarchy of controls

5.4 Determine the impact consequence level and risk rankings (on the basis that all control measures have been implemented)

This step looks at the causal effect between the aspect/hazard and the identified receptor. Impact mechanisms and any thresholds for impacts are determined and described, using scientific literature and modelling where required. Impact thresholds for different critical life stages are also identified where relevant.

The consequence level of the impact is then determined for each planned and unplanned event using the Santos Environment Consequence Descriptors (Appendix F).

These detailed environmental consequence descriptions are based on the consequence of the impact to relevant receptors within the following categories:

Threatened/migratory/local fauna

Physical environment/habitat

Threatened ecological communities

Protected areas

Socio-economic receptors.

This process determines a consequence level, based on set criteria for each receptor category, and takes into consideration the duration and extent of the impact, receptor recovery time and the effect of the impact at a population, ecosystem or industry level.

The level of information required to complete the impact or risk assessment depends on the nature and scale of the impact or risk. Impacts to social and economic values are also considered based on existing knowledge and feedback from stakeholder consultation. As the result of historic consultation with stakeholders, the social and economic values in the region that are of interest are evident.

As planned events are expected to occur during the activity, the likelihood of their occurrence is not considered during the risk assessment, and only a consequence level is assigned.

Table 5-2: Summary of environmental consequence descriptors

Consequence level		Consequence level description
I	Negligible	No impact or negligible impact.

II	Minor	Detectable but insignificant change to local population, industry or ecosystem factors.
III	Moderate	Significant impact to local population, industry or ecosystem factors.
IV	Major	Major long-term effect on local population, industry or ecosystem factors.
V	Severe	Complete loss of local population, industry or ecosystem factors AND / OR extensive regional impacts with slow recovery.
VI	Critical	Irreversible impact to regional population, industry or ecosystem factors.

For unplanned events, the consequence level of the impact is combined with the likelihood of the impact occurring (Table 5-3), to determine a residual risk ranking using the corporate Santos risk matrix (Table 5-4). For oil spill events, potential impacts to environmental receptors are assessed where they occur within the EMBA using results from modelling.

Table 5-3: Likelihood description

No.	Matrix	Description
f	Almost Certain	Occurs in almost all circumstances OR could occur *within days to weeks*
e	Likely	Occurs in most circumstances OR could occur *within weeks to months*
d	Occasional	Has occurred before in Santos OR could occur *within months to years*
c	Possible	Has occurred before in the industry OR could occur *within the next few years*
b	Unlikely	Has occurred elsewhere OR could occur *within decades*
a	Remote	Requires exceptional circumstances and is unlikely even in the long term

Table 5-4: Santos risk matrix

		Consequence					
		I	II	III	IV	V	VI
Likelihood	F	Low	Medium	High	Very High	Very High	Very High
	E	Low	Medium	High	High	Very High	Very High
	D	Low	Low	Medium	High	High	Very High
	C	Very Low	Low	Low	Medium	High	Very High
	B	Very Low	Very Low	Low	Low	Medium	High
	A	Very Low	Very Low	Very Low	Low	Medium	Medium

5.5 First Nations cultural heritage features assessment

The definition of 'environment' under the OPGGS(E) Regulations 2023 is broad, and means:

a. ecosystems and their constituent parts, including people and communities; and
b. natural and physical resources; and
c. the qualities and characteristics of locations, places and areas; and
d. the heritage value of places; and includes
e. the social, economic and cultural features of the matters mentioned in paragraphs (a), (b), (c) and (d).

When assessing the consequence level of impact to cultural features, Santos considers the different types of cultural features and types of impacts. For impacts to cultural features, in the form of impacts to marine species that are either a cultural food source or are considered culturally significant to First Nations people, Santos assesses impacts with reference to the consequence assessment for threatened/migratory/local fauna.

Similarly, where cultural features are linked to a specific place, impacts to cultural features are assessed with reference to the consequence assessment for physical environment/threatened ecological communities/protected areas as applicable.

Where there are concerns raised about cultural and spiritual beliefs that do not link to a specific place (or physical/tangible feature), Santos will evaluate impact and risk acceptability through the consideration of:

Impacts from other activities in the vicinity of the EP activities (e.g. historical drilling, trawl fishing activity, shipping, commercial developments).

Information provided from people and /or organisations who assert the cultural and spiritual connections.

Any expert assessment(s) from suitably qualified expert(s) people with relevant experience and credentials.

Culturally appropriate control measures raised by relevant people, organisations or experts; or proposed by Santos and workshopped with relevant people, organisations or experts.

Impact and risk evaluation of cultural and spiritual beliefs will not form part of an ENVID workshop, and a consequence (or risk) ranking will not be assigned. Instead, a qualitative assessment demonstrating that impacts and risks of the activity will be reduced to as low as reasonably practicable and be of an acceptable level will be presented in the Environment Plan as informed by the above considerations.

5.6 Evaluating if impacts and risks are ALARP

For planned and unplanned events, an ALARP assessment is undertaken to demonstrate that the standard control measures adopted reduce the impact (consequence level) or risk to ALARP. This process relies on demonstrating that further potential control measures would require a disproportionate level of cost/effort in order to reduce the level of impact or risk. If this cannot be demonstrated, then further control measures are adopted. The level of detail included within the ALARP assessment is based upon the nature and scale of the potential impact or risk. For example, more detail is required for a risk ranked as 'Medium' compared to a risk ranked as 'Low'.

5.7 Evaluating impact and risk acceptability

Santos considers an impact or risk associated with the activities to be acceptable if the following criteria are met:

The consequence of a planned event is ranked as I or II; or a risk of impact from an unplanned event is ranked Very Low to Medium

An assessment has been completed to determine whether further information or studies are required to support or validate the consequence assessment

Assessment and management of risks have addressed the principles of ecologically sustainable development

That the acceptable levels of impact and risks have been informed by relevant species recovery plans, threat abatement plans and conservation advice can be demonstrated

Performance standards are consistent with legal and regulatory requirements

Performance standards are consistent with Santos' EHS Policy

Performance standards are consistent with industry standards and best practice guidance (e.g. National Biofouling Management Guidance Guidelines for the Petroleum Production and Exploration Industry [Marine Pest Sectoral Committee 2018])

Performance outcomes and standards are consistent with stakeholder expectations

Performance standards have been demonstrated to reduce the impact or risk to ALARP.

Review of the five principles of ESD under the EPBC Act in relation to acceptability against the activity is detailed in Table 5-5.

Table 5-5: Activity relevant principles of ecologically sustainable development

No.	ESD Principle	Relevance
(a)	Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations.	Santos' environmental impact and risk assessment determines impact consequence levels considering the duration and extent of the impact, receptor recovery time and the effect of the impact at a population, ecosystem, or industry level. The Santos Environment Consequence Descriptors highlights the integration of long-term and short-term environmental, and socio-economic considerations (Appendix F). The assessment of impact consequence levels for the proposed activity simultaneously assesses the activity's potential implications against this principle. Additional assessment of this principle in relation to acceptability will not be conducted.
(b)	If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should	For planned activities, assessment of this ESD principle is inherent in Santos' environmental impact and risk assessment process, as Santos does not

No.	ESD Principle	Relevance
	not be used as a reason for postponing measures to prevent environmental degradation.	proceed with activities if the consequence of a planned event is ranked III (Moderate) or above. For unplanned events, if the residual risk is ranked between Medium and Very High, as assessment against this principle is required. If the residual risk is Medium to Very High and there is significant scientific uncertainty associated with the aspect, additional assessment against this principle is required.
(c)	The principle of inter-generational equity—that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.	For planned activities, assessment of this ESD principle is inherent in Santos' environmental impact and risk assessment process, as Santos does not proceed with activities if the consequence of a planned event is ranked III (Moderate). For an unplanned event, if the residual risk is ranked between Medium and Very high, an assessment against this principle is required. The assessment of this principle is implemented through further details on ALARP assessment highlighting assurance that potential impacts and risks are managed, and the environment is maintained for the benefit of future generations. Evaluation of the importance and relevance of stakeholder interest for this principle, if triggered, is fundamental in demonstrating that the environment is maintained for the benefit of future generations.
(d)	The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making.	Evaluate if there is the potential to affect biological diversity and ecological integrity.
(e)	Improved valuation, pricing and incentive mechanisms should be promoted.	This principle refers to activities which involve valuation, pricing and / or incentive mechanisms for the production, delivery, distribution or consumption of goods and services, especially those that are derived from natural or social capital or from ecological services. This principle is not relevant to the proposed activity as the proposed activity does not involve the production, delivery, distribution or consumption of goods and services.

6. Environmental assessment for planned events

OPGGS(E)R 2023 Requirements
Section 21. Environmental assessment.
Evaluation of environmental impacts and risks (5) The environment plan must include: a) details of the environmental impacts and risks for the Activity; b) an evaluation of all the impacts and risks, appropriate to the nature and scale of each impact or risk; and c) details of the control measures that will be used to reduce the impacts and risks of the Activity to as low as reasonably practicable and an acceptable level. (6) To avoid doubt, the evaluation mentioned in paragraph (5)(b) must evaluate all the environmental impacts and risks arising directly or indirectly from: a) all operations of the Activity; and b) potential emergency conditions, whether resulting from accident or any other reason. *Environmental performance outcomes and standards* (7) The environment plan must: a) set environmental performance standards for the control measures identified under paragraph (5)(c); b) set out the environmental performance outcomes against which the performance of the titleholder in protecting the environment is to be measured; and c) include measurement criteria that the titleholder will use to determine whether each environmental performance outcome and environmental performance standard is being met.

Santos' environmental assessment identified seven potential sources of environmental impacts associated with planned events for this Activity. The consequence rankings resulting from the environmental assessment are summarised in Table 6-1. A comprehensive risk and impact assessment for each of the planned events, and subsequent control measures proposed by Santos to reduce the risk and impacts to ALARP and acceptable levels are detailed in the following subsections.

Table 6-1: Summary of the consequence level rankings for hazards associated with planned events

Hazard	Final consequence ranking
Interaction with commercial fishers	I – Negligible
Interactions with other marine users	II – Minor
Noise emissions	II – Minor
Cumulative and additive seismic impacts	I – Negligible
Light emissions	I – Negligible
Planned operational discharges	I – Negligible
Atmospheric emissions	I – Negligible

6.1 Interaction with commercial fisheries

6.1.1 Description of event

Interaction with commercial fisheries	
Aspect	Interactions with commercial fisheries while undertaking the Activity. The presence of vessels and towed equipment in the Operational Area could potentially inhibit or be an inconvenience to commercial fishing vessels. For commercial fishing licence holders, the level of interaction could lead to temporary displacement. The presence of vessels and the towed streamers could also pose a collision risk (refer to Section 7.6).
Extent	Operational Area (during planned activities). Note, there is also the potential for the seismic vessel and towed equipment to interact with commercial fishing vessels or fishing gear outside of the Operational Area if the Vessel Master is required to sail outside of the Operational Area with towed equipment deployed e.g. due to inclement weather or technical issues.
Duration	For the duration of the Activity as described in Section 2.

6.1.2 Nature and scale of environmental impacts

Commercial fishers may be temporarily impacted by the physical presence of the seismic vessel. The potential effects of noise from the seismic survey on commercial fishers is addressed in Sections 6.3.2.11 and 6.4.

Commercial fishers are considered to be the main marine user with potential to be materially affected by the proposed seismic survey. Based on a detailed review of fisheries overlapping the Operational Area (Section 3.8.1), analysis of fishing effort data, and through consultation with fishing stakeholders (Section 4), Commonwealth, WA and NT managed commercial fisheries have historically fished within the Operational Area and therefore have the potential for interference:

Commonwealth Northern Prawn Fishery (NPF)

WA Northern Demersal Scalefish Managed Fishery (NDSMF)

WA Mackerel Managed Fishery (MMF) – Area 1 (Kimberley)

NT Demersal Fishery (DF)

NT Spanish Mackerel Fishery (SMF)

NT Offshore Net and Line Fishery (ONLF)

NT Aquarium Fishery (AF).

While the management boundaries of several other fisheries overlap the Operational Area, no fishing effort in the Operational Area has been identified through review of fishery publications and historical fishing data as evidenced in Section 3.8.1 or consultation (Section 4).

A number of other Commonwealth, WA and NT managed fisheries operate in waters adjacent to the Operational Area and in the EMBA who could potentially be affected in the event that the vessel is required to sail outside of the Operational Area with towed equipment deployed. The relevant fisheries are listed in Section 3.8.1. It is not possible to determine the exact area where the Vessel Master will need to sail the seismic vessel, the specific fisheries or the level of fishing effort that may occur there, so impacts cannot be assessed quantitatively. However, in the event that the vessel and towed equipment are required to sail outside of the Operational Area, interactions will be managed in accordance with standard maritime vessel practices and Santos protocols for communicating with stakeholders, as included in the adopted control measures.

The limited manoeuvrability of the seismic survey vessel while towing the source array and streamers means that commercial fishing vessels may be asked to take measures to avoid the immediate vicinity of the seismic survey vessel and associated equipment. In addition, commercial fishing vessels may be asked to remove fishing gear such as traps and lines to avoid interaction with the seismic survey vessel and in-water equipment. Potential impacts to commercial fisheries caused by a seismic vessel in the Operational Area, therefore, range from operational inconveniences (e.g. manoeuvring around the seismic vessel and requested area of avoidance) to temporary loss of access to fishing areas (i.e. displacement). Displacement could result in reduced catches and income, or increased costs to operate elsewhere (i.e. relocation costs).

The Operational Area overlaps with waters that have historically been fished by the above fisheries. As summarised in Section 3.8.1, the level of overlap from the Operational Area with the reporting blocks for historic fishing effort in each fishery is as follows (noting NT reporting blocks are 111 × 111 km):

Commonwealth NPF: 0.15%

WA NDSMF: 1.07%

WA MMF – Area 1: 0.22%NT DF: 1.04%

NT SMF: 1.12%

NT ONLF: 1.15%

NT AF: 1.73%

However, the potential for interaction with commercial fishing vessels may be significantly over-represented by the Operational Area, as the Activity will not occupy the entire Operational Area for the duration of the Activity. The potential for interaction is instead limited to the area near where the seismic survey vessel is operating. Typically, other vessels are requested to provide a wide berth of seismic surveys, in the order of 3 nm (5.6 km) around the seismic survey vessel and towed streamers. As the seismic survey vessel acquires seismic data along the sail lines in the racetrack formation described in Section 2.5, the vessel may return to pass within approximately 560-600 m of a location on a previously acquired sail line approximately every 22–24 hours. During the period while the seismic survey vessel is absent, fishing vessels will not be excluded and can potentially continue to access waters to fish. However, it is acknowledged that anticipating the seismic survey vessel's movements in order to trawl nets or deploy traps or lines in the immediate vicinity of the survey activities could be challenging and, therefore, there is the potential for displacement or reduced fishing effort and catch levels to occur in the vicinity of the broader racetrack.

For the NPF, it is noted that the survey will overlap a very small part of the total fishery, which extends from Cape Londonderry on the north Kimberley coast of WA, throughout waters offshore from the NT, the Gulf of Carpentaria and north-west Queensland. However, it is acknowledged that although the JBG region (as defined by the NPF) comprises less than 5% of the total area of the NPF, it contributes about 65% of the NPF's red-legged banana prawn catch and around 20% of the NPF's total banana prawn catch (combined *P. merguensis* and *P. indicus*) (Loneragan et al. 2002).

Fishing intensity has been mapped and reported annually by ABARES with the available spatial data for the years 2010–2020 (eleven years) demonstrating that similar areas are consistently fished each year. The area of mapped fishing intensity is also consistent with confidential fishing data provided by the NPF to Polarcus in 2019 and to Santos in 2021. The 2021 introduction of the JBG closure area during the first season (1 April to 15 June) also reduces the potential for interaction with NPF fishers as activity is currently only permitted during the second season (1 Aug to 1 December) until a review is undertaken in 2026. The maximum potential area of overlap with mapped NPF fishing intensity is presented in Figure 6-1.

Assessment of overlap with the WA NDSMF and MMF is based on fishing effort data available from DPIRD for the period 2012–2022 (11 years). Assessment of overlap with the NT DF, SMF, ONLF and AF is based on fishing effort data available from NT DITT for the period 2016–2020 (five years).

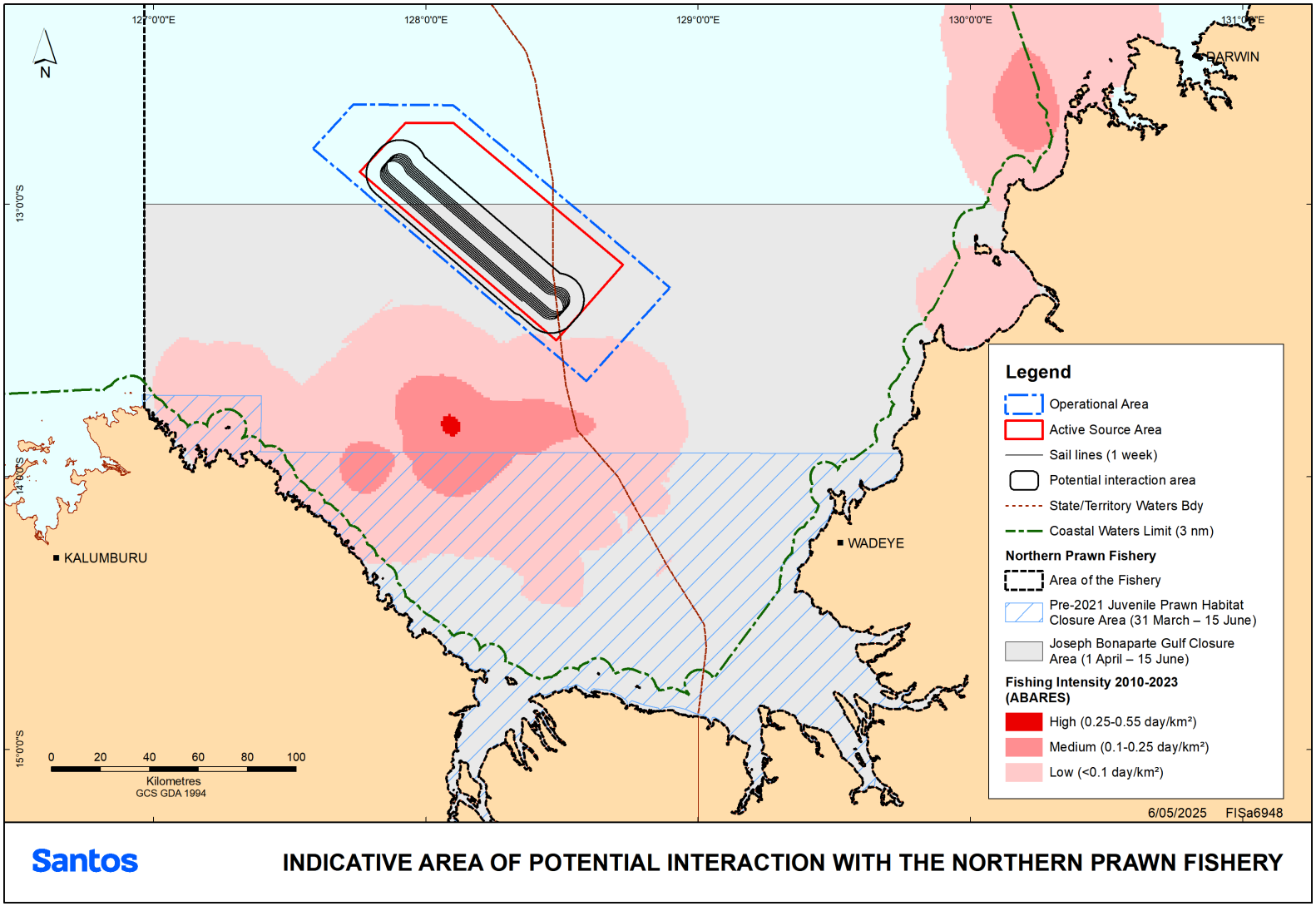


Figure 6-1: Indicative area of potential interaction with the NPF in the JBG

6.1.2.1 Northern Prawn Fishery

The NPF operates during two separate seasons. The first season is from 1 April to 15 June, and during this time banana prawns are mainly caught. Conversely, during the second season (1 August – 1 December) tiger prawns are predominately caught. Either season has the potential to end early, with the end of the seasons determined using catch-rate thresholds; when catch rates across the fishery fall below a set level, the closure of the season is triggered in order to ensure that overfishing does not occur and adequate spawning biomass is retained for subsequent recruitment of the stock (Dichmont et al. 2012; Larcombe et al. 2018; AFMA 2021).

Prior to 2021, fishing in the JBG during the banana prawn fishing season (1 April – 15 June) was required to take place in deep waters to the north of a seasonal closure area that protected nearshore banana prawn nursery and migration habitats in the southern part of the JBG (Figure 6-1). However, from 2021, a new closure area (Figure 6-1) was introduced to the whole of the JBG region south of latitude 13°S during the first 1 April to 15 June fishing season. The new closure area effectively means that banana prawn fishing season will no longer occur in the JBG in the areas it has done previously, which are the waters overlapping the Operational Area. Only a small part of the Operational Area is located outside of the closure area (Figure 6-1) and this is in water depths greater than approximately 100 m. As this depth is beyond the typical depth range for fishing activity in the JBG area for the NPF (35–80 m), no significant prawn fishing effort is expected here. As a result of the closure, only fishing during the 1 August to 1 December tiger prawn season is now permitted in the JBG closure area, south of latitude 13°S.

The highest intensity fishing areas for the NPF are in the Gulf of Carpentaria between the NT and Queensland, with relatively low intensity fishing within the JBG. However, it is acknowledged that the JBG contributes significantly to the NPF's red-legged banana prawn and banana prawn catch (Loneragan et al. 2002).

Fishing effort data published by ABARES, along with additional data provided in confidence by the NPF, indicates that fishing in the western JBG occurs in the southern part of the Operational Area, as well as in waters to the south and west of the Operational Area (Figure 6-1). The level of fishing intensity here has usually been defined by ABARES as 'low intensity (<0.1 days/km²)' or in some years 'medium intensity (0.1–0.25 days/km²)' or 'high intensity (0.25–0.55 days/km²)'. This is compared with the Gulf of Carpentaria and other areas of the fishery which are more frequently subjected to medium intensity (0.1–0.25 days/km²) or high intensity 0.25–0.55 days/km²) fishing each year. Fishing in the JBG generally takes place in waters 35–80 m deep, with most fishing effort between 50 and 60 m. It is acknowledged that the JBG fished area is only indicative and vessel presence may vary each year. As such, there is potential for interaction with fishing vessels outside of this area, but the potential for interaction is considered to be limited.

As noted in Section 3.8.1, historical fishing catch and effort in the JBG has typically been substantially lower during the tiger prawn season compared with the banana prawn season. Based on the historic catch data, tiger prawn catch levels are historically greater in fishing grounds outside of the JBG, particularly from the Gulf of Carpentaria and the north coast of the NT, which are closer to the fishery's primary landing ports of Darwin (NT) and Cairns and Karumba (Queensland) (Parsa et al. 2020).

Although it is acknowledged that historically the JBG area contributed significantly to the NPF's red-legged banana prawn and banana prawn catch (Loneragan et al. 2002), the new closure area ensures that banana prawn fishing season will no longer occur in the JBG in the areas it has done previously. With only a small part of the Operational Area located outside of the closure area, the Eos 3D MSS would have a limited spatial and temporal overlap with the NPF's fished area in the JBG as fishing activities in the JBG would only occur during the less active tiger prawn fishing season (1 August – 1 December). Therefore, there is limited potential for disruption to NPF fishing activities during routine survey activities in the Operational Area. In the event that the seismic vessel and towed equipment are required to sail outside of the Operational Area, there is potential for interaction with fishers operating in other parts of the fishery.

6.1.2.2 WA Northern Demersal Scalefish Managed Fishery

The Operational Area is located in Zone A of Area 2 of the NDSMF, noting that the NDSMF primarily targets deeper waters in Zone B of Area 2 of the fishery (over 200 km from the Operational Area). Based on a review of FishCube data, the 10 nm blocks overlapped by the Operational Area have been fished by less than three vessels on several occasions during the 11-year (2012–2022) reporting period. Therefore, the Operational Area overlaps a very small proportion of the fishery's activity with historical fishing effort considered to be minimal.

Alternative and more viable fishing grounds are available to commercial fishers. The most productive areas for this fishery that are fished consistently throughout each year (Zone B of the fishery) are located over 200 km from the Operational Area. NDSMF annual catches have consistently exceeded 1,000 t and been within Allowable Catch Tolerance Levels of 903–1,332 t per year since 2008 and the vast majority is landed from Zone B (Newman et al. 2019, 2021).

Given that the NDSMF fish in the Operational Area very infrequently, it is unlikely that interactions with NDSMF vessels will occur. Therefore, routine survey activities in the Operational Area are not expected to result in

operational inconvenience or temporary displacement from significant fishing grounds. In the event that the seismic vessel and towed equipment are required to sail outside of the Operational Area, there is potential for interaction with fishers operating in other parts of the fishery.

6.1.2.3 WA Mackerel Managed Fishery (Area 1)

Based on a review of 11 years of FishCube data (2012–2022), the Operational Area overlaps with one 10 nm block (refer to Figure 3-19). The reported historical fishing effort for this grid block shows less than three vessels were active during July 2021 only. compared with other areas that are more regularly and intensively fished to the north and west of Kalumburu (over 90 km west of the Operational Area). Therefore, the Operational Area represents an insignificant portion of the fishery with historical fishing effort highly infrequent.

Alternative and more viable fishing grounds are available to commercial fishers in the MMF and the potential for interaction is limited. Commercial fishing vessels may potentially experience operational inconvenience and temporary displacement from fishing grounds within the Operational Area. However, such interactions are expected to be highly infrequent and short term, due to the transient nature of the seismic survey vessel and the small area occupied by the seismic survey vessel at any one time.

Given the low number of vessels accessing the Operational Area, compared with other areas, the potential for disruption to this fishery is limited. In the event that the seismic vessel and towed equipment are required to sail outside of the Operational Area, there is potential for interaction with fishers operating in other parts of the fishery.

6.1.2.4 NT Demersal Fishery

Although a review of historical catch effort data shows the Operational Area overlaps with a portion of two NT fisheries grid blocks, the data represented in these grids is not representative of the degree of overlap with the fishery. As Figure 3-21 shows, the Operational Area intersects only a fraction of the south western corner of grid block 1228 where approximately 659 days were fished by the DF between 2016–2020, while the second intersecting grid block (1328) shows a total of three days fished over the same five-year period.

It is evident from the data shown in Figure 3-21 that alternative and more viable fishing grounds are available to the north of the Operational Area and commercial fishers have historically used these areas over the south-western portion of the fishery, therefore, the potential for interaction is limited. Commercial fishing vessels may potentially experience operational inconvenience and temporary displacement from fishing grounds within the Operational Area. However, such interactions are expected to be infrequent and short term, due to the transient nature of the seismic survey vessel and the small area occupied by the seismic survey vessel at any one time.

Given the low number of vessels accessing the Operational Area, compared with other areas, the potential for disruption to this fishery is limited. In the event that the seismic vessel and towed equipment are required to sail outside of the Operational Area, there is potential for interaction with fishers operating in other parts of the fishery.

6.1.2.5 NT Spanish Mackerel Fishery

As with the DF above, the historical catch effort data for the SMF is significantly overrepresented given the degree of overlap with the Operational Area. The two reporting grid blocks overlapping the Operational Area already show a very low combined fishing effort of approximately 12.5 days between 2016–2020 (refer to Figure 3-22). However, the rate of interaction is expected to be even less given the minimal overlap with the 60 nm reporting grid blocks and the primary fishing grounds described as waters near Bathurst Island, New Year Island, the Wessel Islands around to Groote Eylandt and the Sir Edward Pellew Group of islands. The closest of these being Bathurst Island at more than 200 km from the Operational Area.

Alternative and more viable fishing grounds are available to commercial fishers of the SMF and the potential for interaction is limited. Commercial fishing vessels may potentially experience operational inconvenience and temporary displacement from fishing grounds within the Operational Area. However, such interactions are expected to be infrequent and short term, due to the transient nature of the seismic survey vessel and the small area occupied by the seismic survey vessel at any one time.

Given the low number of vessels accessing the Operational Area, compared with other areas, the potential for disruption to this fishery is limited. In the event that the seismic vessel and towed equipment are required to sail outside of the Operational Area, there is potential for interaction with fishers operating in other parts of the fishery.

6.1.2.6 NT Offshore Net and Line Fishery

Historical catch effort data for the ONLF shows minimal interaction with the Operational Area. At a total of approximately seven days activity over five years (2016–2020), it is evident that the area overlapping the Operational Area represents an insignificant portion of the fishery.

Given licensees harvested 640.8 t of stock in 2017 (DPIR 2019f), alternative and more viable fishing grounds are available to commercial fishers than those represented in the overlap with the Operational Area (refer to

Figure 3-23). Therefore, the potential for interaction is limited. Commercial fishing vessels may potentially experience operational inconvenience and temporary displacement from fishing grounds within the Operational Area. However, such interactions are expected to be infrequent and short term, due to the transient nature of the seismic survey vessel and the small area occupied by the seismic survey vessel at any one time.

Given the low number of vessels accessing the Operational Area, compared with other areas, the potential for disruption to this fishery is limited. In the event that the seismic vessel and towed equipment are required to sail outside of the Operational Area, there is potential for interaction with fishers operating in other parts of the fishery.

6.1.2.7 NT Aquarium Fishery

Historical catch effort data for the AF shows the least amount of activity overlapping the Operational Area of all the NT fisheries with approximately three days fished over the five-year reporting period (2016–2020). Information obtained from the Chair of the Aquarium Fishery Licence Committee during the consultation process for the nearby Santos Bethany 3D MSS confirmed that licence holders typically scuba dive to a maximum of 30 m. Given water depths in the Operational Area range between 60 and 115 m, interaction with the AF is unlikely.

Therefore, alternative and more viable fishing grounds are available to commercial fishers within the AF and the potential for interaction is limited. Commercial fishing vessels may potentially experience operational inconvenience and temporary displacement from fishing grounds within the Operational Area. However, such interactions are expected to be infrequent and short term, due to the preferred fishing depths for the AF license holders, the transient nature of the seismic survey vessel and the small area occupied by the seismic survey vessel at any one time.

Given the low number of vessels accessing the Operational Area, compared with other areas, the potential for disruption to this fishery is limited. In the event that the seismic vessel and towed equipment are required to sail outside of the Operational Area, there is potential for interaction with fishers operating in other parts of the fishery.

6.1.3 Environmental performance outcomes and control measures

Environmental Performance Outcomes (EPOs) relating to this event include:

Survey information provided to regulatory authorities and marine users directly affected by planned activities prior to commencement of the survey (EPO-1)

No unplanned interactions with commercial fishers (EPO-2)

Commercial fishing licence holders are no worse off as a result of the seismic survey (EPO-3).

The Control Measures considered for this Activity are shown in Table 6-2 with Environmental Performance Standards and Measurement Criteria for the EPOs described in Section 8.6.1.

Table 6-2: Control measures evaluation for interaction with commercial fisheries

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard control measures				
Eliminate				
None identified				
Substitute				
None identified.				
Engineering				
CM-1	Navigation equipment and procedures	Reduces the risk of collisions with other marine users.	Negligible costs of acquiring and operating navigation equipment, as required by maritime law.	**Adopted** – The safety benefits of having navigation equipment and procedures outweighs any cost. This is a maritime requirement.
CM-2	Vessels fitted with AIS systems and radars, including AIS (virtual or installed) to mark the location of streamer tail buoys.	Reduces the risk of vessel collision with the seismic survey vessels and deployed equipment. Enables commercial vessels to understand the extent of in-water equipment in addition to vessel position.	Negligible as it is a standard maritime requirement that the seismic vessel will be fitted with AIS, and the seismic tail buoys can be readily equipped with virtual or installed AIS.	**Adopted** – The safety benefits of having AIS outweigh any costs. This is a maritime requirement. An additional level of visibility is provided by providing virtual or installed AIS for the tail buoys.
Isolation				
CM-3	Exclusion (safety) zone established to reduce potential for collision or interference with other marine user activities.	Requested minimum 3 nm (5.6 km) exclusion zones around the seismic vessel and trailing streamers prevents other vessels from getting too close and causing damage to equipment of either party.	No additional costs to Santos. Other marine users may be temporarily excluded from small areas, disrupting their activities.	**Adopted** – The requested exclusion of other marine users is temporary. Marine users will still be able to access the Operational Area. Normal navigation at sea process whereby shipping vessels avoid navigational risks. Hence, the safety benefits to all marine users outweighs any potential costs.
Administration				
CM-4	Maritime Notices – Notices to Mariners (NTM) and AUSCOAST warnings	Ensures other marine users are aware of the presence of the seismic survey vessel, and the relatively slow speed and restricted manoeuvrability.	Costs associated with the personnel time in issuing notifications and closing out queries and responses.	**Adopted** – Benefits considered to outweigh negligible costs. Maritime requirement to issue marine notices.
CM-5	Stakeholder consultation	Ensures other marine users, such as commercial fishers, are aware of upcoming seismic survey operations so they can plan their business accordingly.	Limited additional costs to Santos. Stakeholder's time required to review consultation material and communicate with Santos.	**Adopted** – Benefits considered to outweigh negligible costs. Important control to ensure other marine users are aware of upcoming seismic activities and potential business disruptions. Provides an opportunity for Santos and stakeholders to discuss additional ways of minimising on-water interference and business disruptions.

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-6	Concurrent operations planning with relevant commercial fishers	As legitimate users of the marine environment, concurrent operations planning (including establishment of communication protocols between the seismic vessel and the fishing vessels) will minimise fisher displacement while allowing Santos to meet its seismic survey objectives.	Concurrent operations planning will require fisher's time to discuss communication protocols, plan vessel movement patterns, etc. It is, however, possible that concurrent operations are simply not practicable i.e. fishing and seismic methods and vessel movements are not operationally compatible.	**Adopted** – There are no apparent reasons why commercial fishing vessels and seismic survey vessels cannot co-exist, providing the requested exclusion (safety) zone around the seismic vessel is observed. Santos commits to working with relevant commercial fisheries to enable fair and reasonable concurrent operations.
CM-7	Commercial fishery payment claims (further details are provided in Section 8.6.2)	Should relevant commercial fishers be displaced from their normal fishing areas because of the physical presence of the seismic vessel then Santos is prepared to consider financial payments so that commercial fishers are not worse off as a result of the seismic survey. Evidenced-based compensation models are not new to seismic surveys in Australia. Consideration will also be given to any reasonable claims from fishers who incur damage to fishing equipment by the seismic vessel or towed equipment while operating outside of the Operational Area.	For Santos to accept a payment claim, fishers will need to provide enough evidence to demonstrate displacement and financial loss. This will require fisher's time and effort. Santos is prepared to invest the time to assess the merits of all claims. Fishing licence holders new to fishing areas overlapping the Operational Area may have difficulty evidencing displacement.	**Adopted** – Santos is prepared to assess the merits of all payment claims if commercial fishers can provide evidence of displacement. This process will apply unless commercial agreements are made with fishing licence holders.
Protective				
CM-8	Support vessel and/or chase vessel present and operational during the Activity to reduce potential for collision or interference with other marine users.	Identifies and communicates with approaching third-party vessels to ensure exclusion (safety) zone is observed, preventing potential interaction or interference.	Additional costs of contracting a support vessel.	**Adopted** – The safety benefits from having a support vessel and chase vessel during the Activity to assist with managing third-party vessels outweighs the cost.
CM-9	Constant bridge watch	Crew of support vessels and the seismic vessel will maintain constant bridge watch, including for third party vessels which may be approaching or enter the exclusion zone.	No additional costs.	**Adopted** – No additional costs. This is a maritime requirement.
CM-10	Recreational fishing restrictions	Reduces potential impacts to fisheries in the vicinity of the activity.	Negligible cost.	**Adopted** – Benefits considered to outweigh negligible cost to Santos.

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Additional control measures				
Eliminate				
N/A	Towed streamers and seismic source array recovered if the seismic vessel is required to transit outside of the Operational Area.	Recovering towed equipment reduces the risk of interactions with other marine users in the event that the seismic vessel is required to sail outside of the Operational Area while under contract to Santos.	Recovery of towed equipment can take in the order of 3–4 days to recover on board the seismic vessel and a similar amount of time to redeploy and test equipment. Therefore, recovery of towed equipment may result in significant lost time during the survey window and is a significant cost (1.5–2 million USD) to Santos. In addition, in the event that the seismic vessel is required to depart the Operational Area urgently due to weather or mechanical issues, recovery may not be possible. The Vessel Master will take whatever action they feel necessary to prevent threats to life on board the vessel or damage to the vessel or equipment. Recovery of equipment is therefore the Vessel Master's decision, not Santos'.	**Not Adopted** – While it is acknowledged that this would provide a reduction in risk to other marine users, it is not practicable or feasible to implement.
Substitute				
N/A	Reduce survey area to decrease overlap with commercial fisheries.	Minimises displacement of fishing vessels from known fishing areas. Fishing effort in the Operational Area by the NPF, NDSMF and MMF is light and variable. Therefore, further reduction of the survey will provide limited or no reduction in interactions with commercial fishing vessels.	Further reduction in the survey area is not possible to meet the objectives of the survey and provide an adequate model of the subsurface characteristics.	**Not Adopted** – Any further reduction in the area of acquisition will render the survey ineffective.
N/A	Amend timing of the survey to reduce overlap with commercial fishing activities.	The Active Source Area does not overlap known fishing areas in the NPF, so temporal restrictions on the seismic survey would not provide environmental benefit. Fishing in the MMF has only occurred here during five of the past 11 years (2010–2020).	If the seismic survey window is limited too much, Santos may not have sufficient time to be able to acquire all of the data necessary to adequately interpret potential green house gas reservoirs and Santos may not meet work programme commitments made under title.	**Not Adopted** – The survey currently has limited spatial and temporal overlap with commercial fisheries. Amending the timing or reducing the survey window will provide limited, if any, additional benefit to fisheries. Given the exact timing of the survey will be subject to vessel availability and a number of other commercial, operational and environmental factors, some level of flexibility is required for the

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
		Therefore, further reducing the survey window provides limited additional benefit to the MMF. The spatial overlap of the Operational Area with the NDSMF represents just 0.25% of the area of historical fishing effort. Therefore, altering survey timing will achieve little or no additional benefit to these fisheries.	The proposed timing is also key to Santos for operational and commercial reasons, with the timing intended to allow for the contracted seismic vessel to transition to/from the Eos 3D MSS to other seismic surveys that could potentially occur off northern Australia during the same years allowed for under this EP. The commercial viability of the Eos 3D MSS depends on the ability to use a seismic vessel that is already in Australian waters and potentially acquire the Eos 3D MSS and other Santos seismic surveys of north-west Australia consecutively. The cost of contracting and mobilising a separate seismic vessel for the Eos 3D MSS or to cover the cost of periods of vessel downtime if scheduling of the various surveys cannot align, can be several millions of dollars. This would mean that the Eos 3D MSS is not financially feasible and it is likely it could not go ahead.	survey window. Reducing the survey window could prevent Santos from being able to complete the survey or it could mean the survey is not financially feasible, if contracting of a seismic vessel cannot align with other potential Santos surveys in Australian waters. Given limited additional benefit can be gained for commercial fisheries by altering or reducing the survey window, the potentially significant cost to Santos means that this option is not practicable.
Engineering				
None identified.				
Isolation				
None identified.				
Administration				
CM-11	Decision making and communications protocol implemented in the event that the seismic vessel and towed equipment are required to leave the Operational Area during the survey.	Ensures other marine users, such as commercial fishers, are aware of the seismic vessel and towed equipment movements outside of the Operational Area.	Time and costs associated with the personnel time in issuing notifications and closing out queries and responses.	**Adopted** – Benefits considered to outweigh negligible costs.

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-12	Santos will ensure the seismic contractor has a protocol in place for handling entangled fishing gear.	Reduces the potential for damaging fishing gear during recovery / relocation and for recovered gear to be communicated to the relevant fishery.	Time and costs incurred by the vessel operator to prepare and implement this protocol, if the vessel operator does not already have one in place.	**Adopted** – Benefits considered to outweigh negligible costs.
Protective				
N/A	Using more than two support vessel to further reduce the potential for collision or interference with other marine users	An additional support vessel allows for communication and management of interactions, if there is an interaction with more than one approaching third party vessel, to ensure the exclusion (safety) zone is observed. The only benefit would be if the primary committed support vessel is non-operational (e.g. breakdown) or in the event of multiple simultaneous vessel collision threats.	Additional costs associated with having an additional vessel during the survey can extend into hundreds of thousands of dollars, and there is an increased environmental and safety risk of 'small' vessels being at sea.	**Not adopted –** An additional vessel will not significantly reduce the risk of interface with commercial vessels. Both the survey vessel and committed support vessel will be monitoring for and communicating with approaching commercial vessels. It is highly unlikely that there would be multiple simultaneous vessel collision threats given existing controls in place and regulated maritime practices (e.g. SOLAS, COLREGs). The survey vessel will avoid large commercial vessels, including cargo ships.

6.1.4 Environmental impact assessment

Receptor	Consequence level
Commercial fisheries	
Threatened / Migratory Fauna	N/A – related to socio-economic receptors only.
Physical Environment/ Habitat	
Threatened ecological communities	
Protected Areas	
Socio-economic receptors	Through consultation Santos understands that the NPF is concerned about seismic surveys (refer to Section 4). The seismic survey has the potential to interact with multiple commercial fisheries, including: • NPF (Commonwealth) • NDSMF (WA) • MMF (WA) • DF (NT) • SMF (NT) • ONLF (NT) • AF (NT). Fishers will be able to continue to access the Operational Area during the survey and Santos is prepared to operate concurrently with fishers. Santos has requested a 3 nm (5.6 km) exclusion zone around the seismic vessel and streamers for safety reasons. An exclusion zone is standard practice for a seismic vessel and no specific concerns about the size of the exclusion zone have been raised by fishers during consultation (Section 4). Nonetheless, due to the physical presence of the seismic vessel and requested safety exclusion zone, fishers' normal operations may be temporarily disrupted. Fishers may be displaced or may choose to avoid parts of, or the entire, Operational Area. This may be for the duration of the seismic survey or for a part of the survey. If alternative fishing grounds outside of the Operational Area are not available, then this may result in a loss of catch and financial income. If alternative fishing grounds are available but are more expensive to fish, then this may increase operating costs. Santos understands that all potentially affected fishers have access to alternative fishing areas. Santos recognises that additional engagement with potentially affected fishers is necessary to determine effective ways of operating concurrently, and/or to determine and evidence any commercial impacts (e.g. relocation costs) of temporary displacement. Santos commits to continued engagement with relevant fishers (refer to Section 4) and to assessing the merits of all evidence-based displacement payment claims (refer to Section 8.6.2). Santos considers there to be enough information available to understand the nature and scale of potential impacts to commercial fishers, and to assess impact consequence. Ongoing engagement with commercial fishers will be used to validate the impact assessment. In accordance with Santos' *Offshore Division Environmental Hazard Identification and Assessment Procedure* (EA-91-IG-00004_5), the consequence of the seismic vessel interfering with or displacing commercial fishers is considered to be I – Negligible – *No impact or negligible impact*. This assumes the implementation of all proposed control measures. The justification for this consequence assessment is: • Commercial fishers will still be permitted to enter the Operational Area providing the requested exclusion (safety) zone around the seismic vessel is observed. • Any interactions or displacements will be temporary and limited to a maximum of 50 days. • Although the survey may result in localised and short-term displacement and inconveniences to a limited number of fishers, the Operational Area is not frequently fished by any WA or NT commercial fisheries, and the data demonstrates that more viable and productive fishing grounds for each fishery are available outside of the Operational Area. • Santos commits to ongoing engagement with commercial fishers before, during and after the seismic survey.
Overall worst-case consequence	I – Negligible

6.1.5 ALARP evaluation

No alternative options to the use of a seismic vessel are possible in order to undertake the Activity. Alternative options to the survey design have been assessed by Santos. In regard to survey design options that affect other marine users, Santos has attempted to optimise the survey to minimise the Operational Area size and seismic survey duration. By doing this, the potential for interaction with commercial fisheries and transiting vessels is reduced.

Stakeholders have been informed of the proposed seismic activity as detailed in Section 4. Santos is committed to continued engagement with relevant stakeholders, with a focus on commercial fishers as active users of the Operational Area. It is through this process the potential operational interference to commercial fishers will be further defined and mitigated to a level that is as low as reasonably practicable. A decision making and communications protocol will be implemented in the event that the seismic vessel and towed equipment are required to leave the Operational Area during the survey.

Santos has made a commitment to consider evidence-based compensation payments should commercial fishers be displaced during the seismic survey. Santos considers it to be appropriate for any commercial agreements with commercial fishers to be managed outside of the environmental approval process.

Santos commits to working with relevant stakeholders to enable fair and reasonable concurrent operations. The exclusion (safety) zone requested by Santos around the seismic vessel and streamers in the Operational Area is 3 nm (5.6 km), as detailed in stakeholder notifications issued by Santos. While this exclusion (safety) zone may temporarily displace marine users, it is required to ensure the safety of the seismic vessel and third-party vessels as directed by AMSA. Requested exclusion (safety) zones are standard industry practice and Santos has not received any specific objection to the size of the exclusion (safety) zone.

The assessed residual consequence for this potential impact is Negligible and cannot be reduced without compromising seismic survey objectives.

No reasonably practicable additional controls were identified in the evaluation of control measures in Section 6.1.3 that would further increase the environmental benefit without a grossly disproportionate cost / sacrifice. Therefore, the proposed control measures for interaction with commercial fisheries are considered appropriate to manage the consequence to ALARP.

6.1.6 Acceptability evaluation

Is the consequence ranked as I (Negligible) or II (Minor)?	Yes – I (Negligible).
Is further information required in the consequence assessment?	No – Sufficient information is available to understand the nature and scale of potential impacts, and to assess impact consequence. Ongoing engagement with commercial fishers will be used to validate the impact assessment and ensure the proposed control measures are effectively implemented.
Are the risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' Offshore Division Environmental Hazard Identification and Assessment Procedure which considers principles of ecologically sustainable development. Specifically: • Taking into account both long term and short term economic, environmental, social and equitable considerations, no long-term impacts on commercial fishers associated with the physical presence of the project vessels and helicopters are anticipated. As per the impact assessment in Section 6.1.2, there is only limited potential for infrequent and short-term interactions and the resulting impacts on the fisheries will be limited because: – The WA NDSMF and MMF are active within in the Operational Area very infrequently; 2012–2022 fishing effort data provided by DPIRD demonstrates that less than three vessels were active in the blocks overlapping the Operational Area. – The NT DF, SMF, ONLF, and AF also show activity within the Operational Area; however, 2016–2020 fishing effort data provided by DITT demonstrates that the grid blocks overlapping the Operational Area are not a high use area for these fisheries. – Fishing effort data provided by DPIRD, DITT and ABARES suggest that more viable and productive fishing grounds for each fishery are available outside of the Operational Area. – No other commercial fisheries routinely fish in the JBG. – Therefore, limited, if any physical interaction with commercial fishing vessels or fishing gear is expected. Any interactions that may occur may result localised and short-term displacement and inconveniences to a limited number of fishers but no long-term impacts are expected. • Santos has made a commitment to consider evidence-based compensation payments should commercial fishers be displaced during the seismic survey, which is consistent with the ESD principle of promoting improved valuation and pricing mechanisms. • The physical presence and interaction of survey vessels with commercial fisheries does not present a risk to the natural environment or the ecological integrity of that natural environment. Therefore, the other ESD principles (relating to serious or irreversible environmental damage; the health, diversity and productivity of the environment; and the conservation of biological diversity and ecological integrity) are not applicable.
Are performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – Management consistent with COLREGS, *Safety of Life at Sea* (SOLAS) 1974 and *Navigation Act 2012*.
Are performance standards consistent with the Environmental Management Policy?	Yes – Aligns with the Environmental Management Policy.
Are performance outcomes and standards consistent with stakeholder expectations?	Santos will continue to assess the merits of any stakeholder claims on the proposed survey, control measures and performance standards, and will continue to engage with stakeholders as committed.

<table>
<tr><td>Are performance standards such that the impact or risk is considered to be ALARP?</td><td colspan="3">Yes – Santos understands through consultation that some commercial fishers do not support seismic surveys and have concerns regarding the impacts of seismic surveys on access to fishing grounds, catchability and fish stock.
This is acknowledged, however, both commercial fishing and seismic operations are legitimate activities in offshore Commonwealth waters.
Based on available information and the proposed control measures, Santos considers interference impacts to commercial fishers to be at an acceptable level. To further reduce potential commercial impacts to a level that is ALARP, Santos commits to assess evidence-based payment claims from commercial fishing licence holders who claim to be affected by the seismic survey, or claim the survey caused fishing equipment located outside of the Operational Area to be damaged or lost at a cost to the licence holder in the event that the seismic vessel is required to transit outside of the Operational Area while under contract by Santos. Santos has made a commitment to ensure that commercial fishing licence holders are no worse off as a result of the seismic survey.
If additional control measures are identified through ongoing engagement with commercial fishers, then Santos will assess the merits of these and communicate these assessments to stakeholders accordingly. This will ensure that impacts to commercial fishers remain acceptable and ALARP for the duration of the seismic survey.</td></tr>
<tr><td colspan="4">Defined Acceptable Levels</td></tr>
<tr><td rowspan="2">Does the predicted impact meet the defined acceptable level of impact (refer to Section 5.7)?</td><td>Defined Acceptable Level of Impact</td><td>Comparison with Predicted Levels of Impact</td><td>EPO</td></tr>
<tr><td>No unplanned interactions with commercial fishers.
Commercial fishing license holders are no worse off as a result of the seismic survey.</td><td>Santos considers the level of impact to commercial fisheries and fishers to be of an acceptable level.
Santos has committed to concurrent operations with commercial fishers, thereby not excluding fishers from their fishing groundings. Santos will provide advanced notification of proposed surveys, and communicate operational survey plans and daily operational reports so that commercial fishers are informed. It is through these control measure that Santos will ensure there are no unplanned interactions with commercial fishers.
The predicted level of impact does not exceed the defined acceptable level of impact given that:
Commercial fishers will still be permitted to enter the Operational Area providing the requested exclusion (safety) zone around the seismic vessel is observed.
Any interactions or displacements will be temporary and limited to a maximum of 50 days.
Although the survey may result localised and short-term displacement and inconveniences to fishers, the Operational Area is not frequently fished by any of the WA or NT commercial fisheries, and the data demonstrates that more viable and productive fishing grounds for each fishery are available a significant distance from the Operational Area.
Santos commits to ongoing engagement with commercial fishers before, during and after the seismic survey.
Santos commits to assessing the merits of all evidence-based displacement payment claims (refer to Section 8.6.2).</td><td>EPO-1
EPO-2
EPO-3</td></tr>
</table>

6.2 Interaction with other marine users

6.2.1 Description of event

Interaction with other marine users	
Aspect	Interactions with other marine users while undertaking the Activity. The presence of vessels and towed equipment in the Operational Area could potentially inhibit or be an inconvenience to marine user groups such as commercial shipping. The level of interaction could lead to temporary avoidance by other users. The presence of vessels and the towed streamers could also pose a collision risk (refer to Section 7.6).
Extent	Operational Area (during planned activities). Note, there is also the potential for the seismic vessel and towed equipment to interact with other marine users outside of the Operational Area if the Vessel Master is required to sail outside of the Operational Area with towed equipment deployed e.g. due to inclement weather or technical issues.
Duration	For the duration of the Activity as described in Section 2.

6.2.2 Nature and Scale of environmental impacts

Santos has identified the following stakeholders as potential marine users of the Operational Area (other than commercial fishers): tourism/recreation, commercial shipping, Defence and other petroleum exploration and production operations, including associated vessel activities. These users maybe temporarily impacted by the physical presence of the seismic vessel. The potential physical interaction between the seismic survey vessel and commercial fishers is addressed above in Section 6.1. The potential effects of noise from the seismic survey on other marine users is assessed in Section 6.3.

Tourism / recreation

Tourism and recreational activities are known to take place along the northern Kimberley coastline, however interactions with the Eos 3D MSS are considered unlikely due to the remoteness and predominantly deep waters of the Operational Area (refer to Section 2). The Operational Area does not include any specific sites of interest to tourism and recreation. Most recreational and tourism activities in the region occur predominantly in coastal waters and typically peaks during the dry season (May to October). Cruise vessels and charter vessels may occasionally transit through the Operational Area between Darwin and the Kimberley coastline; however, displacement would be minimal (localised and short-term) given the transient nature of the seismic activities.

Commercial shipping

High vessel traffic in the northern end of the Operational Area is expected due to vessels travelling between Darwin and offshore petroleum fields Ichthys and Prelude in the Browse Basin. There may also be vessels passing through the southern part of the Operational Area travelling between Darwin and Kalumburu.

Vessel data recorded in the region is presented in Section 3.8.2. It is noted that some vessels may transit through the Operational Area, while some of the vessels recorded may be fishing vessels rather than commercial shipping and may remain within the Operational Area for several days.

Twenty-four-hour radar and visual watch and open radio communications between vessels will occur during the seismic survey. Early communication between vessels allows for the speed and course of vessels to be ascertained in a timely manner and any necessary adjustment of course to be confirmed. Given the seismic survey vessel will be towing the streamer array, manoeuvrability will be limited, and commercial vessels will be required to alter their course as required by Admiralty and AMSA regulations. Vessels will be required to give way 3 nm (5.6 km) around the seismic vessel and trailing streamers.

Should commercial vessels need to deviate from planned routes to avoid the seismic vessel, displacement would be localised and short-term. This may slightly increase transit times and fuel consumption. As the Operational Area is in open waters with no grounding or navigational hazards, it is not likely that any such deviation would increase the potential for vessel collision or grounding.

Defence

The Operational Area overlaps with practice and training areas that comprise the North Australian Exercise Area (NAXA), which is used for military operations including live weapons and missile firings.

UXO may be present on and in the sea floor of the Operational Area (Figure 3-28) Santos has assessed the risk associated with the presence of UXO and determined that since the towed source and streamers are not expected to interact with the seabed under normal operations, no credible scenarios occur where UXO presents a risk to the activity.

Petroleum exploration and production operations

The Bonaparte Basin is an established hydrocarbon province with a number of commercial operations. Vessels associated with nearby petroleum operations (e.g. Blacktip facility and gas pipeline 21 km south of the Operational Area, and vessels traveling from Darwin to the Ichthys Field 465 km to the west) may be asked to deviate from intended routes to avoid the seismic vessel, in-water equipment and support vessels, if transiting through the Operational Area. Based on the controls identified below, displacement would be localised and short-term and no significant or long-term impacts are expected.

Santos will work collaboratively with other petroleum operators to ensure interactions offshore are minimised. With controls adopted as identified below, no significant implications are expected.

6.2.3 Environmental performance outcomes and control measures

Environmental Performance Outcomes (EPOs) relating to this event include:

EPO-1: Survey information provided to regulatory authorities and marine users directly affected by planned activities prior to commencement of the survey

EPO-4: No unplanned interactions with other marine users.

The Control Measures considered for this Activity are shown in Table 6-3 with Environmental Performance Standards and Measurement Criteria for the EPOs described in Section 8.6.1.

Table 6-3: Control measures evaluation for interaction with other marine users

Reference CM	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard control measures				
Eliminate				
None identified.				
Substitute				
None identified.				
Engineering				
CM-1	Navigation equipment and procedures	Reduces the risk of collisions with other marine users.	Negligible costs of acquiring and operating navigation equipment, as required by maritime law.	**Adopted** – The safety benefits of having navigation equipment and procedures outweighs any cost. This is a maritime requirement.
CM-2	Vessels fitted with AIS systems and radars (virtual or installed) to mark the location of streamer tail buoys.	Reduces the risk of impact from vessel collisions.	Negligible as the seismic vessel should be fitted with AIS.	**Adopted** – The safety benefits of having AIS outweigh any costs. This is a maritime requirement.
Isolation				
CM-3	Exclusion (safety) zone established to reduce potential for collision or interference with other marine user activities.	Requested minimum 3 nm (5.6 km) exclusion (safety) zones around the seismic vessel and trailing streamers prevents other vessels from getting too close and causing damage to equipment of either party.	No additional costs to Santos. Other marine users may be temporarily excluded from small areas, disrupting their activities.	**Adopted** – The requested exclusion of other marine users is temporary. Marine users will still be able to access the Operational Area. Normal navigation at sea process whereby shipping vessels avoid navigational risks. Hence, the safety benefits to all marine users outweighs any potential costs.
Administration				
CM-4	Maritime Notices – Notices to Mariners (NTM) and AUSCOAST warnings	Ensures other marine users are aware of the presence of the seismic survey vessel, and the relatively slow speed and restricted manoeuvrability.	Costs associated with the personnel time in issuing notifications and closing out queries and responses.	**Adopted** – Benefits considered to outweigh negligible costs. Maritime requirement to issue marine notices.
CM-5	Stakeholder consultation	Ensures other marine users are aware of upcoming seismic survey operations so they can plan their business accordingly.	Limited additional costs to Santos. Stakeholder's time required to review consultation material and communicate with Santos.	**Adopted** – Benefits considered to outweigh negligible costs. Important control to ensure other marine users are aware of upcoming seismic activities and potential business disruptions. Provides an opportunity for Santos and stakeholders to discuss

Reference CM	Control measure	Environmental benefit	Potential cost/issues	Evaluation
				additional ways of minimising on-water interference and business disruptions.
CM-13	Notices to Department of Defence (DoD)	Ensures defence operations are aware of the presence of the seismic survey vessel, and the relatively slow speed and restricted manoeuvrability.	Costs associated with the personnel time in issuing notifications and closing out queries and responses.	**Adopted** – The DoD will be contacted five weeks prior to the commencement of the survey and following the cessation of activities.
Protective				
CM-8	Support vessel and/or chase vessel present and operational during the Activity to reduce potential for collision or interference with other marine users.	Identifies and communicates with approaching third-party vessels to ensure exclusion (safety) zone is observed, preventing potential interaction or interference.	Additional costs of contracting a support vessel.	**Adopted** – The safety benefits from having a support vessel and chase vessel during the Activity to assist with managing third-party vessels outweighs the cost.
CM-9	Constant bridge watch	Crew of support vessels and the seismic vessel will maintain constant bridge watch, including for third party vessels which may be approaching or enter the exclusion (safety) zone.	No additional costs.	**Adopted** – No additional costs. This is a maritime requirement.
Additional control measures				
Eliminate				
N/A	Towed streamers and seismic source array recovered if the seismic vessel is required to transit outside of the Operational Area.	Recovering towed equipment reduces the risk of interactions with other marine users in the event that the seismic vessel is required to sail outside of the Operational Area while under contract to Santos.	Recovery of towed equipment can take in the order of 3-4 days to recover on board the seismic vessel and a similar amount of time to redeploy and test equipment. Therefore, recovery of towed equipment may result in significant lost time during the survey window and is a significant cost (1.5–2 million USD) to Santos. In addition, in the event that the seismic vessel is required to depart the Operational Area urgently due to weather or mechanical issues, recovery may not be possible. The Vessel Master will take whatever action they feel necessary to prevent threats to life on board the vessel or damage to the vessel or equipment. Recovery of equipment is therefore the Vessel Master's decision, not Santos'.	**Not Adopted** – While it is acknowledged that this would provide a reduction in risk to other marine users, it is not practicable or feasible to implement.
Substitute				
None identified.				

Reference CM	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Engineering				
None identified.				
Isolation				
None identified.				
Administration				
CM-11	Decision making and communications protocol implemented in the event that the seismic vessel and towed equipment are required to leave the Operational Area during the survey.	Ensures other marine users, such as commercial fishers, are aware of the seismic vessel and towed equipment movements outside of the Operational Area.	Time and costs associated with the personnel time in issuing notifications and closing out queries and responses.	**Adopted** – Benefits considered to outweigh negligible costs.
Protective				
CM-10	Recreational fishing restrictions	Seismic survey and support vessels are prohibited from fishing	Negligible costs.	**Adopted** – Benefits considered to outweigh negligible costs to Santos.
N/A	Using more than two support vessels to further reduce the potential for collision or interference with other marine users	An additional support vessel allows for communication and management of interactions, if there is an interaction with more than one approaching third party vessel, to ensure the exclusion (safety) zone is observed. The only benefit would be if the primary committed support vessel is non-operational (e.g. breakdown) or in the event of multiple simultaneous vessel collision threats.	Additional costs associated with having an additional vessel during the survey can extend into hundreds of thousands of dollars, and there is an increased environmental and safety risk of 'small' vessels being at sea.	**Not adopted –** An additional vessel will not significantly reduce the risk of interface with commercial vessels. Both the survey vessel and committed support vessel will be monitoring for and communicating with approaching commercial vessels. It is highly unlikely that there would be multiple simultaneous vessel collision threats given existing controls in place and regulated maritime practices (e.g. SOLAS, COLREGs). The survey vessel will avoid large commercial vessels, including cargo ships.

6.2.4 Environmental impact assessment

Receptor	Consequence level
Interaction with other marine users	
Threatened / Migratory Fauna	N/A – related to socio-economic receptors only.
Physical Environment/ Habitat	
Threatened ecological communities	
Protected Areas	
Socio-economic receptors	In accordance with Santos' Offshore Division Environmental Hazard Identification and Assessment Procedure (EA-91-IG-00004_5), the consequence of the seismic vessel interfering with or displacing other marine users is considered to be II – Minor – *Detectable but insignificant short-term loss of value of the local industry*. This assumes the implementation of all proposed control measures. The justification for this consequence assessment is: • Marine users will still be permitted to enter the seismic survey Operational Area providing the requested exclusion (safety) zone around the seismic vessel is observed. • Any interactions or displacements will be temporary and limited to a maximum of 50 days. • Recreation and tourism activities in the region occur predominantly in coastal waters and during the dry season (May to October). • Commercial shipping traffic within the Operational Area is relatively low. Should commercial vessels need to deviate from planned routes to avoid the seismic vessel, displacement would be localised and short-term. • Other petroleum operations in the JBG are currently limited to the Eni Blacktip facility and gas pipeline 21 km south of the Operational Area. Vessels associated with these operations may be asked to deviate from intended routes if transiting through the Operational Area, however, displacement would be localised and short-term. Other marine users will not be restricted from entering the Operational Area. However, given the low manoeuvrability and slow speed of the seismic vessel, it is possible that third party commercial vessels may be required to deviate from planned routes to avoid the seismic vessel and trailing streamers. Since the seismic vessel will be continually moving, potential displacement from any one location within the Operational Area will be temporary and ***Minor***. AMSA require a high level of communication during the Activity (Marine Notices, NTM, AUSCOAST warnings), therefore, reducing the likelihood of interaction with other sea users (e.g. private leisure craft, etc.).
Overall worst-case consequence	II – Minor

6.2.5 ALARP evaluation

No alternative options to the use of a seismic vessel are possible in order to undertake the Activity. Alternative options to the survey design have been assessed by Santos. In regard to survey design options that affect other marine users, Santos has optimised the survey to minimise the Operational Area size and seismic survey duration.

Stakeholders have been informed of the proposed seismic activity as detailed in Section 4. Santos is committed to continued engagement with relevant stakeholders in the Operational Area.

The area of avoidance requested by Santos around the seismic vessel and streamers in the Operational Area is 3 nm (5.6 km). While this exclusion (safety) zone may temporarily displace marine users, it is required to ensure the safety of the seismic vessel and third-party vessels. Requested exclusion (safety) zones are standard industry practice and Santos has not received any specific objection to the size of the exclusion (safety) zone.

The assessed residual consequence for this potential impact is Minor and cannot be reduced without compromising seismic survey objectives. Without the detailed data this survey will acquire future development activity may be significantly affected resulting in potentially higher capital expenditure on drilling, and delays to drilling programs and any field developments.

No reasonably practicable additional controls were identified in the evaluation of control measures in Section 6.2.3 that would further increase the environmental benefit without a grossly disproportionate cost/sacrifice. Therefore, the proposed control measures for marine user interaction are considered appropriate to manage the consequence to ALARP.

6.2.6 Acceptability evaluation

Is the consequence ranked as I (Negligible) or II (Minor)?	Yes – II (Minor).
Is further information required in the consequence assessment?	No – Sufficient information is available to understand the nature and scale of potential impacts, and to assess impact consequence. Ongoing engagement with other marine users will be used to validate the impact assessment and ensure the proposed control measures are effectively implemented.
Are the risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' Offshore Division Environmental Hazard Identification and Assessment Procedure which considers principles of ecologically sustainable development. Specifically: • Taking into account both long term and short term economic, environmental, social and equitable considerations, no long-term impacts on other marine users associated with the physical presence of the project vessels and helicopters are anticipated. As per the impact assessment in Section 6.2.2, there is the potential for infrequent and short-term interactions but the resulting impacts on other marine users will be limited because: – Recreation and tourism activities in the region occur predominantly in coastal waters and during the dry season (May to October). Cruise vessels and charter vessels may occasionally transit through the Operational Area between Darwin and the Kimberley coastline; however, displacement would be localised and short-term given the transient nature of the seismic activities. No long-term impacts are expected. – Commercial shipping traffic within the Operational Area is relatively low. Should commercial vessels need to deviate from planned routes to avoid the seismic vessel, displacement would be localised and short-term. No long-term impacts are expected. – Other petroleum operations in the JBG are currently limited to the Eni Blacktip facility and gas pipeline 21 km south of the Operational Area. Vessels associated with these operations may be asked to deviate from intended routes to avoid the seismic vessel, in-water equipment and support vessels, if transiting through the Operational Area, however, displacement would be localised and short-term and no significant or long-term impacts are expected. • The physical presence and interaction of survey vessels with other marine users does not present a risk to the natural environment. Therefore, the other ESD principles (relating to serious or irreversible environmental damage;–the health, diversity and productivity of the environment; and the conservation of biological diversity and ecological integrity) are not applicable.
Are performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – Management consistent with COLREGS, *Safety of Life at Sea* (SOLAS) 1974 and *Navigation Act 2012*.
Are performance standards consistent with the Environmental Management Policy?	Yes – Aligns with the Environmental Management Policy.
Are performance standards consistent with stakeholder expectations?	Yes – Control measures and associated performance standards have been included to address stakeholder concerns. Relevant stakeholders were sent details on Santos' proposed Activity. Santos will continue to assess the merits of any stakeholder claims or objections on the proposed control measures and performance standards and will continue to engage with stakeholders as committed.
Are performance standards such that the impact or risk is ALARP?	Yes – Based on available information and the proposed control measures, Santos considers interference impacts to marine users to be ALARP.

Defined Acceptable Levels			
Does the predicted impact meet the defined acceptable level of impact (refer to Section 5.7)?	**Defined Acceptable Level of Impact**	**Comparison with Predicted Levels of Impact**	**EPO**
	No unplanned interactions with other marine users.	Santos considers the level of impact to other marine users to be of an acceptable level, given that any disruptions to third party vessels are anticipated to be temporary and not inconsistent with normal maritime navigational and communication practices.	EPO-1 EPO-4

6.3 Noise emissions

6.3.1 Description of event

Noise emissions	
Aspect	During the Activity noise will be generated through operation of: • Seismic source • Vessels • Helicopters. *Seismic source*: The aspect considered to have the greatest potential impact is noise emitted from the seismic source array, comprising a series of airguns discharged in a pre-determined order, described in detail in the following sections. The seismic sources will be fired at regular intervals, producing pulses of high-intensity low-frequency sound. Seismic pulses typically have approximately 98% of the signal power in dominant frequencies less than 200 Hz; predominantly in the 10–200 Hz range (McCauley 1994), the useful range for seismic data imaging. *Vessels:* The vessels will emit noise from propeller cavitation, thrusters, hydrodynamic flow around the hull, and operation of machinery and equipment. Typically, marine vessels produce low frequency sound (i.e. below 1 kHz) from the operation of machinery on-board; from hydrodynamic flow noise around the hull; and from propeller cavitation, which is typically the dominant source of noise (Ross 1987, 1993; cited in Skjoldal et al. 2009). Most sounds associated with vessels are broadband, though tones are also associated with the harmonics of the propeller blades (Ross 1987; 1993 cited in Skjoldal et al. 2009). The sound is continuous (non-impulsive) in nature but is modulated by propeller cavitation. McCauley et al. (1998) examined the noise from a 64 m, 2,600 t rig tender vessel underway, which had a broadband source level of 177 dB re 1 µPa. Usually, the larger the vessel, or the faster a vessel moves, the higher the noise levels generated (Richardson et al. 1995). Depending on the vessel, source levels can range from less than 160 dB (trawlers) to over 200 dB re 1 µPa @1 m (super-tankers) (Simmonds et al. 2004). Based on these measurements, it is expected that the size of vessels to be used during this Activity will emit sound in the order of 180 dB re 1 µPa @1 m or less, particularly given the slow speed (4.5 knots) at which the seismic survey vessel will be travelling for the majority of the survey. *Helicopters:* Strong underwater sounds are detectable for only brief periods when a helicopter is directly overhead (Richardson et al. 1995). Sound emitted from helicopter operations is typically below 500 Hz and sound pressure in the water directly below a helicopter is greatest at the sea surface but diminishes quickly with depth. A significant proportion of the sound energy is lost due to reflection and attenuation at the air-water interface. Reports for a Bell 214 (regarded to be one of the noisiest), indicated that noise is audible in the air for four minutes before the helicopter passed over underwater hydrophones. The helicopter was audible underwater for only 38 seconds at 3-m depth and 11 seconds at 8-m depth (Greene 1985a; cited in Richardson et al. 1995). Noise levels reported for Bell 212 helicopter during fly-over are 162 dB re 1µPa and for Sikorsky-61 is 108 dB re 1 µPa at 305 m (Simmonds et al. 2004). Helicopters will be used during the survey for crew change and in an emergency. It is expected that underwater sounds as a result of helicopter activity will only be detectable in the upper water column for very brief periods during landing and take-off.
Extent	The extent of underwater noise from the seismic source has been based on acoustic modelling. The acoustic source levels of potential seismic source options being considered for the Eos 3D MSS were modelled by JASCO Applied Sciences (JASCO) (Appendix G) and the loudest used as a 'worst-case' for the purpose of the impact assessment. Acoustic modelling results are described extensively below. The extent of underwater noise from vessels and helicopters is localised.
Duration	For the duration of the Activity as described in Section 2.

6.3.2 Nature and scale of environmental impacts

6.3.2.1 Background

Marine fauna use sound in a variety of functions, including social interactions, foraging, orientation, and responding to predators. Underwater noise can affect marine fauna in three main ways:

+ Injury or impairment to hearing or other organs. Hearing loss may be temporary (temporary threshold shift (TTS)) or permanent (permanent threshold shift (PTS))
+ Disturbance leading to behavioural changes or displacement of fauna. The occurrence and intensity of disturbance is highly variable and depends on a range of factors relating to the animal and situation

- Masking or interfering with other biologically important sounds (including vocal communication, echolocation, signals and sounds produced by predators or prey).
- Receptors with the potential to be impacted by underwater noise include:
- Plankton (i.e. zooplankton), including fish, coral and invertebrate eggs and larvae
- Invertebrates, including commercially targeted prawn stocks
- Fish, including commercial indictor fish stocks
- Sharks and rays
- Seabirds and migratory shorebirds
- Marine reptiles
- Marine mammals
- Commercial fisheries
- Other socio-economic receptors.

The levels of acoustic exposure that may result in injury or behavioural changes in marine fauna is an area of increasing research. Due to differences in experimental design, methodology and units of measure, comparison of studies to determine likely sound exposure thresholds can be difficult. On assessment of the available science, thresholds have been defined to inform the impact assessment, and interpretation of the numerical noise modelling results. These are discussed for each receptor in Appendix H.

To understand the extent and magnitude of underwater acoustic noise that may result from the Eos 3D MSS, JASCO was commissioned to model expected sound fields caused by the survey (Appendix G). It is best practice for seismic survey impact assessments to use underwater acoustic modelling to assess potential impacts to identified environmental and social receptors. The assessment is conducted by comparing modelled received underwater sound levels to defined noise effect criteria, as determined by scientific research and academic papers, for the identified environmental and social receptors.

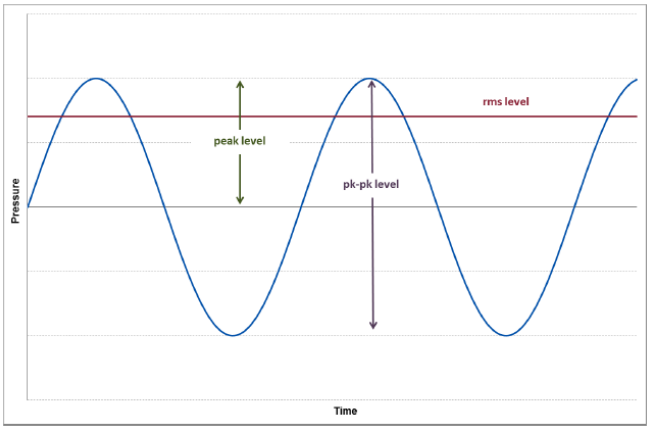
Although the relationship between received sound levels and impacts to marine species is the subject of ongoing research, the science underlying noise modelling is well understood (Farcas et al. 2016).

6.3.2.2 Sound metric terminology

Given the multiple measures commonly used to express sound metrics, it is important to ensure any comparisons between specific sound level values are made using the same measures. These sound level metrics are summarised in Table 6-4.

Table 6-4: Sound level metrics definition

Metric	Definition
Source level	Source level (SL): The sound pressure level or sound exposure level measured 1 m from a theoretical point source that radiates the same total sound power as the actual source. It is a theoretical value for a seismic source because a seismic source is not a point source, but rather is made up of individual elements covering a defined area. Source level can be expressed as an SPL, SEL or PK (as defined below). Unit: dB re 1 μPa^2m^2 or dB 1 μPa^2m^2s.
Sound Frequency	Frequency is the number of times per second that a sound pressure wave repeats itself. The lower the frequency, the fewer the oscillations. High frequencies produce more oscillations. The units of frequency are called hertz (Hz).
Impulse / Pulse	The terms used to refer to the discharge of a seismic source are impulse and pulse, therefore the terms used to describe a single discharge are per-impulse or per-pulse.
Peak pressure (PK) Impulsive sounds	Zero-to-peak sound pressure (PK), the greatest magnitude of the sound pressure during a specified time interval. PK levels are modelled to assess mortality and potential mortal injury to fish, turtles, fish eggs and larvae. Unit: dB re 1 µPa Refer to the below for graphical representation of PK.

Metric	Definition
	
Peak-to-peak pressure (PK-PK) Impulsive sounds	Peak-to-peak sound pressure (PK-PK), is the sum of the peak compressional pressure (highest pressure variation) and the peak rarefactional pressure (lowest pressure variation) during a specified time interval. PK-PK is the difference between the maximum and minimum instantaneous sound pressure levels in a stated frequency band attained by an impulsive sound. Refer to the above for graphical representation of PK-PK. Unit: dB re 1 µPa
Sound pressure level (SPL) (also referred to as rms level)	The time-mean-square sound pressure, in a stated frequency band, to the square of the reference sound pressure over the duration of an acoustic event (i.e. the duration of a single seismic pulse); because the SPL represents the effective sound pressure over the full duration of the acoustic event rather than the maximum instantaneous peak pressure (i.e. PK or PK-PK), it is regularly used to represent the effective or perceived loudness of a sound and to assess the potential for a behavioural response from marine fauna. Unit: dB re 1 µPa
Sound exposure level (SEL)	Sound exposure level (SEL), a measure related to the sound energy in one or more pulses, or the ratio of the time-integrated squared sound pressure to the specified reference value, and can be considered as a dose-type measurement. This measure recognises that the effects of sound are a function of exposure duration as well as maximum instantaneous peak pressure. The SEL metric integrates noise intensity over some period of exposure and is used as it allows exposure duration and the effect of exposure to multiple events to be taken into account. SEL is specified in terms of either per-impulse (per-pulse) or a defined accumulation period. The metrics determined for the defined accumulation period assume that a receptor remains stationary for the period. The accumulation period applied for this assessment is 24 hours, and therefore the SEL is referred to as either per-impulse SEL or SEL_{24h}. Unit: dB re 1 $\mu Pa^2 \cdot s$
Particle motion metrics	Acoustic particle motion is defined as that motion caused by a sound wave of a given infinitesimal part of the medium relative to the medium as a whole, and it is an integral part of any sound field. Unlike pressure, particle motion is directional in nature and is typically described using three-dimensional vector notation. Particle motion levels can be expressed in a variety of units related to displacement, velocity, or acceleration. Acoustic particle velocity is the time derivative of particle displacement, and likewise acceleration is the time derivative of velocity. The particle velocity (v) is the physical speed of a particle in a material moving back and forth in the direction of the pressure wave. The particle acceleration (a) is the rate of change of the velocity with respect to time. Benthic invertebrates and many types of fish are sensitive only to particle velocity or acceleration rather than pressure, however limited measurements or data are available on the levels of particle motion that may result in effects. Some measurements are available from studies on bivalves, and therefore modelled particle motion values have been referenced for the impact assessment.
Hearing Sensitivity	Hearing sensitivity is generally quantified by determining the quietest possible sound that is detectable by an animal (either via a behavioural response or by quantifying an electrical response) on some signal presentations. By testing such responses across a range of test frequencies, a measure of the animal's overall hearing capability may be obtained. Where detection threshold levels are lower, hearing sensitivity is greater (the animal can hear well), and vice versa. This sensitivity usually follows a U-shaped curve with regions of relatively good sensitivity that drop off on the low and high ends. The region of lowest overall average hearing is called the range of 'best hearing sensitivity.' Similarly, the region where

Metric	Definition
	hearing thresholds are within some range from the lowest overall threshold (e.g. 80 dB in Southall et al., 2007) is often referred to as the overall range of functional hearing.

6.3.2.3 Noise effect criteria

During a seismic survey, new sound energy of finite duration is introduced into the environment with each pulse from the seismic source. For this assessment, the sound levels emitted into the marine environment have been modelled and are expressed using the above-mentioned sound metrics (i.e. SL, PK, SPL, SEL, etc.).

Whether the received noise levels injure or disturb marine fauna (i.e. have an effect) is an active research topic. The noise thresholds (i.e. the level that must be exceeded for an effect to occur) for sound-induced effects on marine fauna are described throughout this Section, with additional detail provided in Appendix G and Appendix H.

Noise thresholds have been defined for both the per-pulse sound energy released, as well as the accumulated sound energy from multiple pulses that marine fauna is subjected to over a defined period of time. For recent regulatory assessments of seismic surveys, the period of total sound energy integration (i.e. accumulation) has been typically defined as 24 hours; hence, 24 hours was the period used for modelling and in this assessment. For fish this period is based on available research (Popper et al. 2014) which found fish experiencing TTS in hearing recovered to normal hearing levels within 18–24 hours, and for marine mammals the period is required to be either 24 hours or the length of the activity, whichever is shorter (NMFS 2024).

Importantly, the 24-hour accumulated sound metric reflects the dosimetric impact of noise levels within 24 hours based on the assumption that an animal is consistently exposed to such noise levels at a fixed position. More realistically, marine mammals and many fish (pelagic and some demersal) would not stay in the same location or at the same range for 24 hours. Popper et al. (2014) discuss the complications in determining a relevant sound exposure period of mobile seismic surveys, as the levels received by the receptor change between impulses due to the mobile source. For marine mammals and many fish, sound exposures at the closest point to the seismic source are the primary exposures contributing to a receptors accumulated level (Gedamke et al. 2010). Hence, thresholds based on a 24-hour exposure period are considered to be a conservative measure of potential effect.

6.3.2.4 Acoustic modelling

To assess the potential magnitude and extent of impacts from underwater noise produced during the Eos 3D MSS, JASCO (a specialist in the field of marine acoustics) modelled sound propagation at several locations that were representative of the different water depths, bathymetry, and seabed properties within the Active Source Area (Appendix G).

The objective of this acoustic modelling study was to evaluate the potential effects of sound on marine fauna including marine mammals, marine reptiles, fishes, elasmobranchs, benthic invertebrates, and zooplankton, and on socio-economic receptors such as commercial fisheries, divers, marine protected areas, and KEFs.

A summary of the acoustic modelling is provided below.

6.3.2.4.1 Model scenarios

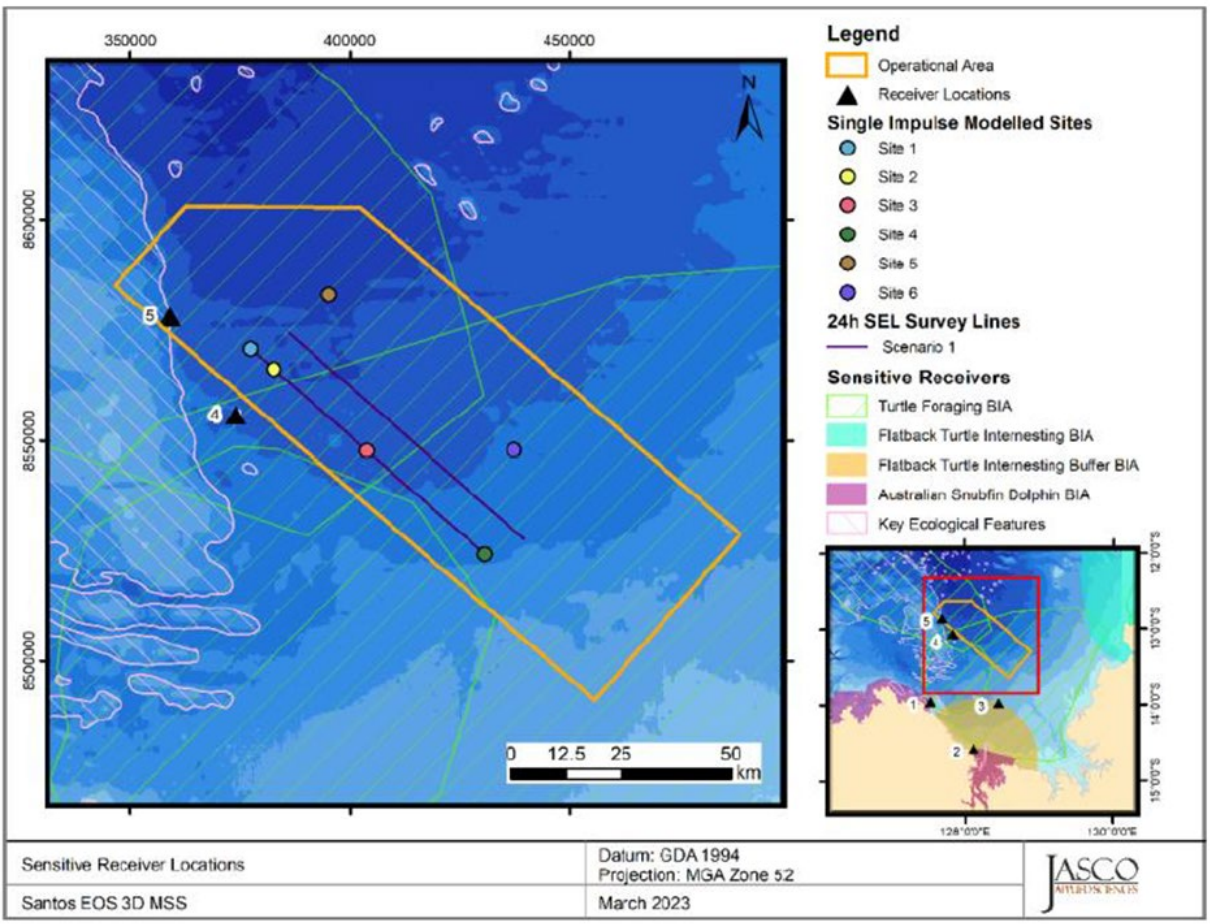
JASCO designed the modelling study to take into consideration key survey factors, such as: the location of environmental and social receptors, and the range of water depths across the Active Source Area.

Six standalone single impulse sites and one representative accumulated sound exposure scenarios were defined (Figure 6-2) based upon the acquisition parameters described in Section 2.5. Water depths of single impulse sites ranged from 83–110 m.

The locations of the six standalone single impulse sites were considered representative of the range of water depths that will be covered during the Eos 3D MSS and were also selected for their proximity to sensitive receptors. In addition to sound levels in the water column, seafloor sound levels were assessed at three different representative depths within the Active Source Area (83, 96.5, and 110 m). One 24-hour scenario was modelled, termed Scenario 1.

The orientations of the modelled seismic source at the single impulse sites and the accumulated sound exposure scenarios were selected to assess the furthest potential sound propagation distance broadside (generally the loudest horizontal direction from the source) from the seismic source towards receptors in both shallow water and deep-water as relevant to the survey. The rationale for the 24-hour Scenario 1 was:

Scenario 1 comprised two full lines orientated north-west to south-east. The orientation of the sail lines for this scenario were selected to examine the broadside sound propagation towards coastal and shallow water receptors including important areas for marine turtles and inshore dolphins, as well as the Pinnacles of the Bonaparte Basin KEF, Carbonate bank and terrace system of the Sahul Shelf KEF and the Joseph Bonaparte Gulf AMP.



Source: Warren and Koessler 2023

Figure 6-2: Location of acoustic modelling single impulse sites and SEL_{24h} scenario

6.3.2.4.2 Seismic source

As described in Section 2.5, the Eos 3D MSS is proposed to use a seismic source up to 3,050 in^3 in total volume.

This EP allows for a source volume of up to 3,050 in^3 to allow some flexibility with the selection of different source volume configurations that may or may not be available at the time of contracting a seismic survey company.

Modelling of the 3,050 in^3 source is representative of the maximum sound levels and effects ranges that may be produced during the survey and is likely to be slightly conservative should a source with lower source levels be selected for the survey. Far-field source level specifications for a 3050 in^3 source with an 8 m tow depth are shown in Table 6-5. These source levels are for a point-like acoustic source with equivalent far-field acoustic output in a specified direction. Sound level metrics are per-pulse and unweighted (more information is provided in Appendix G).

Table 6-5: Far-field source level specifications for a 3,050 in^3 source, with an 8 m tow depth

Direction	Peak source pressure level ($L_{s,pk}$; dB re 1 µPa m)	Per pulse source SEL ($L_{s,E}$; dB 1 μPa^2m^2s)	
		10–2,000 Hz	2,000–25,000 Hz
Broadside	248.3	224.4	185.6
Endfire	247.7	224.8	188.2
Vertical	258.2	230.7	196.5
Vertical (surface affected source level)	258.2	233.0	199.5

Source: Appendix G

Nevertheless, once it has been determined which vessel will carry out the work, Santos will make every effort to use the minimum required source to meet geological objectives. Santos will undertake source modelling for the chosen source array using the same JASCO Airgun Array Source Model (AASM) to confirm if the source specifications are comparable and the potential impacts and risks will be within those assessed and found to be acceptable in this EP. Further information regarding this control measure is provided in Section 6.3.4, with a corresponding environmental performance standard provided in Section 8.6.

6.3.2.4.3 Sound propagation model

Three complementary underwater acoustic propagation models were used in conjunction with the selected modelled seismic source to estimate sound levels over large distances. The modelling assumed that the seismic survey vessel sailed along the survey lines at approximately 4.5 knots, with a source point interval of 8.33 m.

The modelling methodology considered source directivity and range-dependent environmental properties in each of the areas assessed. Estimated underwater acoustic levels are presented as SPL, PK, PK-PK, and either single-impulse (i.e. per-pulse) or accumulated sound exposure levels (SEL) as appropriate for different noise thresholds.

Contours of the modelled underwater sound fields were computed, sampled either as the maximum value over all modelled depths (maximum-over-depth: MOD) or at the seafloor for the six single pulse locations and the cumulative SEL24h scenario. The modelled distances for each of the sound exposure thresholds were computed from these contours. Two distances relative to the source are reported for each sound level:

- R_{max} – the maximum range to the given sound level over all azimuths
- $R_{95\%}$ – the range to the given sound level after the 5% farthest points were excluded.

The difference between R_{max} and $R_{95\%}$ depends on the source directivity and the non-uniformity of the acoustic environment. In some environments a sound level contour might have small anomalous isolated fringes in which case the literal use of R_{max} can misrepresent the area of the region exposed to such effects. In these instances, $R_{95\%}$ is considered more representative. In environments that have bathymetric features that affect sound propagation then the $R_{95\%}$ neglects to account for these and therefore R_{max} might better represent the region of effect in specific directions.

6.3.2.4.4 Model input parameters

Table 6-6 outlines the key input parameters considered in the acoustic modelling and relevant assumptions or limitations. Model predictions inherently carry some uncertainty. Despite some data limitations and assumptions, the JASCO acoustic modelling provides reliable results to support the impact assessment. The models have been extensively tested and validated (refer to Section 6.3.2) and the models are consistently found to show good agreement with measured sound levels. One such validation study (McPherson and Martin 2018) was undertaken in 2018 at a location approximately 32 km west of the Operational Area (permit WA-522-P) with comparable water depths and seabed geoacoustics.

Table 6-6: Key acoustic model inputs

Parameter	Data	Accuracy / limitations
Acoustic source		
Seismic source	3,050 in^3	Representative of the maximum source (3,050 in^3) volume that may be used during the survey.
Tow depth	8 m	An increase in tow depth of approximately 2 m+ would likely support the propagation lower frequency energy enough that its influence may be noticeable in the results. Thus, the deepest survey tow depth of 8 m was used.
Seismic pulse interval (SPI)	8.33 m	Representative of the SPI for a triple source acquisition. Accumulated SEL results will be conservative for an acquisition that uses a larger SPI (e.g. dual source with 12.5 m SPI).
Vessel speed	4.5 knots	Standard seismic survey vessel speed.
Environmental		
Water depth / bathymetry	Geoscience Australia (Beaman 2018)	Water depths throughout the modelled area were extracted from the high-resolution depth model for Northern Australia, approximately 30 m grid rendered for Northern Australia. Bathymetry data was extracted and re-gridded onto a Map Grid of Australia (MGA) coordinate projection (Zone 52) with a regular grid spacing of 250 × 250 m to generate the bathymetry. Bathymetry is referenced to mean sea level (MSL). Tidal ranges in the JBG are in the order of 3 m (1.5 m either side of MSL). The effect that these differences have on the modelling results is expected to be negligible (Whiteway 2009)
Geoacoustics	Refer to Appendix G	Geoacoustic parameters used for modelling at all sites were derived from sedimentary grain size measurements from the Australian Government's Marine Sediments (MARS) database (Heap 2009). On average, the surficial grain size indicates silty sand is present throughout the modelled area. Representative grain sizes were used in the grain-shearing model proposed by Buckingham (2005) to estimate the geoacoustic parameters required by the sound propagation models.

Parameter	Data	Accuracy / limitations
Sound speed (temperature and salinity) profile	U.S. Naval Oceanographic Office Generalized Digital Environmental Model (GDEM)	A mean monthly sound speed profile for June was considered in the modelling study; this was identified as the seasonal period that would provide the farthest sound propagation.

6.3.2.4.5 Model validation

Predictions from JASCO's source model (AASM) and propagation models (MONM-BELLHOP, FWRAM and VSTACK) have been validated against experimental data from a number of underwater acoustic measurement programs conducted by JASCO globally. This includes programs conducted in the United States and Canadian Artic, Canadian and southern United States waters, Greenland, Russia and Australia (e.g. Hannay and Racca 2005, Aerts et al. 2008, Funk et al. 2008, Ireland et al. 2009, O'Neill et al. 2010, Warner et al. 2010, Racca et al. 2012a, Racca et al. 2012b, Matthews and MacGillivray 2013, Martin et al. 2015, Racca et al. 2015, Martin et al. 2017a, Martin et al. 2017b, Warner et al. 2017, MacGillivray 2018b, McPherson et al. 2018a, McPherson et al. 2018b, McPherson and Martin 2018).

In addition, JASCO has conducted measurement programs associated with a significant number of anthropogenic activities which have included internal validation of the modelling (McCrodan et al. 2011, Austin and Warner 2012, McPherson and Warner 2012, Austin and Bailey 2013, Austin et al. 2013, Zykov and MacDonnell 2013, Austin 2014, Austin et al. 2015, Austin and Li 2016, Martin and Popper 2016). The large number of measurement programs conducted by JASCO across a range of environments allows for a rigorous assessment of the performance of propagation models, and a process of continuous improvement to be in place.

All modelled assessment approaches contain an inherent level of uncertainty, which results from the individual uncertainty associated to each model input parameter. For some parameters, such as the airgun array sound source, there is little to no uncertainty when the airgun array is a standard type (MacGillivray 2018a, McPherson et al. 2018a), as is the case for this survey. The propagation models used in this study are based on an understanding of the physics of sound propagation through the water. These models have been extensively tested during its development and use (as described above), with the aim to achieve predictions which match the results of measurement programs.

Uncertainty in the transmission models arise from the choice of parameter values, such as the sound speed profile and the geoacoustic parameters of the ocean bottom substrate. JASCO conducts a thorough analysis of available information to derive these parameters (Appendix G), and where uncertainty exists, values which lead to a conservative estimation of the transmission loss are selected.

6.3.2.5 Plankton

6.3.2.5.1 Receptors

The assessment considers the effects of seismic sound on zooplankton, including eggs and larvae suspended in the water column. Planktonic receptors considered to be of particular value include:

Commercial prawn eggs and larvae

Commercial fish eggs and larvae.

6.3.2.5.2 Impact pathways and sensitivities

Plankton is a collective term for all marine organisms that are unable to swim against a current. This group is diverse and includes phytoplankton (plants) and zooplankton (animals), as well as fish and invertebrate eggs and larvae. There is no scientific information on the potential for noise-induced effect in phytoplankton and no functional cause-effect relationship has been established. Noise-induced effects on zooplankton, such as copepods, cladocerans, chaetognaths and euphausiids, have been investigated in a number of sound exposure experiments. Parry et al. (2002) studied the abundance of plankton after exposure to airgun sounds but found no evidence of mortality or changes in catch-rate on a population-level.

Day et al. (2021) examined the potential impacts of seismic surveys on the larval stages of southern rock lobster (*Jasus edwardsii*) to determine whether early development and recruitment may be affected. Lobster puerulus (post-larval stage) and juveniles were held in baskets and exposed to multiple passes of a seismic source element in 10–12 m water depths. Maximum received sound exposures were 203–219 dB re 1µPa PK-PK, 181–190 dB re 1 µPa²·s per-pulse SEL, and SEL_{cum} of 201–205 dB re µPa²·s, comparable to Day et al. (2016a, 2016b) (Day et al. 2021). Lobster puerulus were randomly assigned to control (not exposed to airgun signals) or E0 (exposed to airgun signals at a nominal range of 0 m from the sail line), and juveniles were assigned to control, E0 and E500 (exposed to airgun signals at a nominal range of 500 m from the vessel sail line). The findings of the study are:

Exposure did not result in any elevated mortality for puerulus or juveniles.

Righting was significantly impaired for all exposure treatments immediately after exposure, indicating that the range of impact extended to at least 500 m from the source (maximum range tested in the study).

Puerelus and juvenile E0 treatment lobsters did not show the capacity for recovery, while juvenile E500 lobsters recovered from impairment after the first moult, providing evidence of a range threshold for recovery.

Intermoult period was significantly increased in E0 juvenile lobsters, and appeared to be increased in puerulus, while juvenile E500 treatment lobsters show a moderate, non-significant increase in moult duration.

Increased intermoult duration suggested impacted development and potentially slowed growth, and physiological stress.

Contrary to these results, McCauley et al. (2017) found that after exposure to airgun sounds generated with a single airgun (150 in³) zooplankton abundance decreased and mortality in adult and larval zooplankton increased two- to three-fold when compared with controls. In this first, large-scale field experiment on the impact of seismic activity on zooplankton, a sonar and net tows were used to measure the effects on plankton. A maximum effect-range of horizontal 1.2 km was determined. The findings contradicted the conventional idea of limited and localised impact of intense sound in general, and seismic airgun signals in particular, on zooplankton, with the results indicating that there may be noise-induced effects on these taxa and that these effects may even be negatively affecting ocean ecosystem function and productivity. The study was compromised by methodological design (small sample sizes, large daily variability in the baseline and experimental data) and the statistical robustness of the data and conclusions (large number of speculative conclusions that appear inconsistent with the data collected over a two-day period). The lead author stressed that even though their conclusions were based on numerous assumptions, the combined likelihood of all measured parameters occurring without being correlated to the airgun survey is extremely low (McCauley, pers. comm.).

CSIRO (Richardson et al. 2017) simulated the large-scale impact of a seismic survey on zooplankton using the mortality rate and effect range found by McCauley et al. (2017). The aim of the CSIRO simulation was to estimate the spatial and temporal impact of seismic activity on zooplankton on the North West Shelf of WA. The CSIRO simulation was based on a hypothetical 3D survey of 2,900 km^2 in size and over a 35-day period. The major findings of the CSIRO simulation were that there was substantial impact of seismic activity on zooplankton populations on a local scale within or close to the survey area, however, on a regional scale the impacts were minimal and were not discernible over the entire North West Shelf Bioregion. The study found that the time for the zooplankton biomass to recover to pre-seismic levels inside the survey area, and within 15 km of the area, was only three days following the completion of the survey. This relatively quick recovery was due to the fast growth rates of zooplankton, and the dispersal and mixing of zooplankton from both inside and outside of the impacted region (Richardson et al. 2017). Richardson et al. (2017) showed that zooplankton communities can begin to recover during the seismic survey, during periods of good oceanic circulation, or ‘bottom out’ at a maximum impact level (presumably where growth rates and/or zooplankton entering the survey area roughly approximate mortality rates) after 23–30 days of commencement of survey operations.

Fields et al. (2019) exposed captive zooplankton (copepods) to seismic pulses at various distances up to 25 m from a seismic source. The source levels were estimated to be 221 dB re 1 µPa2.s, comparable to the far-field source levels associated with some commercial scale seismic surveys. The study observed an increase in immediate mortality rates of up to 30% of copepods in samples at 5 m or less from the airguns compared to the controls. Mortality one week after exposure was significantly higher by 9% relative to controls in the copepods placed 10 m from the airguns. Fields et al. (2019) also reported that no sublethal effects occurred at any distance greater than 5 m from the seismic source. The findings of the study indicate the potential effects of seismic pulses to zooplankton are limited to within about 10 m from the seismic source. Fields et al. (2019) also note that the findings of the McCauley et al. (2017) study are difficult to reconcile with the body of other available research and may therefore be an overly conservative estimate of the potential effects of seismic pulses to zooplankton.

6.3.2.5.3 Thresholds

Popper et al. (2014) has published exposure guidelines for fish eggs and larvae (Table 6-7) which are based on pile driving. Although pile driving and seismic surveys both produce impulsive sound, thresholds derived from pile driving are potentially conservative given that pile driving impulses result in a more rapid rise time in peak pressure than seismic pulses. The thresholds in Table 6-7 have been considered in the assessment of noise impacts to plankton.

Table 6-7: Sound level threshold criteria and values for mortality, injury, TTS and behavioural impacts to plankton

	Plankton (fish eggs and larvae)					
	Mortality/potential mortal injury		**Recoverable injury and TTS**		**Behavioural**	
Threshold criteria	Few studies to base criteria on, however, Popper et al. (2014) provides acoustic criteria extrapolated from simulated pile driving signals which have a more rapid rise time and greater potential for trauma than pulses from a seismic source.		There are currently no acoustic criteria for fish eggs and larvae, however, a scale of relative risk is provided in Popper et al. (2014). The scale assumes that larvae have similar sensitivity to noise as juvenile and adult fish, and that recoverable injury and TTS are possible.		There are currently no acoustic criteria for fish eggs and larvae, however, a scale of relative risk is provided in Popper et al. (2014). The scale assumes that a behavioural response is possible.	
Relevance of thresholds adopted	Popper et al. (2014) has been used as this cites many of the current references and studies on potential impacts of noise emissions on fish eggs and larvae, and when compared to other studies the threshold levels are similar to those proposed, e.g. Day et al. (2016a); Fields et al. (2019). Popper et al. (2014) suggests that injury to larvae resulting from seismic impulses may occur for sound exposures above 207 dB re 1 µPa (PK) or above 210 dB re 1 $\mu Pa^2 \cdot s$ (SEL_{24h}). However, Popper et al. (2014) suggest that recoverable injury and TTS is likely within tens of metres of a seismic source, which is generally less than the distance associated with their proposed mortal injury threshold, hence there is some discrepancy. The threshold proposed for mortal injury is derived from pile driving impacts to fish and is likely to be conservative. The body of literature indicates that mortality and sub-lethal injury are limited to within tens of metres of seismic sources.					
Sound Metric	**Per pulse**	**Over 24 hours**	**Proximity to airgun**	**Relative Risk**	**Proximity to airgun**	**Relative Risk**
Threshold value	207 dB PK[1]	210 dB SEL_{24h}[1]	Near (tens of metres)	Moderate[1]	Near (tens of metres)	Moderate[1]
			Intermediate (hundreds of metres)	Low[1]	Intermediate (hundreds of metres)	Low[1]
Modelled distance (R_{max}) maximum-over-depth	150–170 m	100 m	N/A	N/A	N/A	N/A

1 Popper et al. (2014)

6.3.2.5.4 Impact assessment

Potential impacts to plankton are considered to be within an acceptable level based on:

Phytoplankton and zooplankton biomass in the oceans can vary significantly at spatial scales ranging from hundreds of metres to hundreds of kilometres and temporal scales of hours, days, seasons and inter-annually, due to tidal and large-scale currents, bathymetry, temperature, salinity, water chemistry parameters and other environmental factors (Gibbons & Hutchings 1996; Holliday et al. 2011; McKinnon et al. 2008; Pearce et al. 2000; Sutton & Beckley 2017). Thus, plankton will be spatially and temporally variable throughout a seismic survey.

Predicted impacts to plankton do not remove them from the food web and as such the nutrients and energy they contain are retained within the ecosystem. Even after plankton die, their carcasses remain in the water column for several days where they are scavenged before any remaining carcasses sink to the seafloor to be consumed by opportunistic benthic organisms (Kirillin et al. 2012; Tang et al. 2014; Dubovskaya et al. 2015).

Any mortality or mortal injury effects to fish eggs and larvae resulting from seismic noise emissions are likely to be inconsequential compared to natural mortality rates of fish eggs and larvae, which are very high (exceeding 50% per day in some species and commonly exceeding 10% per day) (Tang et al. 2014). For example, in a review of mortality estimates (Houde and Zastrow 1993), the mean mortality rate for marine fish larvae was M = 0.24, a rate equivalent to a loss of 21.3% per day.

According to information provided by NPFI in relation to previous seismic surveys in the region, less than 1% of prawn larvae survive the 2–4-week planktonic larval phase to reach suitable coastal nursery habitats where they may settle, further indicating that natural mortality rates are high and recruitment rates may vary considerably.

In the seismic exposure experiment undertaken by McCauley et al. (2017) zooplankton mortality rate background levels were 19%, thus predicted impacts to zooplankton from the seismic survey are likely to be within natural mortality rates.

Sætre and Ona (1996) calculated that under the ‘worst-case’ scenario, the number of larvae killed during a typical seismic survey was 0.45% of the total population, and they concluded that mortality rates caused by exposure to airgun sounds are so low compared to natural mortality that the impact from seismic surveys must be regarded as insignificant.

Estimated distances for mortality of fish eggs and larvae (maximum 170 m from the source) and low risk to incur a recoverable injury, TTS or behavioural response (derived from applying the threshold values provided by Popper (2014)) (refer to Table 6-7), would impact fish eggs and larvae at a local rather than a regional scale with sufficient time for recovery to local populations. For this survey, it is considered that the potential impacts and risks to fish eggs and larvae in the water column will be localised and temporary.

Day et al. (2021) found no evidence of elevated mortality for larval and juvenile rock lobster exposed to seismic noise up to 500 m from the source. Therefore, it is possible that similarly there would be no direct mortality to prawn larvae, further supporting that the Popper et al. (2014) threshold for mortality/injury is conservative.

Seismic source signals caused righting impairment in juvenile lobsters to at least 500 m from the source (Day et al. 2021). Intermoult period for juvenile and larval rock lobsters at 0 m from the seismic source was significantly increased, and a moderate non-significant increase in moult duration was found at 500 m from the source (Day et al. 2021). Righting impairment in adult rock lobster corresponded with significant damage to the mechanosensory organ, which is critical for predator avoidance behaviour (Day et al. 2019), and increased intermoult duration suggested impacted development and potentially slowed growth (Day et al. 2021). Similar impacts to prawn larvae may occur, and therefore potential sub-lethal impacts could result in hindered development and/or increased predation of some larvae.

The magnitude of such localised impacts is negligible and is not expected to be discernible at the regional scale when considering the large natural spatial and temporal variability and scale of plankton and spawning biomass throughout the wider region.

As described in Richardson et al. (2017) zooplankton communities can begin to recover during the seismic survey such that a continuous decline in zooplankton throughout the duration of the seismic survey is not anticipated and parts of the survey area would be replenished as the survey progressed.

The potential impacts to plankton are considered further in the context of prawn and fish spawning and recruitment in Sections 6.3.2.9 and 6.3.2.7.

6.3.2.5.5 Summary

Based on the above impact assessment, no long-term impacts to plankton communities or fauna dependent on plankton as a food or recruitment source are predicted. Zooplankton communities can begin to recover during the seismic survey such that a continuous decline in zooplankton throughout the duration of the seismic survey is not

anticipated and parts of the survey area would be replenished as the survey progressed. Thus, the consequence level is assessed as negligible.

6.3.2.6 Invertebrates

6.3.2.6.1 Receptors

Soft sediment habitats that cover the majority of the Active Source Area support relatively little seabed structure or sessile epibenthos. They are sparsely covered by sessile filter-feeding organisms (e.g. gorgonians, sponges, ascidians and bryozoans) and mobile invertebrates (e.g. echinoderms, prawns and detritus-feeding crabs) (Brewer et al. 2007; DSEWPaC 2012a). The shelf and basin geomorphological features that make up the majority of the seabed within the Operational Area are dominated by 'infaunal plains' which mainly support fauna with scattered epifauna (Przeslawski et al. 2011). Woodside (2004) observed infauna assemblages comprised mainly of two phyla, Arthropod crustaceans (including burrowing shrimps and crabs) and tube-dwelling Annelida (polychaete worms).

The Pinnacles of the Bonaparte Basin and Carbonate Bank and Terrace System of the Sahul Shelf KEFs, approximately 7.8 km and 6.2 km, respectively from the Active Source Area, respectively, provide a higher proportion of hard substrate in an otherwise soft sediment environment, and support a greater abundance and diversity of epifauna biota such as octocorals and sponges (Przeslawski et al. 2011). At their shallowest points, the banks rise sharply from seabed from around 69-80 m depth.. These features are part of broader regional scale KEFs.

Commercial invertebrate species, such as banana and tiger prawns, are key invertebrate species in the JBG, as evidenced by NPF fishing activities in the JBG. Though the Active Source Area does not overlap with the NPF area of fishing effort based on 2010–2020 data.

Key invertebrate receptors considered in this assessment include:

Benthic invertebrate communities associated with the Pinnacles of the Bonaparte Basin and Carbonate Bank and Terrace System of the Sahul Shelf KEFs.

Spawning and recruitment of commercially significant prawn stocks in the JBG.

6.3.2.6.2 Impact pathways and sensitivities

Invertebrates are less sensitive to noise impacts than fish species and marine mammals due to their lack of air-filled internal organs. Exposure to anthropogenic sound sources could have a direct consequence on the functionality and sensitivity of the sensory systems of marine invertebrates. The sensory organs involved in receiving underwater sound in this taxonomic group can be classified into three groups (Budelmann 1992b):

Superficial receptor systems on the body surface are receptors sensitive to water displacements, therefore mainly encoding hydrodynamic cues

Internal statocyst receptor systems are found in a wide range of aquatic invertebrates. These are inertial gravity receptor systems that are used by animals to maintain their orientation, direct their movements through the water and may play a key role in controlling the behaviour responses of invertebrates to a wide range of stimuli. They may also function as acoustic particle motion detectors and thus play a role in the detection of underwater sound (Budelmann 1992b) or substrate-borne vibrations (Cohen et al. 1953, Cohen 1955)

Chordotonal organs are proprioceptive receptors that monitor joint movement, the direction of movement, and static position. These organs are sensitive to oscillation of the water column surrounding it (Budelmann 1992a).

Many marine invertebrates are permanently in contact with sediment on the seabed. The sediment, however, does not follow the movement of the surrounding water. Therefore, exposure to underwater sound will result relative to the movement between the body of these animals and the oscillating water column. Accordingly, it is important to also consider the propagation of vibration through the ground. For benthic organisms, this type of vibration is likely of similar or greater importance than the water-borne vibration or even the compressional component of a sound (Roberts and Elliott 2017). The published scientific information on vibration sensitivity in marine invertebrates is scarce (Roberts et al. 2015; Roberts et al. 2016; Popper and Hawkins 2018). To date, there is no convincing evidence for any significant effects induced by non-impulsive noise in benthic invertebrates. Given the rapid attenuation of vibrational signals beyond the near field of a sound source (Morley et al. 2014), it is unlikely that these stimuli are causing more than behavioural effects (e.g. flight or retraction) or physiological (e.g. stress) responses in marine invertebrates.

Santos acknowledge Fisheries Research Report No. 288, Risk Assessment of potential impacts of seismic air gun surveys on marine finfish and invertebrates in Western Australia (Webster et al. 2018), which provide risk assessment outcomes for mobile and immobile invertebrates of 'moderate to high' and severe to high' respectively. Santos notes, however, that the DPIRD risk assessment was undertaken based on the worst-potential effect at the level of individual invertebrate organism and assumed that an individual is positioned directly in the path of the seismic source. Therefore, the WA DPIRD risk assessment represents a conservative scenario that is not

necessarily representative of real-life exposures to all invertebrate organisms that may be exposed within a seismic survey area or impacts at a population or community level. Santos has considered the available scientific research, as well as additional activity-specific and situation-specific context to assess potential risks to populations.

The potential sensitivities of invertebrate organisms are summarised in Table 6-8, for each of the key groups of invertebrates likely to be present within the Active Source Area, further detail on relevant scientific studies and research undertaken used to inform this impact assessment is included in Appendix H.

Table 6-8: Sensitives for invertebrates

Invertebrate	Summary of potential sensitivities
Crustaceans	There have been several recent reviews of seismic noise impacts to invertebrates (Carroll et al. 2017; Edmonds et al. 2016; Salgado Kent et al. 2016; Webster et al. 2018). Several studies have been undertaken on decapod crustaceans (lobsters, prawns, crabs) with a range of effects to no effects identified, though none have found any evidence of increased mortality due to acoustic impacts from seismic exposure. A range of physiological responses have been identified in some studies, however, the received sound levels are typically at levels that would be received within a few tens of hundreds of metres from the sound source or have been from repeated exposure at the same sound levels, which is not realistic in an actual seismic survey. Lethal effects have not been observed in studies of exposure of lobsters, crabs, or shrimps (Christian et al. 2003; Andriguettto-Filho et al. 2005; Parry and Gason 2006; Payne et al. 2007; Day et al. 2016a, Day et al. 2019). No behavioural response or evidence of animals migrating out of a seismic survey area have been reported in snow crabs (Christian et al. 2003) or in shrimp (Celi et al. 2013). A pilot study on snow crabs (Christian et al. 2003) exposed captive adult male crabs and egg-bearing female crabs to approximately 197–237 dB re 1 µPa PK-PK and SELs of <130–187 dB re 1 µPa².s. The crabs were exposed to 200 pulses over a 33-minute period. No acute or chronic (12 weeks post-exposure) mortality impacts were observed in the adult crabs. Stress indicators in the snow crabs also showed no evidence of significant acute or chronic impacts. The crabs also did not exhibit any overt startle response during the exposure period or avoidance of the area following exposure. DFO (2004) also exposed caged egg-bearing crabs to 132 hours of impulses from a seismic survey with maximum received sound levels of approximately 190 dB re 1 µPa PK. Neither acute nor chronic lethal or sub-lethal injury to the female crabs or crab embryos were observed up to five months following exposure. Payne et al. (2007) conducted a pilot study of the effects of exposure to seismic sound on various health indicators of American lobster. Adult lobsters were exposed at approximately 2 m range from a seismic source for either 20 or 200 times to average pressures of 202 dB re 1µPa PK-PK or 50 times to 227 dB re 1µPa PK-PK and then monitored over several months for changes to survival, food consumption, turnover rate, and serum biochemistry. No immediate or delayed mortality was observed, nor damage to mechano-sensory systems and the ability of lobsters to right themselves when turned over. There was evidence of a decrease in serum enzymes and increases in food consumption in the weeks to months post exposure, which may indicate stress effects or potential osmo-regulatory disturbance. The results therefore indicate the potential for sub-lethal effects but there were no obvious impacts to long-term survival and, therefore, limited ecological implications. Payne et al. (2008) did not observe any startle responses in aquarium experiments with lobsters and shrimp exposed to approximately 200 dB re 1µPa PK-PK. From 2013–2015, a long-term study evaluated the acoustic impacts from seismic exposure on southern rock lobsters (*Jasus edwardsii*) (Day et al. 2016a). The study found that sub-lethal effects, relating to impairment of reflexes, damage to the statocysts and reduction in numbers of haemocytes (possibly indicative of decreased immune response function), were observed after exposure to measured received sound levels of 209-212 dB re 1 µPa (PK-PK). Exposure to seismic sound did not result in any mortalities to adult lobsters, even at close proximity directly beneath the seismic source, were not affected. Day et al. (2016a, 2016b) suggested that lobsters may be able to adapt or compensate for long-term statocyst impairment. Day et al. (2016a) found that 'seismic exposure did not result in a decrease in fecundity, either through a reduction in the average number of hatched larvae or as a result of high larval mortality, compromised larvae or morphological abnormalities'. These results support the suggestion by Pearson et al. (1994) that early life stage crustaceans may be more resilient to seismic air gun exposure than other marine organisms. Received levels were approximately 211 dB re 1 µPa (PK-PK; approximately 205 dB re 1 µPa PK). Day et al. (2019) found that airgun exposure caused damage to the righting reflect and statocysts in rock lobsters (*Jasus edwardsii*). Following exposure equivalent to a full-scale commercial array (3,100 cui) passing within 100–500 m, lobsters showed impaired righting and significant damage to the sensory hairs of the statocyst. Reflex impairment and statocyst damage persisted up to 365 days post-exposure and did not improve following moulting. For this study, maximum measured received noise levels were 209-213 dB re 1 µPa (PK-PK). Payne et al. (2007) in a study on seismic impacts to the American lobster (*Homarus americanus*) did not detect any differences in righting time in the 9, 65, or 142 days after exposure to received noise levels of 202 dB re 1 µPa (PK-PK). Payne et al. (2007) also found no effects on American lobster haemolymph biochemistry but possible reduction in calcium.

Invertebrate	Summary of potential sensitivities
	Day et al. (2021) exposed rock lobster puerulus (post larvae stage) to a full commercial scale seismic survey at a range of 500 m from the vessel sail line. Exposure did not result in any elevated mortality for puerulus, but reduced their righting ability and increased inter-moult period, suggesting potentially slowed development and increased physiological stress. The ecological consequences of alterations in physiology and behavioural responses have not been documented.
Bivalves	A number of studies have been undertaken on commercially important scallops (*Pecten fumatus*) with conflicting results. Typically, impacts can be induced in laboratory experiments or have been seen in field studies where there have been repeated exposures that are not necessarily reflective of an actual seismic survey. For example, Matishov (1992; cited in Parry and Gason 2006) reported a single scallop shell splitting in a sample of three scallops, but this was located 2 m beneath a seismic source element and therefore exposed to maximum sources levels (which is not representative of a typical commercial seismic survey). Recent Australian studies (Przeslawski et al. 2016a, 2018; Day et al. 2016b, 2017) have focussed on commercial scallops (*Pecten fumatus*), and found no evidence of immediate mortality or change in condition following exposure to seismic survey. Day et al. (2016b, 2017) concluded that repeated seismic sound exposures resulted in a chronic increase in mortality over timeframes of approximately four months post-exposure, though not beyond naturally occurring rates of mortality. Sub-lethal effects to exposed scallops were also observed by Day et al. (2016b, 2017) indicating a compromised capacity for homeostasis and potential immunodeficiency over acute (hours to days) and chronic (months) timescales post exposure. Exposures did not elicit energetically expensive behaviours (i.e. extensive swimming or long periods of valve closure), but scallops showed significant changes in some behavioural patterns during exposure (e.g. 'flinch' response) and scallops showed an increase in recessing into sediment following exposure (Day et al. 2017). Przeslawski et al. (2018) concluded that there was no evidence of increased scallop mortality, or effects on scallop shell size, adductor muscle diameter, gonad size, or gonad stage due to the seismic sound from an actual seismic survey. The authors concluded that the study provided no clear evidence of adverse effects on scallops, fish, or commercial catch rates due to the 2015 seismic survey undertaken in the Gippsland Basin. Przeslawski et al. (2018) further concluded that the study provided a robust and evidence-based assessment of the potential effects of a seismic survey on some fish and scallops. However, these results should be interpreted in the context of other studies such as Day et al. (2016a, 2016b), and should not be generalised to include other animals due to the vast range of different physiology and sensory systems.
Corals and sponges	There is limited published literature on the potential impacts of seismic noise on hard and soft corals, and unlike other faunal groups, currently there are no peer-reviewed criteria against which potential noise impacts to coral can be assessed. Scleractinian corals, primarily plate corals in families Agaracidae and Acroporidae, and soft corals were monitored *in situ* before, during and after a 3D seismic survey (Heyward et al. 2018). There were no detectable impacts on scleractinian coral mortality, skeletal damage or visible signs of stress immediately after and up to four months following the 3D marine seismic survey. Similarly, there was no evidence of a behavioural response, such as polyp withdrawal or flaccidity in soft corals such as *Lobophytum* spp.

6.3.2.6.3 Thresholds

No published exposure criteria currently exist to enable an evaluation of potential mortality / potential mortal injury effects in crustaceans. The threshold criteria that have been adopted for the assessment of noise impacts to invertebrates and the modelled distances for the criteria are from studies described above and provided in Table 6-9.

Table 6-9: Sound level threshold criteria and values for mortality, injury, TTS and behavioural impacts to invertebrates

Invertebrates	Potential Impacts		
	Crustaceans – recoverable injury	**Bivalves – mortality/mortal injury**	**Corals and sponges – mortality/mortal injury**
acoustic criteria	Crustaceans were the most studied group of invertebrates in terms of the range of metrics investigated, including catch rates and physical, behavioural, and physiological effects (Carroll et al. 2017). No threshold criteria currently exist for acoustic impacts from seismic exposure to crustaceans. Though particle motion is likely the mechanism of impacts for invertebrates rather than sound pressure it is not clear what level of particle motion relates to an effect. Thus, for this assessment sound pressure metrics are used to be able to compare to published study results that use the sound pressure metrics of PK-PK. As Payne et al. (2007) identified no effects on righting time in lobster at 202 dB re 1 µPa (PK-PK), and Day et a***l.*** (2016a) found effects at 209 dB re 1 µPa (PK-PK), the lower level of 202 dB re 1 µPa (PK-PK) has been applied in this assessment. This is a precautionary threshold to determine potential impacts considering other studies (Christian et al. 2003) observed no lethal or sub-lethal effects in response to levels as high as 237 dB re 1 µPa PK-PK.	No threshold criteria currently exist for acoustic impacts from seismic exposure to bivalves. Particle motion is likely the mechanism of impacts for bivalves rather than sound pressure though it is not clear what level of particle motion relates to an effect. Particle motion is seen as a more relevant criteria for assessment of bivalves as they spend the majority of the time in the seabed sediments rather than the water column. To assess the potential impacts associated with the seismic survey, particle motion has been assessed, specifically particle acceleration and velocity, and the results compared to those presented in Day et al. (2016b). The maximum particle acceleration assessed for scallops was 37.57 ms^{-2} (2).	To inform the assessment of potential effects on coral, the PK sound level at the seafloor directly underneath the seismic source was estimated at all modelled sites and compared to the levels of 226-232 dB re 1 µPa PK levels at which no acute or chronic impacts to corals were identified (Heyward et al. 2018).
Sound Metric	**Per pulse**	**Particle Motion Maximum**	**Per pulse**
Threshold criteria	202 dB PK-PK[1]	37.57 ms^{-2} [2]	226 dB PK[3]
Modelled distance	512–673 m	N/A – Particle motion was not modelled for this Activity due to low mollusc species diversity and absence of ecologically or commercially significant bivalve species in the JBG.	Not reached at the seafloor.

1 Payne et al. (2008)

2 Day et al. (2016a)

3 Heyward et al. (2018)

6.3.2.6.4 Impact assessment

Based on the research summarised in Table 6-9 and in Appendix H, limited impacts to benthic invertebrates are expected. Based on the no-effect criteria for crustaceans, 202 dB re 1 µPa (PK-PK) was reached at a range of 512–673 m from the seismic source. Therefore, effects to some organisms may occur across the Active Source Area. Some benthic invertebrate species may experience sub-lethal effects or sessile invertebrates such as bivalve molluscs may experience chronic mortality in some individuals in the weeks or months following exposure within tens or hundreds of metres from the seismic source.

The effects on the infauna communities that dominate the Active Source Area are likely to include sub-lethal effects to Arthropod crustaceans (burrowing shrimps and crabs). The effects of seismic exposures to organisms such as polychaete worms have not been studied but it is possible that these organisms could also experience a range or sub-lethal to chronic mortality effects, similar to the effects observed in bivalve molluscs by Day et al. (2016b, 2017). Should this occur, the continuous natural cycle of death, recovery, and recruitment of invertebrates from adjacent sediments will occur in parallel over the same timescales, and therefore it is questionable whether any impacts from seismic exposure would be detectable from natural fluctuations in relative abundance, benthic community composition and structure.

During the survey, there may be situations when the seismic source must be shutdown (e.g. as mitigation for marine fauna sightings). Should this occur, the seismic vessel will return later in the survey to complete infill of sections of acquisition line that have been missed. In doing so, the survey vessel run-in over the line may result in operation of the seismic source over a small stretch of seabed that have been previously exposed to sound from the seismic source. It is possible that repeat exposures could result in a small increase in the proportion of organisms that experience sub-lethal effects or chronic mortality. For example, Day et al. (2016b, 2017) observed 9.4–11.3% mortality in scallops exposed to a single pass of the seismic source, 11.3–16.1% mortality in scallops exposed to two passes of the seismic source, and 14.8–17.5% mortality in scallops exposed to four passes of the seismic source. The mortality rates were at the low end of the range of naturally occurring mortality rates documented in the wild, which range from 11–51% with a 6-year mean of 38% (Day et al. 2017).

Day et al. (2017) and Payne et al. (2007, 2008) acknowledge that the changes observed in their research are likely within the range of variation that can occur from other common natural and anthropogenic stressors. The ecological implications of such impacts on benthic invertebrate communities are not expected to be significant or long-term.

Sponges and corals that may occur in association with any hard substrate within the Active Source Area are not predicted to be impacted. The threshold value of 226 dB re 1 µPa PK for corals and sponges was not reached at any of the modelling sites (Table 6-9). It is also important to note that the 226 dB re 1 µPa PK reported in Heyward et al. (2018b) is not a threshold above which impacts are expected to occur, but a level at which no short term or long-term effects were observed.

Consequently, indirect impacts on higher trophic level species that target benthic invertebrates as a food source are also not expected. For example, benthic organisms are a key food source for demersal fish species; following the passing of the seismic source, benthic invertebrates are still available to be foraged and any chronic mortality that occurs over the weeks or months following exposure is expected to be negligible in the context or natural mortality and recruitment.

Carbonate Bank and Terrace System of the Sahul Shelf KEF and Pinnacles of the Bonaparte Basin KEF

The Pinnacles of the Bonaparte Basin and Carbonate Bank and Terrace System of the Sahul Shelf KEFs are approximately 7.8 km and 6.2 km respectively from the Active Source Area, thus no impacts to invertebrates associated with these features are predicted. The no-effect criteria for crustaceans, 202 dB re 1 µPa (PK-PK), was reached at a range of 512–673 m from the seismic source and the threshold value, 226 dB re 1 µPa PK, for corals and sponges was not reached at any of the modelling sites.

Spawning and recruitment of commercially significant prawn stocks

The most commercially and economically significant invertebrate species in the JBG are prawns, targeted by the NPF. Species caught include white banana prawns, red-legged banana prawns, brown tiger prawns, grooved tiger prawns, blue endeavour prawns and red endeavour prawns. Banana prawns and tiger prawns are indicator stocks for the fishery, while endeavour prawns are a non-target (but still retained) catch species. Historically, the JBG has been particularly significant for banana prawns, with the JBG contributing about 65% of the NPF redleg banana prawn catch and around 20% of the NPF total banana prawn catch.

White banana prawns can generally be found at depths of 16–25 m but can occur to depths of 45 m and are mainly caught on the eastern side of the Gulf of Carpentaria (Butler et al. 2022). Red-legged banana prawns are found at depths of 35–90 m (AFMA 2021), hence the red-legged banana prawns targeted by the NPF are the species most likely to be present in the Active Source Area. Tiger prawns inhabit shelf waters to depths of 200 m but make up a smaller component of the catch in the JBG.

The biological stock structure of the banana and tiger prawn species is uncertain. There is some evidence that there may be separate biological stocks within the NPF, however, the boundaries of these biological stocks are

unknown. In the JBG, a single separate stock for banana prawns is assumed for stock assessment purposes, although stock status for the species is reported at the management unit level (the whole of the Northern Prawn Fishery) (Parsa et al. 2020).

The banana prawn and tiger prawn stocks are assessed as being 'not overfished' (Butler et al. 2023). Although biological stock boundaries are uncertain and a stock–recruitment relationship is not established, the status of the stocks is based on a weight-of-evidence approach, with the harvest strategy in the NPF designed to ensure adequate remaining spawning biomass closing the fishing seasons if catch rates fall below set catch-rate trigger levels. The species has shown resilience to fishing pressure, with strong subsequent recruitment following historical high levels of catch and fishing mortality. The stock biomass is therefore unlikely to be depleted and that recruitment is unlikely to be impaired (Larcombe et al. 2018; Parsa et al. 2020).

From 2021, a closure area will apply to the whole of the JBG south of latitude 13°S to exclude fishing during the banana prawn fishing season (Figure 3-16). Only fishing during the 1 August to 1 December tiger prawn season is now permitted in the JBG closure area. During stakeholder consultation for the Petrel Sub-Basin SW 3D MSS in 2021–2022, the NPFI advised Santos that they had concerns regarding a seismic survey taking place within the closure area on the basis that it could impact the banana prawn stock recovery and, therefore, potentially influence catch monitoring that is to be undertaken over the next 5 years for the purposes of assessing the JBG prawn biomass and potential reopening of the JBG to fishing during the banana prawn season.

The assessment of impacts to spawning and recruitment of banana and tiger prawn stocks in the JBG considers:

Potential effects to the adult spawning biomass, specifically adult female prawns berried with eggs

Potential effects to eggs and larvae dispersed in the water column

Potential effects to migrating juveniles recruiting to the adult stocks.

While some studies have been undertaken into the effects of seismic on prawn/shrimp, it is acknowledged that many studies have focused on crabs or lobsters and so there is some level of uncertainty in using these results in the prediction of impacts to prawns. However, given the similar physiology of decapod crustaceans such as prawns, lobsters and crabs, the information is relevant.

Effects to adult female prawns berried with eggs

Impacts on prawns are assessed based on research undertaken on seismic exposures to a variety of decapod crustaceans, including lobster, shrimp and crab. As summarised in Table 6-9 and in Appendix H, lethal effects have not been observed in studies of exposure of lobsters, crabs or shrimps (Christian et al. 2003; Andriguettto-Filho et al. 2005; Parry and Gason 2006; Payne et al. 2007; Day et al. 2016a). No behavioural response or evidence of animals migrating out of a seismic survey area have been reported in snow crabs (Christian et al. 2003) or in shrimp (Celi et al. 2013). A range of studies have exposed female crustaceans bearing eggs to sound pressures of approximately 196–237 dB re 1 µPa PK-PK, with no reports of acute or chronic mortality in the adult lobsters and no mortality of embryos (Christian et al. 2003; DFO 2004). Day et al. (2016a, 2016b) also reported that exposures equivalent to approximately 205 dB re 1 µPa (PK) did not impact the condition or development of eggs carried by female lobsters, or the size or morphology of the larvae once hatched. Therefore, potential exposure of berried females to the seismic source is unlikely to result in any mortalities to adult females in addition to natural or fishing mortalities and, therefore, no reduction in the adult spawning biomass. Significant impacts to eggs carried by the females are also unlikely to occur, with berried eggs protected by adults expected to be less sensitive than dispersed planktonic eggs, as assessed below.

Effects to eggs and larvae dispersed in the water column

Female prawns produce hundreds of thousands of eggs each year, released in batches over multiple spawning events (refer to Section 3.8.1.4). Prawns in the JBG spawn to some degree throughout the entire year. Banana prawns have two peak spawning periods, September – November and March – May. Brown tiger prawns have a spawning peak between July and October. Grooved tiger prawns have a spawning peak in in August-September, with a secondary peak in February. Fertilised eggs disperse in the water column and are carried by tides and currents. Larvae hatch within 24 hours and some larvae will eventually settle in nursery habitats in shallow coastal waters (mangroves, creeks, seagrass beds). Loneragan et al. (2002) found that offshore spawning resulted in the advection of larvae over large distances in the JBG before settlement in their nursery habitats. Less than 1% of larvae survive the 2–4 week offshore planktonic larval phase. The majority of larvae will either not reach appropriate settlement habitat or may be lost to predation or other natural factors.

During the egg and larval dispersal phase, some eggs and larvae may be impacted by seismic impulses emitted during the Eos 3D MSS. As described in Section 6.3.2.8, mortality and injury to zooplankton, including eggs and larvae, is likely limited to metres to tens of metres from a seismic source, although based on the Popper et al. (2014) threshold for eggs and larvae, some mortality impacts could occur up to 170 m from the seismic source during the Eos 3D MSS.

To assess the potential impacts to dispersed prawn eggs and larvae, the overlap of the survey and proportion of suitable spawning habitat for the JBG prawn stocks has been considered. The assessment primarily considers the spawning range of red-legged banana prawns on the basis that is it the most significant commercial prawn species in the JBG, but also because its depth range (35–90 m) has the greatest overlap with the Active Source Area where depths range from 67–111 m. Tiger prawns may also spawn in the JBG, but they make up a smaller proportion of the prawn catch. Their depth range extends up to 200 m water depth, so assessment based on the red-legged banana prawn depth range is likely to provide a conservative estimate for tiger prawns. White banana prawns occur in water depths less than 45 m and so are unlikely to be impacted by the survey.

The area of the JBG that corresponds with the red-legged banana prawn 35–90 m depth range is approximately 40,000 km^2. Some level of spawning may occur throughout this area, throughout the year. However, to provide a further level of conservatism, the assessment of potential spatial overlap with spawning habitat is limited to the area that has historically been targeted for prawns by the NPF (based on the 2010–2020 NPF fishing intensity data presented in Figure 6-1). The correlation with historic fishing effort is considered to represent the core area where adult prawns may be found in greatest abundance in the JBG. This area covers 14,484 km^2 and is, therefore, significantly smaller than the area covered by the depth range for the species in the JBG.

In any 24-hour period of seismic data acquisition, during which eggs and/or larvae released from the adult spawning stock may drift through the survey area, the potential effects footprint associated with the 170 m range for potential mortality (based on the Popper et al. 2014 threshold) applied to sail lines would be equivalent to approximately 91 km^2 (0.6%) of the 14,484 km^2 core area of adult prawns in the JBG.

Recent findings by Day et al. (2021) into lobster larvae may indicate that no direct mortality of larvae will occur, however development of larvae may be impacted out to at least 500 m from the seismic source. It is acknowledged that the Day et al. (2021) study could not establish the maximum range to effects, and it is based on the effects of seismic on rock lobster larvae, therefore, some differences may apply to prawn larvae. Therefore, a more conservative distance of 1 km from the seismic source has been applied. Day et al. (2021) did not find evidence of elevated mortality for lobster larvae, and it is not known whether impacts to development will compromise their survival in anyway. However, for the purposes of this assessment and to account for potential uncertainty into the effects of seismic on prawn eggs and larvae, it is conservatively assumed that prawn eggs and larvae within the 1 km range could be compromised in some way, either from direct mortality or from impaired development and survival. In any 24-hour period of seismic data acquisition, during which eggs and/or larvae released from the adult spawning stock may drift through the survey area, the potential effects footprint associated with the 1 km range applied to sail lines would be equivalent to approximately 444 km^2 (3.0%) of the 14,484 km^2 core area of adult prawns in the JBG.

The total spatio-temporal overlap with the core area and peak spawning period for red legged banana prawns is 3.0% based on 3.0% of the core area per day may be exposed for the peak spawning period.

Using 3.0% as a proxy for the proportion of red-legged banana prawn eggs and larvae in the JBG that could be impacted per day, and in the context of natural larvae mortality (potentially higher than 99% natural mortality given the less than 1% settlement rate) and naturally variable annual recruitment rates, the potential risk of the Eos 3D MSS on dispersed prawn eggs and larvae in the JBG is negligible.

Noting again that the area where spawning may occur is likely larger than the core area assessed and that some level of spawning occurs year-round, the proportion of eggs and larvae released during spawning that may be affected by the survey is likely to be even less.

Effects to migrating juveniles recruiting to the adult stock

After 1–3 months on the nursery grounds, juvenile prawns migrate offshore, reaching sexual maturity at approximately 6 months. During this period, larvae that may have previously been exposed to the seismic source and experienced impaired development (3.0%) may experience reduced survival rates. Therefore, it is already assumed that some exposed individuals could potentially die before or during migrating back to the adult stock.

The migration of juvenile banana prawns from coastal nursery grounds to the offshore adult stock in the JBG is variable but appears to be split into two periods, with the migration of the main cohort occurring sometime between November and March, with a possible second cohort migrating from April to June (Neil Loneragan, CSIRO Division of Marine Research, pers. comm., April 2000). Migration of the juveniles occurs throughout the southern and eastern coastal waters of the JBG and is thought to be triggered by rainfall and river discharge. The main migration period and migration route in the southern part of the JBG has been mostly protected from fishing mortality by the NPF using seasonal closures (closed December to March). Until 2021, a closure area in the southern part of the JBG has also applied each year during the 1 April to 15 June banana prawn fishing season, followed by another closure season from 15 June to 1 August, preventing fishing during the migration of the second cohort.

The Active Source Area is just outside where the adult banana prawn stock resides, as indicated by the area that has historically been targeted for prawns by the NPF (based on the 2010–2020) NPF fishing intensity data presented in Figure 6-1). The fishing area, and apparent core area where adult prawns tend to occur, includes waters in the south-east corner of the Operational Area as well as in shallower waters to the south and west of the

Operational Area. The Active Source Area is in deeper waters to the north of the pre-2021 closure area intended to protect the main migration area (refer to Figure 6-1). The Active Source Area is approximately 45 km north of the pre-2021 closure area and main juvenile migration area. Therefore, the main juvenile migration area is avoided.

As summarised in Table 6-9 and in Appendix H, lethal effects have not been observed in studies of lobsters, crabs or shrimps exposed to seismic impulses (Christian et al. 2003; Andriguettto-Filho et al. 2005; Parry and Gason 2006; Payne et al. 2007; Day et al. 2016a). In addition, no behavioural response or evidence of animals migrating out of a seismic survey area have been reported in snow crabs (Christian et al. 2003) or in shrimp (Celi et al. 2013). There is potential for hindered development and slowed growth to some newly moulted juveniles, which could increase chances of predation and mortality (Day et al. 2021). However, the spatial extent of exposure is small in comparison with the broader juvenile migration area and the area inhabited by the JBG adult stock.

As the Active Source Area does not overlap the where adult prawn stock reside that juveniles migrate offshore to recruit to, the survey will not disturb juveniles from migrating through nearshore waters or prevent juveniles from reaching offshore waters greater than 35 m water depth where the adult stock resides. In addition, mortality of juvenile and sub-adult prawns is unlikely based on the available studies on decapod crustaceans (Christian et al. 2003; Andriguettto-Filho et al. 2005; Parry and Gason 2006; Payne et al. 2007; Day et al. 2016a, 2021). Larvae and juveniles that are exposed and experience hindered development (potentially resulting in increased predation) will not be recruited to the adult stock. As prawns reach maturity within 6 months, they will join the stock and contribute to the spawning population over the next 12–18 months (total lifespan is 1–2 years). However, given that the juvenile migration area is not predicted to be impacted and a small proportion of the total larvae (3.0%) may be exposed to effects, the adult stock is not expected to be materially impacted.

6.3.2.6.5 Summary

Based on the impact assessment no long term or population impacts to invertebrates (crustaceans, molluscs, corals, filter-feeders) are predicted. Thus, the consequence level for benthic invertebrates is assessed as negligible.

The invertebrate communities at the Carbonate Bank and Terrace System of the Sahul Shelf KEF and pinnacles of the Bonaparte Basin KEF are not predicted to be impacted, thus there will be no impacts to the ecological integrity, function or values of the KEFs.

The potential risk to commercial prawns within the JBG is also considered to be limited and at an acceptable level based on:

Lethal effects to crustaceans have not been observed in studies (Christian et al. 2003; Andriguettto-Filho et al. 2005; Parry and Gason 2006; Payne et al. 2007; Day et al. 2016a, 2021).

No significant impacts to adult female prawns berried with eggs are expected during the spawning season given that there have been no reports of acute or chronic mortality in the adult lobsters and no mortality of embryos exposed to seismic impulses (Christian et al. 2003; DFO 2004).

The potential for mortality to dispersed eggs and larvae is limited to an insignificant proportion of the total biomass that will occur across the JBG, compared to natural mortality rates and variability in recruitment.

The survey will not prevent juvenile prawns from migrating to the adult stocks in offshore waters. The Active Source Area does not overlap the juvenile migration area.

No discernible impacts to prawn stock levels or catchability are expected.

6.3.2.7 Fish, sharks and rays

6.3.2.7.1 Receptors

The following fish types and receptors have been identified for this assessment:

Demersal fish species including commercial fish species, such as tropical snappers and emperors

Pelagic fish species including commercial fish species, such as mackerel

Sharks and rays, including whale sharks and sawfish

Potential site-attached fish assemblages with the Carbonate Bank and Terrace System of the Sahul Shelf KEF and the pinnacles of the Bonaparte Basin KEF

Spawning and recruitment of commercially significant fish species.

6.3.2.7.2 Impact pathways and sensitivities

Although hearing ranges and sensitivities vary substantially between species (e.g. Ladich and Fay 2013), all fish species tested to date can detect sound and vibration to some degree (Dale et al. 2015). Fishes have developed two sensory mechanisms for detecting, localising, and interpreting underwater sounds and vibrations: the inner ear,

which is tuned to sound pressure detection, and the lateral line system, which allows a fish to detect vibration and water flow. Inter-specific variations in hearing range and sensitivity result from the different adaptations in these systems for perceiving sound pressure and particle motion information (Popper and Fay 2011).

Based on their morphology, Popper et al. (2014) classified fishes into three categories comprising:

Fishes with swim bladders whose hearing does not directly involve the swim bladder or other gas volumes

Fishes whose hearing does directly involve a swim bladder or other gas volume; and

Fishes without a swim bladder that can sink and settle on the substrate when inactive (Popper et al. 2014, Carroll et al. 2017).

The Popper et al. (2014) classifications can be assigned to the following families or species of fish, common in Australian waters:

Fishes with swim bladders or other gas volumes, but whose hearing does not directly involve the swim bladder, e.g. snappers, emperors, groupers and rock cods (*Lutjanids* and *Lethrinids* such as *Pristipomoides spp., Lethrinus spp., Lutjanus spp.*, and family *Serranidae*), and some species of tuna (*Thunnus sp*.) (Tavolga and Wodinsky 1963; Higgs et al. 2006; Braun and Grande 2008; Engineering-Environmental Management, Inc. 2008; United States Department of the Navy 2008; Caiger et al. 2012; Bertrand and Josse 2000; Song et al. 2006)

Fishes whose hearing does directly involve a swim bladder or other gas volume e.g. family *Clupeidae* (herrings, sardines, pilchards and shads), family *Gadidae* (true cods such as whiting), and potentially some nearshore / reef species relevant to tropical Australia, including some *Pomacentridae* (damsel fishes and clown fishes), some *Holocentridae* (soldierfishes and squirrelfishes) and some *Haemulidae* (grunters and sweetlips) (Nedwell et al. 2004; Braun and Grande 2008; Popper et al. 2014); and

Fishes without a swim bladder (e.g. mackerel, *Scomberomorus spp*., some species of tuna, *Thunnus sp*. and sharks and rays, including whale sharks and sawfish) (Casper et al. 2012; Popper et al. 2014; Carroll et al. 2017).

The most relevant metric for perceiving underwater sound for most fish species is particle motion (Popper and Hawkins 2019; Popper et al. 2019) but, with the exception of few species (Popper and Fay 2011; Popper et al. 2014), there is an almost complete lack of relevant data on particle motion sensitivity in fishes (Popper and Hawkins 2019).

Most fish species detect sounds from below 50 Hz up to 500-1500 Hz. A smaller number of species can detect sounds to over 3 kHz, while a very few species can detect sounds to well over 100 kHz. The critical issue for understanding whether an anthropogenic sound affects hearing is whether it is within the hearing frequency range of a fish and loud enough to be detectable above threshold. For this impact assessment, it is assumed that all fishes can detect signals below 500 Hz and therefore can 'hear' the seismic source.

Limited research has been conducted on shark responses to marine seismic surveys. Myrberg (2001) stated that sharks differ from bony fish in that they have no accessory organs of hearing such as a swim bladder and therefore are unlikely to respond to acoustical pressure. The study also suggested that the lateral line system does not respond to normal acoustical stimuli and is unable to detect sound-induced water displacements beyond a few body lengths, even with large sound intensities (Myrberg 2001). Other reports indicate that sharks are highly sensitive to sound between approximately 40 and 800 Hz, which overlaps with seismic sound frequencies. Klimley and Myrberg (1979) established that an individual shark will suddenly turn and withdraw from a sound source of high intensity (more than 20 dB re 1 µPa above broadband ambient SPL) when approaching within 10 m of the sound source.

The Working Group on the Effects of Sound on Fish and Turtles undertook a review of experimental findings of sound on fishes. In their American National Standards Institute (ANSI) accredited report (Popper et al. 2014) sound exposure guidelines for different levels of effects for different groups of species are presented, for three types of immediate effects:

- Mortality, including injury leading to death
- Recoverable injury, including injuries unlikely to result in mortality, such as hair cell damage and minor hematoma
- Temporary threshold shift (TTS).

Fish populations may be further impacted if behavioural responses result in deflection from migration paths, feeding grounds or disturbance of spawning, potentially affecting recruitment of fish stocks.

The potential impacts and sensitivities are summarized in Table 6-10, further detail on relevant scientific studies and research undertaken used to inform this impact assessment is included in Appendix G and Appendix H.

Santos has taken into consideration WA DPIRD's risk assessment on the impacts of seismic to finfish stocks in the assessment of impacts from the seismic survey (Webster et al. 2018), taking into consideration aquatic resource type, water column depth and seismic sound intensity.

Table 6-10: Impact pathways and sensitivities for fish

Impact pathway	Summary
Mortality and mortal injury	Immediate or delayed death.
Recoverable injury	Injuries, including hair cell damage, minor internal or external hematoma, etc. None of these injuries are likely to result in direct mortality.
TTS	As per Popper et al. (2014): 'Temporary threshold shift (TTS) is a temporary reduction in hearing sensitivity caused by exposure to intense sound. TTS has been demonstrated in some fishes, and its extent is of variable duration and magnitude. TTS results from temporary changes in sensory hair cells of the inner ear and/or damage to auditory nerves innervating the ear (Smith et al. 2006; Liberman 2015). However, sensory hair cells are constantly added in fishes (e.g. Corwin 1981, 1983; Popper and Hoxter 1984; Lombarte and Popper 1994) and also replaced when damaged (Lombarte et al. 1993; Smith et al. 2006; Schuck and Smith 2009), unlike in the auditory receptors of mammals. When sound-induced hair cell death occurs in fishes, its effects may be mitigated over time by the addition of new hair cells (Smith et al. 2006, 2011; Smith 2012, 2015). After termination of a sound that causes TTS, normal hearing ability returns over a period that is variable, depending on many factors, including the intensity and duration of sound exposure (e.g. Popper and Clarke 1976; Scholik and Yan 2001, 2002a, 2002b; Amoser and Ladich 2003; Smith et al. 2004a, 2004b, 2006, 2011; Popper et al. 2005, 2007). While experiencing TTS, fishes may have a decrease in fitness in terms of communication, detecting predators or prey, and/or assessing their environment.'
Masking	Masking is the impairment of hearing sensitivity by greater than 6 dB, including all components of the auditory scene, in the presence of noise. Masking impairs an animal's hearing with respect to the relevant biological sounds normally detected within the environment and can have long lasting effects on survival, reproduction and population dynamics of fishes. Acoustic masking only occurs while the interfering sound is present, and therefore, masking resulting from a single pulse of sound (such as an airgun impulses) or widely separated pulses would be infrequent and not likely affect an individual's overall fitness and survival. In the absence of any qualitative scientific information, acoustic masking of signals caused by the reception of seismic sounds are assessed qualitatively, by assessing relative risk rather than by specific sound level thresholds.
Behavioural effects	Substantial change in behaviour for the marine fauna exposed to a sound. This may include long-term changes in behaviour and distribution, such as moving from preferred sites for feeding and reproduction, or alteration of migration patterns. This behavioural criterion does not include effects on single animals, or where animals become habituated to the stimulus, or small changes in behaviour such as a startle response or small movements. It is currently impossible to determine single value thresholds for the onset of behavioural reactions. Popper et al. (2014) propose broad response and effect categories. In the absence of any qualitative scientific information, behavioural effects caused by the reception of seismic sounds are assessed qualitatively, by assessing relative risk rather than by specific sound level thresholds. The transient nature of a seismic survey and the standard soft start ramp-up practices mean that for all fishes that have a relatively large home range and are mobile the possible effects are predicted to commence with a behavioural effect. As the proximity to the sound source increases the effect is anticipated to increase.

6.3.2.7.3 Thresholds

For the assessment of impact to fish from seismic sound it is industry practice to use the exposure guidelines proposed by Popper et al. (2014). The presence or absence of a swim bladder and ancillary structures determines the level of susceptibility of fishes to injurious effects from exposure to intense sound. Accordingly, different exposure guidelines were developed for fishes without a swim bladder, fishes with a swim bladder not involved in perception of acoustic signals and fishes that use their swim bladders for hearing. The fish receptors identified for this assessment, such as site-attached species (including syngnathids) and demersal fish species, are included in the category of fish having a swim bladder while mackerel, a pelagic fish species, do not have a swim bladder.

The guidelines set out criteria for injury due to different sources of noise. The criteria include a mixture of indices including SEL, peak sound pressure levels and where insufficient data exists to determine a quantitative guideline value the risk is categorised in relative terms as 'high', 'moderate' or 'low' at three distances from the source.

There are currently no quantitative guidelines or criteria for fish behaviour as Popper et al. (2014) found that there was insufficient data available with which to establish sound level thresholds for behaviour. Instead, masking and

behavioural effects are qualitatively assessed as relative risk, being the distance of a fish from the seismic source, rather than by a specific threshold. Based on the application of the Popper et al. (2014) semi-quantitative exposure criteria, there could be a high risk of behavioural impacts in fish species near (tens of metres) from the seismic source with the level of risk declining to low at thousands of metres from the seismic source.

As described above and in Appendix G and Appendix H, the threshold criteria in Table 6-10 have been adopted for the assessment of potential noise impacts to fish. Table 6-11 provides the modelled distances for the criteria.

Table 6-11: Sound level threshold criteria and values for mortality and impairment in fish

	Mortality/potential mortal injury		Recoverable injury		TTS	
Threshold criteria	No studies to date have demonstrated direct mortality of adult fish in response to airgun emissions, even when fired at close proximity (within 1–7 m; DFO 2004; Boeger et al. 2006 as cited in NSW DPI 2014; Popper et al. 2014). Environmental Resources Management Australia (ERM) undertook a detailed literature review of potential fish mortality and physical injury as a result of exposure to seismic sources (ERM 2017). Of the 28 studies reviewed, only three observed direct mortality and in each case, mortalities occurred to caged fish at very close proximity to the seismic source (<2 m), which is not representative of real-life exposures from seismic surveys as fish are free-swimming and are not typically exposed at such close range. Though mortality or mortal injury of fish from seismic sources has not been demonstrated it is industry practice to apply the Popper et al. (2014) exposure guidelines as part of the impact assessment process. The sound exposure criteria proposed by Popper et al. (2014) for mortality and injury are considered to be highly conservative and provide a precautionary approach in the assessment of potential injury and mortality effects to fishes from exposure to underwater noise from marine seismic surveys.		The effects of change in pressure (barotrauma – resulting in tissue injury) can result in injury. Recoverable injuries include fin hematomas, capillary dilation, and loss of sensory hair cells. Full recovery from these injuries is possible (Popper et al. 2014).		Temporary threshold shift (TTS) is a temporary reduction in hearing sensitivity caused by exposure to intense sound. After termination of a sound that causes TTS, normal hearing ability returns over a period that is variable, depending on many factors, including the intensity and duration of sound exposure (Popper et al. 2014). Sound exposure guidelines proposed in Popper et al. (2014), which indicated that TTS may occur at SEL_{cum} levels >186 dB re 1 $\mu Pa^2 \cdot s$. Popper et al. (2014) summarises that in all TTS studies considered, fish that showed TTS recovered to normal hearing levels within 18–24 hours. Due to this, a period of accumulation of 24-hours has been applied in this study for SEL, which is similar to that applied for marine mammals in Southall et al. (2007) and NMFS (2016).	
	Popper et al. (2014) proposes a dual criteria of PK and SEL_{24hr} for mortality or potential mortal injury and recoverable injury. For the impact assessment the furthest distance to the criteria is be used. For this impact assessment, the time period of 24-hours is applied to the SEL_{cum} metric.					
Relevance of thresholds adopted	Based on the literature review presented in Appendix H, and the indicator commercial species that are present within the Operational Area (pelagic and demersal fish), Popper et al. (2014) has been adopted as relevant to set the threshold criteria. This American National Standards Institute (ANSI) accredited report by the Working Group on the Effects of Sound on Fish and Turtles undertook a review of experimental findings of sound on fishes, presenting thresholds for mortality, recoverable injury and TTS in 2014, and is adopted by industry in Australia for the basis of impact assessment.					
Fish with no swim bladder (including sharks and rays) [Group I in JASCO report][3]						
	Mortality/potential mortal injury		***Recoverable injury***		***TTS***	
Sound metric	Per pulse	Over 24 hours	Per pulse	Over 24 hours	Per pulse	Over 24 hours
Threshold values	213 dB PK[1]	219 dB SEL_{24h}[1]	213 dB PK[1]	216 dB SEL_{24h}[1]	Popper et al. (2014) does not define a per pulse criteria for TTS for fish.	186 dB SEL_{24h}[1]
Modelled distance	70 m MOD 69–76 m seafloor	100 m MOD Not reached at seafloor	70 m MOD 69–76 m seafloor	100 m MOD Not reached at seafloor		7.11 km MOD 6.4 km seafloor

	Mortality/potential mortal injury		Recoverable injury		TTS	
Fish with swim bladder (not involved in hearing) [Group II in JASCO report] [4]						
	Mortality/potential mortal injury		***Recoverable injury***		***TTS***	
Sound metric	Per pulse	Over 24 hours	Per pulse	Over 24 hours	Per pulse	Over 24 hours
Threshold criteria	207 dB PK[1]	210 dB SEL_{24h}[1]	207 dB PK[1]	203 dB SEL_{24h}[1]	Popper et al. (2014) does not define a per pulse criteria for TTS for fish.	186 dB SEL_{24h}[1]
Modelled distance	150–170 m MOD 186–200 m seafloor	100 m MOD Not reached at seafloor	150–170 m MOD 186–200 m seafloor	120 m MOD 100 m seafloor		7.11 km MOD 6.4 km seafloor
Fish with swim bladder (involved in hearing) [Group III in JASCO report]						
	Mortality/potential mortal injury		***Recoverable injury***		***TTS***	
Sound metric	Per pulse	Over 24 hours	Per pulse	Over 24 hours	Per pulse	Over 24 hours
Threshold criteria	207 dB PK[1]	207 dB SEL_{24h}[1]	207 dB PK[1]	203 dB SEL_{24h}[1]	Popper et al. (2014) does not define a per pulse criteria for TTS for fish.	186 dB SEL_{24h}[1]
Modelled distance	150–170 m MOD 186–200 m seafloor	100 m MOD Not reached at seafloor	150–170 m MOD 186–200 m seafloor	120 m MOD 100 m seafloor		7.11 km MOD 6.4 km seafloor
Threshold adopted for assessment	The distance to sound levels associated with mortality and potential mortal injury on fish based on Popper et al. (2014), using the SEL_{24h} metric, are smaller than those estimated using the PK-based metric. Therefore, in line with the conditions of the criteria as per Popper et al. (2014), the PK metric should be used to assess these impacts to fish.		The distance to sound levels associated with recoverable injury on fish based on Popper et al. (2014), using the SEL_{24h} metric, are smaller than those estimated using the PK-based metric. Therefore, in line with the conditions of the criteria as per Popper et al. (2014), the PK metric should be used to assess these impacts to fish.		There is no per pulse criteria for TTS, as such the SEL_{24h} metric is used to assess these impacts to fish. Modelled ranges to TTS are based on unweighted sound energy accumulated over 24 hours. However, fish lack the ability to detect many of the distant impulses that occur during this 24-hour period and so the ranges are likely to be conservative. The majority of sound energy contributing to potential TTS effects will be received when the seismic survey vessel is at very close range to the fish (Popper 2018).	
	Behaviour					
	It is currently impossible to determine single value thresholds for the onset of behavioural reactions. Popper et al. (2014) propose broad response and effect categories. For all three groups of fish (Group I, II and III) the behavioural criteria are described as a relative risk qualitatively. • For Group I (no swim bladder) fish the risk is High within tens of metres, Moderate within hundreds of metres, and Low within thousands of metres. • For Group II fish (swim bladder not directly involved in hearing) the risk is High within tens of metres, Moderate within hundreds of metres, and Low within thousands of metres. • For Group III fish (swim bladder directly involved in hearing) the risk is High within tens of metres, High within hundreds of metres, and Moderate within thousands of metres.					

	Mortality/potential mortal injury	Recoverable injury	TTS
	Based on these categories, significant behavioural responses in fish are predominantly limited to within tens or hundreds of metres from the seismic source. At greater distances (i.e. kilometres), fishes with a swim bladder or gas-filled volume are able to detect sound pressure to varying degrees, but behavioural responses at these ranges are unlikely to be significant, except potentially for fishes with swim bladders directly involved in hearing.		

1 Popper et al. (2014)

2 Pelagic fish (mackerel): For PK thresholds, the modelling results for maximum-over-depth have been used for pelagic fish as they reside within the water column.

3 Demersal fish (snapper, emperor and cod): For PK thresholds, the modelling results with the maximum distance has been used as demersal fish reside in both the water column and close to the seafloor.

6.3.2.7.4 Impact assessment

Potential impacts to fish in general are within an acceptable level based on:

The assessment criteria applied are conservative (based on the review of the research and scientific papers (Appendix H).

In relation to the Fisheries Research Report No. 288, Risk Assessment of potential impacts of seismic air gun surveys on marine finfish and invertebrates in Western Australia (Webster et al. 2018), the risk assessment outcomes for individuals of finfish, based on water depth and volume of air guns categories, returned a risk scores of 'high' for demersal finfish and 'negligible' for pelagic finfish. Note: The DPIRD risk assessment was undertaken at the level of individual finfish and assumed that an individual remains stationary (i.e. does not flee) while positioned directly in the path of the seismic source. Therefore, the WA DPIRD risk assessment represents a conservative scenario that is not necessarily representative of real-life exposures to fish.

Mortality of fish (both immediate and delayed) is considered highly unlikely based on no documented cases of mortality in free-swimming fish upon exposure to seismic airgun sound under experimental or field operating conditions (ERM 2017). Given that the type of demersal and pelagic fishes characteristic of the habitats in the Operational Area are free swimming species, the potential for exposure to sound at levels that can result in mortality, mortal injury or recoverable injury is unlikely given that fish are able to detect the direction of the sound and may move. Adult fish not in the immediate vicinity of the noise generating activity are generally able to vacate the area and avoid physical injury.

Popper et al. (2005) reports that fish that showed TTS recovered to normal hearing levels within 18–24 hours, the potential area of impact for fish TTS is assessed as being acceptable based on hearing loss (and subsequent decrease in fitness) being temporary and recovery taking place in a relatively short timeframe after the source array has moved away from the exposed fish, and the sound levels are reduced.

Any behavioural impacts are likely to be short-lived and fish would return to normal behaviours once the vessel has moved away based on research by Woodside (2011a, 2011b), Miller and Cripps (2013) and Wardle et al. (2001). Based on Popper et al. (2014) behavioural effects to fishes without a swim-bladder connection involved in hearing are assessed as high within tens of metres of the seismic source and moderate within hundreds of metres from the source. Behavioural impacts to demersal and pelagic fish species are possible but would be temporary, localised, and unlikely to impact at a population level.

Pelagic fish such as mackerel are strong swimmers swimming up to 100 km along the coast (DPIRD 2018). Thus, potential mortality injury, recoverable injury and TTS are unlikely as they can swim away from a seismic source. Impacts are more likely to be behavioural including avoiding or moving away from the area for the period of the survey.

Demersal fish species such as snapper, emperor and cod though not as strong swimmers as pelagic fish species are able to move away from an approaching seismic source. Thus, potential mortality, potential mortality injury, recoverable injury and TTS are unlikely with behavioural impacts more likely.

Available evidence suggests that behavioural changes for some fish species may be no more than a nuisance factor, and that within a few seconds they continue their previous activity. The temporary, short range displacement of pelagic or migratory fish populations may have insignificant repercussions at a population level (McCauley 1994).

Meekan et al. (2021) found no short-term (days) or long-term (months) effects of seismic exposure on the composition, abundance, size structure, behaviour or movement of demersal fishes targeted by commercial fishers on the North West Shelf.

Demersal Fish Species

The various species of demersal snappers (Lutjanidae), emperors (Lethrinidae), rock cods and groupers (Serranidae) that may occur in the Active Source Area do not possess a mechanical connection between swim bladder and ears. These species have also mid to poor hearing ability (Tavolga and Wodinsky 1963; Higgs et al. 2006; Braun and Grande 2008; Engineering-Environmental Management, Inc. 2008; United States Department of the Navy 2008; Popper 2012; Caiger et al. 2012). Note that demersal rock cods are not true cods (Gadidae) and so are not considered to have the same specialised hearing sensitivity. Therefore, these species of fish are considered to belong to the group of fishes that are primarily sensitive to particle motion with some limited sensitivity to sound pressure (Group II fishes according to the Popper et al. 2014 classification).

As shown in Table 6-11, fish with a swim bladder not involved in hearing could reach mortality / Potential Mortal Injury (PMI) and recoverable injury thresholds at 170 m from the seismic source within the entire water column, and 200 m at the seafloor, based on the single pulse PK thresholds. Therefore, injury effects could occur to demersal fishes in close proximity to the seismic source within or adjacent to the Active Source Area. The maximum predicted distance to TTS thresholds were 7.11 km within the water column and 6.4 km the seafloor, based on the

cumulative SEL_{24h} threshold. However, this SEL_{24h} threshold typically represents an unlikely worst-case scenario, as more realistically fish would not stay in the same location or at the same range for a period of 24-hours.

In his expert review of the TTS effects to demersal fishes for the Santos Bethany 3D MSS, located north-east of the Eos 3D MSS Operational Area, Popper (2018) noted:

It is highly unlikely that there would be physical damage to fishes as a result of the survey unless the animals are very close to the source (perhaps within a few metres).

Most fishes in the Bethany region (and given the similarity in fish species, therefore can be applied for the Eos 3D MSS Operational Area), being species that do not have hearing specialisations, are not likely to have much (if any) TTS as a result of the survey.

If TTS does take place, the duration of exposure to the most intense sounds that could result in TTS will be over just a few hours. Thus, accumulation of energy over longer periods than a few hours is probably not appropriate.

If TTS takes place, its level is likely to be sufficiently low that it will not be possible to easily differentiate it from normal variations in hearing sensitivity. Even if fishes do show some TTS, recovery will start as soon as the most intense sounds end, and recovery is likely to even occur, to a limited degree, between seismic pulses. Based on very limited data, recovery within 24 hours (or less) is very likely.

Nothing is known about the behavioural implications of TTS in fishes in the wild. However, since the TTS is likely very transitory, the likelihood of it having a significant impact on fish fitness is very low.

Despite exhibiting particular habitat preferences and some fidelity to an area, these demersal fish species can be found across a variety of habitats and are typically more mobile and have relatively large home ranges (several kilometres) (Ovenden et al. 2004; Moran et al. 2004; Newman et al. 2008; Parsons et al. 2011; Harasti et al. 2015). Therefore, demersal fishes can reasonably be expected to exhibit an avoidance response and swim away from the approaching seismic source before sound levels approach levels that may result in mortality, injury or significant TTS effects.

Popper et al. (2014) indicate that the potential for behavioural impacts in this category of fishes is high in the near-field (tens of metres), moderate at intermediate distances (hundreds of metres) and low in the far field (thousands of metres). Therefore, behavioural responses are considered likely to occur within tens or hundreds of metres from the seismic source. The fishes' awareness of the sound and any resultant behavioural responses may be limited to a few hours as the seismic source approaches from several kilometres away and passes, while significant behavioural responses (startle or avoidance) are more likely to be limited to a short period (less than an hour) when the seismic source passes close by. As the seismic source will be transient (i.e. continuously moving) during seismic data acquisition, demersal fishes will only be exposed to significant sound levels for a relatively short period of time as the seismic survey vessel passes nearby before sailing away again.

Fish behaviours may return to normal within less than an hour (sometimes just minutes) of the seismic survey vessel passing (Wardle et al. 2001; Woodside 2011a, 2011b; Miller and Cripps 2013). Limited data on biochemical stress indicators in fishes exposed to seismic sound indicates there may not be any discernible change (e.g. McCauley et al. 2000a, 2003). However, if fishes were to experience stress as a result of sound exposure, levels may return to normal within 72 hours (Santulli et al. 1999).

Meekan et al. (2021) found no short-term (days) or long-term (months) effects of seismic exposure on the composition, abundance, size structure, behaviour, or movement of various commercially targeted demersal fish species, including tropical demersal emperors, snappers and groupers/rock cods. Further, there was no evidence for the departure of fish after exposure, or on their willingness to feed (Meekan et al. 2021).

Pelagic Fish Species

Key pelagic fish species that may occur in the Active Source Area include Spanish mackerel and various other mackerels (e.g. grey mackerel), as well as various species of tuna and billfish. These species either do not possess a swim bladder or it is poorly developed and not directly connected to hearing (Popper et al. 2014), indicating that they are sensitive only to the particle motion component of sound at close range to a sound source.

Mortality/PMI and recoverable injury thresholds for fish with no swim bladder (Group I) and fish with a swim bladder not involved in hearing (Group II) are 100 m and 170 m from the seismic source, respectively, within the water column (Table 6-10). Therefore, injury effects could occur to pelagic fishes near the seismic source within or adjacent to the Active Source Area. The maximum predicted distance to TTS thresholds were 7.11 km within the water column, based on the cumulative SEL_{24h} threshold.

Pelagic fishes such as mackerel travel distances up to 100–300 km or more, while tunas and billfish may travel in the order of thousands of kilometres. Therefore, pelagic fishes can reasonably be expected to exhibit an avoidance response and swim away from the approaching seismic source before sound levels approach levels that may result in mortality, injury or TTS.

Popper et al. (2014) indicate that the potential for behavioural impacts in fishes that do not possess a swim bladder or where the swim bladder is not directly linked to hearing is high in the near-field (tens of metres), moderate at intermediate distances (hundreds of metres) and low in the far field (thousands of metres). Therefore, behavioural responses in species such as mackerel are considered likely to occur within tens or hundreds of metres from the seismic source. Therefore, the extent and duration of behavioural impacts to large pelagic fishes in the Operational Area is likely to be similar or less than those predicted for demersal fishes. In addition, the transient nature of the seismic source and the highly mobile nature of pelagic fish species means that behavioural avoidance responses and effects on distribution will be incidental, localised and of short duration.

It is acknowledged that the large predatory pelagic fishes target smaller pelagic fishes as prey such as herrings or sardines which have a swim bladder connection in their hearing and may therefore be more sensitive to sound from the seismic source than mackerels, tunas and billfish. These more sensitive baitfish may exhibit a behavioural response and some level of avoidance over several kilometres from the seismic source. Again, given the highly transient nature of the survey and pelagic fishes, the impacts will be short-term and relatively insignificant, but may result in predatory pelagic species such as mackerel following the food source, which may result in changes in distribution over several kilometres. While changes in fish behaviours may be limited to a few minutes or hours, the duration of changes in fish distribution may vary. For example, Wardle et al. (2001) observed that the distribution of mackerels showed no sign of moving away from the reef where they were being studied, whereas studies into more sound sensitive herring and cod species reported that their distribution may potentially remain altered for days following exposure (e.g. Slotte et al. 2004; Engås et al. 1996 and Engås and Løkkeborg 2002).

Sharks and Rays (including Sawfish)

Fifteen threatened or migratory shark and ray species are likely or may occur in the Operational Area (eight shark species, the whale shark, four species of sawfish and two ray species (refer to Table 3-16).

No sound exposure thresholds currently exist for acoustic impacts from seismic sources to sharks and rays, which are sensitive only to particle motion. However, as a conservative approach the Popper et al. (2014) guidelines for fish with no swim bladder have been used for this assessment.

As shown in Table 6-10, fish with no swim bladder could reach mortality/PMI and recoverable injury thresholds at 100 m and 76 m from the seismic source within the entire water column and at the seafloor, respectively. Therefore, injury effects could occur to sharks and rays in very close proximity to the seismic source within or adjacent to the Active Source Area. The maximum predicted distance to TTS thresholds were 7.11 km within the water column, and 6.4 km at the seafloor based on the cumulative SEL_{24h} threshold.

Popper et al. (2014) indicates that the potential for behavioural impacts in this category of fishes is high in the near-field (tens of metres), moderate at intermediate distances (hundreds of metres) and low in the far field (thousands of metres).

The presence of sharks and rays (including whale sharks and sawfish) within the Operational Area during acquisition of the survey is likely to be limited to occasional transits of isolated individuals or small groups. Shark species are highly vagrant and naturally cover large distances, and as such, short-term exposures from the transient seismic source is expected to result in only localised behavioural responses and movements of sharks. The research by Bruce et al. (2018), which tagged two commercially targeted shark species (broadnose shark and school shark) and monitored their movements in response to a seismic survey in Australian waters, noted that both control sharks and exposed sharks moved freely in and out of the study area which did not indicate any changes in behaviour or distribution as a result of seismic sound exposure.

During stakeholder consultation for the Petrel Sub-Basin South-West 3D MSS EP in 2021-22, the NPFI noted that sub-adult and adult sawfishes have been inadvertently caught in the offshore waters of Operational Area. As described in Section 3.7.5, all four listed threatened and/or migratory sawfish species are associated with shallow, nearshore waters. Juvenile sawfish (i.e. pups) generally inhabit river and estuarine environments in shallow, nearshore waters and these environments are known sawfish nursery habitats. Therefore, pups are unlikely to occur within the Active Source Area. The nearest known location for sawfish pupping (dwarf sawfish – pupping likely to occur) is over 140 km south of the Active Source Area, in Cambridge Gulf (DoE 2015f). Green sawfish and narrow sawfish adults have been reported to occur in water depths of over 70 m (Stevens et al. 2005) and 40 m (Last and Stevens 2009) respectively. Dwarf sawfish and freshwater sawfish adults are found in shallower coastal waters (DoEE 2019a). The presence of sawfish in the Active Source Area (water depths of 67–111 m) is, therefore, likely to be limited to occasional transient adult or sub-adult individuals and most likely green or narrow sawfish.

Sawfish are recognised as primarily bottom dwellers; therefore, they are expected to be present at the seafloor. Based on the modelling results presented in Table 6-11, sawfish would have to be within 76 m of the seismic source to experience mortality / PMI or recoverable injury. Similarly, a behavioural response is expected to occur within tens of metres to hundreds of metres. Therefore, impacts to sawfish as a result of the seismic survey are likely to be limited to localised and temporary behavioural disturbance. No impacts to key life stages or nursery habitats are expected, and there will be limited impact to their food sources as outline above and in Section 6.3.2.6 (invertebrates).

Potential site-attached fish assemblages

For the purposes of the risk assessment, site-attached fishes are defined as fishes that rely on the benthic habitat and demonstrate a very high degree of site fidelity to the extent that they are unlikely or unable to flee an approaching seismic source and are instead likely to remain and/or seek refuge within habitat structures.

The biomass, diversity and abundance of fishes is typically greatest in the photic and upper meso-photic zones (<60 m depth) where biota such as hard corals are most abundant. The disappearance of live coral cover and corresponding lower fish diversity is often reported in water depths greater than 60 m (Lesser et al. 2009; Kahng et al. 2010, 2014; Lindfield et al. 2016; Fukunaga et al. 2016; Abdul Wahab 2018), including at other banks and shoals within the Carbonate Bank and Terrace System of the Sahul Shelf KEF (Heyward et al. 2011 and ERM 2012). The banks and shoals within the Carbonate Bank and Terrace System of the Sahul Shelf KEF have the greatest potential for supporting diverse site-attached fish assemblages in water depths of 30–45 m or less due to the increased presence of photosynthetic biota such as hard corals. However, these habitats become increasingly sparse with depth until approximately 60–80 m depth when hard corals are absent and dominant habitat types give way to rubble, sponges and filter feeders (Heyward et al. 2011 and ERM 2012). At these depths, fish species diversity and the potential for site-attached fishes is significantly reduced.

The Active Source Area does not overlap the Carbonate Bank and Terrace System of the Sahul Shelf KEF, at the closest point it is 6.2 km. Banks in the KEF that rise to within 45 m water depth support more biodiversity, such as communities of sessile benthic invertebrates including hard and soft corals, sponges, whips, fans and bryozoans (Brewer et al. 2007; Nichol et al. 2013). The Active Source Area does not overlap any pinnacle features within the Pinnacles of the Bonaparte Basin KEF, the closest being 7.8 km. Pinnacles provide areas of hard substrate in an otherwise soft sediment environment.

Based on the modelling results presented in Table 6-11, potential injury or mortality to fishes may occur within 69–200 m of the seismic source, depending on the type and sensitivity of the fishes. Thus, potential injury or mortality to fishes associated with the Carbonate Bank and Terrace System of the Sahul Shelf KEF or Pinnacles of the Bonaparte Basin KEF are not predicted.

TTS effects range from 7.11 km in the water column and 6.4 km at the seafloor from the seismic source (refer to Table 6-11). The Pinnacles of the Bonaparte Basin KEF are 7.8 km from the Active Source Area; thus, TTS impacts to site attached fish in this KEF are not predicted.

The Carbonate Bank and Terrace System of the Sahul Shelf KEF is 6.2 km from the Active Source Area, thus there is the potential for some fishes within this KEFs to experience TTS. However, as the survey lines are 500 m apart this could potentially only occur for the two lines closest to the Carbonate Bank and Terrace System of the Sahul Shelf KEF.

The potential for TTS to occur is not the same for all fish species. The Popper et al. (2014) threshold is based on exposure experiments to different types of fish including sensitive fishes with a swim bladder mechanism involved in hearing. Most marine fish species do not have this hearing mechanism and are less sensitive to sound pressure. Therefore, some types of fish may not begin to experience TTS until sound exposure levels are higher. As Popper (2018) summarises, if TTS takes place in site-attached fishes, its level is likely to be sufficiently low that it may not be possible to easily differentiate it from normal variations in hearing sensitivity, and recovery will start as soon as the most intense sounds end and is likely to occur within 24 hours.

The potential for such effects to have significant implications on the fishes' fitness and survival is low. For example, fishes exposed during the Woodside Maxima 3D survey at Scott Reef were examined for evidence of TTS. This included four species of tropical reef fishes, including the pinecone soldierfish (a sound pressure-sensitive species which has a swim bladder connection with the inner ear). None of the four species experienced any TTS following close-range exposure to 190 dB re 1 µPa2·s SEL_{cum} (Hastings et al. 2008; Hastings and Miksis-Olds 2012). No significant decreases were detected in the diversity and abundance of either sound pressure-sensitive or non-pressure sensitive fish species after the seismic survey compared to the long-term temporal trend before the survey (Woodside 2011b; Miller and Cripps 2013). Therefore, while TTS effects in site-attached fishes at the Carbonate Bank and Terrace System of the Sahul Shelf KEF may occur for the two lines closest to this KEF, the potential for impacts to individuals' fitness and survival is limited and impacts to fish community structure in the KEF is unlikely.

Spawning and recruitment of commercially significant fish species

During the relatively short periods of behavioural disturbance, fishes may be temporarily diverted away from activities such as egg production and spawning (Hawkins and Popper 2016; Carroll et al. 2017).

The following assessment considers the potential magnitude of effects to fish spawning behaviours, and therefore the potential influence of the survey on recruitment success and the sustainability of key indicator fish species. The assessment considers:

Spatial-temporal analysis – to provide context on the proportion of the spawning biomass that may be exposed to sound during the Eos 3D MSS

Consideration of the natural variability in fish distribution, spawning biomass and recruitment

Consideration of the sustainability status of the relevant WA and adjacent NT fish stocks and fisheries.

While the focus of the assessment is on the key indicator species, the status of the key indicator fish stocks is also used as a robust indicator of the sustainability status within the broader suite of demersal scalefish species within Australian fisheries management units.

Spatial-Temporal Analysis

A spatial-temporal analysis has been conducted to determine the overlap between the survey and the principal spawning ranges and periods of key commercial indicator species of the fisheries overlapped by the Active Source Area. The analysis provides an indication of the proportion of the spawning area and the proportion of the spawning period for each species that may be exposed to sound from the survey.

The following assessment focuses on the following commercial key indicator fish species:

- Goldband snapper (WA)
- Red emperor (WA)
- Spanish mackerel (WA)

Saddle-tail snapper, goldband snapper, crimson snapper and Spanish mackerel stocks in the NT fisheries management area adjacent to the Operational Area. The NT fisheries management area is located approximately 30 km from the Active Source Area and so no material impacts to the behaviours, spawning and recruitment of these fish stocks is expected. Therefore, they are not considered any further.

It is understood from DPIRD (2019) that all of these species and other species in the same families undergo group spawning throughout their ranges, rather than aggregating at specific locations.

The spatial-temporal analysis is not intended to provide an exact estimate of how much of each species' spawning success rate will be impacted. Instead, this method demonstrates how the proportion of fishes that may be affected is relatively small compared to the larger overall spawning biomass, spawning area and spawning periods of each stock, which is important context for the assessment. It is important to note that a number of assumptions have been applied to the analysis in order to address uncertainty about behavioural effects to spawning fishes and provide a highly conservative and more precautionary estimate of the proportion of spawning fish stocks that may be exposed and potentially affected during the survey. These assumptions are outlined below:

Spatial overlap is based on a week (seven days) of acquisition lines with a 7.11 km buffer applied to the racetrack formation as it is the furthest distance to the noise threshold criteria for fish. This approach accounts for an area that will be encircled during a typical racetrack line acquisition and therefore subject to sound exposure from the seismic source. A week of racetrack was selected as this reflects an area where the seismic survey vessel will acquire consecutive, adjacent lines within proximity to the same general area of seabed and groups of demersal fishes. The seven-day timeframe is also precautionary in order to account for scientific uncertainty in relation to the duration and recovery of behavioural disturbances in fishes; it provides a conservative reflection of the longest duration changes in fish behaviour or fish distribution (approximately five days, as noted by Slotte et al. (2004); Engås et al. (1996); Engås & Løkkeborg (2002), noting that such changes are limited to studies that focused primarily on migrating sound pressure-sensitive types of fish with a swim bladder-ear connection (Clupeidae, Gadidae). Behavioural changes in demersal fish species typically return to normal within minutes or hours following exposure, although noting that during the racetrack formation, the same groups of fish may be exposed again when the seismic source returns to acquire an adjacent line nearby. Within any seven-day period, the seismic survey vessel (travelling at a speed of approximately 4.5 knots [8.3 km/h]) will cover approximately 1,400 km.

It is also appropriate to consider a week of acquisition lines, given that over the duration of the survey, the seismic survey vessel would gradually move across the survey area; following a week, the racetrack would have progressed sufficiently far that it would no longer disturb the same areas and groups of demersal fishes as may be disturbed at the start of the racetrack. Therefore, this seven-day scenario already provides a highly conservative reflection of the spawning area that may be exposed at any time during the survey, and accounting for a larger area would significantly over-represent this area.

To apply an additional level of conservatism and account for possible uncertainty about the exact range over which fish may be disturbed, a 7.11 km sound exposure buffer has been applied to the racetrack formation. This allows to account for potential variability in the hearing of different fish species and to broadly represent where some fishes may have some awareness of sound pressure changes; noting that the key indicator demersal fish species are primarily sensitive to particle motion effects more so than sound pressure and significant behavioural effects are more likely to be limited to within tens or hundreds of metres of the seismic source (Popper et al. 2014). Overall, the seven-day scenario and 7.11 km sound exposure buffer would result in an area of disturbance of approximately 2,806 km^2.

The spatial extent of the spawning areas for each key indicator fish species has been estimated based on each species' depth range (as advised by DPIRD 2019) and the Kimberley and NT fishery management areas. As described in Section 3.8.1.4, genetic connectivity and the biological stocks have been confirmed across significantly larger areas (hundreds of thousands of square kilometres compared with the tens of thousands of square kilometre spawning areas considered in the analysis). The biological stocks of the key indicator species generally extend across northern Australia, usually covering the waters of WA, the NT and Queensland. The biological stock areas may be more relevant to the impact assessment from a biological perspective. However, the boundaries of the biological stocks are not clearly defined, and it is noted that genetic connectivity and recruitment within the biological stock ranges occurs over multiple years of spawning and dispersion of eggs and larvae (Martin et al. 2014; Gaughan et al. 2018). In any given year or a single spawning season, the genetic connectivity between the area of seabed exposed to disturbances from the survey depends on the duration of the egg and larval dispersion phase and the oceanographic currents. Connectivity and recruitment in a single season may therefore occur within and well beyond the limits of the fishery management units, but potentially not across the entire biological stock area.

Therefore, to address any potential uncertainty in the biological stock ranges, fishery management areas have been selected by Santos to provide a conservative indication of the proportion of the stocks that may be affected in a single spawning season. Referencing the fishery management units also allows the results to be considered in relation to the annual fish stock status assessments, which are also reported per fishery management area (an approach that is recognised as being a conservative approach for fishery management purposes [Gaughan et al. 2018]). As a result, the spatial overlaps accounted for in the spatial-temporal analysis are likely to significantly overestimate the percentage of spawning area available to each species.

The spatial-temporal analysis is a simplistic approach that assumes that fish spawning in the area and period of exposure will definitely be compromised. In reality, it is possible that fishes may continue to spawn regardless, may move away from the seismic source and spawn nearby, or, given that fish behaviours may return to normal within minutes or hours of exposure, spawning may be delayed but may occur a short time later. In either of these cases, the impact on spawning success may be negligible. However, given uncertainty about how the spawning behaviours of individual fishes and populations may be affected in response to seismic sound exposure, it is conservatively assumed that cessation of spawning will occur.

Therefore, the following analysis provides a highly conservative indication of the proportion of each indicator fish stock that may be exposed in a 7-day period. This provides useful context for the impact assessment, but the extent and duration of actual impacts will likely be significantly smaller.

Table 6-12 presents the spatial and temporal overlaps with the spawning areas and spawning periods of key indicator species based on each species' principal depth range and the Kimberley management unit. The maximum spatial-temporal overlap of the 50-day duration Eos 3D MSS ranges from 0.0% to 0.21%.

Given there is either negligible or no overlap with the NT stocks and Spanish mackerel, the remainder of the assessment is focused on the WA (Kimberley) demersal fish stocks.

Table 6-12: Spatial and temporal overlap of the Eos 3D MSS with the spawning range and spawning periods of key indicator fish stocks

Key Indicator Fish Stock	Max. spatial overlap with the Eos 3D MSS		Max. temporal overlap with fish spawning period		Combined spatial-temporal overlap with fish spawning period and principal depth range
	km²	%	Days	%	%
Goldband snapper (Kimberley)					
Principal depth range: 50–200 m	2,806	1.02%	50	20.57%	0.21%
Spawning Area (area within depth range) in the Kimberley Management Area*: 274,856 km²					
Spawning period: 243 days (Oct–May)					
Red emperor (Kimberley)					
Principal depth range: 10–180 m	2,806	0.81%	50	16.50%	0.13%
Spawning Area (area within depth range) in the Kimberley Management Area*: 345,982 km²					
Spawning period: 303 days (Sep–Jun)					
Spanish mackerel (Kimberley)					
Principal depth range: 0–50 m	0	0.0%	NA	NA	0.00%
Spawning Area (area within depth range) in the Kimberley Management Area*: 88,694 km²					
Spawning period: 153 days (Sep–Jan)					

** Spawning areas have been estimated based on each species' depth range and the relevant management area (Kimberley). It is important to note that genetic connectivity and the biological stocks have been confirmed across significantly larger areas, however, the fishery management areas are a useful and conservative indicator for assessment purposes and allows the results to be directly related to annual stock status assessments, which are also reported per fishery management area.*

+ The temporal overlap is based on the number of days of acquisition coinciding with the days that each species is known to spawn.

Natural variability in fish distribution, spawning biomass and recruitment

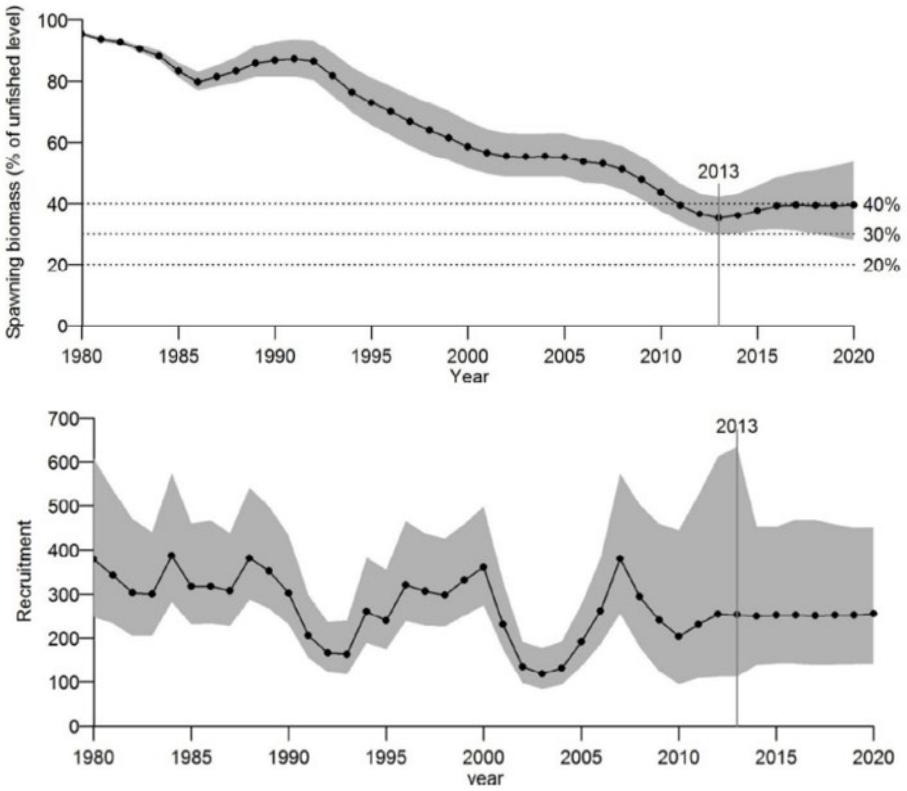
In addition to the above spatial-temporal analysis, it is important to note that fishes may not be evenly distributed throughout their range. The spatial-temporal analysis accounts for disturbance to fish throughout the entire duration of the survey (up to 50 days), whereas the natural variability in the distribution of fish means that areas of high fish abundance may be exposed for a limited period, while the seismic survey vessel is operating in that area. At other times of the survey, while the seismic survey vessel is operating in areas of lower fish abundance, fewer fish may be exposed.

To provide further context, Santos has considered the natural levels of variability in spawning and recruitment. Spawning biomass and recruitment rates fluctuate annually, with years of elevated or reduced recruitment influencing the overall stock population (Marriott et al. 2014). Newman et al. (2003) and Marriott et al. (2014) suggest that both spawning and recruitment success can vary depending upon both environmental (e.g. water temperature, cyclones, El Nino-La Nina cycles) and anthropogenic influences (e.g. fisheries catch levels over and above natural mortality rates).

Extended periods of high exploitation by fisheries can result in decreases in the spawning stock biomass and effective spawning (Newman et al. 2003). For example, between 1980 and 2013, red emperor spawning biomass in the Kimberley management unit generally decreased to approximately 35% of unfished (pre-1980) levels, while recruitment success fluctuated inter-annually between a minimum of approximately 150 million fish and 400 million fish (a fluctuation of approximately 250%) (Refer to Figure 6-3). Similarly, goldband snapper spawning biomass declined steadily while recruitment success fluctuated inter-annually between a minimum of approximately 250,000 fish and 900,000 fish (a fluctuation of 350%) (Refer to Figure 6-4). This provides an indication of the high natural inter-annual variability in the spawning and recruitment of these indicator species. The trends in spawning biomass and recruitment do not clearly reflect one another, indicating that there may also be significant variation in spawning biomass and stock recruitment success as a result of other natural factors.

In the context of this large natural variability, the potential for approximately 0.21% or less of the spawning biomass of each species in the Kimberley management unit to be disturbed is expected to have a negligible effect. The effects of the survey are unlikely to be discernible from natural variation, given that it is only the groups of fishes exposed at a particular site and point in time that may be affected; spawning will continue undisturbed elsewhere throughout the stocks' ranges and the majority of spawning groups in the region at any point in time will be undisturbed. The affected groups of fishes will also spawn again at multiple other times during the spawning season and so discernible impacts to recruitment and populations are not expected.

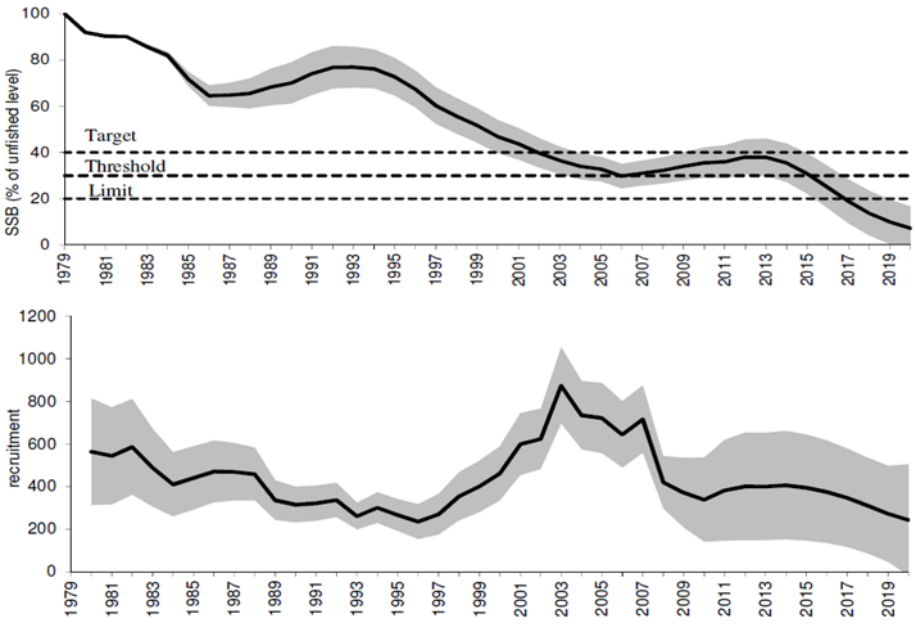
The serial, broadcast spawning strategies of the indicator demersal fish species, by their very nature, offsets potential high natural embryo and larval mortality as a result of predation or other environmental factors and thereby spreads the risk or potential opportunity for larval settlement over large areas and long timeframes. Subsequent recruitment of fishes to the adult stock also occurs over extended timeframes and is ongoing. For example, with reference to goldband snapper stocks, the Australian Government's FRDC has previously noted that moderate or long-lived species such as goldband snapper are unlikely to be affected by 'short-duration' environmental/climatic changes (of one or a few years), because adult stocks comprise fish that are recruited over many years (Martin et al. 2014). Therefore, in comparison, the occasional, short-term, transient and localised disturbances to groups of fish as a result of a seismic survey would have impacts many orders of magnitude smaller than regional scale environmental/climatic events that would affect entire stocks.



*Source: DoF 2015a**

** Levels after 2015 are predictions made in 2015 based on different fishing and stock scenarios, and do not represent real levels.*

Figure 6-3: Red emperor spawning biomass as a percentage of unfished levels (top) and recruitment (millions of fish) (bottom)



*Source: DoF 2015a**

** Levels after 2015 are predictions made in 2015 based on different fishing and stock scenarios, and do not represent real levels.*

Figure 6-4: Goldband snapper spawning biomass as a percentage of unfished levels (top) and recruitment (thousands of fish) (bottom)

Fish stock assessments and sustainability status

The monitoring and assessment of commercial fish stocks in WA and elsewhere in Australia is undertaken by the relevant Commonwealth or State Government agency for fisheries. Each fishery and its target species are

assessed in accordance with stock sustainability reference levels and in many cases, fishery harvest strategies are developed in accordance with the DOF (2015b) Harvest Strategy Policy. The stock assessment process and objectives are consistent with the principles of ecologically sustainable development as it aims to maintain spawning stock biomass, high productivity and recruitment, as well as to ensure that impacts do not result in serious or irreversible environmental harm (DoF 2015b). Any stock size at or above the threshold level is consistent with meeting the objectives for biological sustainability and is also sufficient to meet the stock status certification requirements under the Marine Stewardship Council's standard for sustainability (DPIRD 2017).

The main commercial fish species that are present and spawn within the Acquisition Areas are the suite of demersal scalefish. Assessment and management of the north coast demersal scalefish resource is undertaken by DPIRD for the Kimberley management unit. As outlined in the North Coast Demersal Scalefish Resource Harvest Strategy 2017–2021 (DPIRD 2017), assessment of the sustainability of the fisheries and fish stocks is undertaken by DPIRD based on two assessment processes. The first is a formal resource-level review, which is undertaken every 3–5 years and assesses the current status of the resource (the overall stock abundance and spawning biomass, and fish mortalities from fishing catch) against defined biological reference levels (target, threshold and limit) to determine whether management arrangements are appropriate (DPIRD 2017).

Spawning biomass is estimated based on abundance, sex and age composition derived from catch data. The target, threshold and limit levels in each stock correspond with 40%, 30% and 20% of the virgin spawning biomass (unfished levels) respectively. The target level is an aspirational and acceptable level based on stock biomass and the fishing mortality rate that fisheries managers aim to achieve to be protective of the stock. Due to natural variability in the sizes of fish populations, DPIRD set a target range of 30-40% of unfished biomass (DPIRD 2017).

The second process involves an annual, fishery-level review, which determines whether the current catch/effort is consistent with the reference levels and the status of the resource defined during the resource-level review process. (DPIRD 2017). The last available published integrated assessment (both processes) was undertaken in 2015.

Table 6-13 outlines the stock assessments of these key indicator fish species, as published online by the FRDC. Overall, all indicator species are classed as sustainable, and all evidence indicates that the biomass of the stocks is unlikely to be depleted and that recruitment is unlikely to be impaired.

Table 6-13: Stock assessments of key indicator fish species

Fish species	Stock assessment*
Red emperor (Newman et al. 2020)	The spawning biomass level of red emperor was estimated to be approximately 30% in the NDSMF in 2017. This indicates that the biomass of this stock is unlikely to be depleted and that recruitment is unlikely to be impaired. An assessment of fishing mortality derived from representative samples of the age structure of red emperor has also been undertaken for the NDSMF. The fishing mortality-based assessments indicated that the fishing level on Red Emperor is at or below the limit level in 2017. This indicates that fishing is not having an unacceptable impact on the age structure of the population. Catch levels of Red Emperor in the NDSMF over the last 10 years (2010–2019) have ranged from 128–192 t, with a mean annual catch of 141 t. The above evidence indicates that the current level of fishing mortality is unlikely to cause the stock to become recruitment impaired. Based on the evidence provided above, the Kimberley (WA) management unit is classified as a **sustainable** stock.
Goldband snapper (Trinnie et al. 2020)	The spawning biomass of goldband snapper was estimated to be approximately 30% of the unfished level in the Kimberley management unit (i.e. at the threshold reference level) in 2017 (the year the last integrated assessment was undertaken). This indicates that the biomass of this stock is unlikely to be depleted and that recruitment is unlikely to be impaired. Goldband snapper catches from the NDSMF (Kimberley management unit) over the last 10 years (2010–2019) have ranged from 400–602 t, with a mean annual catch of 490 t. The above evidence indicates that the current level of fishing mortality is unlikely to cause the stock to become recruitment impaired. On the basis of the evidence provided above, the Kimberley (WA) management unit is classified as a **sustainable** stock.

** Stock assessments are based on FRDC (2019) stock assessment data.*

In comparison with fishing mortalities (which DPIRD considers to be acceptable and sustainable) and the normal variability in the fish biomass and recruitment levels (250-350%), the survey is not expected to result in any direct reduction in the spawning biomass through fish mortalities. Furthermore, the potential spatial-temporal overlap of the survey with the spawning fish stocks (maximum of 0.21%) will be negligible. Therefore, the survey will not result in a serious or irreversible impact to the sustainability of key indicator commercial fish stocks.

It is acknowledged that the Eos 3D MSS may affect spawning fish and the fish stocks in addition to other natural influences and commercial fishing pressures placed on the stocks. However, the proportion of the spawning biomass exposed to the seismic source is negligible. The Australian Government's Fisheries Research and

Development Corporation has previously noted that long-lived species such as goldband snapper are unlikely to be affected by 'short-duration' environmental/climatic changes (of one or a few years), because adult stocks comprise fish that are recruited over many years (Martin et al. 2014). Therefore, in comparison, the occasional, short-term, transient and localised disturbances to groups of fish as a result of the seismic survey would have impacts many orders of magnitude smaller than regional scale environmental/climatic events that would affect entire stocks.

Potential impacts to spawning and recruitment within commercially significant demersal and pelagic fish stocks are therefore within an acceptable level based on:

The survey is not expected to result in any direct reduction in the spawning biomass through fish mortalities.

The high fecundity and broadcast spawning characteristics of key demersal and pelagic fish species in the region, which provide for genetic connectivity of the stocks over extensive areas.

The very short ranges to injury thresholds for fish eggs and larvae shown in Table 6-7 (170 m from the seismic source) and negligible impacts in the context of natural turnover

Localised (tens to hundreds of metres) and short-term (minutes, hours, days) behavioural disturbances resulting from a transient seismic source are unlikely to result in a discernible impact to demersal fish populations given that spawning and stock connectivity occurs over significantly larger geographic areas, over protracted spawning periods of several months, and involves the production of millions of eggs over multiple spawning events.

No short-term (days) or long-term (months) effects of exposure on the composition, abundance, size structure, behaviour or movement of demersal fish species targeted by commercial fisheries on the North West Shelf of WA were found (Meekan et al. 2021).

A small spatial-temporal overlap of the survey with the spawning areas in the Kimberley management unit and spawning periods of key indicator fish species (maximum spatial-temporal overlap of 0.21%, based on highly conservative spatial-temporal analysis).

The approach to assessing the spatial-temporal overlap of the survey includes a significant level of conservatism due to the assumptions outlined previously.

The level of disturbance and spatial-temporal overlap (maximum of 0.21%) with the key fish stocks is expected to be negligible in the context of natural variability in spawning biomass and recruitment (250-350%).

Key indicator species in the Kimberley management unit have been assessed annually as 'sustainable', the biomass of the stocks is unlikely to be depleted and recruitment is unlikely to be impaired despite a history of ongoing commercial fishing and seismic surveys across the fisheries. The sustainability status is based upon the target and threshold levels for spawning biomass, which DPIRD note in their Harvest Strategy is a conservative approach, as well as being consistent with the principles of ESD.

Adult stocks comprise fish that are recruited over many years and are unlikely to be affected by seasonal disturbances, even at a regional scale (Martin et al. 2014). Therefore, in comparison, the occasional, short-term, transient, and localised disturbances to groups of fish as a result of a seismic survey are not expected to impact recruitment.

DPIRD Status of the Fisheries reports indicate that fish catches have remained stable or increased despite a history of ongoing commercial fishing and seismic surveys across the fisheries, with evidence that fish abundance is increasing, and stocks are rebuilding. and

The latest DPIRD Status of the Fisheries report (Newman et al. 2021) also considers other activities in the region, including oil and gas activities and seismic surveys. DPIRD consider the risk status of oil and gas activities to be 'Low' and states that 'While there are a number of specific oil and gas related offshore developments that are proposed in this region, at the overall ecosystem level there is only a low risk that the ecosystem will be altered measurably'. The Status of the Fisheries assessments are undertaken by DPIRD's principal research scientists, responsible for assessing risks to the stocks and maintaining suitable management measures.

6.3.2.7.5 Summary

Based on the impact assessment, no long term or population impacts to individual fish, sharks and rays or commercial fish stocks are expected, given:

- The potential impacts to free-swimming demersal and pelagic fishes are predicted to be limited to localised and temporary behavioural effects.
- Impacts to elasmobranchs (sharks) are also predicted to be localised and short term behavioural effects. In the context of their naturally vagrant behaviours, any avoidance is predicted to be insignificant.
- Impacts to sawfish as a result of the seismic survey are likely to be limited to localised and temporary behavioural disturbance. No impacts to their key life stages or nursery habitats in coastal and estuarine waters are predicted.

- Temporary impacts to site-attached fish community structure in the Carbonate Bank and Terrace System of the Sahul Shelf KEF may occur but impacts to the ecological integrity of fish communities within the KEF are not predicted.

Therefore, the consequence level is assessed as minor.

6.3.2.8 Marine mammals

6.3.2.8.1 Receptors

Three listed threatened and migratory marine mammal species (blue, fin and sei whales) may or are likely to occur within the Active Source Area and six migratory species (Australian snubfin dolphin, Australian humpback dolphin, Bryde's whale, humpback whale, killer whale, spotted bottlenose dolphin) may occur within the Active Source Area.

The presence of these marine mammal species within the Active Source Area during acquisition of the survey is likely to be limited to occasional transits of isolated individuals or small pods. Though not an EPBC Act listed species, the Omura's whale may also be present. Given their year-round presence in the JBG, Omura's whales may occur within the Active Source Area during the survey.

There are no marine mammal BIAs located within or adjacent to the Active Source Area. The closest marine mammal BIA is approximately 101 km from the Active Source Area (Australian snubfin dolphin foraging/breeding/calving/resting BIAs near Cape Londonderry and King George River). Other foraging/breeding/calving/resting BIAs are located further east along the north Kimberley coastline and are approximately 112 km from the Active Source Area.

6.3.2.8.2 Impact pathways and sensitivities

The potential impacts of anthropogenic noise on marine mammals, especially cetaceans (whales and dolphins), have been the subject of considerable research. Current data and predictions show that marine mammal species differ in their hearing capabilities, in absolute hearing sensitivity, as well as frequency band of hearing (Richardson et al. 1995; Wartzok and Ketten 1999; Southall et al. 2007; Au and Hastings 2008). To better reflect the auditory similarities between phylogenetically closely related species, but also significant differences between species groups among the marine mammals, Southall et al. (2007) assigned the extant marine mammal species to functional hearing groups based on their hearing capabilities and sound production, later revised by Southall et al. (2019). More recently, U.S. Navy technical reports proposed new auditory weighting functions and the U.S. NMFS (2024) undertook a comprehensive review of PTS and TTS dual metric criteria for marine mammals and revised the threshold criteria for each frequency-weighted functional hearing category of cetacean. As discussed within NMFS (2024), intense noise exposures can cause auditory injury (AUD INJ) without PTS occurring. Here, the terms PTS and auditory injury can be considered to be used interchangeably, however it is acknowledged that auditory injury may occur without PTS.

Table 6-14 summarises the generalised hearing ranges and main sensitivity ranges for each of the defined functional hearing groups of marine mammals (except pinnipeds), adapted from NMFS (2024) and Accomando et al. (2025). The potential impact pathways and sensitivities are summarised in Table 6-15, further detail on relevant scientific studies and research undertaken used to inform this impact assessment is included in Appendix H.

Table 6-14: Marine mammal functional hearing groups (excluding pinnipeds)

Functional hearing group	Generalised hearing ranges
Low-frequency (LF) cetaceans (mysticetes or baleen whales)	This functional hearing group comprises all baleen whale species (mysticetes). There have been no published, successful direct measurements of hearing sensitivity in any of these species to date. The audible frequency range of mysticetes – collectively treated as a single functional hearing group – is approximately between 10 Hz to 35 kHz (based on anatomical data and functional models of the hearing system). Baleen whales (such as humpback and pygmy blue whales) are predominantly LF species. Generalised hearing range*: 7 Hz to 36 kHz Main sensitivity (auditory weighting): 168 Hz to 26.6 kHz
High-frequency (HF) cetaceans (delphinid species (e.g. bottlenose dolphin, common dolphin, pilot whale and killer whale), beaked whales, sperm whale	Based on the frequency range of their vocal emissions as well as the known hearing ranges, most dolphin species including killer whales, all beaked whale species and the sperm whale belong to this functional hearing group. The frequency range of their sounds excluding echolocation clicks are mostly <20 kHz with most of the energy typically around 10 kHz, although some calls may be as low as 100–900 Hz, ranging from 100–180 dB re 1 µPa (Richardson et al. 1995). Generalised hearing range*: 150 Hz to 160 kHz Main sensitivity (auditory weighting): 1.73 kHz to 129 kHz
Very-high frequency (VHF) cetaceans	Porpoises, dwarf and pygmy sperm whales (*Kogia* spp.), river dolphins, as well as hourglass dolphins and Peale's dolphin produce narrow-band high-frequency

Functional hearing group	Generalised hearing ranges
(true porpoises, most river dolphin species, pygmy/dwarf sperm whales as well as some delphinid species)	echolocation signals. This group of species have been collectively classified as VHF cetaceans. Generalised hearing range*: 200 Hz to 165 kHz Main sensitivity (auditory weighting): 5.93 kHz to 186 kHz
Sirenians (SI) (manatees and dugong)	The sirenian group contains all four species of 'sea cows', namely, the manatees and the dugong. No generalised hearing range has been published for sirenians, but hearing threshold measurements suggest lower upper-cutoff frequencies and lower sensitivities (i.e. higher thresholds) compared to HF cetaceans. Main sensitivity (auditory weighting): 5.91 kHz to 37.6 kHz

Source: NMFS 2024 (LF, HF and VHF cetaceans) and Accomando et al. 2025 (sirenians)

** Represents the generalised hearing range for the entire group as a composite (i.e. all species within the group), where individual species' hearing ranges are typically not as broad.*

Table 6-15: Impact pathways and sensitivities for marine mammals

Impact pathway	Summary
Mortality and mortal injury	There is no conclusive evidence of a link between noise produced from seismic surveys and mortality of marine mammals (Gotz et al. 2009).
PTS (permanent reduction in hearing sensitivity due to physical injury to an animal's hearing organs)	Permanent threshold shift (PTS) is hearing loss from which marine fauna do not recover (permanent hair cell or receptor damage). PTS is considered injurious in marine mammals, but there are no published data on the sound levels that cause PTS in marine mammals. The NMFS (2024) criteria incorporate the best available science to estimate PTS onset in marine mammals from sound energy (SEL_{24h}), or very loud, instantaneous peak sound pressure levels. As discussed in NMFS (2024), auditory injury (AUD INJ) may also occur without resulting in PTS. Based on data from terrestrial mammals, an exposure producing 40 dB TTS (see below) measured only minutes after exposure is used as an upper limit to prevent AUD INJ and potentially PTS.
TTS (temporary reduction in an animal's hearing sensitivity)	Hearing loss from which marine fauna recover, usually within a day at most. Exposure to sufficiently intense sound may lead to an increased hearing threshold in any living animal capable of perceiving acoustic stimuli. If this shift is reversed and the hearing threshold returns to normal, the effect is called a temporary threshold shift (TTS). The onset of TTS is often defined as threshold shift of 6 dB above the normal hearing threshold (Southall et al. 2007). If the threshold shift does not return to normal, the residual shift is called a permanent threshold shift (PTS). Threshold shifts can be caused by acoustic trauma from a very intense sound of short duration, as well as from exposure to lower-level sounds over longer time periods (Houser et al. 2017). Injury to the hearing apparatus of a marine animal may result from a fatiguing stimulus measured in terms of sound exposure level (SEL), which considers the sound level and duration of the exposure signal. Intense sounds may also damage the hearing apparatus independent of duration, so an additional metric of peak pressure (PK) is needed to assess acoustic exposure injury risk. In marine mammals, the TTS onset level and growth is frequency specific, and depends on the temporal pattern, duty cycle and the hearing test frequency of the fatiguing stimuli. Sounds generated by seismic airguns, pile-driving and mid-frequency sonars have been tested directly and proven to cause noise-induced threshold shifts in marine mammals at high received levels. However, there is considerable individual difference in all TTS-related parameters between subjects and species tested so far.
Masking	Masking is the process by which the threshold of hearing for one sound is raised by the presence of another (masking) sound (Erbe and Farmer 1998; Erbe 2008; Erbe et al. 2016). This describes the reduction in audibility for one sound (termed 'signal') caused by the simultaneous presence of another sound (termed 'noise'). Auditory masking can lead to disruption of a behaviour, lack of appropriate behavioural reactions, increased vulnerability to predators, reduced access to prey, reduced communication, changes in vocal behaviour, disruption of spawning activities and stress. While masking can be detrimental to the fitness, reproduction, and survival of individuals, it ends immediately after the masking sound ceases. Both anthropogenic and natural marine sound can affect hearing and partially or completely reduce an individual's ability to effectively communicate; detect important predator, prey, and/or conspecific signals; and detect important environmental features associated with spatial orientation (Clark et al. 2009). This is true for all marine fauna; however, masking is most frequently associated with marine mammals. Masking reduces the communication space of marine mammals (Clark et al. 2009; Hatch et al. 2012).
Behavioural effects	Numerous studies on marine mammal behavioural responses to sound exposure have not resulted in consensus in the scientific community regarding the appropriate sound exposure metric for assessing behavioural reactions. It is considered that avoidance behaviour represents a temporary and minor effect, unless avoidance results in displacement of whales from breeding, resting or feeding areas. There are no such known areas within the Operational Area. The intensity of behavioural responses of marine mammals to sound exposure ranges from subtle responses, which may be difficult to observe and have little implications for the affected animal, to

Impact pathway	Summary
	obvious responses, such as avoidance or panic reactions. The context in which the sound is received by an animal affects the nature and extent of responses to a stimulus. The threshold for elicitation of behavioural responses depends on received sound level, as well as multiple contextual factors such as the activity state of animals exposed to different sounds, the nature and novelty of a sound, spatial relations between a sound source and receiving animals, and the gender, age and reproductive status of the receiving animal.

6.3.2.8.3 Thresholds

The threshold criteria in Table 6-16 have been adopted for the assessment of potential noise impacts to marine mammals. Threshold criteria are presented as dual metric thresholds using weighted cumulative sound exposure level (SELcum,) and peak sound pressure (PK) metrics for impulsive sounds. NMFS (2024) considers onset of PTS or TTS to have occurred when either one of the two is exceeded. Table 6-16 also provides the modelled distances for the criteria.

There are no defined noise exposure criteria for mortality and potential mortal injury impacts for marine mammals. These effects are extremely unlikely to occur as received sound levels of sufficient magnitude to cause mortality/ potential mortal injury are only likely to occur at extremely close range (i.e. <10 m) to an operating seismic source. This scenario is extremely unlikely to occur given the control and mitigation measures that are implemented for marine seismic surveys in Australian waters, in compliance with EPBC Policy Statement 2.1 (i.e. use of MFOs; observation, low-power and shutdown zones; soft starts etc.).

Table 6-16: Sound level threshold criteria and values for impairment and behavioural response in marine mammals

	Potential Impacts		
	Impairment – PTS	**Impairment – TTS**	**Behavioural**
Threshold criteria	PTS is considered injurious in marine mammals, but there are no published data on the sound levels that cause PTS in marine mammals. Impact assessment evaluates dual metric criterion requiring consideration of both PK and accumulated SEL. PTS onset thresholds for marine mammals have not been directly measured, the NMFS (2024) criteria incorporate the best available science to estimate PTS onset in marine mammals from sound energy (SEL_{24h}), or very loud, instantaneous peak sound pressure levels (PK) through extrapolation from available TTS onset measurements. As discussed in NMFS (2024), auditory injury (AUD INJ) may also occur without resulting in PTS. Based on data from terrestrial mammals, an exposure producing 40 dB TTS measured only minutes after exposure is used as an upper limit to prevent AUD INJ and potentially PTS.	The onset of TTS is often defined as threshold shift of 6 dB above the normal hearing threshold (Southall et al. 2007). In marine mammals, the onset level and growth of TTS is frequency specific, and depends on the temporal pattern, duty cycle, and the hearing test frequency of the fatiguing stimuli. There is considerable individual difference in all TTS-related parameters between subjects and species tested so far.	NMFS currently uses a step function with a 50% probability of inducing behavioural responses at an unweighted SPL of 160 dB re 1 µPa to assess behavioural impact (NOAA 2019, 2024). This threshold value was derived from the HESS (1999) report, which, in turn, was based on the responses of migrating mysticete whales to an airgun sounds (Malme et al. 1984). An extensive review of behavioural responses to sound was undertaken by Southall et al. (2007, their Appendix B). They found varying responses for most marine mammals between an SPL of 140 and 180 dB re 1 µPa, consistent with the HESS (1999) report. There is no SEL_{24h} metric for behavioural responses in marine mammals, so per pulse SPL of 160 dB re 1 µPa criterion is used to assess these impacts. Note – the same unweighted behavioural response criteria are used for all marine mammals.
Relevance of thresholds adopted	The PTS and TTS thresholds are from NMFS (2024) which is the most current, globally recognised technical guidance for assessing the effect of anthropogenic sound on marine mammal hearing has been adopted for this Activity. It is difficult to determine thresholds for behavioural response in individuals or groups of cetaceans (Southall et al. 2007, 2021). Often the way individuals or groups respond varies (Nowacek et al. 2004; Gomez et al. 2016; Southall et al. 2016, 2021) and is influenced by both biological and environmental factors such as age, sex, and activity at the time etc. The behavioural disturbance threshold criteria applied is the current NOAA criterion for marine mammals and which summates the most recent scientific literature on the impacts of sound on marine mammal hearing so considered the most relevant to this Activity (NOAA 2024).		
	Potential impacts: Very-high-frequency (VHF) cetaceans		
	Impairment – PTS	***Impairment – TTS***	***Behavioural***
Sound Metric	Per pulse / Over 24 hours	Per pulse / Over 24 hours	Per pulse / Over 24 hours
Threshold Values	202 dB PK[1] / 159 dB SEL_{24h}[1]	196 dB PK[1] / 144 dB SEL_{24h}[1]	160 dB SPL[2] / NOAA (2024) does not define SEL exposure criteria for behaviour for cetaceans.
Modelled Distance[3]	370 m MOD / 100 m MOD	730 m MOD / 2.10 km MOD	11.0 km MOD
	Potential impacts: High-frequency (HF) cetaceans		
	Impairment – PTS	***Impairment – TTS***	***Behavioural***
Sound Metric	Per pulse / Over 24 hours	Per pulse / Over 24 hours	Per pulse / Over 24 hours
Threshold Criteria	230 dB PK[1] / 193 dB SEL_{24h}[1]	224 dB PK[1] / 178 dB SEL_{24h}[1]	160 dB SPL[2] /

	Potential Impacts					
	Impairment – PTS		**Impairment – TTS**		**Behavioural**	
Modelled Distance[3]	Not reached	Not reached	Not reached	100 m MOD	11.0 km MOD	NOAA (2024) does not define SEL exposure criteria for behaviour for cetaceans.
	Potential impacts: Low-frequency (LF) cetaceans					
	Impairment – PTS		***Impairment – TTS***		***Behavioural***	
Sound Metric	Per pulse	Over 24 hours	Per pulse	Over 24 hours	Per pulse	Over 24 hours
Threshold Criteria	222 dB PK[1]	183 dB SEL_{24h}[1]	216 dB PK[1]	168 dB SEL_{24h}[1]	160 dB SPL[2]	NOAA (2024) does not define SEL exposure criteria for behaviour for cetaceans.
Modelled Distance[3]	30 m MOD	8.15 km MOD	50 m MOD	94.8 km MOD	11.0 km MOD	
	Potential impacts: Sirenians					
	Impairment – PTS		***Impairment – TTS***		***Behavioural***	
Sound Metric	Per pulse	Over 24 hours	Per pulse	Over 24 hours	Per pulse	Over 24 hours
Threshold Criteria	225 dB PK[1]	186 dB SEL_{24h}[1]	219 dB PK[1]	171 dB SEL_{24h}[1]	160 dB SPL[2]	NOAA (2024) does not define SEL exposure criteria for behaviour for sirenians.
Modelled Distance[3]	Not reached	Not reached	40 m MOD	100 m MOD	11.0 km MOD	

1 NMFS (2024) – Table 6

2 NOAA (2024)

3 Modelled distances are reported in m or km MOD (maximum-over-depth)

6.3.2.8.4 Impact assessment

The type and scale of the effect of seismic sound on marine mammals will depend on several factors. These include the level of exposure, the physical environment, the location of the animal in relation to the sound source, how long the animal is exposed to the sound, the exposure history, how often the sound repeats (repetition period) and the ambient sound level. The context of the exposure plays a critical and complex role in the way an animal might respond (Gomez et al. 2016; NMFS 2016). Without appropriate control measures in place, noise emissions from the seismic source have the potential to impact marine mammals by causing changes to hearing (PTS and TTS) as a result of high sound levels at close range to the seismic source, or behavioural disturbance impacts.

Sirenians

The furthest distance to a noise threshold criterion for sirenians is 11 km (Table 6-16). A review of the PMST did not identify any sirenians such as dugongs, within 11 km of the Active Source Area. There are no dugong BIAs within the JBG. Dugongs are typically associated with seagrass areas, their main food source. A survey of intertidal seagrasses carried out by the WA Museum did not record any seagrasses in the JBG (Walker et al. 1996). Galaiduk et al. (2018) details that dugongs are not abundant in the JBG due to lack of seagrass, but there were previous anecdotal sightings near the shallow seagrass patches along the eastern coastal boundary of the JBG and the eastern part of the Joseph Bonaparte Gulf Marine Park. At its closest point the Active Source Area is approximately 50 km from the Joseph Bonaparte Gulf Marine Park.

No dugongs were observed during the Petrel Sub-Basin South-West 3D MSS undertaken 29 February to 23 March 2022 in the JBG (Santos 2022).

As it is unlikely that dugongs will be present within 11 km of the Active Source Area impacts to dugongs are not predicted.

Very-high frequency cetaceans

The furthest distance to a noise threshold criterion for very-high frequency cetaceans is 11 km (Table 6-16). A review of the PMST did not identify any very-high frequency cetaceans within 11 km of the Active Source Area. No very-high frequency cetaceans were observed during the Petrel Sub-Basin South-West 3D MSS undertaken 29 February to 23 March 2022 in the JBG (Santos 2022).

Very-high frequency cetaceans are unlikely to be present in the Active Source Area and surrounding waters and thus impacts are not predicted.

High-frequency cetaceans

The furthest distance to a noise threshold criterion for high-frequency cetaceans is 11 km (Table 6-16). High-frequency cetaceans such as dolphins, false killer whales and killer whales may be present in the area above the noise threshold criteria. All High-frequency cetaceans identified are migratory species. No BIAs or biologically important behaviours were identified. The nearest BIA for a high-frequency cetaceans is the Australian snubfin dolphin resting BIA at Cape Londonderry and King George River, which is approximately 102 km from the Active Source Area. Received levels at this BIA of 134.5 dB SPL (141.9 dB weighted SEL_{24h}) are well below the behavioural noise threshold criteria of 160 dB SPL and the TTS 24hr criteria of 178 dB re 1 $\mu Pa^2 \cdot s$ (Appendix G). The Australian snubfin dolphin breeding BIA at Ord River is approximately 125 km from the Active Source Area. Received levels at this BIA of <131 dB SPL (<140.6 dB weighted SEL_{24h}) are well below the behavioural noise threshold criteria (160 dB SPL) (Appendix G). Thus, impacts to animals using the BIA are not predicted.

Four Indo-pacific bottlenose dolphins in one pod were observed swimming during the Santos Petrel Sub-Basin South-West 3D MSS undertaken 29 February to 23 March 2022 in the JBG (Santos 2022).

Only the TTS 24hr and behavioural noise threshold criteria were reached for high-frequency cetaceans at 100 m and 11 km, respectively (Table 6-16). As it is unlikely that a high-frequency cetacean would remain within 100 m of the seismic source for 24 hours, impacts to any high-frequency cetaceans would be restricted to behavioural responses. As there are no BIAs or biologically important behaviours being undertaken within the area of impact, any behavioural impacts are likely to be short-lived and high-frequency cetaceans would return to normal behaviours once the vessel has moved away.

Low-frequency cetaceans

The furthest distance to a noise threshold criterion (for TTS over 24 hours) for low-high frequency cetaceans is 94.8 km (Table 6-16). Low-frequency cetaceans such as blue, Bryde's, fin, humpback and sei whales may be present in the area above the noise threshold criteria. No BIAs or biologically important behaviours were identified.

The Operational Area is not known to support significant numbers of any cetacean species and it does not provide unique habitat for known aggregations or sensitive life stages for listed threatened and/or migratory species. However, acoustic recordings documented the year-round presence of Omura's whales throughout north-western Australia, including in the JBG (McCauley 2009, 2014; McPherson et al. 2016, 2017). This species is discussed in further detail in the section below.

No low-frequency cetaceans were observed during the Petrel Sub-Basin South-West 3D MSS undertaken 29 February to 23 March 2022 in the JBG (Santos 2022).

The nearest BIAs for low-frequency cetaceans is the pygmy blue whale migration and resting on migration BIA which is approximately 310 km from the Active Source Area and the humpback whale resting BIA which is approximately 330 km from the Active Source Area. The TTS and behavioural disturbance footprint do not extend to these BIAs. Thus, no impacts to animals engaged in biologically important behaviours within these BIAs are predicted.

As detailed in Table 6-16, further distance to the PTS noise threshold criteria for low-frequency cetaceans such as pygmy blue whales and humpback whales (and potentially Omura's whales) is 8.14 km from the nearest survey line, based on application of the multiple pulse SEL_{24h} threshold across all water depths modelled (maximum-over-depth: MOD). For the single pulse PK metric the distance is 30 m.

The maximum predicted distance to the TTS noise threshold criteria for low-frequency cetaceans is 94.8 km from the nearest survey line, based on application of the multiple pulse SEL_{24h} threshold and within 50 m based on the single pulse PK metric.

As detailed in Section 6.3.2.3, the 24-hour SEL is a cumulative metric that reflects the dosimetric (measured dose) impact of noise levels over a period of 24 hours based on the assumption that an animal is consistently exposed to such noise levels at a fixed position. The modelling results show that the corresponding SEL_{24h} radii for low-frequency cetaceans are considerably larger than those for peak pressure criteria, but they represent a worst-case scenario that is overly conservative and unlikely to occur. More realistically, whales would not stay in the same location or at the same range for 24 hours. This would particularly be the case for an animal transiting through offshore waters that don't represent critical habitat, biologically important area or a narrow restricted migratory pathway and where biologically important behaviours have not been identified. Therefore, a reported radius for SEL_{24h} criteria does not mean that a whale travelling within this radius of the source will experience PTS or TTS, but rather that an animal could be exposed to the sound levels associated with these effects if it remained in that range for 24 hours (Warren and Koessler 2023).

The likelihood of an individual whale remaining within a range of 8.15 km (maximum predicted distance for PTS, based on the SEL_{24h} metric) from the operating seismic source (which is moving) for a full 24-hour period, or even for a few hours, is highly unlikely given that the activity area does not overlap areas where resting, calving or foraging occurs. Should an individual remain within the range for potential impact, some recoverable TTS could occur. However, the likelihood of TTS occurring is reduced by the implementation of control measures including a shutdown zone of 500 m and a low-power zone of 2 km under Part A of EPBC Policy Statement 2.1.

Behavioural impacts, such as behavioural avoidance, are more likely to occur if cetaceans pass near the active seismic source. The predicted maximum distance to the NOAA (2019) marine mammal behavioural threshold (single-pulse 160 dB re 1 µPa unweighted SPL), for all types of cetaceans, is approximately 11 km, across all water depths modelled. The predicted level of impact is avoidance of the area which will not result in any impacts at a population level. Any low-frequency cetaceans such as blue, Bryde's, fin, humpback and sei whales that may be present in the area are likely to be transiting as no BIAs or biologically important behaviours were identified.

Omura's whales

Limited information is available on Omura's whales. It is believed that some Omura's whale populations around the globe may be non-migratory, and, therefore, foraging, breeding, calving, and resting are likely to occur in waters where the population is distributed. A review of acoustic data by McPherson et al. (2016, 2017) suggests they may be transient across north-western Australia, and Browne et al. (2024) reported year-round acoustic presence in the JBG and Kimberley regions, seasonal acoustic presence in the Pilbara and Gascoyne regions, and a southernmost acoustic detection off the North West Cape. However, habitat use for key life stages (foraging, breeding, calving and/or resting) across the Australian north-west region are unknown.

Omura's whales warrant special consideration given they may be present in the JBG and the wider region throughout the year. Although potentially transient to some degree, their movements and behaviours throughout the region are uncertain so key behaviours and life stages such as breeding, feeding, and migration in or through the JBG cannot be confirmed or ruled out. Similar species such as Bryde's whales have swim speeds of between 2 and 7 km/h while feeding but can swim as fast as 20–25 km/h (Kato 2002). Sei whale swim speeds may be similar with top speeds reported to be 55 km/h over short distances (NOAA Fisheries n.d.). Omura's may therefore be capable of moving away from the active seismic source before significant hearing impairment or injury occurs. Given the proposed observation, soft-start, low power and shut-down procedures, and other procedures that will be implemented in accordance with Part A of EPBC Act Policy Statement 2.1, the risk of PTS or TTS from acute close-range exposures is reduced. Given the species' likely swim speeds, behavioural avoidance is also possible prior to SEL_{24hr} levels exceeding PTS or TTS thresholds over longer distances (up to a maximum of 8.15 km and 94.8 km respectively based on 24 hours of exposure).

However, given that Omura's behaviours in the JBG are unknown, additional pre-start observations and adaptive management procedures are proposed specifically for this species to account for this uncertainty. These additional

controls were developed for the Petrel Sub-Basin South-West 3D MSS undertaken 29 February to 23 March 2022 in the JBG. This survey had two MFOs on the seismic vessel and the support vessel crew also provided observations. However, no Omura's whales were observed for the survey (Santos 2022).

An MFO will undertake marine fauna observations during the deployment of the seismic source and streamers (typically in the order of 3-4 days) prior to commencement of seismic data acquisition. The extended pre-start observations will provide advanced opportunity for the detection of Omura's whales (or potential or suspected Omura's whales) within the JBG and over distances comparable to the SEL_{24hr} TTS ranges. In addition, the following adaptive management will be applied for the species:

In the event that there are three confirmed, potential/suspected Omura's whale sightings[5], in a 24-hour period, the seismic source will be shut down for 24 hours.

If, during the 24-hour shutdown period, a confirmed or potential/suspected Omura's whale[4] is sighted, then the seismic source will remain shut down until there has been 24 hours of no confirmed, or potential/suspected Omura's whale sightings[4]. Operations may recommence provided there has been no confirmed, or potential/suspected Omura's whale sightings in the Operational Area for 24 hours since the last sighting event, and start-up of the seismic source will commence according to soft-start procedures consistent with Part A.3.2 of EPBC Act Policy Statement 2.1 (DEWHA 2008c).

With the implementation of these control measures, the potential for injury and hearing impairment (PTS and TTS) is further reduced. The adaptive management recognises that if other Omura's are detected, then the area is potentially being used by the species as an aggregation area; therefore, the seismic source will remain shut down for 24 hours to avoid interference with potential key life stages. The seismic source will not recommence operations until 24 hours has elapsed to ensure that impacts to potentially aggregating animals are reduced. This approach is considered precautionary in order to address the scientific uncertainty regarding this species.

6.3.2.8.5 Summary

The Active Source Area and the area where the noise threshold criteria are reached, up to 94.8 km is not known to support significant numbers of any marine mammal species or provide unique habitat for any known aggregations or sensitive life stages for listed threatened and/or migratory species. The are no BIAs and no species were identified as undertaking biologically important behaviours within 94.8 km from the Active Source Area, except for Omura's whales that may be present in the JBG and the wider region throughout the year.

The likelihood of PTS or TTS occurring in marine mammals is reduced by the implementation of control measures under Part A of EPBC Policy Statement 2.1. Additional pre-start observations and adaptive management measures are proposed to manage potential effects to Omura's whales given the potential uncertainty about their distribution and where sensitive life stages may occur in the region. With the implementation of these control measures, the potential for injury and hearing impairment (PTS and TTS) is further reduced. The adaptive management recognises that if other Omura's whales are detected, then the area is potentially being used by the species as an aggregation area; therefore, the seismic source will remain shut down for 24 hours to avoid interference with potential key life stages. The seismic source will not recommence operations until 24 hours has elapsed to ensure that impacts to potentially aggregating animals are reduced. This approach is considered precautionary in order to address the scientific uncertainty regarding this species.

The closest Australian snubfin dolphin BIA is approximately 105 km from the Active Source Area and impacts to the BIA are not predicted.

Overall, the potential impacts of noise emissions from the seismic source on cetaceans any one-time during acquisition are considered to be temporary behavioural changes (e.g. avoidance) by transient individuals.

Based on the impact assessment no long-term or population impacts to marine mammals are predicted thus the consequence level is assessed as minor.

6.3.2.9 Marine reptiles

6.3.2.9.1 Receptors

Seven threatened and migratory marine turtle species were identified in the PMST Report as having the potential to occur in the Active Source Area: flatback, green, hawksbill, leatherback, loggerhead olive ridley and pig-nosed turtles (Section 3.7.4.1). There are several BIAs for marine turtle species in the region, including those along the coastline in the JBG. The Active Source Area overlaps with the year-round foraging BIAs for the flatback, green, loggerhead and olive ridley turtles.

Additionally, an internesting BIA for the flatback turtle is located offshore from Cape Domett, approximately 39 km from the Active Source Area. The nearest habitat critical to the survival of the species is also the flatback turtle

rookery located on the coast at Cape Domett and is located approximately 127 km from the Active Source Area. The Cape Domett stock nest year-round with a peak between July and September (DoEE 2017).

6.3.2.9.2 Impact pathways and sensitivities

Marine turtles are considered to be less sensitive to noise than marine mammals as they do not have an external hearing organ but can detect sound through bone-conducted vibration in the skull with their shell providing a receiving surface (Lenhardt et al. 1985). Morphological studies of green and loggerhead turtles (Ridgway et al. 1969; Wever 1978; Lenhardt et al. 1985) found that the turtle ear is similar to other reptile ears but has adaptations for underwater listening.

Most studies researching the effect of seismic noise on sea turtles focused on behavioural responses, as physiological impacts are more difficult to observe in living animals. Turtles avoid low-frequency sounds (Lenhardt 1994) and sounds from an airgun (O'Hara and Wilcox 1990), but these reports did not note received sound levels. Moein et al. (1995) found that penned loggerhead turtles initially reacted to an airgun but then showed little or no response to the sound (i.e. they habituated to it). Caged green and loggerhead turtles increased their swimming activity in response to an approaching airgun when the received SPL was above 166 dB re 1 µPa, and they behaved erratically when the received SPL was approximately 175 dB re 1 µPa (McCauley et al. 2000).

6.3.2.9.3 Thresholds

As described above and in Appendix G and Appendix H, the threshold criteria in Table 6-17 have been adopted for the assessment of noise impacts to marine turtles. Table 6-17 also provides the modelled distances for the criteria.

Popper et al. (2014) suggested thresholds for onset of mortal injury (including PTS) and mortality for sea turtles and, in absence of taxon-specific information, adopted the levels for fish that do not hear well suggesting that this likely would be conservative for sea turtles. Finneran et al. (2017) in turn presented revised thresholds for sea turtle injury and hearing impairment (TTS and PTS). Their rationale is that sea turtles have best sensitivity at low frequencies and are known to have poor auditory sensitivity (Bartol and Ketten 2006, Dow Piniak et al. 2012). Accordingly, TTS and PTS thresholds for turtles are likely more similar to those of fishes than to marine mammals (Popper et al. 2014). These thresholds have subsequently been superseded by those presented by Accomando et al. (2025) (Table 6-17).

McCauley et al. (2000a) found that marine turtles showed behavioural responses (i.e. increased swimming behaviour) to an approaching seismic source at received sound levels of approximately 166 dB re 1 µPa SPL, and a stronger avoidance response at around 175 dB re 1 µPa SPL. Similarly, Moein et al. (1995) monitored the behaviour of penned loggerhead turtles to seismic sources operating at 175–179 dB re 1 µPa SPL at 1 m. Avoidance of the seismic source was observed at first exposure, but the turtles habituated to the sound over time. The 166 dB re 1 µPa SPL reported by McCauley et al. (2000a) has been used by the U.S. NMFS as the threshold level for a behavioural disturbance response (NSF 2011). Finneran et al. (2017) identified 175 dB re 1 µPa SPL as the level at which marine turtles are expected to actively avoid seismic exposures. However, the Recovery Plan for Marine Turtles in Australia (DoEE 2017) acknowledges the 166 dB re1 µPa SPL reported by McCauley et al. (2000) as the level that may result in a behavioural response to marine turtles.

Table 6-17: Sound level threshold criteria and values for impairment and behaviour in marine turtles

	Turtles		
	PTS and TTS		**Behavioural**
Threshold criteria	Revised thresholds defined by Accomando et al. (2025) for PTS and TTS onset in marine turtles have been adopted.		McCauley et al. (2000a) reported that turtles behaved more erratically at 175 dB re 1 µPa SPL, and observed behavioural response in caged marine turtles at 166 dB re 1 µPa SPL, as referenced by NSF 2011 and in the Recovery Plan for Marine Turtles in Australia (DoEE 2017).
Relevance of thresholds adopted	There is limited information on marine turtle hearing. Most studies looking at the effect of seismic noise on marine turtles have focussed on behavioural responses given that physiological impacts are more difficult to observe in living animals. Revised exposure criteria developed by Accomando et al. (2025) have been adopted for PTS and TTS and criteria by McCauley et al. (2000a) for behaviour. These thresholds are typically applied by NMFS, and within Australia as relevant threshold levels.		
Sound metric	**Per pulse**	**Over 24 hours**	**Per pulse**
Threshold value	PTS: 230 dB re 1 µPa (PK) TTS: 224 dB re 1 µPa (PK)	PTS: 184 dB SEL_{24hr} TTS: 169 dB SEL_{24h}	Behavioural response†: 166 dB SPL Behavioural disturbance‡: 175 dB SPL
Modelled distance*	PTS: Not reached TTS: Not reached	PTS: 7.46 km MOD TTS: 89.3 km MOD	Behavioural response†: 5.37–6.12 km MOD Behavioural disturbance‡: 1.84–2.26 km MOD

† Threshold for turtle behavioural disturbance from impulsive noise (McCauley et al. 2000a, 2000b).

‡ Threshold for turtle behavioural response to impulsive noise (NSF 2011). Modelled distances are reported in m or km MOD (maximum-over-depth)*

6.3.2.9.4 Impact assessment

The furthest distance to a noise threshold limit for marine turtles is 6.12 km (Table 6-17). Within this area flatback, green, hawksbill, leatherback, loggerhead, and olive ridley turtles are likely to be present and there are foraging BIAs for the flatback, green, loggerhead and olive ridley turtles.

Two unidentified turtles were observed during the Petrel Sub-Basin South-West 3D undertaken 29 February to 23 March 2022 in the JBG and seven unidentified turtles were observed in the operational area during the INPEX Bonaparte Seismic Survey between 6 January and 27 February 2024.

As detailed in Table 6-17:

- PK marine turtle injury (PTS) and TTS threshold criteria were not reached within the limits of the modelling resolution (20 m).
- Multiple pulse SEL_{24h} PTS threshold was reached at 7.46 km and the TTS threshold criteria was reached 89.44 km.
- Behavioural response was reached at 6.12 km.
- Behavioural disturbance was reached at 2.26 km.

The closest internesting BIAs or habitat critical to the survival of the species to the Active Source Area is approximately 39 km away (Cape Domett). Received levels at this BIA of 129.8 dB SPL are well below the behavioural noise threshold criteria of 166 dB SPL (Appendix G). The 24hr SEL at the boundary of the internesting BIA is 154.2 dB (weighted) which is well below the 169 dB threshold for TTS. Thus, impacts to turtles using the internesting BIAs or habitat critical to the survival of the species are not predicted.

Foraging BIAs for the flatback, green, loggerhead and olive ridley turtles are within the area where the multiple pulse SEL_{24h} PTS and TTS thresholds, and the behavioural response and disturbance thresholds are reached. No information regarding the reasons for the foraging BIAs being defined in the JBG are published. These foraging BIAs cover an area of approximately 85,000 km², of which the Active Source Area overlaps with approximately 4,028 km², or 4.7%.

The average core foraging range of flatback turtles has been described as being 68.2 ± 64.1 km^2 (Mean ± SD; Wildermann 2017). Despite ranging over broad foraging areas turtles may spend an average of 87.34 ± 90.95 days (Mean ± SD; Wildermann 2017) in a single foraging area.

Flatback turtles are typically considered habitat generalists with large home ranges and diverse behavioural strategies. Studies have reported no clear trends in behavioural strategies related to foraging between different years or nesting beaches suggesting that flatbacks exhibit behavioural plasticity in foraging strategies and may use multiple resources as a strategy to adjust to environmental variability.

This plasticity is likely to be beneficial to flatbacks in responding to anthropogenic pressures (Wildermann 2017). While the above information suggests that turtles within the foraging BIA may be exposed to noise levels above the TTS 24hr SEL criteria, it is noted that flatback turtle foraging behaviour is flexible, making them somewhat resilient to anthropogenic threats (Whittock, Pendoley & Hamann, 2016).

It is understood that foraging is not constrained to one particular area of a foraging BIA and foraging occurs throughout widely dispersed areas with turtles using inter-connected pathways between several foraging areas (Whittock, Pendoley & Hamann, 2016). Given this, it is assumed that if disturbed, flatback turtles will likely move on and be able to resume foraging elsewhere.

It should also be noted that the ranges presented above assume the marine turtle is a static receiver and not moving through the water column or surfacing to breathe. These ranges also do not consider the role of mitigation measures such as shutdowns in minimising the exposure of marine turtles to seismic noise.

As the noise exposure closest to the seismic array will be the most intense, the implementation of a 500 m shutdown zone for marine turtles, as well as adaptive management measures including changing to a different acquisition line if there are greater than 3 turtle related shutdowns in a 24-hour period, are considered to significantly reduce the risk of marine turtles experiencing TTS.

Though the Recovery Plan for Marine Turtles in Australia (DoEE 2017) identifies noise from seismic survey as a threat and for the JBG stocks, the consequence is stated as being minor where individuals may be affected but no effect at stock level. The recovery plan recommends that a precautionary approach should be applied to seismic work, such that surveys planned to occur inside important internesting habitat should be scheduled outside the nesting season. As detailed, the Active Source Area is approximately 39 km from the closest internesting habitat and no impacts to these habitats are predicted. In addition, the recovery plan recommends that the EPBC Act Policy Statement 2.1 – Interactions between Offshore Seismic Exploration and Whales: Industry Guidelines, which require all seismic survey vessels operating in Australian waters to undertake a soft start for the protection of cetaceans, also afford protection for marine turtles. As soft starts will be implemented as per the guidelines it is

likely that turtles that may be within the area where PTS and TTS effects could occur will move away from the seismic source and are unlikely to be affected over a 24-hour period.

There are no specific actions within the Recovery Plan that relate to the management of underwater noise, however it is suggested that seismic surveys should be scheduled to occur outside of internesting BIAs during the nesting season. Given that the Santos Eos survey is not overlapping an internesting BIA, and the proposed mitigation and management measures are considered to minimise the threats to marine turtles from underwater noise, it is likely that the proposed survey can be undertaken in a manner that is not inconsistent with the Recovery Plan for Marine Turtles in Australia. A study of the marine turtle bycatch of the NPF, which included the waters of the southern JBG, recorded five species: flatback (59% of the total), loggerhead (10%), olive ridley (12%), green (8%) and hawksbill (5%). They identified that marine turtle catches varied with water depth: the highest catch rates were from trawls in water between 20 and 30 m deep, relatively few turtles (10%) were captured in water deeper than 40 m (Poiner and Harris 1996). Tagging studies of flatback turtles off north-western Australia and the Timor Sea (Whittock et al. 2016a, 2016b; Thums et al. 2017) found that foraging typically occurs in less than 50 m water depth (36.5 m mean depth) and post-nesting migration in water depths of 63 ± 5 m. Thus, most foraging activity in likely to be in water depths shallower than the Active Source Area (67–111 m).

In addition, MFOs onboard the seismic vessel during Santos' Beehive 3D MSS in the JBG in 2019, 43 km south of the Eos Active Source Area and closer to the flatback turtle nesting beaches at Cape Domett, reported a total of 15 individual turtles over the 20-day duration of the survey (late-July to mid-August), averaging 1.3 turtles every day. Only two unidentified turtles were observed during the Petrel Sub-Basin South-West 3D MSS undertaken 29 February to 23 March 2022 in the JBG (Santos 2022). The INPEX Bonaparte MSS, 175 km west of Darwin, undertaken between 6 January and 27 February 2024 over 52 days, detected 7 unidentified turtles within the Operational Area.

Thus, it is unlikely that the whole Active Source Area (water depth range of 67–111 m) is a significant foraging area for marine turtles. Marine turtles encountered in the Active Source Area are more likely to be transient individuals. The shallow carbonate banks and pinnacles supporting diverse epifaunal communities within the Carbonate Bank and Terrace System of the Sahul Shelf KEF and the Pinnacles of the Bonaparte Basin KEF are likely to provide the most suitable foraging habitats in the offshore waters of the JBG and foraging turtles may be encountered in greater numbers in these areas. The Pinnacles of the Bonaparte Basin KEF is approximately 7.8 km from the Active Source Area and the Carbonate Bank and Terrace System of the Sahul Shelf KEF is approximately 6.2 km from the Active Source Area, The furthest distance to a turtle noise threshold is 89.3 km, which is the distance at which TTS may occur at 24h SEL, and both KEFs are within the area where this threshold is exceeded. In addition, the Sahul Shelf KEF is within the area where the 24h SEL threshold for PTS is exceeded (7.46 km). Received levels at these KEFs were 156.3 dB SPL (180.5 dB unweighted SEL_{24h}) and 148.7 dB SPL (173.7 dB unweighted SEL_{24h}), respectively, which are both below the behavioural response (166 dB SPL) and behavioural disturbance (175 dB SPL) thresholds. A possible implication of this is that if foraging turtles are exposed to levels exceeding SEL_{24h} thresholds for TTS and PTS but not exceeding behavioural response thresholds, they may remain in the area for periods long enough to be affected.

Behavioural disturbances to marine turtles are expected to be temporary and localised and affect a relatively small number of individuals. These disturbances are not expected to affect a significant proportion of populations in the JBG based on sound exposure in the foraging areas will be short term given the transient nature of both the seismic vessel and marine turtles. For example, based on the modelled ranges for behavioural response (6.12 km) and behavioural disturbance (2.26 km), an individual turtle may respond to the seismic source for approximately one hour and exhibit stronger signs of disturbance for approximately 30 minutes. At any one time, the potential for behavioural responses to occur up to 6.12 km from the seismic source represents an area of 118 km^2 where turtle foraging may be temporarily disturbed at any one time, which is approximately 0.14% of the defined turtle foraging BIAs. Therefore, greater than 99% of the foraging BIAs will remain undisturbed at any one time.

No long term or widespread disturbances to foraging or internesting populations of marine turtles are predicted. Should behavioural disturbances occur to foraging marine turtles, it will likely be limited to one-off disturbances to individuals or discrete groups given the transient nature of both the seismic vessel and marine turtles. Therefore, biologically important foraging behaviours will continue within the foraging BIAs.

The survey is not expected to result in the decreased availability of prey and is not expected to result in the displacement of turtles from foraging BIAs. Localised and short-term disturbances to individuals or discrete groups of foraging turtles may occur for a few hours at a time when the seismic source passes in the vicinity of suitable foraging habitat. Impacts to turtles foraging at the Carbonate Bank and Terrace System of the Sahul Shelf KEF or the Pinnacles of the Bonaparte Basin KEF are not predicted.

No long term or widespread disturbances to foraging or internesting populations of marine turtles are expected. therefore, the survey is not expected to impact the viability of marine turtle stocks.

6.3.2.9.5 Summary

Based on the impact assessment, no long term or population impacts to marine turtles are predicted. No long term or widespread disturbances to foraging or internesting populations of marine turtles are predicted. Impacts are predicted to be limited to one-off disturbances to individuals or discrete groups given the transient nature of both the seismic vessel and marine turtles, therefore, biologically important foraging behaviours will continue within the foraging BIAs. While it is possible some marine turtles may be exposed to noise levels of a high enough level for a long enough duration that some level of TTS may occur, this is expected to be recoverable and not have any impact on reproductive fitness. Marine turtles do not use sound for foraging or reproductive purposes and thus a temporary impairment of auditory sensing capabilities is highly unlikely to result in disruptions to either of these critical behaviours or translate to population level impacts. Further it is noted that the actual exposure of marine turtles would likely be much less than predicted owing to diving and surfacing patterns, and this combined with the implementation of mitigation measures is expected to significantly reduce the likelihood of TTS in marine turtles.

No impacts are predicted to internesting BIAs or habitats critical to the survival of the species or to turtles that may be foraging in the Carbonate Banks and Terrace System of the Sahul Shelf KEF or the Pinnacles of the Bonaparte Basin KEF. Thus, the consequence level is assessed as minor.

6.3.2.10 Seabirds and migratory shorebirds

6.3.2.10.1 Receptors

There are 23 bird species considered to be ecologically significant to the NWMR; that is, they are either endemic to the region, have a high number of interactions with the region (nesting, foraging, roosting or migrating) or have life history characteristics that make them susceptible to population decline. In addition, there are 11 bird species considered to be ecologically significant to the NMR, due to the presence of important feeding sites in the NMR.

The Active Source Area does not overlap with any bird BIAs. There is no emergent land within the Active Source Area or Operational Area to support breeding colonies of seabirds. The closest known breeding sites occur onshore approximately 100 km from the Active Source Area. Shorebird species may fly over the Operational Area (and Active Source Area) during migrations, given nearby coastal habitats support larger migratory populations.

6.3.2.10.2 Impact pathways and sensitivities

Acoustic noise from seismic surveys is not anticipated to have a direct effect on seabird or shorebird species, due to the method of the Activity, and the fact that birds and vessels are transient. Only bird species that plunge dive (such as tropicbirds, boobies, shearwaters and tern species) could potentially be exposed to underwater noise, although little or no impact is expected. Stemp (1985; as cited in LGL 2012) conducted observations on the effects of seismic exploration on seabirds and did not observe any negative effects. Lacroix et al. (2003; as cited in LGL 2012) investigated the effect of near shore seismic surveys on moulting long-tailed ducks in the Beaufort Sea, Alaska, and also failed to detect any negative effects. Furthermore, they noted that seismic activity did not appear to change the diving intensity of the ducks significantly. However, some species may be affected indirectly as identified below.

6.3.2.10.3 Threshold

There are no thresholds or assessment criteria for noise impacts to seabirds and migratory shorebirds from seismic surveys.

6.3.2.10.4 Impact assessment

The EPBC Act Policy Statement 3.21 – Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species (Commonwealth of Australia 2017) does not identify any impacts and risks to shorebirds from offshore seismic activities.

Impacts to foraging seabirds have not been observed previously during seismic surveys. Only birds diving and foraging within the Active Source Area have the potential to be exposed to increased sound levels generated by the operating seismic source, while diving for small pelagic fishes near the sea surface. Such behaviours may result in a startle response during diving. Birds resting on the surface of the water in proximity to the seismic vessel have limited potential to be affected by sound emissions underwater due to the limited transmission of sound energy between the water/air interface but may be startled by seismic pulses in close proximity to the seismic source. However, given the likely avoidance response from fish and other prey species in waters immediately surrounding the seismic source, birds are unlikely to forage near the operating seismic source.

In the unlikely event that birds dive and forage near the seismic source, this is likely to only affect individual birds, resulting in a startle response with the affected birds expected to move away from the area as a result. The consequence of this is expected to be negligible and impacts at a population level are extremely unlikely to occur.

The behaviour and distribution of some fishes may be affected for short periods during and after exposure to the seismic source, which may result in short-term and localised changes in the distribution of target prey species for some species. However, these effects are unlikely to be discernible to foraging birds in the context of the normal

movements and variation in the distribution of fishes. The behaviours and distribution of prey at any one time will remain largely unaffected in the Active Source Area. Therefore, impacts to seabird populations are highly unlikely to occur.

6.3.2.10.5 Summary

Based on the impact assessment no significant or long-term impacts to seabirds and migratory shorebirds are predicted thus the consequence level is assessed as negligible.

6.3.2.11 Commercial fisheries

Effects on fishing from seismic surveys may occur in two ways. The physical presence and interaction of the seismic survey vessel and towed equipment (as assessed in Section 6.1) has the potential to directly impact the physical activities of commercial fishing operators, potentially limiting access to specific fishing grounds. Underwater sound from the seismic source has the potential to affect target fish species and may result in temporary effects to fisheries catch rates.

6.3.2.11.1 Receptors

The following key fisheries that have historic fishing effort within the Operational Area have been identified for this assessment:

- Commonwealth Northern Prawn Fishery (NPF)
- WA Northern Demersal Scalefish Managed Fishery (NDSMF)
- WA Mackerel Managed Fishery (MMF – Area 1).

The Active Source Area does not overlap the NPF area of effort based on data for 2010–2020.

6.3.2.11.2 Impact pathways and sensitivities

Scientific evidence of acoustic impacts on fish catches are somewhat equivocal because of the lack of determination between natural movements and changes in fish abundance. Based on studies presented in Engås et al. (1996) and Slotte et al. (2004) where fish were observed to return to survey areas within 3-5 days following completion of the seismic surveys, any disruptions would likely be short-term and during the survey, with conditions returning to 'normal' levels soon after.

However, not all studies have resulted in behavioural alteration. Feeding Atlantic herring (*Clupea harengus*) schools off northern Norway showed no changes in swimming speed, direction or school size in response to a transmitting seismic survey vessel as it approached from a distance of 27 km to 2 km, over a 6-hour period (Peña et al. 2013). As fishing areas are large and commercial fish species are free-swimming, if fish are 'scared' temporarily from an area, based on evidence presented, it is likely they will be displaced temporarily to another area still within the fishing zone and so able to be caught.

There is little research undertaken on what effect seismic surveys have on fish catchability. Kent et al. (2016) 'The issue of changes in commercial fisheries catch rates due to seismic surveys is almost always contentious in Australia'. They acknowledge that there has been some effort to relate fisheries catch data to seismic survey effort, but to date none of the Australian efforts to relate finfish catch rates with seismic surveys have yielded results of any meaning. The GMEM project provided no clear evidence of adverse effects on scallops, fish, or commercial catch rates due to the 2015 seismic survey (Przeslawski et al. 2016): '*Catch rates in the six months following the seismic survey were different than predicted in nine out of the 15 species examined across both Danish Seine and Demersal Gillnet sectors. Across both fishing gear types, six species (tiger flathead, goatfish, elephantfish, boarfish, broadnose shark and school shark) indicated increases in catch subsequent to the seismic survey, and three species (gummy shark, red gurnard, sawshark) indicated decreases in catch. These results support previous work in which the effects of seismic surveys on catch seem transitory and vary among studies, species, and gear types*.' Research to date has identified effects and no effects from seismic surveys on catch rates and abundance. This is likely due to the importance of the context of exposure. In many instances, fish may move away from an area when a seismic survey is being undertaken. This could impact on the catchability and catch rates for the target species of any commercial fisheries occurring in the same area at the same time.

A critical review of the potential impacts of marine seismic surveys on fish and invertebrates (Carroll et al. 2017) found that other studies on fish have positive, inconsistent, or no effects from seismic surveys on catch rates or abundance. A desktop study of four species (gummy shark, tiger flathead, silver warehou, school whiting) in Bass Strait, Australia, found no consistent relationships between catch rates and seismic survey activity in the area, although the large historical window of the seismic data may have masked immediate or short-term effects which cannot therefore be excluded (Przeslawki et al. 2016). Przeslawki et al. (2016) concluded that '*These results support previous work in which the effects of seismic surveys on catch seem transitory and vary among studies, species, and gear types*'. The body of peer-reviewed literature does not indicate any long-term abandonment of fishing grounds by commercial species, with several studies indicating that catch levels were similar to pre-survey

levels after seismic activity had ceased (Carroll et al. 2017). As noted by Przeslawski et al. (2016), it is possible that fish may be displaced from a survey footprint to adjacent areas, however, the total number of fish within the fishery stock remains unchanged.

In October 2020, the Fish Research and Development Corporation (FRDC) released preliminary results of a Multiple Before-After Control-Impact (BACI) experiment that they funded to investigate the effects of a 3D marine seismic survey in eastern Bass Strait on Danish Seine catch rates (Fishwell Consulting 2020). The key targets for this Danish Seine fishery in the areas of the MSS are flathead (*Platycephalus* sp.) and whiting (*Sillago* sp.). The October 2020 report (Fishwell Consulting 2020) provided preliminary results of three phases of the four-phase study and found that overall, the BACI analyses provide robust evidence for a negative impact of seismic acquisition on whiting catch rates in the Danish Seine Fishery up to approximately 100 days following the survey and on flathead rates up to approximately 200 days. Relative catch indices for both species in the years preceding the marine seismic survey were highly variable (temporally and spatially), and that relative catch index is a measure of catch per effort, not an absolute measure of abundance. As the relative catch indices for both species in the years preceding the marine seismic survey were highly variable it is difficult to determine the effect of the survey.

Recently, Meekan et al. (2021) undertook a large-scale experiment that quantified the impacts of exposure of an assemblage of tropical demersal emperors (*Lutjanidae*), snappers (*Lethrinidae*) and groupers / rock cods (*Epinephelidae*) targeted by commercial fisheries to a commercial-scale seismic source on the North West Shelf of WA. A combination of Baited Remote Underwater Video Systems (BRUVS) and acoustic tagging methods were used to measure the behaviours and movements of fishes at high, medium and low exposure sites, as well as at control sites. There were no short-term (days) or long-term (months) effects of exposure on the composition, abundance, size structure, behaviour, or movement of fishes. The authors argue that it is a reasonable assumption that the behavioural responses of demersal fishes to the bait cue provided by the BRUVS are a realistic proxy of the likely response of the same species to baited hooks or traps used by the commercial fisheries that target them. The acoustic tags and telemetry found little evidence that fish were displaced by the exposure to the seismic source. Movements of tagged fish occurred over a limited area focused on two or three acoustic receivers, and there was no evidence for the departure of tagged fish after exposure. These multiple lines of evidence suggest that seismic surveys have little impact on demersal fishes in this environment.

6.3.2.11.3 Impact assessment

The effects of sound produced by the seismic source during the Eos 3D MSS are not expected to result in the mortality or injury of fishes targeted by the key commercial fisheries that operate in the same waters. This is because the demersal and pelagic species targeted by the fisheries are relatively free-moving species with the capability of avoiding the approaching sound source. In addition, no significant impacts to fish spawning and recruitment are predicted (refer to Section 6.3.2.6). Therefore, a direct reduction in the targeted stocks is not predicted.

The principal mechanism for impacts to fisheries catch rates is likely the result of behavioural effects or changes in distribution. While significant behavioural effects are likely to be limited to within tens or hundreds of metres from the seismic source, changes in distribution may also occur over larger areas if the distribution of target prey species is also affected (refer to Section 6.3.2.6). Changes in behaviour may last for minutes or hours, while the distribution of fishes may take hours or days to return to normal.

It is acknowledged that seismic surveys may influence fish behaviour and catchability during the survey, but such effects are expected to be limited to the vicinity of the survey area and temporary as the seismic vessel traverses each survey line. As described above, significant behavioural responses in the key indicator demersal fish species (which primarily detect particle motion, with limited, or no sensitivity to sound pressure changes at distance from a seismic source) will be limited to distances of a few hundreds of metres from the operating seismic source, and there are no short-term (days) or long-term (months) effects of seismic exposure on the behaviour, movement, composition, abundance or size structure of fishes. Overall annual catch levels throughout the fisheries are not expected to be significantly impacted.

As described in Section 6.3.2.6, no behavioural effects are expected to prawns. Exposure of prawns within a few hundred metres of the seismic source may result in sub-lethal effects such as reduced reflexes. However, this is not expected to impact catchability or fishery catch rates. Section 6.3.2.6 has also assessed potential impacts to spawning and recruitment of the prawn stocks. No mortalities to spawning adult females are expected. A conservative approach has been adopted in Section 6.3.2.6 that assumes that exposed eggs and larvae may either be killed directly or indirectly due to impaired development reducing their survival. Even accounting for this, 3.0% of red-legged banana prawn eggs and larvae in the JBG are predicted to be impacted, which is not significant in the context of natural larvae mortality (potentially higher than 99% natural mortality given the less than 1% settlement rate) and naturally variable annual recruitment rates. The area where juveniles migrate from the coast out to join the adult stock is south of the Active Source Area and so is not predicted to be impacted. No discernible impacts to prawn stock levels or catchability are predicted.

To provide further context on the proportion of the fisheries that may be affected by the Activity, Table 6-18 presents the areas of overlap with commercial fisheries based upon the area of overlap from approximately one week of survey lines (a racetrack) with a 7.11 km buffer applied to account for the ranges where finfish behaviour and distribution may be affected by the active source. This is representative of the area that may be ensonified by the operating seismic source during normal survey activities and is broadly indicative of where the behaviours of target fish may be affected. The 7.11 km distance is considered highly conservative, given that target demersal and pelagic fish species (as well as prawns) are primarily sensitive to particle motion effects rather than sound pressure over long distances, and any significant behavioural change is likely to be limited to within tens or hundreds of metres from the seismic source. An equivalent area will apply throughout the duration of the survey as the seismic survey vessel progresses acquisition over the survey area.

Table 6-18 shows that relatively large areas of the fisheries will be available for fishing outside of the Active Source Area, with the conclusion based on previously presented evidence (Appendix H) that any fish behavioural affects within these areas should be localised and temporary.

Table 6-18: Active Source Area overlap with commercial fisheries

Fishery	Area of fishing effort (km^2)*	Spatial overlap (km^2) with Active Source Area	Spatial overlap (%)
Northern Prawn Fishery – Entire fishery	215,085	0	0%
Northern Prawn Fishery – JBG area	14,484	0	0%
WA Northern Demersal Scalefish Managed Fishery	145,186	1,029	0.7%
WA Mackerel Managed Fishery (Area 1)	65,690	343	0.52%

** Based on coarse resolution 10 nm blocks. Area of fishing effort and % overlap for these fisheries therefore may be overestimated.*

Santos has assumed that past fishing activity is representative of future target areas, fish presence and fishery catch. The % impacts calculation in Table 6-18 is based on the fishing effort area of the fishery and excludes any closure areas where fishing is not permitted to take place.

Potential impacts to catch rates are within an acceptable level based on:

- Mortality, injury or impairment to target demersal and pelagic fish (both immediate and delayed) is considered highly unlikely based on no documented cases of fish mortality upon exposure to seismic airgun sound under experimental or field operating conditions (ERM 2017) and the free-swimming nature of the key indicator fish species
- Meekan et al. (2021) found no short-term (days) or long-term (months) effects of exposure on the composition, abundance, size structure, behaviour or movement of demersal fish species targeted by commercial fisheries on the North West Shelf of WA
- No mortality or behavioural effects are expected to prawns
- Santos has applied all the relevant mitigation strategies listed in Table 1 of the Fisheries Occasional Publication No. 112, Guidance Statement on undertaking seismic surveys in WA waters (Department of Fisheries 2013)
- Large areas of the fisheries (more than 99%) are out of range of predicted sound levels that could disturb fish or crustaceans and affect catchability at any one time (refer to Table 6-17)
- The Active Source Area does not overlap the NPF area of effort based on data for 2010–2020. Therefore, the potential for disturbance to target fish species is limited to the NDSMF and MMF. For the NDSMF only 0.7% of the area of past fishing effort is overlapped by the Active Source. This area is fished very infrequently by the NDSMF (less than three vessels in total between 2010 and 2022) and during many years no fishing has occurred. For the MMF only 0.52% of the area of past fishing effort is overlapped by the Active Source Area. This area is fished very infrequently by the MMF (only fished in 2019 by less than 3 vessels). Therefore, disturbances to fishes and prawns are highly unlikely to result in impacts to catch rates during fishing activities
- No significant impacts to fish or prawn stocks or their catchability are predicted
- Given the presence of fish in previously surveyed areas following cessation of the acoustic disturbance, if there was an impact to catchability because of the Activity, catch rates post-survey return to typical catch levels relative to fishing effort
- Santos will have a commercial fisher's payment claim protocol in place. Should a loss of catch be demonstrated as a result of the survey then commensurate make good payments will be made.

Santos' commercial fisher's payment claim protocol (Section 8.6.2) provides for fishers to claim for loss of catch up to six months from the completion of the survey. This is consistent with other similar industry compensation arrangements in Australia. Six months is considered an appropriate timeframe for loss of catch to be realised. Santos has also assessed the potential for impacts to spawning and recruitment of target fish and prawn species. A conservative approach has been applied to these assessments and the potential proportion of the stocks that may be affected. In the worst case, 0.21% of the spawning area and 3.0% of fish stocks may be affected, which is negligible in the context of natural variability in spawning biomass, mortality rates and recruitment rates. Therefore, no discernible impacts are predicted. Future catch rates may fluctuate for a number of environmental and operational factors within the fisheries, and it will not be possible to identify impacts that are be attributable to the effects of the seismic survey.

In relation to the NPF specifically, prawns migrate offshore and reach maturity within 6 months, when they join the stock and contribute to the spawning population over the next 12–18 months (total lifespan is 1–2 years). The potential for exposure to 3.0% of larvae and potential for reduced survival rates in some of these prawns as they mature will not be discernible from natural variability and the remaining surviving cohort and subsequent cohorts will contribute to the spawning population and recruitment rates. The NPF will not be fishing in the JBG during the banana prawn fishing season for approximately the next five years, therefore, no impacts to stock recruitment or fishery catch rates will occur that would warrant extending the six-month claim period provided for in the commercial fisher's payment claim protocol.

6.3.2.11.4 Summary

Based on the impact assessment no long-term impacts to the overall catch rates in the commercial fisheries are predicted. The survey is not expected to result in any direct reduction in the spawning biomass or recruitment of key indicator commercial fish or prawn stocks. Therefore, the survey is not expected to result in a serious or irreversible impact to the sustainability of key indicator commercial fish or prawn stocks or their catchability for fisheries.

Localised and short-term behavioural effects in target fish and prawn species may occur. However, as the Active Source Area does not overlap the NPF area of effort and there have been highly infrequent and low levels of effort in the WA fisheries in the Operational Area, impacts to commercial catch rates are highly unlikely to occur.

6.3.2.12 Diving

6.3.2.12.1 Receptors

In addition to commercial fisheries, other potential socio-economic receptors that may be affected by underwater noise emissions include potential commercial diving activities servicing the Eni Blacktip platform located 21 km from the Active Source Area. No recreational scuba diving or snorkelling activities or dive shops or clubs have been identified in the JBG or adjacent townsites. The presence of saltwater crocodiles and other potentially dangerous fauna generally makes these waters unsuitable for such recreational activities (refer to Section 3.8.4). The closest coastline is over 100 km from the Active Source Area.

Commercial fishing data confirms that there have been no WA pearl oyster or marine aquarium diving activities within or near the Operational Area or the JBG in the last 11 years, although future activity cannot be ruled out. NT fisheries are located adjacent to the Operational Area. The NT Pearl Oyster Fishery has not been active since 2008, but it is possible that the scuba divers in the NT Aquarium Fishery infrequently access waters near the Operational Area (refer to Section 3.8.1).

The following impact assessment relates to potential commercial diving activities and potential for future diving activities in the WA and NT pearl oyster and aquarium fisheries.

6.3.2.12.2 Impact pathways and sensitivities

Divers exposed to high levels of underwater sound can suffer from dizziness, hearing damage or other injuries to other sensitive (mainly air-filled) organs, depending on the frequency and intensity of the sound. The human auditory system is significantly less sensitive underwater than in air and is further degraded if diving equipment obstructs the ears or face (e.g. diving with a hood or full facemask). If seismic activities occur near dive sites, there is the potential for divers to be displaced.

6.3.2.12.3 Thresholds

Under water, the human ear is about 20 dB less sensitive than it is in air at low frequencies (20 Hz), increasing to 40 dB at mid-frequencies (less than 1 kHz), and increasing to 70–80 dB less sensitive at higher frequencies (Parvin 1998). Divers who wear neoprene hoods have even higher hearing thresholds (lower sensitivity) above 500 Hz because the hood material absorbs high-frequency sounds (Sims et al. 1999). Exposure studies related to divers have typically focused on military sonar exposure, with little information on seismic survey operations, and as such care is required when considering thresholds for non-military divers, particularly for impulsive sounds such as seismic source impulses (Ainslie 2008).

Underwater auditory threshold curves indicate that the human auditory system is most sensitive to waterborne sound at frequencies between 400 Hz to 1 kHz (Parvin et al. 1994); cited in Anthony et al. 2009), and these frequencies have the greatest potential for damage. Within the literature (all as cited in Ainslie 2008), there is some variation in acceptable SPLs for divers.

The auditory threshold of hearing under-water was lowest at 1 kHz (70 dB re 1 µPa SPL) and increased for lower and higher frequencies to around 120 dB re 1 µPa at 20 Hz and at 20 kHz (Parvin 1998). Fothergill et al. (2000) and Fothergill et al. (2001) conducted controlled acoustic exposure experiments on military divers under fully controlled conditions at a US Ocean Simulation Facility and an US Open water test facility. The following exposure limit for both military and recreational divers was suggested as a conservative measure: For frequencies between 100 and 500 Hz, the maximum SPL should be 145 dB re 1 µPa over a maximum continuous exposure of 100 seconds or with a maximum duty cycle of 20 per cent and a maximum daily cumulative total of three hours. The trading relation between the maximum SPL and duration was 4 dB per doubling of duration (e.g. 141 dB SPL for a 200-second exposure) (Pestorius et al. 2009).

In alignment with these studies, and considering only frequencies between 100 and 500 Hz, Parvin (2005) suggested 145 dB re 1 µPa SPL as a safety criterion for recreational divers and swimmers. Seismic sources are broadband sources, and therefore, for this assessment the most precautionary and conservative diver acoustic impact threshold is the 145 dB re 1 µPa SPL suggested by Parvin (2005). This does not imply that this level is associated with the onset of injury but represents a conservative level for protection against prolonged sound exposure for health and safety purposes.

6.3.2.12.4 Impact assessment

The furthest distance to a noise threshold criterion for divers is 47.8 km (Appendix G). Potential commercial diving activities may take place at the Eni Blacktip platform located 21 km from the Active Source Area. Santos has consulted with Eni regarding activities at Blacktip and while no commercial diving is planned in 2023, it cannot be ruled for the duration of the EP.

Commercial fishing data confirms that there have been no WA pearl oyster or marine aquarium diving activities within or near the Operational Area or the JBG in the last 11 years. Therefore, future diving activities in the JBG by these fisheries is highly unlikely but cannot ruled out completely. The NT Pearl Oyster Fishery has not been active since 2008. Infrequent NT Aquarium Fishery diving activity may take place in a fishing effort reporting block in waters adjacent to the Operational Area, however, the 60 nm x 60 nm block size means it is difficult to confirm the location of these diving activities. A review of NT fishing effort data indicates that the fishery was active in this block for less than 5 days during the 5-year period 2016-2020. Therefore, diving activities in the block are highly infrequent and it is unlikely that divers will be present in offshore waters adjacent to the Operational Area. However, these activities cannot be ruled out completely.

From the acoustic modelling the maximum distance where received levels exceed 145 dB re 1 µPa SPL is 47.8 km. Guidance note DMAC 12 issued by the UK Diving Medical Advisory Committee (DMAC) ‘Safe Diving Distance from Seismic Surveying Operations’ (DMAC 2020) suggests that adverse effects may be experienced by divers at distances of up to 27 km from a seismic source but does not provide any further details as to what this distance is based on. DMAC (2020) recommends that where diving and seismic activity occur within 30 km of each other, a joint risk assessment should be conducted, and planning/mitigation agreed between parties. Where diving and seismic activities occur within 45 km of each other, all parties should be made aware of the planned activity.

Eni and the WA and NT pearl oyster and aquarium fisheries will be engaged prior to commencement of the Eos 3D MSS to identify any overlap within the area where received levels reach 145 dB re 1 µPa SPL and diving activities. Where an overlap is identified a joint risk assessment will be conducted, and planning/mitigation agreed between parties.

6.3.2.12.5 Summary

Commercial diving activities are unlikely to take place within the area where the diving noise threshold is exceeded but cannot be ruled out. With application of DMAC guidelines, potential impacts to divers can be avoided and the impacts are considered to be negligible.

6.3.2.13 AMP values

The Eos 3D MSS Active Source Area abuts the Oceanic Shoals AMP Multiple Use Zone (see Figure 2-1). While the seismic vessel will perform line turns inside the AMP Multiple Use Zone, the seismic source will not be discharged during run-ins and run-outs, so that noise impacts to habitats within the AMP are minimised. The next closest AMP to the Active Source Area is the Joseph Bonaparte Gulf AMP, approximately 50 km away.

6.3.2.13.1 Receptors

As summarised in Section 3.5.1, the AMP values considered in this assessment are summarized below.

Oceanic Shoals AMP

Examples of ecosystems representative of the Northwest Shelf Transition. The pinnacles, carbonate banks and shoals within the AMP are sites of enhanced biological productivity.

Four KEFs, namely:

- Carbonate bank and terrace systems of the Van Diemen Rise.
- Carbonate bank and terrace system of the Sahul Shelf.
- Pinnacles of the Bonaparte Basin.
- Shelf break and slope of the Arafura Shelf.

Foraging and internesting BIAs for marine turtles.

- Sea country within the marine park is valued for Indigenous cultural identity, health and wellbeing.
- Commercial fishing and mining are important activities in the AMP.

Joseph Bonaparte Gulf AMP

Ecosystems representative of the Northwest Shelf Transition.

The presence of the Carbonate Bank and Terrace System of the Sahul Shelf KEF.

Foraging and internesting BIAs for marine turtles and the Australian snubfin dolphin.

Sea country within the marine park is valued for Indigenous cultural identity, health and wellbeing.

Tourism, commercial fishing, mining and recreation (including fishing) are important activities in the AMP.

6.3.2.13.2 Impact assessment

Oceanic Shoals AMP

The potential impacts to the values of the Oceanic Shoals AMP are summarised as follows. As outlined above, the Active Source Area does not overlap the AMP and the seismic source will be switched off when the vessel enters the AMP during run-ins and run-outs.

Marine ecosystems and KEFs:

The Active Source Area is approximately 100 km from the Carbonate bank and terrace systems of the Van Diemen Rise KEF. As no noise threshold criteria were reached at this distance no impacts to this KEF are predicted.

The Active Source Area is approximately 330 km from the Shelf break and slope of the Arafura Shelf KEF. As no noise threshold criteria were reached at this distance no impacts to this KEF are predicted.

The Active Source Area is approximately 6.2 km from the Carbonate Bank and Terrace System of the Sahul Shelf KEF. No impact is predicted to this KEF as follows:

The no-effect criterion for invertebrates was reached at a range of just 512–673 m from the seismic source.

The noise threshold criterion for corals and sponges was not reached at any of the modelling sites.

The noise threshold criteria for potential injury or mortality to fishes may occur within just 69–200 m of the seismic source.

TTS effects range from 7.11 km in the water column and 6.4 km at the seafloor from the seismic source, thus there is the potential for some fishes within this KEFs to experience TTS. However, as the survey lines are 500 m apart this could potentially only occur for the two lines closest to the Carbonate Bank and Terrace System of the Sahul Shelf KEF. TTS impacts to fish have been shown to be recoverable within 24 hours.

The furthest distance to a turtle noise threshold is 6.12 km. In addition, received levels at this KEF were 148.7 dB SPL which is below the behavioural response (166 dB SPL) and behavioural disturbance (175 dB SPL) thresholds.

The Active Source Area is approximately 7.8 km from the Pinnacles of the Bonaparte Basin KEF. No impact is predicted to this KEF based on:

The no-effect criterion for invertebrates was reached at a range of just 512-673 m from the seismic source.

The noise threshold criteria for corals and sponges were not reached at any of the modelling sites.

The noise threshold criteria for potential injury or mortality to fishes may occur within just 69–200 m of the seismic source.

TTS effects range from 7.11 km in the water column and 6.4 km at the sea floor from the seismic source.

The furthest distance to turtle noise threshold is 6.12 km. In addition, received levels at this KEF were 156.3 dB SPL which is below the behavioural response (166 dB SPL) and behavioural disturbance (175 dB SPL) thresholds.

BIAs for foraging and internesting marine turtles:

No impacts to the Tiwi Islands turtle internesting BIAs within the Oceanic Shoal AMP are predicted as it is approximately 100 km from the Activity Source Area and the furthest distance to a turtle noise criteria threshold is 6.12 km.

The olive ridley foraging BIA is the only turtle BIA within the Oceanic Shoals AMP that is within the area where noise levels exceed the noise threshold criteria for turtles. Based on the impact assessment, no long term or population impacts to marine turtles are predicted. Impacts are predicted to be limited to one-off disturbances to individuals or discrete groups given the transient nature of both the seismic vessel and marine turtles, therefore, biologically important foraging behaviours will continue within the foraging BIAs.

Cultural, heritage, social and economic values:

As impacts to the biological values of the Oceanic Shoals AMP are not predicted to be impacted, impacts to indigenous cultural identity, health and wellbeing associated with Sea Country are also not predicted to be impacted. No disturbance to traditional fisheries or other traditional practices will occur within the AMP.

The Northern Demersal Scalefish Fishery is the only fishery with catch effort in the Oceanic Shoals AMP that could be impacted by noise from the Eos 3D MSS. Fishing effort is low as detailed in Section 3.8.1. An assessment of impacts to demersal fish (Section 6.3.2.11) and commercial fisheries (Section 6.1) detailed that any affects would be localised and temporary.

Joseph Bonaparte Gulf AMP

The potential impacts to the values of the Joseph Bonaparte Gulf AMP are summarised as follows.

Marine ecosystems and KEFs:

The Active Source Area is over 100 km from the Carbonate Bank and Terrace System of the Sahul Shelf KEF within the boundaries of the AMP and, as such, no impacts to the KEF within the AMP are predicted.

As summarised above for the Oceanic Shoals AMP, impacts within the KEF (outside of the AMP) will be limited and the ecological function and values of the KEF will not be impacted.

BIAs for foraging and internesting marine turtles:

No impacts to the Cape Domett turtle internesting BIA, which overlaps the AMP, are predicted as it is approximately 50 km from the Activity Source Area and the furthest distance to a turtle noise criteria threshold is 6.12 km.

The green turtle foraging BIA is the only turtle foraging BIA that overlaps the AMP and is within the area where noise levels exceed the noise threshold criteria for turtles. Based on the impact assessment, no long term or population impacts to marine turtles are predicted. Impacts are predicted to be limited to one-off disturbances to individuals or discrete groups given the transient nature of both the seismic vessel and marine turtles, therefore, biologically important foraging behaviours will continue within the foraging BIAs.

BIA for Australian snubfin dolphin:

No impacts to the Ord River Australian snubfin dolphin breeding BIA, which overlaps the AMP, are predicted as it is approximately 125 km from the Activity Source Area and the furthest distance to the noise criteria threshold for dolphins is 11 km. The potential for behavioural effects to cetaceans is predicted to extend up to approximately 11 km from the seismic source. As the Active Source Area is located approximately 50 km from the Joseph Bonaparte Gulf AMP, no impacts to snubfin dolphins within the AMP are predicted.

Cultural, heritage, social and economic values:

As impacts to the biological values of the Joseph Bonaparte AMP are not predicted to be impacted, impacts to indigenous cultural identity, health and wellbeing associated with Sea Country are also not predicted to be impacted. No disturbance to traditional fisheries or other traditional practices will occur within the AMP.

As the Active Source Area is located approximately 50 km from the Joseph Bonaparte Gulf AMP, no impacts to commercial fish and invertebrate species and fisheries within the AMP are predicted.

No disturbance to tourism and recreation within the AMP are predicted.

6.3.2.13.3 Summary

Received sound levels in the Oceanic Shoals AMP and Joseph Bonaparte Gulf AMP will be below any threshold for physical or significant behavioural impacts for any marine fauna.

No impacts to AMP values within the Oceanic Shoals AMP or Joseph Bonaparte Gulf AMP are predicted to occur.

The above assessment has also considered potential impacts to values, where they occur outside of AMP boundaries, in order to account for potential impacts to the values of the broader Marine Park Network as a whole. No significant, long term or population levels impacts are predicted.

The objectives of the North Marine Parks Network Management Plan are to provide for:

a. The protection and conservation of biodiversity and other natural, cultural and heritage values of marine parks in the North Network

b. Ecologically sustainable use and enjoyment of the natural resources within marine parks in the North Network, where this is consistent with objective (a).

Based on the predicted levels of impact to values of the AMPs, the Eos 3D MSS is expected to be undertaken in a manner that is not inconsistent with the management objectives for the Marine Park Network.

6.3.3 Nature and scale of environmental impacts – helicopter and vessel noise

A seismic survey vessel and two support vessels will be used for the survey. Vessel noise comprises a combination of continuous noise generated by engine and machinery noise, and modulated, broadband noise produced by propeller rotation and cavitation (Richardson et al. 1995; Southall 2007; Jensen et al. 2009; Wales and Heitmeyer 2002; Hildebrand 2009). Vessel noise emissions varies with the size, speed, and engine type and the activity being undertaken. Noise levels for a range of vessels have been measured at 150–182 dB re 1 µPa at 1 m (SPL) at dominant frequencies between 50 Hz and 7 kHz (Wyatt 2008; Simmonds et al. 2004; Jiménez-Arranz et al. 2017).

In addition, a helicopter may be employed for the survey for the purpose of crew changes. Crew changes are expected to occur every 35 days (via helicopter or support vessel). The main source of noise from a helicopter is the main rotor. Dominant tones from helicopters are generally below 500 Hz (Richardson et al. 1995). The penetration of noise into the ocean is dependent on the angle of the aircraft and its distance from the sea surface. Typically, noise does not transmit well from air into water due to impedance at the air-water interface. Noise levels from a Bell 212 helicopter flying at altitudes of 610–152 m respectively were measured at 101–109 decibels (dB) at 3 m water depth (Richardson et al. 1995). This provides an indication of the low received level noise that may be expected from a helicopter.

In general, exposure to helicopter sound emissions is of short duration, peaking as the helicopter passes directly overhead. Received levels are expected to be low during transit when helicopter altitude is greatest and disturbance to marine fauna is not expected. The highest received levels will occur at lower altitudes on approach to landing. Some minor behavioural disturbance may occur for short periods if marine fauna is present near the surface in the vicinity of helicopters landing on the seismic survey vessel. This would be limited to a temporary change in behaviour due to avoidance of the area but is not expected to have any longer term impacts.

The potential receptors of sound produced by vessels and helicopters are cetaceans, marine turtles, seabirds and migratory shorebirds.

Reactions of cetaceans to circling aircraft (fixed wing or helicopter) are sometimes conspicuous if the aircraft is below an altitude of 300 m, uncommon at 460 m and generally undetectable at 600 m (NMFS 2001). Baleen whales sometimes dive or turn away during over-flights, but sensitivity seems to vary depending on the activity of the animals. The effects on cetaceans seem transient, and occasional over-flights probably have no long-term consequences on cetaceans. Observations by Richardson and Malme (1995) indicate that, for bowhead whales, most individuals are unlikely to react significantly to occasional single-pass low-flying helicopters transporting personnel and equipment at altitudes above 150 m. Leatherwood et al. (1983) observed that minke whales responded to helicopters at an altitude of 230 m by changing course or slowly diving.

Marine fauna including cetaceans, marine turtles, seabirds and migratory shorebirds are expected to show minor behavioural responses to vessels, with avoidance and other significant behavioural responses most likely to occur within tens or hundreds of metres from a passing vessel (Southall et al. 2007; Popper et al. 2014). However, based on a practical spreading loss of 15log10(Range) (Urick 1983) and accounting for the NOAA (2019) recommended 120 dB re 1µPa marine mammal behavioural response threshold for continuous sound sources, some behavioural effects may occur over ranges of a few kilometres. For example, McCauley (1998) measured underwater sound levels from a 64 m long support vessel transiting at 11 knots during calm conditions in the Timor Sea and found the distance to 120 dB re 1 µPa to be approximately 1 km, while a 62 m long research vessel transiting at 10 knots was found to exceed to 120 dB re 1 µPa at distances up to 1.6 km (Chorney et al. 2011).

Any potential marine fauna behavioural impacts due to vessel or helicopter noise are expected to be localised and short term. Some transient individuals may avoid the immediate proximity of a vessel or helicopter, but this is not expected to have any widespread or longer-term impacts on their behaviour or populations.

6.3.4 Environmental performance outcomes and control measures

Environmental Performance Outcomes relating to this hazard include:

- EPO-3: Commercial fishing licence holders are no worse off as a result of the seismic survey.
- EPO-5: Undertake seismic acquisition in a manner that prevents serious or irreversible impacts to plankton communities or fauna dependent on plankton as a food source.
- EPO-6: No serious or irreversible impacts to listed marine fish, sharks and rays due to noise associated with the operation of seismic source, consistent with the MNES Significant Impact Guideline 1.1.
- EPO-7: Undertake seismic acquisition in a manner that prevents serious or irreversible impacts to marine invertebrate populations due to noise associated with the operation of seismic source.
- EPO-8: No injury to cetaceans due to noise associated with the operation of seismic sources.
- EPO-9: Seismic activities are undertaken in a manner that prevents injury and interference to Omura's whales.
- EPO-10: Seismic activities are undertaken in a manner that prevents disruption to sensitive life stages and displacement of Australian snubfin dolphins from the foraging/ resting/ calving/ breeding BIA.
- EPO-11: No injury to turtles due to noise associated with the operation of seismic sources.
- EPO-12: Undertake seismic acquisition in a manner consistent with the Recovery Plan for Marine Turtles in Australia 2017-2027.
- EPO-13: No serious or irreversible impact to the sustainability of indicator commercial fish stocks for the following commercial fisheries due to noise associated with the operation of the seismic source:
  - Commonwealth Northern Prawn Fishery (NPF)
  - WA Northern Demersal Scalefish Managed Fishery (NDSMF)
  - WA Mackerel Managed Fishery (MMF)
  - NT Demersal Fishery (DF)
  - NT Spanish Mackerel Fishery (SMF)
  - NT Offshore Net and Line Fishery (ONLF)
  - NT Aquarium Fishery (AF)
- EPO-14: Seismic acquisition is undertaken in a manner that prevents impacts to divers.
- EPO 15: Far-field source levels for the selected seismic source for the Eos 3D MSS are consistent with levels assessed in this EP.
- EPO-16: Protect and maintain biological diversity and other natural, cultural and heritage values of the North and North-west Marine Parks Network.
- EPO-22: No injury to marine fauna during the Activity.

The Control Measures considered for this Activity are shown in Table 6-19, with Environmental Performance Standards and Measurement Criteria for the EPOs described in Section 8.6.1.

Table 6-19: Control measures evaluation for noise emissions

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard control measures				
Eliminate				
None identified.				
Substitute				
None identified.				
Engineering				
None identified.				
Isolation				
CM-14	Implementation of EPBC Policy Statement 2.1 (Part A): • Pre start-up visual observations • Soft start procedures • Start-up delay procedure • Operations procedure • Shut-down procedure • Night-time and low visibility procedures	Minimise acoustic impacts to cetaceans transiting through the survey area.	Use of MFOs and shutdowns can result in downtime of activity increasing survey duration and costs to Santos. Costs of employing MFOs and personnel costs involved in reporting sightings to authorities.	**Adopted** – benefits in reducing impacts to cetaceans outweigh the costs incurred by Santos. MFOs will be on the seismic survey vessel.
CM-15	Marine fauna observations undertaken to minimise the disturbance to fauna caused by the Activity.	Reduces risk of physical impacts to marine fauna from vessels, and close proximity to seismic source	Use of MFOs and shutdowns can result in downtime of activity increasing survey duration and costs to Santos. Costs of employing MFOs and personnel costs involved in reporting sightings to authorities.	**Adopted** – benefits in reducing impacts to marine fauna outweigh the costs incurred by Santos.
Administration				
CM-16	EPBC Regulations (Part 8) for interacting with cetaceans	Reduces risk of physical and behavioural impacts to cetaceans from support vessels, helicopters, and seismic survey vessel (when not operating)	Potential additional costs in not being able to recommence activity (if not acquiring the seismic survey) increasing survey duration and costs to Santos. Personnel costs involved in reporting sightings to authorities.	**Adopted** – benefits in reducing impacts to cetaceans and other marine fauna outweigh the costs incurred by Santos implementing EPBC Regulations (Part 8).
CM-17	Implementation of control measures consistent with EPBC Policy Statement 2.1 Part B:	The use of dedicated observers ie. MFOs/MMOs/SEA, is expected to achieve a higher standard of marine fauna activity surveillance, when compared to assigning vessel crew	Use of MFOs and shutdowns can result in downtime of activity increasing survey duration and costs to Santos. Costs of employing MFOs and personnel costs	**Adopted** – benefits in reducing impacts to marine fauna outweigh the costs incurred by Santos.

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
	2 MFOs (MMOs) and one Survey Environment Advisor (SEA) on board the seismic survey vessel.	members to perform marine fauna observations in addition to other core duties. Reduces risk of physical and behavioural impacts to cetaceans, whale sharks and turtles from vessels, and close proximity to seismic source	involved in reporting sightings to authorities. Employment of experienced MFOs is not considered a significant additional cost.	
Protective				
None identified.				
Additional control measures				
Eliminate				
N/A	No operation of the seismic source within the Carbonate Bank an– Terrace System of the Sahul Shelf or the Pinnacles of the Bonaparte Basin KEFs.	Minimise potential for acoustic impacts to ecological and biological features of the KEFs.	None. The Active Source Areas where the seismic source will be operated is already designed to exclude the KEFs.	**Not Adopted –** Cost outweighs the environmental benefit as the survey area already causes minimal noise impacts to KEFs.
N/A	No start up or operations at night-time / low visibility (EPBC Policy Statement 2.1 – Part B.2)	Would reduce probability of a cetacean occurring within the low power/shutdown zone and not being detected.	Increases time of MSS as operations only continue for approximately 10 hours/day. Increase cost due to increased MSS time (more than double the cost). Survey objectives would not be met in available timeframe.	**Not Adopted** – Cost outweighs the environmental benefit given the low numbers of marine fauna that reside in the area as opposed to transiting through. Given the lack of spatial overlap with humpback whale and pygmy blue whale migration BIAs, Santos considers the likelihood for migrating blue and humpback whales to be present in the survey area during the Activity to be unlikely. Therefore, no additional controls such as 'no start up or operations at night-time or in low visibility (EPBC Policy Statement 2.1 Part B.2)' are further considered.
CM-18	Start-up, shutdown and restart procedures for turtles	Minimise potential for acoustic impacts to turtles.	Increased costs of the survey through additional shutdowns, prolonging the survey duration.	**Adopted** – Small numbers of turtles may be transiting through the survey area. Thus, EPBC Act Policy Statement 2.1 – Interaction between Offshore seismic exploration: Part A will be applied to turtles as a control to minimise impacts to turtles. In order to reduce the potential risks to turtles, a 500 m shutdown zone is considered to be a practicable measure to implement. Observing for turtles at distances

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
				greater than 500 m from the source (which itself is towed a short distance behind the vessel) is unreliable due to the small size of turtles' heads above the surface, even in calm conditions, and is not considered practicable. If a turtle is observed within the shutdown zone, the seismic source will be shut down, or start-up will be delayed for 15 minutes,. Operation of the seismic source using soft start shall only resume when 15 minutes have lapsed since the turtle sighting, or the turtle has been observed to move outside the shutdown zone. Over the course of 15 minutes, the seismic survey vessel will travel approximately 2 km from the sighting location at a speed of 4.5 knots. The benefit of turtle shut-down procedures is considered to outweigh the cost.
N/A	No operation of the seismic source within the internesting BIA for flatback turtles during the nesting season.	Minimise potential for acoustic impacts to turtles.	None. The survey and Active Source Area are already designed to ensure no impacts to the internesting BIA for flatback turtles.	**Not Adopted** – The Recovery Plan for Marine Turtles in Australia (DoEE 2017) states that a precautionary approach should be applied to seismic surveys, such that surveys should not occur inside important internesting habitat during nesting season. As there are no planned impacts to turtle interesting habitat during nesting season, including noise TTS, this control is not adopted.
N/A	Further start up delay (of more than 15 minutes) for turtles.	Minimise potential for acoustic impacts to turtles.	Further start up delay will result in increases in other impacts (Section 6) and risks (Section 7) as a result of increased survey duration over and above what is described and assessed in this EP,	Further start up delay to minimise potential for acoustic impacts to turtles is not considered to outweigh the increase in other impacts and risks assessed in this EP as a result of prolonging the survey duration.

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
			Increased costs of the survey through additional shutdowns, prolonging the survey duration.	
N/A	Exclude seismic acquisition within turtle foraging BIAs.	Minimise potential for acoustic impacts to foraging turtles.	The entire Active Source Area overlaps with turtle foraging BIAs. Avoiding these BIAs would mean the survey would not proceed.	**Not Adopted** – The combined foraging BIAs for flatback, loggerhead, green and olive ridley turtles in the JBG overlap the entire Active Source Area. Therefore, it is not possible to exclude the BIAs from seismic acquisition. Complete exclusion of the BIAs is not considered feasible as the loss in data would be too significant and the survey would not be able to acquire the clients' (block titleholders) required line kilometre commitments under their permit to NOPTA. The majority of the Active Source Area is unlikely to represent significant foraging habitat for any turtle species. The Carbonate Bank and Terrace System of the Sahul Shelf KEF and the Pinnacles of the Bonaparte Basin KEF likely represent the main viable turtle foraging habitat areas overlapped by the survey. Impacts to foraging turtles at these KEFs are not predicted. Shutdown procedures for turtles (CM-18) will be implemented to minimise PTS, TTS and behavioural impacts. Given that only short-term and localised behavioural impacts are predicted in response to the transient seismic source, displacement from critical foraging habitat or population level impacts is not likely to occur and foraging behaviours will continue in the foraging BIAs. The risk to turtles is already low. The Active Source Area overlaps with turtle foraging BIAs. Therefore, the cost of excluding the BIAs far outweighs the benefit, and the control is not feasible or practicable.

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
N/A	Avoidance of prawn spawning and/or migration periods	Minimise the potential impacts to spawning fish of commercial importance and their fish eggs and larvae.	Survey would not be able to occur due to spawning occurring year round and peak spawning periods for different prawn species occurring at different times of year.	**Not Adopted** – Given the exact timing of the survey will be subject to vessel availability and a number of other commercial, operational and environmental factors, some level of flexibility is required for the survey window. Reducing the survey window could prevent Santos from being able to complete the survey or it could mean the survey is not financially feasible, if contracting of a seismic vessel cannot align with other potential surveys in Australian waters. In addition, the Operational Area overlaps only 0.15% of the NPF fishing area, which is considered a low intensity fishing area as shown in Figure 3-14. Given limited additional benefit can be gained for commercial fisheries by altering or reducing the survey window, the potentially significant cost to Santos means that this option is not practicable.
Substitute				
None identified.				
Engineering				
N/A	Thermal Imaging camera can be used to detect cetaceans and blows during daylight and low visibility/night-time by detecting heat signatures. Can detect cetaceans at night which reduces the risk of impacts if undertaking seismic acquisition due to no MFO observations.	Could increase probability of detection of cetaceans which may not be detected by MFOs.	Requires good weather conditions, stabilised platform required to mount camera, and camera must still be focused on the cetacean when it surfaces: limited field of vision. Expensive (approximately $250K plus trained personnel), should be used in conjunction with PAM.	**Not Adopted** – the observer must be focusing the thermal imaging camera on the cetacean when it surfaces to enable a positive verification to be made. Given the costs involved in the use of the equipment, requirement for calm weather conditions so the whales can be spotted between peaks and troughs on the water, as well as the recommendation that it should be used in conjunction with PAM (which is not considered ALARP), the cost outweighs the environmental benefit and therefore is not considered an appropriate mitigation control.

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
N/A	Passive Acoustic Monitoring (PAM) involves the use of hydrophones subsea to detect and monitor the presence of vocalising marine mammals and can assist in the confirmation of the presence of vocalizing cetaceans therefore supporting MFO observations on board the seismic survey vessel. Additional detection methods reduce the risks to marine fauna in the vicinity by influencing the seismic survey operations (EPBC Policy Statement 2.1 – Part B.5)	Potential to detect vocalizing cetaceans which might not otherwise be visible at the sea surface (e.g. on long dives). The approach is most effective for detecting odontocetes (toothed cetaceans, e.g. orcas, dolphins, sperm whales) that produce clicks and whistles that can be more readily differentiated from low frequency seismic impulses and vessel noise than low frequency calls by baleen whales (e.g. humpback, pygmy blue, fin, sei, Bryde's, Omura's).	It is often difficult to detect the distance and direction of cetaceans accurately to enable implementation of precaution zones unless confirmed by visual observations. Although PAM can be used to supplement visual observations made by the MFO, the method is dependent upon animals vocalising. Therefore, the method is only effective at detecting vocalizing cetaceans and is also dependent on environmental conditions. Sophisticated PAM systems are required to effectively filter low frequency cetacean calls (e.g. humpback, pygmy blue, fin, sei, Bryde's, Omura's) and such systems are not readily available on all seismic vessels. Costs for engaging a trained PAM operator for the survey are approximately US$40,000. The significant additional cost of having a qualified PAM operator on board for the duration of the survey when there may be few or no detections of listed threatened or migratory species was determined to outweigh any limited additional benefit that PAM might provide, particularly given the proposed soft start, night time and low visibility procedures. MFOs may be trained in the operation of the PAM system on board the vessel, however, MFOs on board the vessel will be contracted to undertake observational duties on deck (not operate PAM) and therefore additional MFOs would need to be engaged at a similar cost.	**Not Adopted** – Consideration has been given to the other controls provided for in Part B of the EPBC Policy Statement 2.1, including the use of PAM. The additional management measures described in Part B are designed to ensure that impacts and interference to whales are avoided/and or minimised for seismic surveys operating in areas where the likelihood of encountering whales is moderate to high. There are no known aggregation areas or BIAs for listed threatened or migratory cetacean species / cetacean species with a recovery plan or conservation advice in place, within or in close proximity to the Active Source Area and area where noise thresholds are reached for cetaceans. The only listed threatened or migratory cetacean species for which a designated BIA exists is the Australian snubfin dolphin and no impacts are predicted to this BIA. The species is limited to shallow coastal waters and is not expected to be present in the offshore waters of the Active Source Area or where impacts to this species could occur. Therefore, limited benefit would be provided by using PAM to detect this species during the survey. Given that the Operational Area is not significant for cetaceans, and the limited detections of listed threatened or migratory species expected from the use of PAM, the cost of this option is considered to outweigh the limited potential for any further reduction to an already low level of risk.
Isolation				
None identified.				

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Administration				
CM-20	Seismic source validation.	If the seismic source selected for the Activity is greater than the 3,050 in^3 seismic source modelled, then additional acoustic modelling will be undertaken to confirm whether the sound levels are consistent with the levels assessed as acceptable in this EP. Sound propagation modelling (Appendix G) and the risk assessment was based upon a 3,050 in^3 source with a far-field source specification of 248.3 dB re 1 µPa m PK in the broadside direction. Therefore, if modelling of the selected seismic source confirms that it does not exceed peak source pressure levels of 250 dB re 1 µPa m PK in the horizontal plane, it can be concluded that the acoustic output is consistent with the seismic source evaluated and provides reasonable confidence that propagated sound levels will be comparable to those assessed and found to be acceptable in this EP. This provides confidence in the impact assessment which was based on the acoustic modelling results.	Source modelling can be undertaken at minimal cost and relatively quickly.	**Adopted** – Given that the seismic source to be used is not yet confirmed, this control measure ensures that the impact assessment is accurate at limited cost.
N/A	Baseline monitoring prior to the survey and monitoring for potential impacts within the Oceanic Shoals AMP and Joseph Bonaparte Gulf AMP during and after the survey.	The received sound levels in the AMPs are predicted to be below levels that could result in any physical effects or behavioural impacts to identified species associated with the AMPs values. No impacts to habitats within the AMPs will occur. No significant long term or population level impacts to AMP values are predicted to occur. Therefore, monitoring within the AMPs is not expected to provide a material environmental benefit.	Baseline monitoring and impact monitoring campaigns have the potential to cost millions of dollars to implement, given reliance on survey vessels, multiple survey events and subsequent analysis and reporting.	**Not adopted** – Baseline monitoring and monitoring during and after the survey will not be undertaken, given that the Active Source Area is not within an AMP and no impacts are predicted to AMP values. The costs associated with monitoring programmes is grossly disproportionate to the limited benefit that would be gained.

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
N/A	Pre-survey marine fauna research would involve sending a dedicated research vessel to the planned survey area ahead of time. Allows for MSS planning around areas of peak migration and aggregation, therefore reducing risks to marine fauna (EPBC Policy Statement 2.1 – Part B.2)	Would increase knowledge of marine fauna activity in the area. Allows for MSS planning around areas of peak migration and aggregation, therefore reducing risks to marine fauna.	Long lead time as a research vessel sent out to the field would need to go one year ahead of the MSS at the planned time to collect relevant data, survey areas often not defined >1 yr. in advance, further risks from vessel collision and emissions; Cost of research vessel.	**Not Adopted** – Given the lack of spatial overlap of the Active Source Area and area where noise levels are above the noise threshold criteria with cetacean BIAs, Santos considers the presence of cetaceans in the survey area to be limited to transient individuals/small groups. Santos has captured all relevant information in this EP of the likely behaviour and migration routes of marine fauna in the vicinity and through observations made on their own vessels and platforms (which are reported to DCCEEW), and therefore have a sound baseline knowledge to enable MSS planning. Additional baseline surveys are not considered necessary as they would introduce further environmental risks to the marine environment through vessel emissions and discharges (e.g. sewage, cooling water, noise) in areas of known marine fauna activity. To benefit from the pre-survey the finalised survey area and timing would need to be known at least 1 year in advance to allow for it to be undertaken at the same time as the planned MSS which is not practicable. The environmental benefit is therefore outweighed by the cost and scheduling issues and Santos' existing environmental review and working knowledge of the area is considered to reduce the seismic survey timing impacts to ALARP.
N/A	Spotter planes / vessels sent ahead to survey planned night-time survey area (EPBC Policy Statement 2.1 – Part B.2 and B.3)	Could increase detection of individuals or groups of marine fauna which may be displaced or disturbed during night-time operations when visibility is low.	Marine fauna may have moved away from the area by the time the operating seismic survey vessel arrives, or other marine fauna entered the area rendering the pre survey check invalid. Diving cetaceans may not be observed during pre-survey check. Cost of specialist aircraft with good downward visibility, or cost of an	**Not Adopted** – Costs outweigh benefits given the relatively low densities of whales expected in the Active Source –Area and area where noise levels are above the noise threshold criteria during survey acquisition, and the absence of any overlap between critical habitats (i.e. feeding, breeding, calving areas) or a

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
			additional spotter vessel additional MFOs required on board aircraft (approximately $10,000– $20,000 per day). Additional risks to environment through use of vessels/airplanes, increased safety risks to personnel on board additional vessels/airplanes.	constricted migratory pathway and the area potentially impacted.
N/A	Marine fauna sightings – vessels/aircraft used to spot fauna ahead of the seismic survey vessel over whole survey area (EPBC Policy Statement 2.1 – Part B2 and B.3).	Could increase detection of individuals or groups of marine fauna which may be displaced or disturbed.	As above for spotter planes used prior to nightfall.	**Not Adopted** – Only benefit would be marine fauna aggregations could be spotted and MSS acquisition route amended for the day, but the aggregations of large fauna would be spotted by MFOs on board the seismic survey vessels and the same precaution zones observed. Similarly, given the lack of spatial overlap with cetacean BIAs, Santos considers the presence of cetaceans in the survey area during the Activity to be limited to transient individuals/small groups. The additional control of sightings from support vessels is considered effective, as the support vessels patrol a larger area around the seismic survey vessel and can radio marine fauna sightings to the seismic survey vessel. As before, the cost and safety considerations would outweigh the environmental benefit considering the MSS is not being completed in a key breeding or resting area for cetaceans and other fauna, they will only be passing through the area.
CM-21	Increased duration of pre-start visual observations.	Increased duration of pre-start visual observations could increase detectability of marine fauna. However, for most species there is limited benefit in conducting extended pre-start visual observations. The JBG does not provide unique habitat for any deep or long diving cetacean species or other marine fauna, for which extended observation periods might be of benefit.	As the MFOs will already be on board the vessel, there is limited additional cost associated with them conducting observations during deployment of equipment.	**Adopted** – It is proposed that an MFO will conduct observations during the period that the seismic source and streamers are being deployed from the vessel. While observations may record all fauna, the primary purpose would be to look for Omura's whales. In the event that an Omura's whale (or potential or suspected Omura's whale) is observed during the pre-start visual observation period then it will trigger

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
		In the additional time that would be given to observations, the seismic vessel will have transited a significant distance, and so observations made at the start of the pre-start phase may not actually reflect fauna presence at the time of start-up. Extended pre-start visual observations could, however, be of benefit for detecting Omura's whales. Omura's whales are not a listed threatened or migratory species, and they do not have a recovery plan or conservation advice in place. They are a recently identified species that has been detected in the JBG previously, however, they are notoriously elusive. Therefore, extended pre-start observations would provide some benefit in helping to determine if the species is present in the JBG prior to start up. It is therefore proposed that an MFO will conduct observations during the period that the seismic source and streamers are being deployed from the vessel. While observations may record all fauna, the primary purpose would be to look for Omura's whales.		the adaptive management procedure in CM-22.
N/A	Noise management plan	None – an impact assessment has been conducted, and control measures have been developed for this EP. The Active Source Area and area where noise levels are above the noise threshold criteria do not overlap with any cetacean BIAs.	No additional cost to Santos other than negligible personnel costs of preparing and reviewing the management plan	**Not Adopted** – this EP, including control measures constitutes a management plan, no additional benefits identified.
CM-22	Implementation of EPBC Policy Statement 2.1 (partial part B.6 – adaptive management). Adaptive management measures for Omura's whales.	Consideration has been given to the controls provided for in Part B of the EPBC Policy Statement 2.1, including adaptive management. The additional management measures described in Part B are designed to ensure that impacts and interference to whales are avoided/and or minimised for	Adaptive management for Omura's whales, including increased shut down procedures in the event a sighting, may result in additional periods of shutdown. In the event that multiple Omura's whales (or potential/suspected Omura's whales), are sighted, extended shutdown periods of 24 hours or more could impact the	**Adopted** – for Omura's whales: • In the event that there are three confirmed, potential/suspected Omura's whale sightings, in a 24-hour period, the seismic source will be shut down for 24 hours.

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
		seismic surveys operating in areas where the likelihood of encountering whales is moderate to high. There are no known aggregation areas within or near the Active Source Area and areas where noise levels are above the noise threshold criteria, for foraging, breeding, calving or resting habitat for a listed threatened or migratory cetacean species / cetacean species with a recovery plan or conservation advice in place. The only listed threatened or migratory cetacean species for which a designated BIA exists is Australian snubfin dolphin. The species is limited to shallow coastal waters and is not expected to be present in the offshore waters. Therefore, limited additional benefit would be provided by implementing adaptive management, given that no impact is predicted at the coastal BIA. However, adaptive management may be a useful approach for managing the potential presence of Omura's whales. Omura's whales are not a listed threatened or migratory species and they do not have a recovery plan or conservation advice in place. They are a recently identified species that has been detected in the JBG and elsewhere off north-west Australia, however, their life history and whether they use the JBG for any important behaviours or life stages is uncertain. By implementing adaptive management measures, the potential for injury/PTS/TTS or interference to these species can be reduced.	survey schedule. The cost of the vessel being on standby without acquiring data is likely to be approximately US$250,000 per day. However, Santos acknowledge that the species has been reported in the JBG previously and its movements, life stages and usage of the JBG are uncertain. Santos have therefore proposed the adaptive management procedure as a precautionary measure to be protective of potentially sensitive life stages for this species. The approach is also consistent with the requirements of the Australian Whale Sanctuary, where it is an offence to kill, injure or interfere with a cetacean in the Commonwealth Marine Area.	• If, during the 24-hour shutdown period, there are three confirmed or potential/suspected Omura's whale is sighted, then the seismic source will remain shut down until there has been 24 hours with no confirmed, or potential/suspected Omura's whale sightings. Operations may recommence provided there has been no confirmed, or potential/suspected Omura's whale sightings[5] for 24 hours since the last sighting event, and start-up of the seismic source will commence according to A.3.2 Soft-Start Procedure.
CM-23	Night-time and low-visibility procedures for whales and turtles. Consistent with EPBC Policy Statement 2.1 procedure A.3.6 for	Visual observations and shutdown procedures for whales and marine turtles are effective during daylight (during periods of good visibility).	Should start-up and operations at night-time / during low-visibility conditions be delayed, the seismic source may be shut down overnight or for an extended period	**Adopted** – The benefit of night-time and low-visibility procedures for turtles is considered to outweigh the cost.

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
	whales, start-up of the seismic source (according to the A.3.2 Soft-Start Procedure) may only commence at night-time or at other times of low-visibility provided: • There have not been 3 or more shutdowns for whales and turtles during the preceding 24-hour period • If operations were not previously underway during the preceding 24 hours, the vessel has been in the vicinity (approximately 10 km) of the proposed start up position for at least 2 hours (under good visibility conditions) within the preceding 24-hour period, and no whales or turtles have been sighted.	However, observations for whales and turtles cannot be effectively conducted at night-time or during periods of low visibility. Therefore, implementation of night-time and low visibility procedures, such that start-up and operation of the seismic source may only commence at night-time or at other times of low visibility if adequate daylight observations have taken place beforehand, provide a practicable means to reduce the likelihood of exposing significant numbers of whales and turtles to PTS/TTS effects and close-range behavioural effects.	of time until conditions of good visibility return. Such delays may use a significant portion of the contingency timeframe applied to the survey which could limit the total amount of acquisition that is possible during the survey timeframe.	
N/A	Adaptive management procedures for marine turtles: Increased shutdown zone if the observed numbers of turtles are higher than expected.	Increasing the shutdown zone if the observed numbers of turtles are higher than expected would reduce potential impacts to individual species. The current proposed 500 m shutdown zone, associated 15-minute shutdown / start up delay, and soft start procedures and adaptive management are considered appropriate controls given the difficulty observing turtles beyond 500 m.	Observing for turtles at distances greater than 500 m from the seismic source (which is towed a short distance behind the vessel) is unreliable due to the small size of turtles' heads above the surface, even in calm conditions.	**Not Adopted** – Turtles are difficult to observe at sea and while Santos considered increasing this observation and shutdown zone further, it was identified that 500 m is the furthest extent at which a turtle can be observed from a seismic vessel making this the maximum possible extent of the shutdown zone that can be implemented for turtles.
N/A	Adaptive management procedures for marine turtles: 24-hour shutdown if the observed numbers of turtles are higher than expected.	The current proposed shutdown procedures, soft-start procedures and night-time / low visibility procedures are considered to be effective in reducing the risk of PTS/TTS effects and also limits significant close range behavioural disturbance to some degree. Disturbances to turtles are currently predicted to be localised and short term. Foraging behaviours are expected to be able to continue within the foraging BIAs. Displacement from critical foraging habitat or population	The adaptive management procedure would result in a loss of time for shut-downs, which may cost approximately US$250,000 per day. The lost survey time may result in the survey being incomplete within the 50-day survey timeframe, which includes limited contingency time for extended shut-down periods such as this.	**Not Adopted** – Given behavioural effects are expected to be localised and short term, and a large proportion of the area potentially impacted is not expected to provide any significant foraging habitat, the potential delay and cost associated with 24-hour shutdowns exceeds the limited benefit that will be achieved. This approach is not considered to be practicable.

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
		level impacts is not likely to occur and the risk to turtles is already low. Shutting down for 24 hours may reduce the potential for disturbance to turtles for the shutdown period. Therefore, there is potentially some small environmental benefit and reduction in risk achieved by implementing a temporary, 24-hour shutdown.		
N/A	Adaptive management procedures for marine turtles: No night-time operations if the observed numbers of turtles are higher than expected.	The current proposed shutdown procedures, soft-start procedures and night-time / low visibility procedures are considered to be effective in reducing the risk of PTS/TTS effects and also limits significant close range behavioural disturbance to some degree. Disturbances to turtles are currently predicted to result in a detectable but insignificant impact to the local population. Foraging behaviours are expected to be able to continue within the foraging BIAs. Displacement from critical foraging habitat or population level impacts is not likely to occur and the risk to turtles is already low. Completely excluding night-time operations may prevent disturbance to turtles during night-time. However, turtles often forage more during the day than at night, as they use light and visual cues to locate prey (e.g. Narazaki et al. 2013; Enstipp et al. 2016).	Excluding night-time operations would approximately double the duration of the survey. It would not be possible to complete the survey in the 50 days proposed in this EP. The duration and cost of the survey would also double (tens of millions of dollars). Doubling the duration of the survey would also result in the survey vessel being present in the Operational Area for up to 100 days. This would result in increased interactions and risks to marine fauna, commercial fisheries and other marine users and an extended period of underwater noise exposure from the daytime operations.	**Not Adopted** – The costs and additional risks associated with this control option are grossly disproportionate to the limited benefit that would be gained.
CM-19	Adaptive management procedures for marine turtles..	Relocating to a new seismic line will result in a move of at least 7 km. The PTS threshold is reached up to 7.46 km from the source, so acquiring a new line would minimise PTS impacts to individual species in a location where observed numbers of turtles are higher than expected.	Relocating is disruptive and time consuming for the survey with no certainty that the new location will be any better, with respect to the presence and abundance of turtles. Relocating would result in a loss of time for shutdowns and relocation and there is	**Adopted** – The benefit of relocating to avoid an area where higher than expected numbers of turtles have been seen is considered to outweigh the cost.

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
			limited contingency time included in the 50-day survey timeframe. Relocating may not always be possible if there are no alternative lines a sufficient distance from the location where the observed numbers of turtles are higher than expected. This would then require the survey to shut-down until operations can resume. There are no acquisition line options available that avoid the turtle foraging BIAs completely.	
N/A	Adaptive management procedures for marine turtles: No operation of the seismic source within 5 km of the carbonate banks and terraces of the Sahul Shelf KEF and within 5 km of the pinnacles of the Bonaparte Basin KEF during daylight and good visibility conditions (i.e. no night time / low-visibility acquisition in these areas) during the survey.	Night time and low-visibility procedures have already been defined that manage night-time / low-visibility operations based on the number of turtle sightings and shutdowns in a 24-hour period. If a high number of turtles are encountered during daylight hours in the KEF, it is a reasonable indication that a high number of turtles may continue to be present in the area at night time. This would not be indicative of the number of turtles that may be present in the vicinity of the KEFs during every night of the survey, and so there is limited / no additional benefit in applying an ongoing exclusion of night time operations	No night-time or low visibility operations in the vicinity of the KEFs is likely to result in fragmented acquisition of lines in these areas. This would require additional vessel movements as the seismic vessel moves to and from the KEFs on multiple occasions, which could potentially increase the risk of collisions with marine fauna or interference with other marine users.	**Not adopted –** Additional night-time shutdowns provide limited environmental benefit. They may result in increased impacts to other receptors and may prevent acquisition from be completed near the KEFs.
N/A	Adaptive management procedures for marine turtles: Marine fauna observations (scouting) undertaken by the support vessel prior to any operation of the seismic source within 5 km of the carbonate banks and terraces of the Sahul Shelf KEF or within 5 km of the pinnacles of the Bonaparte Basin KEF.	Scouting by the support vessel increases the potential to detect turtles in the KEF but is not considered to provide significant additional benefit given the standard shut-down and start-up times that will be implemented by the seismic vessel.	Assigning scouting and marine observation duties to the support vessel limits the support vessel and crews' ability to complete other critical tasks, such as managing interactions with other marine users	**Not adopted –** The cost of dedicating the support vessel for a single purpose is considered to outweigh the limited environmental benefit.
CM-7	Commercial fishery payment claims (further details are provided in Section 8.6.2)	Should relevant commercial fishers be displaced from their normal fishing areas because of the physical presence of the seismic vessel then Santos is prepared to consider financial payments so that commercial	For Santos to accept a payment claim, fishers will need to provide enough evidence to demonstrate displacement and financial loss. This will require fisher's time and effort. Santos is prepared to invest the time to assess the	**Adopted** – Santos is prepared to assess the merits of all payment claims if commercial fishers can provide evidence of displacement. This process will apply unless commercial

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
		fishers are not worse off as a result of the seismic survey. Evidenced-based compensation models are not new to seismic surveys in Australia.	merits of all claims. Fishing licence holders new to fishing areas overlapping the Operational Area may have difficulty evidencing displacement.	agreements are made with fishing licence holders.
N/A	Reduce the survey area to reduce the area of overlap with commercial fisheries	Minimise the potential impacts to the commercial fishers.	Would not achieve objectives of the survey.	**Not Adopted** – Santos would not be able to obtain the data necessary for the GHG Activity being targeted. While it is acknowledged that this would provide a reduction in risk to the commercial fishing industry, it is not practicable or feasible to implement. As assessed, acquisition has the potential to disrupt up to just 9.37% of NPF fishing activities in the JBG and for a small proportion of the fishing season. Overlap with other commercial fisheries is less (<1%).
N/A	Avoidance of spawning times for commercially targeted key indicator finfish species.	Minimise the potential impacts to spawning fish of commercial importance and their fish eggs and larvae.	Survey would not be able to occur due to combined spawning of these species occurring year-round. Further reduction in the proposed operating window may mean multiple years of surveys at a cost to the business.	**Not Adopted** – Combined spawning periods for the key indicator species covers all 12 months of the year, and therefore the survey could not be acquired. Santos has considered in detail fish spawning periods. Significant disturbance to groups of spawning fishes are limited to short periods while the seismic source is passing within hundreds of metres of their location, however this is not expected to have a significant impact on the stocks. The costs are grossly disproportionate to any potential environmental benefit gained.
CM-24	Adopt UK Diving Medical Advisory Committee Guidance Note DMAC 12 (DMAC 2020): • Eni and the WA and NT pearl oyster and aquarium fisheries will be engaged prior (minimum 4 weeks) to commencement of the Eos 3D MSS to identify any overlap within the area where received noise levels reach 145 dB re 1 µPa SPL and diving activities occur.	Reduce potential health and safety risks to commercial divers	Minimal additional cost to Santos. Pre-survey engagement will take place with Eni and the WA and NT pearl oyster and aquarium fisheries.	**Adopted** – potential risks to diver health and safety are a priority.

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
	• Where an overlap is identified a joint risk assessment will be conducted, and planning/mitigation agreed between parties.			
N/A	No helicopter operations	Minimise acoustic disturbance to marine fauna from helicopter operations	Vessel would be required to return to port (approximately every five weeks) for crew change. This would increase the duration of the survey incurring additional costs. Survey may not be completed in available timeframe.	**Not Adopted** – Considering the low potential for impacts to marine fauna to occur, the potential costs associated with vessel downtime, extended duration and the risk of not meeting survey objectives are grossly disproportionate.
Protective				
None identified				

6.3.5 Environmental impact assessment

Receptor	Consequence level
Noise from operation of the seismic source	
Threatened / Migratory / Protected Fauna	Acoustic emissions generated by the seismic source may result in impacts to receptors including behavioural response, TTS, PTS or injury and mortality. Noise levels at which these effects have been recorded differs between species, as such receptor-specific thresholds have been applied, as support by the scientific literature. *Plankton* Any mortality effects to zooplankton resulting from seismic noise emissions are likely to be highly localised and inconsequential compared to natural mortality rates. Given the currents in the area aiding natural replenishment, plankton depletion is not expected to have ecosystem-wide impacts or have population level effects to species with planktonic life stages, including commercial fish and invertebrate species. Based on the impact assessment no long-term impacts to plankton or fauna dependent on plankton as a food or recruitment source are predicted, thus, the consequence level is assessed as ***Negligible***. *Invertebrates* Based on the impact assessment no long term or population impacts to invertebrates (crustaceans, molluscs, corals, filter-feeders) are predicted. Thus, the consequence level for benthic invertebrates is assessed as negligible. No effects to benthic invertebrates are predicted within the Pinnacles of the Bonaparte Basin and the Carbonate Bank and Terrace System of the Sahul Shelf KEFs. The potential risk to commercial prawns within the JBG is also considered to be limited. Thus, the consequence level for crustaceans and molluscs is assessed as ***Minor***. *Fish, sharks and rays* Hearing ranges and sensitivities vary substantially between species depending on anatomy (e.g. presence of swim bladder) and behaviour (e.g. mobile or site attached). Fish species may be exposed to noise levels exceeding thresholds for mortality/ mortal injury, recoverable injury, TTS and behavioural responses. Mortality/ mortal injury is not expected to occur to fishes/elasmobranchs that have the ability to move away from the source array, and to date such have impacts have not been documented. TTS and recoverable injury may occur to a small proportion of the overall population and recovery is expected. Behavioural effects are likely to be limited to tens or hundreds of metres of the seismic source, which pelagic and demersal fish can avoid. Based on the impact assessment no long term or population impacts to individual fishes (including sawfish), site-attached fish communities or commercial fish stocks are predicted, thus the consequence level is assessed as ***Minor***. *Cetaceans* PTS through cumulative sound exposure is considered unlikely because of the behavioural response of the individual whales (e.g. moving away from the source) and the application of the EPBC Act Policy Statement 2.1 (pre-start visual observations, soft start, lower-power zone and shutdown zone). Due to control measures in place (soft starts and application of the EPBC Policy Statement 2.1 – Part A), physical injury or PTS is unlikely to occur. Impacts will be restricted to temporary impacts to hearing (TTS) or behavioural responses, such as avoidance. Given that the area of potential impact does not overlap with any cetacean BIAs, the presence of cetaceans is expected to the limited to transient individuals/small groups. Impacts are predicted to be temporary behavioural response (lasting days) or TSS (lasting 24 hours) to transient individuals only. Additional pre-start observations and adaptive management measures are proposed to manage potential effects to Omura's whales given the potential uncertainty about their distribution and where sensitive life stages may occur in the region. No impacts are predicted to the Australian snubfin dolphin breeding, calving, resting and foraging BIAs. As such, the consequence has been assessed as ***Minor***. *Marine turtles* The potential for injury and hearing impairment in turtles may be limited to waters in immediate proximity to the seismic source. The potential for injury or significant hearing impairment is further limited as turtles would likely attempt to swim away and avoid the approaching seismic source before being in such close range. The implementation of soft starts will prevent discharge of the seismic source at full capacity in close proximity to marine turtles, and therefore impacts will be limited to one-off disturbances to individuals or discrete groups given the transient nature of both the seismic vessel and marine turtles, therefore, biologically important foraging behaviours will continue within the foraging BIAs. While it is possible some marine turtles may be exposed to noise levels of a high enough level for a long enough duration that some level of TTS may occur, this is expected to be recoverable and not have any impact on reproductive fitness. Marine turtles do not use sound for foraging or reproductive purposes and thus a temporary impairment of auditory sensing capabilities is highly unlikely to result in disruptions to either of these critical behaviours or translate to population level

Receptor	Consequence level
	impacts. Further it is noted that the actual exposure of marine turtles would likely be much less than predicted owing to diving and surfacing patterns, and this combined with the implementation of mitigation measures is expected to significantly reduce the likelihood of TTS in marine turtles. No long term or widespread disturbances to foraging or internesting populations of marine turtles are expected. Should behavioural disturbances occur to foraging marine turtles, it will likely be limited to one-off disturbances to individuals or discrete groups given the transient nature of both the seismic vessel and marine turtles. Turtles will not be displaced from the identified habitat critical to the survival or marine turtles, located approximately 70 km from the Active Source Area. Internesting behaviour in the internesting BIA, located approximately 50 km from the Active Source Area will not be impacted and the stock will not be compromised. Localised and short-term disturbances to individuals or discrete groups of foraging turtles may occur for less than an hour at a time when the seismic source passes in the vicinity. No impacts to turtles that may be foraging within the Carbonate Bank and Terrace System of the Sahul Shelf KEF or the Pinnacles of the Bonaparte Basin KEF are predicted. Biologically important foraging behaviours will continue within the foraging BIAs. Thus, the consequence level is assessed as ***Minor***. *Seabirds and migratory shorebirds* Diving seabirds and migratory shorebirds may be exposed to underwater noise during foraging, particularly plunge-divers, although incidence of injury is absent. Due to the scale of impacts to prey species (fish and invertebrates) indirect effects due to displacement of prey species is unlikely. Temporary displacement may occur around the vessels, however, given the areas over which pelagic seabirds forage, this is unlikely to be of significant impact to individuals or populations. The consequence level is assessed as ***Negligible***.
Physical Environment/Habitat	Not applicable – no impacts to corals, filter-feeders or the physical habitat structure of the seabed are predicted to occur.
Threatened Ecological Communities	Not applicable – no threatened ecological communities are identified in the area over which noise emissions are expected to occur.
Protected Areas	The closest protected areas are the Oceanic Shoals AMP, adjacent to the Active Source Area, and the JBG AMP, located approximately 50 km from the Active Source Area. The physical environment/habitat and marine fauna are included as values of the AMPs and the consequence of potential impacts to these receptors is discussed above. As no long term or population level impacts are predicted, the Eos 3D MSS will not impact upon the values of the AMP or the wider Marine Parks Network. The consequence level is assessed as ***Negligible***.
Socio-economic receptors – Commercial fisheries	Potential impacts to fish from noise levels exceeding exposure thresholds may have direct effects on commercial fisheries. Population level impacts to fish or prawns are not expected, with potential impacts being restricted to behavioural responses at the individual level. Localised and short term behavioural effects in target fish and prawn species may occur. However, given the Active Source Area does not overlap the NPF area of fishing effort and there have been highly infrequent and low levels of effort in the area potentially impacted, impacts to commercial catch rates are highly unlikely to occur. The survey is not expected to result in any direct reduction in the spawning biomass or recruitment of key indicator commercial fish or prawn stocks. Therefore, the survey is not expected to result in a serious or irreversible impact to the sustainability of key indicator commercial fish or prawn stocks or their catchability for fisheries. The consequence to commercial fisheries has been assessed as ***Minor***.
Socio-economic receptors – Commercial diving activities	Commercial diving activities are unlikely to take place within the area where the diving noise criteria threshold is reached but cannot be ruled out. With application of DMAC guidelines, potential impacts to divers can be avoided and the impacts are considered to be negligible.
Overall worst-case consequence	II – Minor Consequence rankings were provided for receptor groups due to the variation in receptor sensitivity. Impact assessments were based on worst case scenarios for received noise levels and receptor sensitivity (e.g. behaviour in BIAs). Where evidence is lacking or contradictory, a conservative approach was taken.
Noise operation from vessels and helicopters	
Threatened/Migratory/ Protected Fauna	Noise generated from vessels and helicopters may result in momentary behavioural effects to marine fauna. However, acoustic emissions from vessels and helicopters will be less than that of the seismic source.

Receptor	Consequence level
Physical Environment/Habitat	Not applicable
Threatened Ecological Communities	Not applicable – no threatened ecological communities are identified in the area over which noise emissions are expected to occur.
Protected Areas	Not applicable – noise emissions form vessels and helicopters in the Operational Area will not result in noise levels exceeding impact thresholds in protected areas.
Socio-economic receptors – Commercial fisheries	Due to lower noise emissions from vessels and helicopters compared to the seismic source, the consequence of impacts to fish, and therefore fisheries, will be less than that of the seismic sources.
Overall worst-case consequence	I – Negligible Considering the levels of received noise from operating vessels and helicopters, potential impacts will be restricted to temporary behavioural responses and are expected to have negligible consequence on populations or ecosystem function.

6.3.6 ALARP evaluation

No alternative options to the use of a seismic source are possible in order to undertake the Activity. Alternative options to the survey design have been assessed by Santos. In regard to survey design options, Santos has optimised the survey to minimise the Active Source Area size to avoid impacts to the adjacent Oceanic Shoals AMP and the Pinnacles of the Bonaparte Basin and Carbonate Bank and Terrace System of the Sahul Shelf KEFs.

Omura's whales have been identified as a species of cetacean that may be present in the JBG throughout the year. Additional pre-start observations and adaptive management procedures are proposed specifically for this species to account for the uncertainty regarding their presence and potentially sensitive behaviours and life stages in the JBG. Extended observation times in the lead up to the survey during the survey streamer deployment have been adopted to inform the likelihood of Omura's whales being present during the survey itself. If they are observed during this time, this will inform the application of extended shutdown periods for this species. An extended start up observation period of 60 minutes was considered but was not considered necessary noting the activity area is in relatively shallow waters and whales would not be expected to be undertaking deep dives. As a result the standard pre-start observation period was considered appropriate.

The survey design avoids impacts to turtles within the internesting BIA and habitat critical for the survival of the species by spatially avoiding these areas. Night-time / low-visibility procedures and adaptive management measures for turtles will be adopted to reduce behavioural impacts to foraging turtles in the foraging BIAs. Consistent with the Recovery Plan for Marine Turtles in Australia, internesting and foraging behaviours are expected to be able to continue without disruption in the BIAs and habitat critical for the survival of the species. An increased 500 m observation zone has been implemented for turtles and if turtles are observed within that range that seismic source will be shut down. Turtles are difficult to observe at sea and while Santos considered increasing this observation and shutdown zone further, it was identified that 500 m is the farthest extent at which a turtle can be observed from a seismic vessel making this the maximum possible extent of the shutdown zone that can be implemented for turtles.

The survey design also avoids impact to the Australian snubfin dolphin BIA.

No additional control measures to those provided in Section 6.3.4 were identified to further minimise impacts to prawn and fish spawning and recruitment, commercial fishers, invertebrates, and plankton. The survey is unable to be timed to avoid all spawning periods due to the species present.

No reasonably practicable additional controls were identified in the evaluation of control measures in Section 6.3.4 that would further increase the environmental benefit without a grossly disproportionate cost/sacrifice. Therefore, the proposed control measures are considered appropriate to manage the consequence of acoustic impacts due to operation of the seismic sources to ALARP.

6.3.7 Acceptability evaluation

Is the consequence ranked as I (Negligible) or II (Minor)?	Yes – Maximum consequence from noise emissions is II (Minor).
Is further information required in the consequence assessment?	No – Sufficient information is available to understand the nature and scale of potential impacts, and to assess impact consequence. It is recognised that the levels of acoustic exposure that may result in injury or behavioural changes in marine fauna is an area of ongoing research. Due to differences in experimental design, methodology and units of measure, comparison of studies to determine likely thresholds can be difficult. There are numerous studies on the effects of seismic sound on receptors with a range of effects to no effects identified. Seismic surveys in Australia are well regulated and guidance is available for managing potential impacts to sound sensitive marine fauna. On assessment of the available science, the thresholds used for informing the impact assessment, and interpreting the numerical noise modelling are considered conservative, and in line with industry practice.
Are the risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' Offshore Division Environmental Hazard Identification and Assessment Procedure which considers principles of ecologically sustainable development, which is further elaborated on by species type below. *Plankton* Considering the available research into the effects of seismic on plankton and recommended impact thresholds, impacts to planktonic communities are predicted to be within the realms of natural variation and are not expected to be discernible at the regional scale when considering the rapid natural turnover and large natural spatial and temporal variability in plankton mortality and replenishment. Even if adopting a precautionary approach to the assessment and applying worst-case effects ranges, such as those reported by McCauley et al. (2017) and assessed by Richardson et al. (2017), localised losses of plankton do not result in regional scale impacts and recovery is expected within a matter of days. Zooplankton communities can begin to recover during the seismic survey such that a continuous decline in zooplankton throughout the duration of the seismic survey is not anticipated and parts of the survey area would be replenished as the survey progressed. Therefore, no long-term impacts to plankton communities or fauna dependent on plankton as a food or recruitment source are predicted. Based on the impact assessment in Section 6.3.2.8 and noting that impacts to plankton communities recover quickly, no significant or long term impacts are predicted. Therefore, in the context of the principles of ESD: • There is no threat of serious or irreversible environmental damage (including to matters of national environmental significance) as a result of localised and recoverable impacts to plankton communities • The health, diversity and productivity of the environment will be maintained • The biological diversity and ecological integrity of the marine environment (including KEFs) will be conserved. *Invertebrates* Based on the impact assessment in Section 6.3.2.9, no long term or population impacts to invertebrates (crustaceans, molluscs, corals, filter-feeders) are predicted. Some benthic invertebrate species may experience sub-lethal effects or chronic mortality in some individuals in the weeks or months following exposure within tens or hundreds of metres from the seismic source. Should this occur, the continuous natural cycle of death, recovery and recruitment of invertebrates from adjacent sediments will occur in parallel over the same timescales, and therefore impacts to benthic invertebrates are unlikely to be detectable from natural variability in community abundance, composition and structure. Changes that occur are likely within the range of variation that can occur from other common natural and anthropogenic stressors. The ecological implications of such impacts on benthic invertebrate communities are not expected to be significant or long term. The invertebrate communities at the Carbonate Bank and Terrace System of the Sahul Shelf KEF and Pinnacles of the Bonaparte Basin KEF are not predicted to be impacted and thus the ecological integrity, function, and values of the KEFs will not be impacted. Impacts to commercially significant prawn stocks, spawning and recruitment are predicted to be negligible given high natural larval mortality rates and high inter-annual variability in recruitment rates. Mortality to adults is unlikely and based on conservative exposure scenarios, just 3.0% of prawn eggs and larvae are predicted to be impacted, which is negligible in the context or natural mortality (99%) and recruitment.

	Based on the impact assessment in Section 6.3.2.9, no significant or long term impacts to invertebrates are predicted. Therefore, in the context of the principles of ESD: • There is no threat of serious or irreversible environmental damage (including to matters of national environmental significance) as a result of localised and recoverable impacts to invertebrate communities • The health, diversity and productivity of the environment will be maintained • The biological diversity and ecological integrity of the marine environment (including KEFs) will be conserved. *Fish, Sharks and Rays* Based on the impact assessment in Section 6.3.2.7, the potential impacts to free-swimming demersal and pelagic fishes are expected to be limited to localised and temporary behavioural effects. Recent research on commercially significant demersal fish species (Meekan et al. 2021) suggests no short-term (days) or long-term (months) effects of seismic exposure on the composition, abundance, size structure, behaviour or movement of demersal fish species similar to those that may occur in the JBG. Impacts to elasmobranchs (sharks) are also expected to be localised and short term behavioural effects, as sharks are unable to detect sound pressure and only detect changes in particle motion near the operating source. In the context of their naturally vagrant behaviours, any avoidance is expected to be insignificant. Impacts to sawfish as a result of the seismic survey are likely to be limited to localised and temporary behavioural disturbance. No impacts to their key life stages or nursery habitats in coastal and estuarine waters are predicted. Impacts to site-attached fish assemblages associated with the Carbonate Bank and Terrace System of the Sahul Shelf KEF or pinnacles within the Pinnacles of the Bonaparte Basin KEF are not predicted. Therefore, the ecological integrity of fish communities within the KEFs will therefore be maintained. Based on the impact assessment in Section 6.3.2.7, no significant or long term impacts to fish, sharks and rays are predicted. Therefore, in the context of the principles of ESD: • There is no threat of serious or irreversible environmental damage (including to matters of national environmental significance) as a result of localised and recoverable impacts to fish communities • The health, diversity and productivity of the environment will be maintained • The biological diversity and ecological integrity of the marine environment (including KEFs) will be conserved. *Cetaceans* The JBG is not known to support significant numbers of cetaceans and it does not provide unique habitat for known aggregations or sensitive life stages for listed threatened and/or migratory species. Based on the impact assessment in Section 6.3.2.8, the potential impacts of noise emissions from the seismic source on cetaceans at any one-time during acquisition are considered to be temporary behavioural changes (e.g. avoidance) by transient individuals. The potential for injury, PTS and TTS are reduced through the implementation of the proposed controls, including the required standards and control measures set out in EPBC Policy Statement 2.1. Additional controls are proposed to reduce the risk of interfering with Omura's whales, if present for key life stages in the JBG. No impacts are predicted to Australian snubfin dolphins within the breeding, calving, resting and foraging BIAs. Based on the impact assessment in Section 6.3.2.8, no significant or long term impacts to cetaceans are predicted. Therefore, in the context of the principles of ESD: • There is no threat of serious or irreversible environmental damage (including to matters of national environmental significance) as a result of localised and recoverable impacts to cetacean populations • The health, diversity and productivity of the environment will be maintained • The biological diversity and ecological integrity of the marine environment (including KEFs) will be conserved. *Marine Turtles*

	Based on the impact assessment in Section 6.3.2.9 no long term or population impacts to marine turtles are predicted. No impacts are predicted to turtles undertaking reproductive behaviours in internesting BIAs or any habitat critical to the survival of marine turtles. Behavioural effects to individual or small groups of transient and foraging marine turtles may occur, however, disturbances will be localised and short term. Based on the understanding of the foraging behaviour of marine turtles, foraging BIAs are interconnected and biologically important foraging behaviours will continue within the foraging BIAs. Additional controls are proposed to reduce any potential impacts to foraging turtles. Despite the increased predicted ranges to TTS and PTS, it is important to acknowledge that the actual range over which these impacts may occur is likely much smaller. This is a result of the modelling predictions being based on a stationary receiver at the seabed. Foraging marine turtles, unlike internesting turtles, are highly mobile and are moving through the water column and surfacing regularly. Foraging marine turtles spend considerable periods of time in the surface waters where noise exposure will be considerably less owing to the design of seismic airguns to produce downward propagating signals. It is also considered that while TTS and PTS represent potential impacts to marine turtles, marine turtles do not use sound to find food resources or for reproductive purposes, thus there is no biological link between auditory impairment and reproductive output. Santos is confident that with the implementation of precautionary control measures, the risk of TTS and PTS is significantly reduced and that there will be no disruption to critical foraging and reproductive behaviours. Based on the impact assessment in Section 6.3.2.9, no significant or long term impacts to turtles are predicted. Therefore, in the context of the principles of ESD: • There is no threat of serious or irreversible environmental damage (including to matters of national environmental significance) as a result of localised and recoverable impacts to marine turtle populations • The health, diversity and productivity of the environment will be maintained • The biological diversity and ecological integrity of the marine environment (including KEFs) will be conserved. *Seabirds and Migratory Shorebirds* Based on the impact assessment in Section 6.3.2.13, birds are only expected to be affected by underwater sound in the unlikely event that birds dive and forage near the seismic source, which may result in a startle response from the affected individuals. Birds will not be displaced from the wider areas of the breeding and foraging BIAs in the JBG. The behaviour and distribution of some fishes may be affected for short periods during and after exposure to the seismic source, which may result in short-term and localised changes in the distribution of target prey species for some species. However, these effects are unlikely to be discernible to foraging birds in the context of the normal movements and variation in the distribution of fishes. Impacts to seabird populations are not predicted to occur. Based on the impact assessment in Section 6.3.2.10, no significant or long term impacts to seabirds and migratory shorebirds are predicted. Therefore, in the context of the principles of ESD: • There is no threat of serious or irreversible environmental damage (including to matters of national environmental significance) as a result of localised and recoverable impacts to seabird or migratory shorebird populations • The health, diversity and productivity of the environment will be maintained • The biological diversity and ecological integrity of the marine environment (including KEFs) will be conserved. *Commercial Fisheries* Based on the impact assessment in Section 6.3.2.11, the survey is not expected to result in any direct reduction in the spawning biomass of key indicator commercial fish stocks through fish mortalities. The high fecundity and broadcast spawning characteristics of key demersal and pelagic fish species in the region provide for genetic connectivity of the stocks over extensive areas. Localised (tens to hundreds of metres) and short-term (minutes, hours, days) behavioural disturbances resulting from a transient seismic source are unlikely to result in a discernible impact to demersal fish populations given that spawning and stock connectivity occurs over significantly larger geographic areas, over protracted spawning periods of several months, and involves the production of millions of eggs over multiple spawning events. A small spatial-temporal overlap of the survey with the spawning areas in the Kimberley management unit and spawning periods of key indicator fish species for WA fisheries (maximum spatial-temporal overlap of 0.21%, based on highly conservative spatial-

	temporal analysis), is expected to be negligible in the context of natural variability in spawning biomass and recruitment (250-350%). There is no spatial-temporal overlap predicted with the spawning range of Spanish mackerel in the Kimberley management unit. Key indicator fish species in the Kimberley management unit have been assessed annually as 'sustainable', including during years when seismic surveys have also taken place. The sustainability status is based upon the target and threshold levels for spawning biomass, which DPIRD note in their Harvest Strategy is a conservative approach, as well as being consistent with the principles of ESD. Impacts to the spawning and recruitment of commercially significant prawn stocks are also predicted to be negligible given high natural larval mortality rates and high inter-annual variability in recruitment rates. To address potential scientific uncertainty in seismic effects to prawns, a precautionary assessment approach was applied, whereby potential sub-lethal effects were assumed to compromise 100% of exposed eggs and larvae. Based on conservative exposure scenarios, just 3.0% of prawn eggs and larvae are predicted to be impacted, which is negligible in the context or natural mortality (99%) and recruitment. The Active Source Area does not overlap the NPF area of effort based on data for 2010–2020. Therefore, the potential for disturbance to target fish species is limited to the NDSMF and MMF. For the NDSMF only 0.7% of the area of past fishing effort is overlapped by the Active Source Area. This area is fished very infrequently by the NDSMF (less than three vessels in total between 2010 and 2022 and during many years no fishing has occurred). For the MMF only 0.52% of the area of past fishing effort is overlapped by the Active Source Area. This area is fished very infrequently by the MMF (only fished in 2019 by less than 3 vessels). Therefore, disturbances to fishes and prawns are highly unlikely to result in impacts to commercial catch rates. Therefore, the survey is not expected to result in a serious or irreversible impact to the sustainability of key indicator commercial fish or prawn stocks or their catchability for fisheries. Based on the impact assessment in Section 6.3.2.11, no significant or long-term impacts to commercial fish stocks or commercial catch rates are predicted. Therefore, in the context of the principles of ESD: • There is no threat of serious or irreversible environmental damage to commercial fish and prawn stocks • The health, diversity and productivity of the environment will be maintained • The biological diversity and ecological integrity of the marine environment will be conserved • The assessment of impacts to commercial fisheries catch rates addresses both the short term and long term economic, environmental, social and equitable considerations. Short-term impacts to any fishery are highly unlikely and no long term impacts are predicted. Santos has also made a commitment to consider evidence-based compensation payments should claims be received from commercial fisheries (refer to Section 8.6.2), which is consistent with the ESD principle of promoting improved valuation and pricing mechanisms. *AMP Values* Based on the impact assessment in Section 6.3.2.13, no impacts to the values of the Oceanic Shoals and the Joseph Bonaparte Gulf AMPs are predicted, and the Eos 3D MSS will be undertaken in a manner that is consistent with the management objectives for the AMPs and the North Marine Park Network. The management objectives account for the ecologically sustainable use of natural resources in the network. Therefore, the risks and impacts are broadly consistent with the principles of ESD.
Are control measures and performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	EPBC Act Policy Statement 1.1 – Significant Impact Guidelines Yes – The overall worst-case consequence for noise emissions has been determined to be ***Minor*** and will not have a significant impact upon protected matters in accordance with EPBC Policy Statement 1.1. – Significant impact guidelines.
	EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales: Industry guidelines (DEWHA 2008) Yes – Management is consistent with Part 8 of the EPBC Regulations and EPBC Policy Statement 2.1. Controls implemented will minimise the potential impacts from the Activity to species identified as having the potential to be impacted by noise emissions.
	Blue Whale Conservation Management Plan (DoE 2015)

	Yes – The Conservation Management Plan states that 'Anthropogenic noise in biologically important areas will be managed such that any blue whale continues to use the area without injury and is not displaced from a foraging area'. The Conservation Management Plan, with reference to EPBC Act Policy Statement 2.1, also advises that seismic surveys should not result in disturbance in biologically important areas at biologically important times. The pygmy blue whale migration BIA is located over 310 km from the Active Source Area and PTS or TTS (i.e. injury) impacts or behavioural effects are not predicted to occur to pygmy blue whales as they migrate through these waters along the continental slope. The Active Source Area and area above the cetacean noise criteria thresholds are not located near a known foraging area and is unlikely to provide for opportunistic foraging given the distance from the species migration route.
	Approved Conservation Advice for *Megaptera novaeangliae* (Humpback Whale) Yes – The Conservation Advice states that all seismic surveys must be undertaken consistently with the EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales. As stated above, Santos has proposed control measures that meet and exceed the required standards and control measures set out in Part A of EPBC Policy Statement 2.1. The humpback whale migration BIA is located approximately 330 km from the Active Source Area. No impacts to humpback whales will occur in the BIA.
	Approved Conservation Advice for Sei and Fin whales Yes – The Conservation Advice for both species do not specify required standards for managing noise impacts from seismic surveys, but they do recognise anthropogenic noise as a potential threat to the species. No significant or long-term disturbance, or injury, to sei or fin whales from noise emissions is expected as a result of the seismic survey.
	Australian Whale Sanctuary Yes – Within the Australian Whale Sanctuary it is an offence to kill, injure or interfere with cetaceans. The JBG is not known to support significant numbers of cetaceans and it does not provide unique habitat for known aggregations or sensitive life stages for listed threatened and/or migratory species. Overall, the potential impacts of noise emissions from the seismic source on cetaceans at any one-time during acquisition are considered to be temporary behavioural changes (e.g. avoidance) by transient individuals. The potential for injury, PTS and TTS are reduced through the implementation of the proposed controls, including the required standards and control measures set out in EPBC Policy Statement 2.1. Additional controls are proposed to reduce the risk of interfering with Omura's whales, if present for key life stages in the JBG.
	Recovery Plan for Marine Turtles in Australia (DoEE 2017) Yes – The Recovery Plan states that a precautionary approach should be applied to seismic surveys, such that surveys should not occur inside important internesting habitat during the nesting season. Consistent with this approach, the closest BIA or habitat critical to the survival of the species is the Cape Domett flatback turtle internesting BIA located approximately 50 km from the Active Source Area. The Recovery Plan states that in accordance with EPBC Act Policy Statement 2.1 – Interactions between Offshore Seismic Exploration and Whales, all seismic survey vessels operating in Australian waters must undertake a soft start during surveys irrespective of location and time of year of the survey. Soft-starts (as well as shut-down procedures, which exceed this requirement) will be implemented during the seismic survey. Action Area A1 of the Recovery Plan also states that activities must be managed to ensure marine turtles are not displaced from identified habitat critical to the survival marine turtles. Given that the closest internesting BIA or habitat critical to the survival of the species to the Active Source Area is approximately 50 km away (Cape Domett), displacement of turtles from these habitats are not predicted. Action Area A1 of the Recovery Plan also states that anthropogenic activities in BIAs must be managed to ensure that biologically important behaviour can continue. The intent of Action Area A1 is further described, requiring that actions undertaken in or adjacent to designated habitat critical to the survival of the species or BIAs do not change important behaviours such that the recovery of the stock is compromised. Potential disturbances to turtles in the foraging BIAs will be localised and short term and, therefore, biologically important foraging behaviours will continue within the foraging BIAs. No impacts are predicted to turtles that may be foraging in the Carbonate Banks and Terrace System of the Sahul Shelf

<table>
<tr><td></td><td colspan="4">KEF and the Pinnacles of the Bonaparte Basin KEF which are the most viable foraging habitat areas in the BIAs. It is predicted that impacts to foraging behaviours, to the extent that the recovery of the stock is compromised, will not occur.</td></tr>
<tr><td></td><td colspan="4">North Marine Parks Network Management Plan
Yes – The objectives of the North Marine Parks Network Management Plan are to provide for:
• the protection and conservation of biodiversity and other natural, cultural and heritage values of marine parks in the North Network
• ecologically sustainable use and enjoyment of the natural resources within marine parks in the North Network, where this is consistent with objective (a).
Based on the predicted levels of impact to values of the Oceanic Shoals and the Joseph Bonaparte Gulf AMPs, the Eos 3D MSS is expected to be undertaken in a manner that is not inconsistent with the management objectives for the AMPs and the North Marine Park Network.</td></tr>
<tr><td>Are control measures and performance standards consistent with the Santos Environmental Management Policy?</td><td colspan="4">Yes – Aligns with the Environmental Management Policy.</td></tr>
<tr><td>Are performance outcomes and standards consistent with stakeholder expectations?</td><td colspan="4">Yes – Commercial fisheries stakeholders have raised concerns regarding potential impacts to fish and prawn stocks. The Wurankuwu Clan have also raised the importance of Crocodiles and Turtles to their clan. Santos has therefore assessed the potential for such impacts in detail.
Detailed responses have been provided to stakeholders, as detailed in Section 4.
Relevant fishery stakeholders were also sent details on Santos' proposed concurrent operations and commercial fishery payment claim protocols.
Santos will continue to assess the merits of any stakeholder claims on the proposed survey, control measures and performance standards, and will continue to engage with stakeholders as committed</td></tr>
<tr><td>Are control measures and performance standards such that the impact or risk is considered to be ALARP?</td><td colspan="4">Yes (see ALARP evaluation above).</td></tr>
<tr><td colspan="5">Defined Acceptable Levels</td></tr>
<tr><td rowspan="3">Does the predicted impact meet defined acceptable levels of impact (refer to Section 5.7)?</td><td>Receptor Category</td><td>Defined Acceptable Level</td><td>Comparison with Predicted Levels of Impact</td><td>EPO</td></tr>
<tr><td>EPBC Act-listed threatened and migratory cetaceans</td><td>Seismic activities are not inconsistent with a recovery plan or wildlife conservation plan/ advice that is in force for a species of cetacean. This includes no injury to a cetacean and no displacement of foraging, aggregating, calving/breeding, or migrating cetaceans from identified BIAs.</td><td>Santos considers the level of impact to cetaceans to be of an acceptable level.
Potential impacts of noise emissions from the seismic survey have been evaluated against the requirements within relevant conservation management plans and approved conservation advice. With control measures implemented, no injury to a cetacean is expected. No EPBC Act-listed cetacean species will be displaced from any BIAs.</td><td>EPO-8
EPO-10
EPO-22</td></tr>
<tr><td>Cetaceans including non EPBC Act listed threatened or migratory species.</td><td>Seismic activities are undertaken in a manner that is not inconsistent with the objectives of the Australian Whale Sanctuary where it is an</td><td>The JBG is not known to support significant numbers of cetaceans and it does not provide unique habitat for known aggregations or sensitive life stages. Overall, the potential</td><td>EPO-8
EPO-9
EPO-22</td></tr>
</table>

		offence to kill, injure or interfere with cetaceans.	impacts of noise emissions from the seismic source on cetaceans at any one time during acquisition are considered to be temporary behavioural changes (e.g. avoidance) by transient individuals. The potential for injury, PTS and TTS are reduced through the implementation of the proposed controls, including the required standards and control measures set out in EPBC Policy Statement 2.1. Additional controls are proposed to reduce the risk of interfering with Omura's whales, if present for key life stages in the JBG. With the proposed controls in place the survey is not expected to result in injury or interfere with potential key life stages. Therefore, no mortality, injury or interference with key life stages are expected.	
	Australian snubfin dolphins	Seismic activities are undertaken in a manner that does not result in displacement of Australian snubfin dolphins from the foraging/resting/calving/breeding BIA.	No impacts to Australian snubfin dolphins from the foraging/resting/calving/breeding BIAs are predicted as noise levels at theses location are below the noise threshold criteria.	EPO-10 EPO-22
	EPBC Act-listed threatened and migratory marine turtles	Seismic activities are not inconsistent with the Recovery Plan for Marine Turtles. This includes: • No acquisition inside important internesting habitat during the nesting season • No change to important behaviours in designated habitat critical to the survival of the species or BIAs such that the recovery of the stock is compromised.	Santos considers the level of impact to marine turtles to be of an acceptable level. Potential impacts of noise emissions from the seismic survey have been evaluated against the requirements within the Recovery Plan for Marine Turtles in Australia. No seismic acquisition will occur within defined internesting BIA and habitat critical for the survival or marine turtles, and soft-starts as well shut-down procedures will be implemented. Disturbance to internesting turtles is therefore not expected. Potential disturbances to turtles in the foraging BIAs will be localised and short term and, therefore, biologically important foraging behaviours will continue within the foraging BIAs. Shut downs and night time / low-visibility procedures will be implemented to further reduce the potential for disturbance to foraging turtles in foraging BIAs. Therefore, no impacts to foraging behaviours, to the extent that the recovery of the stock is compromised, will occur.	EPO-11 EPO-12 EPO-22

	EPBC Act-listed threatened and migratory fish, sharks and rays	Seismic activities are not inconsistent with the conservation advice that is in force for whale sharks and the MNES Significant Impact Guideline 1.1, including no serious or irreversible impacts to listed marine fish (including sharks) due to noise associated with the operation of seismic source.	Santos considers the level of impact to fish, sharks and rays (including whale sharks and sawfish) to be of an acceptable level. Potential impacts of noise emissions from the seismic survey have been evaluated against the requirements within the conservation advice that is in force. Given the control measures to be implemented for the seismic survey, which include shut-down procedures for whale sharks, no injury is expected and the potential for disturbance or serious or irreversible impacts is limited.	EPO-6 EPO-22
	Non-EPBC Act-listed species and ecological communities	Given the widespread distribution of non-EPBC listed marine fauna species and ecological communities, and that non-EPBC listed species and communities are not formally managed, Santos considers it acceptable to have a Negligible (I) or Minor (II) consequence. As defined within *Santos' Offshore Division Environmental Hazard Identification and Assessment Guideline* (EA-91-IG-00004), a Minor consequence is defined as a 'Detectable but insignificant change to a local population, industry or ecosystem factor. Localised effect, lasting weeks up to 12 months.	Santos considers the level of impact to non-EPBC Act-listed species and ecological communities to be of an acceptable level. The consequence of potential impacts to such marine fauna and ecological communities (including plankton and benthic invertebrate communities) from noise emissions has been assessed to be Negligible (I) to Minor (II).	EPO-7
	Commercial fisheries	No serious or irreversible impact to the sustainability of key indicator commercial stocks within the: • Commonwealth Northern Prawn Fishery • WA Northern Demersal Scalefish Managed Fishery • WA Mackerel Managed Fishery • NT Demersal Fishery • NT Spanish Mackerel Fishery • NT Offshore Net and Line Fishery • NT Aquarium Fishery • Commercial fishing license holders are no worse off as a result of the seismic survey.	Santos considers the level of impact to commercial fisheries and fishers to be of an acceptable level. The survey is not expected to result in any direct reduction in the spawning biomass through fish mortalities. The high fecundity and broadcast spawning characteristics of key demersal and pelagic fish species in the region, which provide for genetic connectivity of the stocks over extensive areas. Localised (tens to hundreds of metres) and short-term (minutes, hours, days) behavioural disturbances resulting from a transient seismic source are unlikely to result in a discernible impact to demersal fish populations given that spawning and stock connectivity occurs over significantly larger geographic areas, over protracted spawning periods of several months,	EPO-3 EPO-13

			and involves the production of millions of eggs over multiple spawning events. A small spatial-temporal overlap of the survey with the spawning areas in the Kimberley management unit and spawning periods of key indicator fish species (maximum spatial-temporal overlap of 0.21%, based on highly conservative spatial-temporal analysis), which is expected to be negligible in the context of natural variability in spawning biomass and recruitment (250-350%). No spatial-temporal overlap is predicted with the spawning range of Spanish Mackerel in the Kimberley management unit. Key indicator species in the Kimberley management unit have been assessed annually as 'sustainable', the biomass of the stocks is unlikely to be depleted and recruitment is unlikely to be impaired despite a history of ongoing commercial fishing and seismic surveys across the fisheries. The sustainability status is based upon the target and threshold levels for spawning biomass, which DPIRD note in their Harvest Strategy is a conservative approach, as well as being consistent with the principles of ESD. The seismic survey is not expected to result in any direct reduction in the spawning biomass through fish mortalities. Impacts to the spawning and recruitment of commercially significant prawn stocks are also predicted to be negligible given high natural larval mortality rates and high inter-annual variability in recruitment rates. Based on conservative exposure scenarios, just 3.0% of prawn eggs and larvae are predicted to be impacted, which is negligible in the context or natural mortality (99%) and recruitment. Therefore, the survey is not expected to result in a serious or irreversible impact to the sustainability of key indicator commercial fish or prawn stocks, or their catchability for fisheries.	
	Divers	Seismic activities will not result in physical injury to any diver.	Santos considers the level of impact to divers to be of an acceptable level. Commercial diving activities are unlikely to take place near the Operational Area during the survey but cannot be ruled out. With application	EPO-14

			of DMAC guidelines, potential injury to divers will be avoided.	
	Australian Marine Parks (AMPs)	Protect and maintain biological diversity and other natural, cultural and heritage values in accordance with the conservation objectives of the North-west Marine Parks Network Management Plan (2018) and North Marine Parks Network Management Plan (2018).	Santos considers the level of impact to AMPs to be of an acceptable level. The activity is consistent with AMP management prescriptions, IUCN conservation objectives and the ecological use of the AMPs.	EPO-16

6.4 Cumulative and additive seismic impacts

6.4.1 Description of event

Cumulative and additive seismic impacts	
Aspect	Cumulative and additive impacts refer to situations where successive seismic surveys are undertaken over the same area, or where concurrent seismic survey activities occur throughout the region, affecting the same environmental or socio-economic receptors. It is recognised that the effects resulting from multiple seismic surveys, when considered collectively, may result in a greater level of impact or risk than the effects arising solely from the Eos 3D MSS. The two types of impacts are defined: • **Cumulative impacts** – Cumulative impacts are considered where the spatial footprint of impacts from previous seismic surveys (or other significant underwater sound-producing activities) have occurred over the same area as the predicted impacts from the Eos 3D MSS. Cumulative impacts will only occur where the effects of previous surveys overlap the same area and receptors, and when recovery of the impacts from previous seismic surveys has not occurred prior to the Eos 3D MSS commencing. • **Additive impacts** – Additive impacts are different from cumulative impacts and are assessed separately. Additive impacts may result from other seismic surveys (or other significant underwater sound-producing activities), where the effects may or may not overlap spatially, but when taken together have an additive or incremental effect on the same receptors. Additive impacts may occur if other seismic surveys (or other significant underwater sound-producing activities) are undertaken concurrent with the Eos 3D MSS and within the range and extent of the same receptors, for example, where both surveys overlap with the distribution of the same population of a marine species or within the footprint of the same commercial fishery. Cumulative and additive impacts are assessed in relation to the aspects of underwater noise emissions and the physical interaction of the seismic survey activities with other marine users. This section does not assess cumulative impacts from activities that may occur after the Eos 3D MSS. It is not possible to anticipate what surveys will be planned after the Eos 3D MSS and it is the responsibility of future proponents to assess the potential cumulative impacts in their EPs.
Extent	Operational Area (cumulative impacts) North West Marine Region and North Marine Region (additive impacts)
Duration	For the duration of the Activity as described in Section 2.

6.4.2 Nature and scale of cumulative impacts

A review of data available on the National Offshore Petroleum Information Management System (NOPIMS) and SeisIntel websites identified five 3D and one 2D seismic surveys that have been undertaken in the waters of the JBG, either overlapping or adjacent to the Eos 3D MSS Operational Area, in the past seven years (since 2017). These surveys are presented in Figure 6-5 and summarised in Table 6-20.

Other significant anthropogenic sound producing activities that have previously occurred in the region include day-to-day vessel traffic (including fishing vessels, oil and gas support vessels, recreational vessels and regional shipping traffic), Defence exercises and live firing, and other oil and gas activities (such as drilling, operating facilities, geophysical surveys, and associated vessel activities).

Individually, the noise from all of these activities will have had the potential to impact marine fauna. Behavioural disturbances to invertebrates, fishes, cetaceans and marine turtles from activities in the JBG and wider region likely occur frequently but are likely to be limited to individual or discrete groups of marine fauna. Santos has not identified any specific activities that may occur prior to the Eos 3D MSS that may result in a significant cumulative impact in the Operational Area.

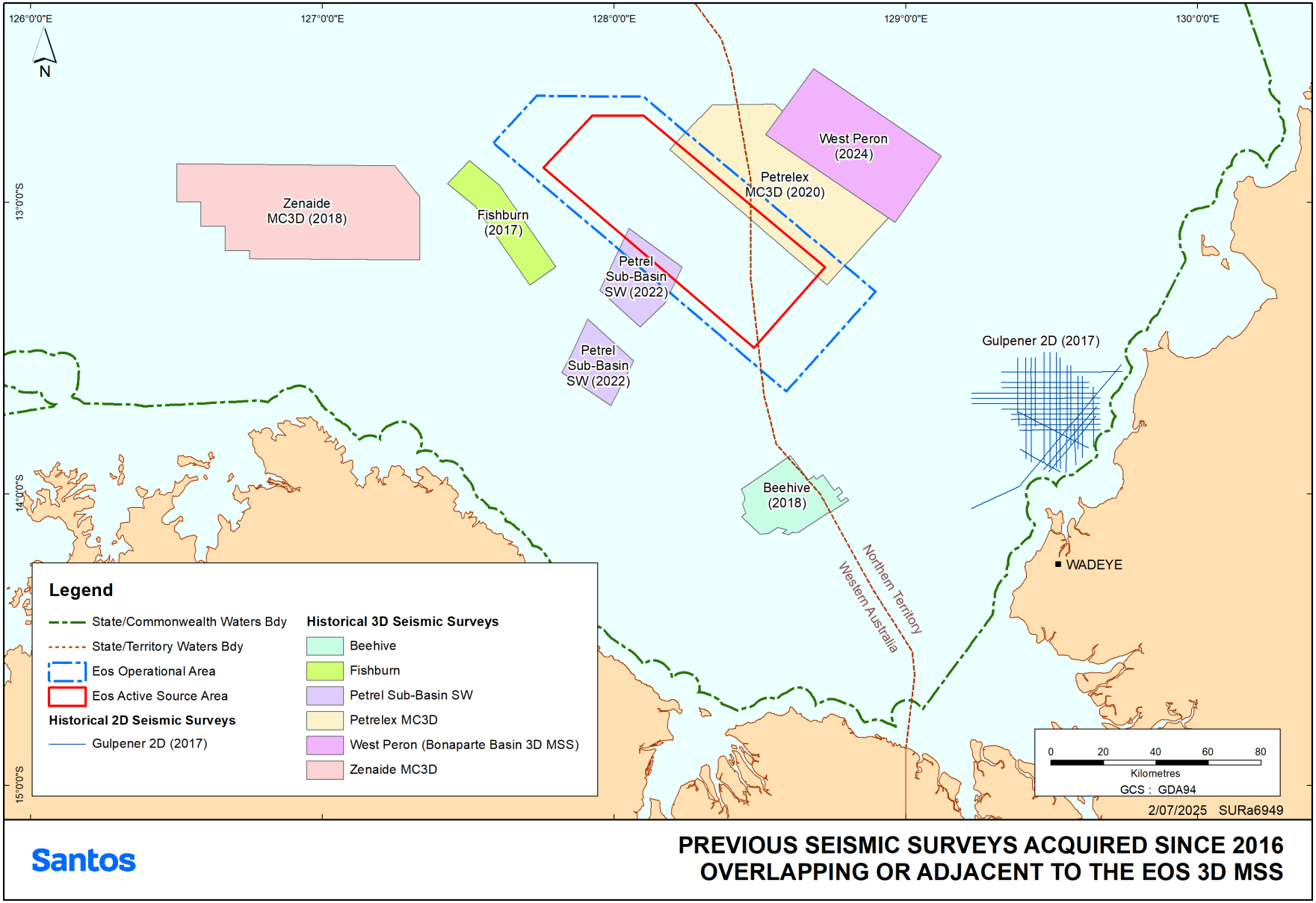


Figure 6-5: Previous seismic surveys acquired since 2016 overlapping and/or adjacent to the Eos 3D MSS

Table 6-20: Previous seismic surveys acquired in the JBG since 2017 overlapping or adjacent to the Eos 3D MSS

Survey name and size	Company	Survey location	Timeframe	Potential cumulative impacts to ecological receptors
Bonaparte Basin 3D Marine Seismic Survey 1,811 km^2 of 3D seismic acquisition in GHG assessment permit G-7-AP	INPEX Browse E&P Pty Ltd	Located directly east of the Active Source Area	Completed 06/01/2024–27/02/2024 52 days of acquisition	The Bonaparte Basin 3D MSS does not overlap the Eos 3D MSS area. The Bonaparte Basin survey was completed approximately 2-3 years before the start of the Eos 3D MSS. Ecological receptors, including benthic communities, are expected to have recovered within that timeframe. No cumulative impacts are expected from the Eos and Bonaparte surveys.
Petrel Sub-Basin South-West 3D Marine Seismic Survey 1,080 km^2 of 3D seismic acquisition in petroleum permits WA-27-R and WA-40-R	Santos Offshore Pty Ltd	Located directly south of the Active Source Area, including 115 km^2 overlap	Completed 18/02/2022–24/03/2022 36 days of acquisition	The Petrel Sub-Basin SW 3D MSS overlaps the Eos 3D MSS area by 115 km^2. The Petrel survey was completed 2 years prior to the potential start date for the Eos 3D MSS. Ecological receptors, including benthic communities, are expected to have recovered within that timeframe. No cumulative impacts are expected from the Eos and Petrel surveys.
Petrelex 3D Marine Seismic Survey Approximately 2,900 km^2 of 3D seismic acquisition	Polarcus Seismic Limited	Located directly north-east of the Active Source Area, including 299 km^2 overlap	Completed 01/12/2019–16/01/2020. 46 days of acquisition	The Petrelex 3D MSS overlaps the Eos 3D MSS area by 299 km^2. The Petrelex survey was completed 4 years prior to the earliest potential start date for the Eos 3D MSS. Ecological receptors, including benthic communities, are expected to have recovered within that timeframe. No cumulative impacts are expected from the Eos and Petrelex surveys.
Beehive 3D MSS Maximum of 690 km^2 of 3D seismic acquisition in exploration permit WA-488-P	Santos Limited	Located 43 km south of the Active Source Area.	Completed 23/07/2018–11/08/2018 20 days of acquisition	The Beehive 3D MSS was completed >5 years prior to the earliest potential start date for the Eos 3D MSS. Ecological receptors, including benthic communities, are expected to have recovered within that timeframe. No cumulative impacts are expected from the Eos and Beehive surveys.
Zénaïde 3D MSS Maximum of 2,860 km^2 of 3D seismic acquisition in exploration permit WA-552-P	Polarcus Seismic Limited	Located 47 km west of the Active Source Area	Completed 18/01/2018–18/04/2018 Maximum of 60 days of acquisition	The Zénaïde 3D MSS was completed >5 years prior to the earliest potential start date for the Eos 3D MSS. Ecological receptors, including benthic communities, are expected to have recovered within that timeframe. No cumulative impacts are expected from the Eos and Zénaïde surveys.
Fishburn WA-459-P Seismic Survey Maximum of 595 km^2 of 3D seismic acquisition in exploration permit WA-459-P	Santos Limited	Located 18 km to the west of the Active Source Area	Completed 27/06/2017–11/07/2017 15 days acquisition	The Fishburn survey was completed >6 years prior to the earliest potential start date for the Eos 3D MSS. Ecological receptors, including benthic communities, are expected to have recovered within that timeframe. No cumulative impacts are expected from the Eos and Fishburn surveys.
Gulpener 2D MSS Maximum of 2,850 km^2 of 2D seismic acquisition in permit NT/P84	Origin Energy Resources Limited	Located 72 km south-east of the Active Source Area	Completed 24/06/2017–05/07/2017 12 days acquisition	The Gulpener 2D MSS was completed >6 years prior to the earliest potential start date for the Eos 3D MSS. Ecological receptors, including benthic communities, are expected to have recovered within that timeframe. No cumulative impacts are expected from the Eos and Gulpener surveys.

6.4.2.1 Cumulative effects on ecological receptors

The potential for cumulative impacts to occur depends on whether recovery of impacts from previous surveys will have occurred prior to the Eos 3D MSS commencing or not. As described in Section 6.3, the duration of recovery following exposure to underwater noise emissions from a seismic survey is in the order of minutes to hours for some receptors, or weeks to months for other receptors, for example:

Localised changes in zooplankton abundance (including eggs and larvae) are likely to be replenished and indistinguishable from natural levels within hours of a seismic survey vessel passing or, based on the most conservative studies and a precautionary approach (e.g. McCauley et al. 2017; Richardson et al. 2017), within a few days of a seismic survey being completed.

Sub-lethal effects and chronic lethal effects to some benthic invertebrates may occur for weeks or several months after exposure, although changes in overall benthic community composition and structure are expected to be negligible in the context of natural variability in mortality and recruitment.

Changes in fishes' behaviour, abundance and distribution have been observed to last for minutes, hours or days, depending on the species, hearing sensitivity and situational context.

Behavioural changes in migrating or foraging marine fauna (e.g. cetaceans, turtles, whale sharks) returning to normal within hours or days after exposure.

Ecological receptors are therefore expected to have recovered from the effects of a seismic survey within days to months of completion, with potential lethal and sublethal effects to some immobile benthic invertebrate communities considered to have the longest population recovery period. Longer term, only sublethal impacts to some benthic invertebrate organisms may persist but would not inhibit reproductive potential or community structure (refer to Section 6.3.2.6).

Based on these recovery periods, an assessment of the potential cumulative impacts to ecological receptors is included in Table 6-20.

Given the time that has elapsed since previous surveys were undertaken in this area, all receptors are expected to have recovered from the effects of previous surveys prior to commencement of the Eos 3D MSS. Therefore, cumulative impacts to ecological receptors are not expected to occur as a result of any of the identified previous seismic surveys in the region and the proposed Eos 3D MSS.

6.4.2.2 Cumulative effects on commercial fisheries

A separate assessment has been undertaken on the potential cumulative impacts to commercial fisheries. Consultation with commercial fishery stakeholders, in particular the NPF, has highlighted concerns regarding seismic surveys taking place within the fishery, including surveys that have taken place in past years.

Of particular concern to NPF stakeholders was that catch in JBG was significantly lower in 2015 and 2016 compared to long-term historical catches. While there may be a number of influencing factors, stakeholders are concerned that impacts resulting from seismic exploration have been a contributing factor. Confidential catch and effort data provided by NPFI for the JBG in 2019 (provided to NOPSEMA in the Sensitive Information Report) confirms that banana prawn catch levels (the main component of the JBG section of the fishery) during 2015 and 2016 was low.

To address these concerns, Santos has assessed the potential cumulative impacts from previous seismic surveys on the NPF. Noting that the Eos 3D MSS has limited overlap with historical fishing effort by the WA and NT-managed fisheries, no further detailed assessment of cumulative impacts has been undertaken for these fisheries.

Santos has reviewed historical seismic surveys within the JBG based on survey data on the National Offshore Petroleum Information Management System (NOPIMS) database and compared these with the NPF catch and effort data for the JBG. No seismic surveys were undertaken in the JBG between 2015 and 2016 when catch levels were reportedly low, therefore, direct interference from seismic surveys on NPF fishing activities could not have been a contributing factor to the reduced banana prawn catch levels in those years.

It is noted from the confidential catch and effort data provided by NPFI for the JBG that in addition to banana prawn catch being low in 2015 and 2016, fishing effort during the banana prawn season in these years was also lower than normal. Catch per unit effort (CPUE) was actually comparable to other years.

Noting the approximate 6-month timescale of recruitment (from spawning of eggs to recruitment of juveniles to the adult stock in the JBG) and the 1–2 year life cycle of prawns, it is also unlikely that reduced catches during the 2015–2016 fishing seasons (2–3 years after the last seismic survey prior to this in the region) are the result of seismic impacts to the recruitment of the prawn stocks. As noted in Section 6.3.2.6, the potential effects of seismic to prawn spawning and recruitment are likely to be negligible in the context or natural variability. It is also consistently noted in each annual fishery status report published by ABARES that annual catches are variable from year to year because of natural variability in the banana prawn component of the fishery.

Santos has also reviewed banana prawn catch and effort data for the broader NPF for the years 2010-2019 (Table 6-21). Relatively low catch levels are evident in 2015 and 2016 (albeit less pronounced than the JBG, probably because banana prawns make up a relatively larger proportion of the catch in the JBG compared with the wider fishery). The low catch levels in 2015 and 2016 resulted in the assessment of the banana prawn stock biomass being classified as uncertain in 2016. Given that low banana prawn catch levels evident across the entire fishery in 2015 and 2016, and not just in the JBG, external factors other than seismic surveys need to be considered.

Table 6-21: NPF banana prawn catch and effort data, 2010–2019

Year	Banana prawn catch (t)	Banana prawn season effort (days)	Banana prawn CPUE	Red-legged banana prawn biomass status
2010	5642	3146	1.793	Not overfished
2011	7141	3440	2.076	Not overfished
2012	4901	2526	1.940	Not overfished
2013	3094	2192	1.411	Not overfished
2014	6245	2476	2.522	Not overfished
2015	3931	2249	1.748	Not overfished
2016	2877	2302	1.250	Uncertain
2017	5045	2304	2.190	Not overfished
2018	4708	2506	1.879	Not overfished
2019	5640	2392	2.358	Not overfished

Source: ABARES

The annual fishery status report for 2017 (Larcombe and Bath 2017) provides some explanation for the very low catch and effort levels in 2015 and 2016:

> *'The Northern Prawn Resource Assessment Group (NPRAG) analysed the anomalously low JBG catches of red-legged banana prawns in 2015 and 2016 (Plagányi et al. 2017). One hypothesis is that recruitment or availability was lower in 2015 and 2016 as a result of anomalous environmental factors. Preliminary work by Plagányi et al. (2017) found an association between catch rates and different combinations of El Niño conditions (Southern Oscillation Index) and seasonal rainfall. The model predicted low catch rates in both 2015 and 2016 as a result of El Niño conditions and below-median rainfall.*
>
> *Another hypothesis for the low JBG catches is the potential existence of more favourable fishing opportunities in other parts of the multispecies NPF, particularly for tiger prawn fishing in the Gulf of Carpentaria, thereby leading to low fishing effort in JBG. Preliminary analysis found some association between lower JBG catches and higher catch rates in the tiger prawn fishery, which would contribute to low effort in JBG during years of unfavourable environmental factors, as explained above. So, low JBG catches may result from a combination of both poor environmental conditions in JBG and better fishing opportunities elsewhere.'*

It was subsequently confirmed that extensive marine environmental impacts occurred in the region as a result of an unprecedented marine heat wave (Nohaïc et al. 2017). The event, linked to a record El Niño, resulted in coral bleaching and impacts to marine species throughout Australia. The heatwave primarily affected the Kimberley region of WA (including the JBG) and effects were also documented far south in the Tasman Sea. The heat wave was also farther reaching than Australia, with the El Niño being documented as the third global mass coral bleaching event on record (Nohaïc et al. 2017). The reduced catch and effort in 2015 and 2016 can therefore be attributed to unprecedented environmental factors.

Santos also notes that prior to the decrease catch levels in 2015 and 2016, between 2007 and 2014, catch per unit effort (CPUE) in the JBG banana prawn fishery was relatively high compared with other years, increasing from a typical CPUE in 2007 by as much as 30–100% for the next seven years. This same period coincided with a period of seismic surveys in the JBG, including the Petrel 3D MSS (2007), the Bernier 2D MSS (2008), Penguin 2D MSS (2010), Falcon 2D MSS (2011) and the Petrel Sub-Basin CO2 MSS (2012). Seismic surveys occurred again in the JBG in 2017 and 2018 (Gulpener 2D MSS, Fishburn 3D MSS, Beehive 3D MSS) when banana prawn CPUE was once again at or above average.

If seismic surveys do have an effect on prawns, the CPUE data assessed above suggests that they have not previously resulted in impacts on the JBG stocks at a population level and that larger scale environmental factors have a greater influence on recruitment, prawn biomass and CPUE.

Based on the above assessment, there is no correlation between past seismic surveys and changes in prawn catch or fishing effort in the JBG or broader NPF. Occasional interactions between seismic vessels and fishing vessels may have taken place, resulting in relocation by fishing vessels, but this appears not to have a longer-term impact on overall catch levels in any year.

6.4.3 Nature and scale of additive impacts

INPEX is planning to undertake survey activities in G-7-AP between 2025 and 2027 over several multi-week campaigns and could consist of approximately 90–120 days of survey activities in total potentially over three calendar years. The survey project area is shown in Figure 6-6.

Note, the following assessment does not consider cumulative or additive impacts from seismic surveys in the region that occur after the Eos 3D MSS or that have not yet submitted an EP to NOPSEMA, as it is the responsibility of that titleholder to assess the cumulative impacts.

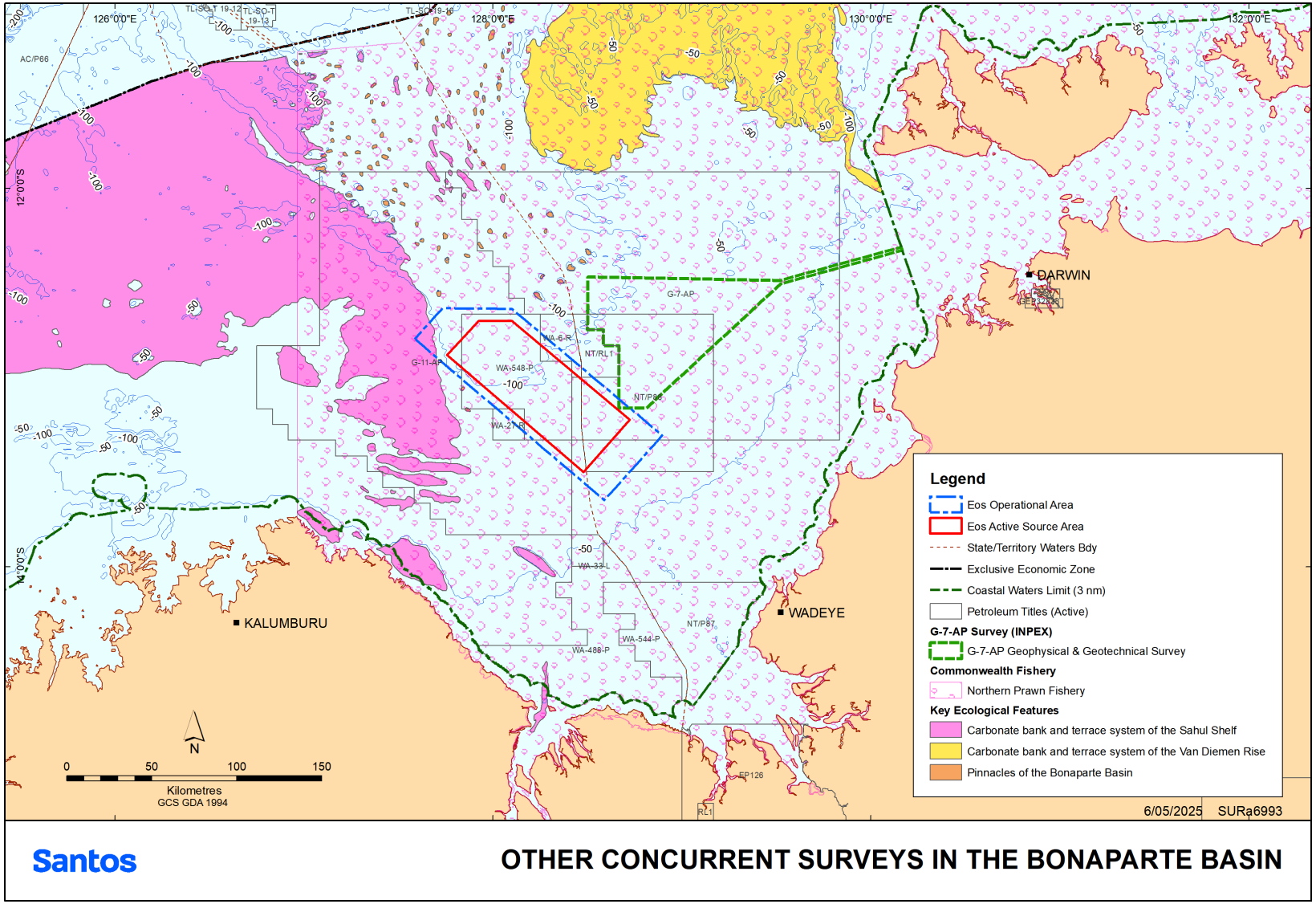


Figure 6-6: Other concurrent surveys in the Bonaparte Basin

6.4.3.1 Sound fields from multiple seismic surveys

The additive effects of concurrent seismic surveys in the region include:

- The effects of multiple individual sound fields in separate geographic locations resulting in spatially separate areas of disturbance, such as when surveys occur at distance from one another
- The potential interaction of sound fields produced by separate seismic surveys, where sound waves from the separate seismic sources may be received either in synchrony ('in synch') or out of synchrony ('out of synch').

As there are no concurrent seismic surveys planned of the region, additive impacts from seismic surveys are not assessed further.

6.4.3.2 Additive impacts from other activities

Other potentially significant anthropogenic sound producing activities (in addition to seismic surveys) that may occur in the JBG and wider region include:

- Day-to-day vessel traffic (including fishing vessels, oil and gas support vessels, recreational vessels and regional shipping traffic)
- Defence exercises
- Operating petroleum facility noise from the Eni Blacktip well-head platform (WHP) and pipeline
- Other future petroleum activities that may occur in the JBG during the same timeframes as the Eos 3D MSS.

Commercial shipping traffic and other vessel noise are significant component of the ambient noise in the JBG and wider region (McCauley 2011, 2012; McPherson et al. 2016b). Depending on the size and type of vessels, typical source levels can range between 150-182 dB re 1 µPa at 1 m (SPL) with dominant frequencies between 50 Hz and 7 kHz (Wyatt 2008; Simmonds et al. 2004; Jiménez-Arranz et al. 2017). Limited fishing vessel activity is expected to occur in or near the Operational Area at the same time as the Eos 3D MSS, given the NPF closure and very limited historical fishing effort that has occurred in the Operational Area by other commercial fisheries such as the NDSMF and MMF. Therefore, the main source of vessel noise in the Operational Area will be from the seismic vessel and support vessels, combined with other vessels occasionally transiting through or near the Operational Area. In that sense, additive impacts from vessel noise are considered negligible.

Marine fauna individuals are expected to show relatively minor behavioural responses to vessel noise, with avoidance and other significant behavioural responses most likely to occur within tens or hundreds of metres from a passing vessel (Southall et al. 2007; Popper et al. 2014), although some level of response in cetaceans is possible at greater distances. For example, based on a practical spreading loss of $15_{\log}10$ (Range) (Urick 1983), the NOAA (2019) 120 dB re 1 µPa marine mammal behavioural response threshold for continuous sound sources may be exceeded over ranges of a few kilometres (refer to Section 6.3.3). Some marine fauna may avoid the immediate proximity of individual vessels throughout the JBG and wider region, but these brief responses to transient vessel noise are not expected to have widespread or long term impacts on populations.

Defence activities in the JBG may include extensive vessel and low-level aircraft movements. Occasional live firing that may involve detonations at or beneath the sea surface has the potential to produce sound levels significantly greater than those produced during seismic survey and potential for behavioural disturbances to marine fauna over many kilometres.

Therefore, in addition to vessel noise, other petroleum activities in the JBG have the most potential for additive noise impacts. The only known, planned petroleum activities in the JBG at the time of preparing this EP are the Eni Blacktip WHP operations and Santos' own activities.

The Eni operated Blacktip WHP is located approximately 21 km from the Operational Area. The Blacktip Offshore EP Summary (Eni Australia 2019) describes the potential for underwater noise from the WHP, inspection, maintenance and repair (IMR) activities, geophysical surveys, and from a mobile offshore drilling unit (MODU) associated with the potential drilling of a new development well in 2022. Santos regularly engages with Eni regarding its activities at Blacktip in order to coordinate activities in the JBG. Engagement with Eni during preparation of this EP did not identify that any specific drilling or survey activities would take place and routine WHP operations and associated vessels are expected to be the main sound sources. An indication of underwater noise levels from the Blacktip WHP is taken from McCauley (1998) where noise from a drilling rig when it was working but not drilling resulted in 117 dB re 1 µPa SPL at 125 m from the wellhead. The noise was audible up to 1–2 km away. McCauley (2002) also measured noise levels above a wellhead and pipeline and reported broadband noise levels of just 113 dB re 1 µPa SPL.

Other than the Eos 3D MSS, Santos is also proposing to conduct well plug and abandonment at the Tern-2 wellsite, close to the western side of the Eos 3D MSS Operational Area (in WA-27-R). The activity could be undertaken anytime under the five-year EP, valid until 2030 (subject to EP acceptance), however it is likely to be undertaken in 2026. The activity would be relatively brief (up to 40 days) and undertaken by a light well intervention vessel. No additive noise effects are expected.

INPEX is planning to undertake survey activities in G-7-AP between 2025 and 2027 over several multi-week campaigns and could consist of approximately 90–120 days of survey activities in total potentially over three calendar years.

Noise emissions from the survey are primarily generated by geophysical equipment such as Multi-Beam Echo-Sounder (MBES), Side Scan Sonar (SSS) and sub-bottom profilers. Operating at 137–240 dB re 1 µPa at 1 m. These high-frequency, low-energy geophysical survey instruments are significantly less intrusive than high-energy seismic survey instruments. The high frequency range pulses of sound (from 100 kHz to 700 kHz) are produced in a highly directional and in narrow beams, which rapidly attenuate outside of the beam. (INPEX, 2025). No additive noise effects are expected.

Other titleholders also have petroleum permits in the JBG, but Santos has not identified any other proposed activities by other titleholders that have submitted an EP to NOPSEMA or had an EP accepted by NOPSEMA.

Modelling of the 3,050 in^3 seismic source for the Eos 3D MSS (Appendix G) demonstrates that sound levels may exceed 160 dB re 1 µPa up between 9.74 and 11 km from the seismic source. In the event that seismic pulses occur in synchrony with the other described sound sources in the JBG, it is estimated that a 3 dB increase in SPL (doubling of sound levels) may occur, with the combined sound levels exceeding 160 dB re 1 µPa when the other activity is within approximately 11 km from the Eos 3D MSS seismic source. As the distance between sound sources increases, the two activities will increasingly become separate sources of disturbance.

It is, therefore, expected that Blacktip WHP operations (21 km from the Operational Area) and other potential future vessel, drilling or geophysical survey activities in the JBG will result in separate discrete areas where localised behavioural disturbances to discrete groups or individual marine fauna may occur. It is acknowledged that the same species of cetacean, turtle, fishes or sharks may be impacted by both activities and so a small additive impact is possible, however, these localised disturbances are not expected to result in widespread or long-term impacts on populations. The level of disturbance is not expected to displace cetaceans or marine turtles from any overlapping or adjacent BIAs.

6.4.4 Environmental performance outcomes and control measures

Environmental Performance Outcomes (EPOs) and Control Measures for managing the interaction with other marine users (including commercial fishers) and noise emissions are described in Sections 6.1.3, 6.2.3 and 6.3.4, and are not restated in this section.

An additional Environmental Performance Outcome (EPO) relating specifically to the management of cumulative and additive seismic survey impacts is:

EPO-17: Potential cumulative and additive impacts resulting from the Eos 3D MSS and other petroleum activities are identified and reduced as far as reasonably practicable.

The Control Measures considered for this Activity are shown below with Environmental Performance Standards and Measurement Criteria for the EPOs described in Section 8.6.1.

Table 6-22: Control measures evaluation for cumulative and additive seismic impacts

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard control measures				
Eliminate				
None identified.				
Substitute				
None identified.				
Engineering				
None identified.				
Isolation				
None identified.				
Administration				
None identified.				
Protective				
None identified.				
Additional control measures				
Eliminate				
None identified.				
Substitute				
None identified.				
Engineering				
None identified.				
Isolation				
CM-25	Seismic source separation distance during concurrent surveys: minimum 40 km while operating.	The Bureau of Ocean Energy Management (BOEM 2014) published an environmental review of geological and geophysical survey activities in the south Atlantic Ocean. To minimise impacts to marine life by providing a 'corridor' between vessels, the environmental impact statement from this review included a requirement for a 40 km geographic separation distance (based on worst case scenarios) between the sources of simultaneous seismic surveys.	In the event that another seismic survey occurs, a 40 km separation distance may result in delays due to vessel downtime or loss of survey area.	**Adopted** – Despite potential significant costs associated with vessel downtime, Santos will adopt this control to limit the potential additive impacts to all marine fauna receptors. A separation distances of 40 km is also consistent with some other seismic survey environment plans in Australia.

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Administration				
CM-26	Management of concurrent seismic surveys within commercial fisheries.	Commercial fishing operators may be frustrated by concurrent seismic survey vessels operating within their fishery. To this end, prior to commencing the Eos 3D MSS, Santos will consult with other seismic survey operators potentially operating in the same fishery and discuss practicable ways to minimise interference with commercial fishing vessels. It is through open communication channels with other seismic survey operators and awareness of seismic survey vessel plans and locations that Santos can take action to minimise interference with commercial fishing vessels potentially interacting with multiple seismic survey vessels within their fishery.	Consultation with other seismic operators and development of vessel communication and interaction protocols can be undertaken at minimal cost.	**Adopted** – Reducing interference with commercial fishing vessels, wherever practicable, is a priority for Santos.
N/A	Further reducing the months in which the survey can be acquired because of potential additive impacts to spawning periods of commercially significant prawns and fishes.	Santos intends to acquire the full survey anytime between EP acceptance and 31 December 2027. Reducing the number of months that the Eos 3D MSS can be acquired in any year may minimise potential additive impacts from multiple seismic surveys on spawning prawns and fishes. However, the impacts to the spawning and recruitment of prawn and fish species is predicted to be negligible.	Survey would not be able to occur due to combined spawning of commercially important fish species occurring year-round. Further reduction in the proposed operating window may mean multiple years of surveys at a cost to Santos.	**Not Adopted** – Survey cannot be timed to avoid all spawning periods due to the species present. Reducing the survey window by one or two months over one or two survey years is unlikely to have a detectable benefit to fish stock levels of commercial importance, particularly in consideration of naturally high levels of variability in spawning and recruitment.
CM-27	Identification and risk assessment of other concurrent petroleum activities within 20 km of the operating seismic source.	Simultaneous activities may result in sound levels greater than 160 dB re 1 µPa when the other activity is approximately 9–11 km from the Eos 3D MSS seismic source. As the distance between sound sources increases, the two activities will increasingly become separate sources of disturbance. 20 km is therefore considered to be conservative. At distances greater than 20 km, the activities will increasingly become separate sources of disturbance and additive effects from activities such as facility operations, drilling, VSP, geophysical surveys and vessel activities are expected to be negligible. Note no MSS are currently proposed to occur at the same time as the Eos 3D MSS.	Consultation with other titleholders, risk assessment and development of SIMOPS protocols to manage concurrent petroleum activities can be undertaken at relatively minimal cost.	**Adopted** – Reducing the risk of potentially significant additive noise impacts is considered to be practicable.
Protective				
None identified.				

6.4.5 Environmental impact assessment

Receptor	Consequence level
Cumulative and additive impacts	
Threatened / Migratory Fauna	**Plankton** Multiple cumulative seismic surveys will result in localised mortalities to plankton; however, losses will be negligible in the context of natural turnover rates and variability. The consequence level is assessed as ***Negligible.*** **Benthic invertebrates** Some sublethal effects and chronic mortality may occur to a small proportion of the benthic invertebrates in each survey area, however, benthic communities are expected to recover in the weeks and months following the surveys. The consequence level is assessed as ***Negligible.*** **Fish** No significant discernible cumulative impacts to fish are expected. Potential disturbances to spawning fishes are expected to be minor given the large genetic stock ranges of the commercially significant demersal and pelagic species, the high natural variability in spawning and recruitment success of these species and the temporal nature of seismic surveys. Based on the impact assessment, no long term or population impacts to individual fishes or fish stocks are predicted. The consequence level is assessed as ***Negligible***. **Sharks** No significant discernible long term or population cumulative impacts to whale sharks, sawfish or other shark species, are predicted thus the consequence level is assessed as ***Negligible***. **Marine turtles** No cumulative or additive impacts to marine turtles are expected. As a result, impacts are expected to be limited to those from the Eos survey with minor behavioural disturbance and potential recoverable TTS in some animals. The consequence level is assessed as ***Minor.*** **Cetaceans** No significant discernible long term or population cumulative impacts to the same species and populations are expected. The consequence level is assessed as ***Negligible.***
Physical Environment/ Habitat	Not applicable
Threatened ecological communities	Not applicable – no threatened ecological communities identified in the area over which the survey will be conducted are expected.
Protected Areas	No cumulative impacts are expected within any AMP. As such, the values of the AMP network will be protected, and the conservation objectives will be met. The consequence level is assessed as Negligible.
Socio-economic receptors	Potential impacts to fishers include potential repeat disruptions to their activities. However, based on the limited shared overlap between the seismic activity and commercial fisheries, the consequence level is assessed as ***Negligible***. Should a loss of catch be demonstrated as a result of the Eos 3D MSS then commensurate 'make good' payments will be made by Santos. Other socio-economic receptors are not expected to be significantly impacted.
Overall worst-case consequence	I – Negligible Based on the maximum consequence ranking by receptor, the overall consequence is Negligible.

6.4.6 ALARP evaluation

Santos has adopted a 40 km seismic source separation control to avoid increased behavioural responses from marine fauna located between the two seismic sources (vessels) in the event that the surveys are occurring at the same time.

No alternative options to the use of a seismic source are possible in order to undertake the Activity. Alternative options to the survey design have been assessed by Santos. In regard to survey design options, Santos has attempted to optimise the survey to minimise the Operational Area size and seismic survey duration.

A further reduction of the survey area or a limit to the area/number of days that may be acquired in any year was considered. To reduce the survey area would prevent acquisition over all geological targets of the required data. This will likely result in additional future surveys and defer potential impacts and risks to a future time (including future additional interference with commercial fishing licence holders). The survey has been optimised to acquire

data over specific geological trends, changing the survey direction or shape to potentially reduce impacts to commercial fishing effort will cause the survey to become less efficient and more time consuming, leading to greater cost and more noise emissions. A further reduction in survey area and duration would mean that the survey objectives would not be met.

There are currently no other seismic surveys that could potentially occur concurrently with the Eos 3D MSS. In the event that other surveys occur concurrently, Santos will consult with other seismic operators to identify ways of minimising interference with commercial fishers and will establish vessel interaction protocols. Santos will notify commercial fishers of the survey and provide ongoing communications regarding survey progress to minimise the disruption to their fishing effort during the survey.

No reasonably practicable additional controls were identified in the evaluation of control measures in Section 6.4.4 that would further increase the environmental benefit without a grossly disproportionate cost/sacrifice. Therefore, the proposed control measures are considered appropriate to manage the consequence of cumulative and additive acoustic impacts to ALARP.

6.4.7 Acceptability evaluation

Is the consequence ranked as I (Negligible) or II (Minor)?	Yes – Maximum consequence from cumulative and additive noise emissions is I (Negligible).
Is further information required in the consequence assessment?	The greatest uncertainty associated with the assessment of cumulative and additive impacts is the scheduling of future seismic surveys. Therefore, in the presence of this uncertainty, a precautionary impact assessment approach has been applied based on a maximum credible scenario. In accordance with Section 6.4.2, Santos will maintain up-to-date information on completed and proposed seismic surveys, and assess this information prior to conducting any stage of the Eos 3D MSS. As such, no further information is currently required.
Are the risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' Offshore Division Environmental Hazard Identification and Assessment Procedure which considers principles of ecologically sustainable development. Based on the impact assessments in Sections 6.4.2 and 6.4.3, cumulative impacts to ecological receptors and commercial fisheries are not expected to occur as a result of any previous seismic surveys in the region given the time that has elapsed since past surveys were completed will have allowed for the recovery from the impacts. Given there are no other planned seismic surveys in the broader region, that overlap spatially or temporarily, there is limited potential for impacts to the same receptors and, therefore, additive impacts are expected to be negligible. Based on the impact assessments, no significant or long term cumulative or additive impacts are predicted. Therefore, in the context of the principles of ESD: • There is no threat of serious or irreversible environmental damage • The health, diversity and productivity of the environment will be maintained • The biological diversity and ecological integrity of the marine environment will be conserved.
Are control measures and performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	There are no specific standards or requirements in Australia relating to the management of cumulative or additive impacts from multiple seismic surveys. Santos has therefore proposed management measures to limit the potential impacts.
	EPBC Policy Statement 1.1. – Significant Guidelines Yes – The overall worst-case consequence for cumulative and additive seismic impacts has been determined to be Minor and are not predicted to have a significant impact upon protected matters in accordance with EPBC Policy Statement 1.1. – Significant guidelines.
	Conservation Advice, Recovery Plans and Other Guidelines Yes – As described in Section 6.3, the activity will be undertaken in a manner consistent with the applicable objectives and actions of Conservation Advice, Recovery Plans or Guidelines in relation to seismic sound emissions. No specific Conservation Advice, Recovery Plans or Guidelines have been identified for managing cumulative impacts from seismic sound.
Are control measures and performance standards consistent with the Santos Environmental Management Policy?	Yes – Aligns with the Environmental Management Policy.
Are performance outcomes and standards consistent with stakeholder expectations?	Yes – Where concerns have been raised by stakeholders, Santos has attempted to understand these concerns and has included them in the assessment. As detailed in Section 4.6, commercial fisheries raised concerns about the impact of seismic surveys on commercial fish stocks. This included concerns regarding the impact of cumulative seismic surveys on commercial fish stocks. Santos has assessed the impact of the Activity on commercial fish stocks in isolation (Section 6.3) and in the context of past seismic surveys undertaken in the region (this section).

	Concerns were also raised by commercial fisheries regarding the impact of the Activity in the context of future seismic surveys in the region. The assessment of future seismic activities in the region must be undertaken by the proponents of these surveys.			
Are control measures and performance standards such that the impact or risk is considered to be ALARP?	Yes (see ALARP evaluation above).			
Defined Acceptable Levels				
Does the predicted impact meet defined acceptable levels of impact (refer to Section 5.7)?	**Receptor Category**	**Defined Acceptable Level**	**Comparison with Predicted Levels of Impact**	**EPO**
	EPBC Act-listed species (cetaceans; marine turtles; fish, sharks and rays)	Seismic activities are not inconsistent with the requirements of a recovery plan or wildlife conservation management plan/ advice that is in force for an EPBC Act-listed species. No injury to a cetacean and no displacement of foraging, aggregating, calving/breeding, or migrating cetaceans from identified BIAs. No injury to a turtle and no seismic surveys inside critical internesting habitat during the nesting season. No serious or irreversible impacts to listed marine fish due to noise associated with the operation of seismic source.	Santos considers the level of impact to EPBC Act-listed species to be of an acceptable level. Noise-related impacts are described in Section 6.3 and cumulative and additive seismic surveys will not significantly change the predicted level of impacts (Section 6.4). A precautionary 40 km separation distances between seismic surveys has been applied to address potential additive impacts. Given the separation distance between potential surveys, no additive impacts to the same BIAs or populations/stocks are expected.	EPO-6 EPO-7 EPO-8 EPO-10 EPO-11 EPO-12 EPO-17 EPO-22
	Non-EPBC Act-listed species and ecological communities	Given the widespread distribution of non-EPBC listed marine fauna species and ecological communities, and that non-EPBC listed species and communities are not formally managed, Santos considers it acceptable to have a Negligible (I) or Minor (II) consequence. As defined within *Santos' Offshore Division Environmental Hazard Identification and Assessment Procedure* (EA-91-IG-00004_5), a Minor consequence is defined as a 'Potentially detectable but insignificant change to a local population, industry or ecosystem factor. Localised effect, lasting weeks up to 12 months.	Santos considers the level of impact to non-EPBC Act-listed species and ecological communities to be of an acceptable level. The maximum consequence from cumulative and additive noise emissions have been assessed as Negligible (I).	EPO-7
	Commercial fisheries	No serious or irreversible impact to the sustainability of key indicator commercial stocks within the: • Commonwealth NPF • WA NDSMF • WA MMF. Commercial fishing license holders are no worse off as a result of the seismic survey.	Santos considers the level of impact to commercial fisheries and fishers to be of an acceptable level. Impacts to prawn and fish stocks in terms of spawning and recruitment are expected to be negligible and stocks within the Operational Area will have had >2 years to recover from historical seismic surveys over the same area.	EPO-3 EPO-13

			Significant percentages of commercially important key indicator prawn and fish stocks have not been exposed to, and are not expected to be exposed to seismic surveys on an annual basis.	
	Australian Marine Parks (AMPs)	Protect and maintain biological diversity and other natural, cultural and heritage values in accordance with the conservation objectives of the North-west Marine Parks Network Management Plan (2018) and North Marine Parks Network Management Plan (2018).	Santos considers the level of impact to AMPs to be of an acceptable level. The activity is consistent with AMP management prescriptions, IUCN conservation objectives and the ecological use of the AMPs.	EPO-16

6.5 Light emissions

6.5.1 Description of event

Light Emissions	
Aspect	During the Activity, safety and navigational lighting on the vessels will generate light emissions that may potentially affect marine fauna behaviour. The minimum level of lighting proposed is required for safety and navigational purposes on board vessels, therefore it cannot be eliminated if the proposed Activity is to proceed. The *Navigation Act 2012* requires vessels to be well lit for safe navigation. Vessels are required to show lights when operating at night to indicate their position and seismic survey vessels must indicate their limited ability to manoeuvre. Spot lighting may also be used on an as-needed basis e.g. streamer deployment and retrieval. Lighting will typically consist of bright white (i.e. metal halide, halogen, fluorescent) lights.
Extent	Direct light spill on surface waters will be limited to the area directly adjacent to the vessels and would not directly spill outside of the Operational Area.
Duration	Artificial lighting will be required on a 24-hour basis for the duration of the Activity as described in Section 2.

6.5.2 Nature and scale of environmental impacts

Potential adverse impacts on marine fauna from artificial lighting during seismic surveys are well understood and in WA there are guidelines for mitigating impacts from artificial lighting (WA EPA 2010). In addition, National Light Pollution Guidelines for Wildlife (NLPG) have also been published (DCCEEW 2023). According to the NLPG, a 20 km threshold provides a precautionary limit based on observed effects of sky glow on marine turtle hatchlings demonstrated to occur at 15-18 km and fledgling seabirds grounded in response to artificial light 15 km away. The effect of light glow may occur at distances greater than 20 km for some species and under certain environmental conditions (DCCEEW 2023).

Artificial light is considered to potentially have a significant impact in areas adjacent to sensitive habitats, such as turtle and seabird nesting sites. Given the transient nature of the survey, the predominantly open oceanic location of the Operational Area and the minimum distance to known turtle nesting beaches (127 km away at Cape Domett) and bird breeding colonies (73 km away at the Kimberley coast), marine fauna are unlikely to be impacted by artificial light.

Potential receptors include fish, sharks and rays, marine turtles, seabirds and migratory shorebirds.

There is no evidence to suggest that artificial light spill adversely affects the migratory, feeding or breeding behaviours of cetaceans. Cetaceans predominantly use acoustic senses to monitor their environment rather than visual cues (Simmonds et al. 2004), therefore, impacts are considered to be unlikely.

Continuous lighting may result in localised alterations to normal marine fauna behaviours, as discussed below for each fauna group. Potential impacts are more likely in instances when the light source is stationary, which is not the case during an MSS activity when the vessels are constantly moving. The combination of colour, intensity, closeness, direction and persistence of a light source are key factors in determining the magnitude of environmental impact (EPA 2010; DCCEEW 2023).

6.5.2.1 Fish, sharks and rays

The response of fish to light emissions varies according to species and habitat. Experiments using light traps have found that some fish and zooplankton species are attracted to light sources (Meekan et al. 2001), with traps drawing catches from up to 90 m away (Milicich et al. 1992). Lindquist et al. (2005) concluded from a study that artificial lighting associated with offshore oil and gas activities resulted in an increased abundance of clupeids (herring and sardines) and engraulids (anchovies) around lighted structures; these species are known to be highly photopositive. Attraction of fish to light may result in an increase in predation from larger fish and sharks on prey species, or exclusion of nocturnal foragers/predators aggregating in the immediate vicinity of the vessels at night (Marchesan et al. 2006).

Overall, a short-term localised increase in fish activity as a result of vessel lighting is expected to occur, however, it will be limited to night-time operations and with negligible impacts. Sound emissions from the seismic survey vessel and support vessels and from the seismic source, are also expected to act as a localised and temporary deterrent to fish (refer to Section 6.3).

6.5.2.2 Marine turtles

Artificial light can disrupt marine turtles wherever it is stronger than natural light sources (DoEE 2017). For a vessel at sea, light is most likely to affect marine turtles at breeding sites through direct light shining on nesting beaches or nearshore dispersal areas (DoEE 2017). The Recovery Plan for Marine Turtles in Australia: 2017-2027 (DoEE 2017) highlights artificial light as one of several threats to marine turtles. Specifically, the plan indicates that artificial light may reduce the overall reproductive output of a stock, and therefore recovery of the species, by:

- Inhibiting nesting by females
- Creating pools of light that attract swimming hatchlings and increase their risk of predation
- Disrupting hatchling orientation and sea finding behaviour. Once in the ocean, hatchlings are thought to remain close to the surface, orient by wave fronts and swim into deep offshore waters for several days to escape the more predator-filled shallow inshore waters. During this period, light spill from coastal port infrastructure and ships may 'entrap' hatchling swimming behaviour, reducing the success of their seaward dispersion and potentially increasing their exposure to predation via silhouetting (Salmon et al. 1992).

Action Area 8 of the Recovery Plan for Marine Turtles (DoEE 2017) states that 'artificial light within or adjacent to habitat critical to the survival of marine turtles will be managed such that marine turtles are not displaced from these habitats'. Additionally, Action Area 1 states that anthropogenic activities should be managed to ensure marine turtles are not displaced from identified habitat critical to the survival', and 'manage anthropogenic activities in Biologically Important Areas to ensure that biologically important behaviour can continue'.

The Operational Area is located 39 km from the nearest habitat critical for the survival of marine turtles at Cape Domett (Figure 3-10), however internesting turtle distribution is likely closer to shore, and the Operational Area is approximately 127 km north-east of the flatback turtle nesting beach at Cape Domett.

The internesting BIA for the flatback turtle at Cape Domett is located adjacent (south) of the Operational Area, but not overlapping. No seismic acquisition will occur within the internesting BIA; however, vessels may occasionally transit the edge of the BIA, with very brief exposure to light during this time. The internesting buffer for flatback turtle BIAs is 80 km in radius and is considered very conservative.

The Operational Area overlaps with foraging BIAs for flatback, loggerhead, olive ridley and green turtles. Adult turtles that may be present within the Operational Area may be attracted to the seismic survey vessel and support vessel lighting. However, attraction of turtles to the vessels would be localised, short-term and affect a small proportion of the population due to the transient nature of vessels during the survey and the limited disturbance of visible light from the vessels and/or seismic equipment. In addition, during acquisition, sound emissions from the seismic survey and support vessels and from the seismic sound, are expected to act as a localised and temporary deterrent to approaching adult turtles.

The potential impacts of light emissions to turtles from the activities are considered to be minimal with no long term or residual impact due to the continual movement of the vessels and distance from known turtle nesting beaches. It is considered that the Activity will not compromise the objectives set out in the Recovery Plan for Marine Turtles (DoEE 2017) and the impact of lighting associated with the Activity to turtles is negligible.

6.5.2.3 Seabirds and migratory shorebirds

Studies conducted between 1992 and 2002 in the North Sea confirmed that artificial light was the reason that birds were attracted to and accumulated around illuminated offshore infrastructure when travelling within a radius of 3-5 km from the light source (Marquenie et al. 2008). The light sources associated with the vessels may also provide enhanced capability for seabirds to forage at night. The Operational Area is located approximately 75 km away from recognised important roosting sites for migratory birds (i.e. the Keep, Victoria and Fitzmaurice rivers at the head of the JPG).

Light emission effects to birds within the Operational Area (including those migrating) are expected to be localised and temporary based on the transient nature of the survey, limited duration of the survey (up to 50 days) and the limited distance of visible light from the seismic vessel. The minor radius of potential disorientation/attraction compared to the wide extent of known migratory routes further reduces the risk of impacts from light emissions on migratory birds present during the survey.

6.5.3 Environmental performance outcomes and control measures

Environmental Performance Outcomes relating to this hazard include:

EPO-18: Reduce impacts to marine fauna from lighting on project vessels through limiting light to that required by safety and navigational lighting requirements.

The Control Measures considered for this Activity are shown below with Environmental Performance Standards and Measurement Criteria for the EPOs described in Section 8.6.1.

Table 6-23: Control measures evaluation for light emissions

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard control measures				
Eliminate				
None identified.				
Substitute				
None identified.				
Engineering				
None identified.				
Isolation				
CM-28	Lighting will be used as required for safe work conditions and navigational purposes.	Light spill from unnecessary lighting reduced, even further lowering the likelihood of impacts to fauna from project vessel lighting. Lighting is assessed to only provide necessary lighting for safety and navigation during the activity. Reducing the potential for additional light pollution to the environment, thus reducing the potential impacts to marine fauna. HSE induction includes information for vessel crew to minimise light emissions during night hours, where possible.	Limited additional cost associated with compliance assurance only.	**Adopted** – Cost is considered acceptable for the benefit that may be realised from the control.
Administration				
Protective				
None identified.				
Additional control measures				
Eliminate				
N/A	Limit or exclude night-time operations.	Would eliminate potential impacts of artificial light during hours of darkness when light sources are more apparent and potential impacts are greatest.	This control would double duration of Activity; increase impacts or potential impacts in other areas including increase in waste, air emissions, risk to navigation and increase potential for vessel collision.	**Not Adopted** – Given the minimal risk of impacts to turtles and seabirds/migratory shorebirds occurring, the costs of extending Activity duration outweigh the benefits.
Substitute				
None identified.				

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Engineering				
N/A	Review lighting and change to a type (colour) that has less impact.	Could reduce potential impacts of artificial light on certain fauna.	High cost to complete lighting change-out on vessels in area of low sensitivity. Lighting type may not be suitable for safe work conditions and navigational purposes.	**Not Adopted** – Cost outweighs the benefit.
N/A	Review lighting in line with NLPG best practice lighting design (e.g. block out blinds)	Could reduce potential impacts of artificial light on certain fauna.	Additional cost to implement block out blinds on vessels in area of low sensitivity.	**Not Adopted** – Cost outweighs the benefit.
Isolation				
N/A	Schedule to avoid sensitive windows at location.	The Operational Area is located outside of important marine turtle internesting habitats and the schedule avoids the peak nesting season. However, turtle nesting and foraging, and the presence of seabirds in the JBG occur year-round and therefore, scheduling achieves limited benefit.	Activity schedule is dictated by vessel availability. There are high costs associated with amending the schedule and potential to increase other more significant impacts to other receptors.	**Not Adopted** – Cost outweighs the benefit.
Administration				
None identified.				
Protective				
None identified.				

6.5.4 Environmental impact assessment

Receptor	Consequence level
Light emissions	
Threatened / Migratory Fauna	Continuous lighting in the same location for an extended period of time may result in alterations to normal marine fauna behaviour. Sensitive receptors that may be impacted include fish at the surface, marine turtles and mammals, and seabirds and migratory shorebirds. Given that the Activity will involve vessels that are continually moving, for a limited time, and the Operational Area is located 39 km offshore from the flatback turtle habitat critical at Cape Domett and 127 km from the nearest nesting beach (Cape Domett) lighting is unlikely to be at a level that could impact nesting turtles or hatchlings (Commonwealth of Australia 2020). Marine mammals are not known to be significantly attracted to light sources at sea and therefore disturbances to behaviour are unlikely to occur. Fish and birds have been shown to be attracted to artificial light sources; however, the low level of light emitted from vessels is unlikely to lead to large scale changes in species abundance or distribution (Commonwealth of Australia 2020). Impacts to transient fish and seabirds and migratory shorebirds will therefore be limited to short-term behavioural effects with no decrease in local population size, area of occupancy of species or loss or disruption of critical habitats and/or disruption to the breeding cycle.
Physical Environment/ Habitat	Not applicable – no physical environments and/or habitats are identified in the area where light emissions could occur other than open water, which will not be impacted.
Threatened ecological communities	Not applicable – no threatened ecological communities are identified in the area where light emissions could occur.
Protected Areas	Not applicable – no protected areas are identified in the area where light emissions could occur.
Socio-economic receptors	Not applicable – lighting is not expected to cause an impact to socio-economic receptors other than as a visual cue for avoidance of the area.
Overall worst-case consequence	I – Negligible Given the considerable distance offshore from turtle and seabird nesting sites and associated nearshore waters, disruption to nesting activities is not be expected. There is a low probability that individual turtles and seabirds will be attracted by the moving light source at sea for a short period.

6.5.5 ALARP evaluation

With the described controls, the consequence of artificial light on marine fauna, including seabirds, is considered to be negligible with insignificant impacts to ecological function. No population level impacts are expected, and the consequence is considered environmentally acceptable.

Artificial lighting is required on a 24-hour basis for navigational safety in the area and additional light is required to allow the Activity to proceed safely on a 24- hour basis for occupational health and safety reasons. Santos has considered the actions prescribed in the Recovery Plan for Marine Turtles in Australia (DoEE 2017) to minimise lighting impacts on marine turtles, especially flatback turtles. The impacts of lighting to the receiving environment are well understood and the consequence is expected to be low.

The Operational Area is 127 km from the nearest turtle nesting beach (Cape Domett), which is considerably further than the EPA's estimated light influence distance of approximately 1.5 km (EPA 2010). In addition, the distance of the Operational Area from the closest nesting beach is also much greater than the draft NLPG (Commonwealth of Australia 2020) precautionary threshold of 20 km. Therefore, impacts are not expected on fauna including turtles at nesting beaches (inter/nesting adults or emerging hatchlings), with impacts limited to short-term behavioural effects observed in transient fish and seabirds.

The activity will not compromise the objectives as set out in the Recovery Plan for Marine Turtles in Australia (DoEE 2017) or the NLPG (Commonwealth of Australia 2020). The assessed residual consequence for this impact is negligible and cannot be reduced further. Additional control measures were considered but rejected since the associated cost or effort was grossly disproportionate to any benefit, as detailed in Section 6.5.3.

No reasonably practicable additional controls were identified in the evaluation of control measures in Section 6.5.3 that would further increase the environmental benefit without a grossly disproportionate cost/sacrifice. Therefore, the use of 24-hour per day artificial lighting at an intensity to allow work to proceed safely is considered ALARP.

6.5.6 Acceptability evaluation

Is the consequence ranked as I (Negligible) or II (Minor)?	Yes – maximum consequence from artificial light is I (Negligible).
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are the risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' Offshore Division Environmental Hazard Identification and Assessment Procedure, which considers principles of ecologically sustainable development. Based on the impact assessment in Section 6.5.2, light emissions are expected to result in short-term and localised effects to fish, turtles, seabirds and migratory shorebirds. No significant short term or long-term impacts to populations are predicted. Therefore, in the context of the principles of ESD: • There is no threat of serious or irreversible environmental damage • The health, diversity and productivity of the environment will be maintained • The biological diversity and ecological integrity of the marine environment will be conserved.
Are performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – Management consistent with *Navigation Act 2012,* Recovery Plan for Marine Turtles in Australia (DoEE 2017) and NLPG (Commonwealth of Australia 2020).
	EPBC Policy Statement 1.1. – Significant Guidelines Yes – The overall worst-case consequence for light emissions has been determined to be Negligible and will not have a significant impact upon protected matters in accordance with EPBC Policy Statement 1.1. – Significant guidelines.
	NLPG (including marine turtles, seabirds and migratory shorebirds) and Recovery Plan for Marine Turtles in Australia Yes – The aim of the NLPG is to manage artificial light so that wildlife is not disrupted, nor displaced from important habitat and is able to undertake critical behaviours such as foraging, reproduction and dispersal. The Recovery Plan for Marine Turtles in Australia (DOEE 2017) also identifies lighting as a threat to marine turtles. Action area A8 of the Recovery Plan for Marine Turtles in Australia details the following action in order to protect turtles from effects of light pollution: *Artificial light within or adjacent to habitat critical to the survival of marine turtles will be managed such that marine turtles are not displaced from these habitats*. In addition, the intent of Action area A1 of the Recovery Plan for Marine Turtles in Australia is to ensure that activities undertaken in or adjacent to designated habitat critical to the survival of the species or biologically important areas (BIAs) do not change important behaviours such that the recovery of the stock is compromised. The transient nature of the light source on board the survey vessels will affect only a small number of individuals in the immediate area of the vessel. Any behavioural effects will be localised, short term and incidental in the context of their normal movements. Turtles will not be displaced from the habitat critical to the survival of marine turtles, which is located 39 km from the Operational Area. The localised and short-term effects of vessel lighting on discrete individuals or small groups of turtles at times when the vessel is operating within turtle foraging BIAs or adjacent to the turtle internesting BIA, will not have a significant impact on these behaviours. Biologically important behaviours will continue in the BIAs and the recovery of the turtle stock will not be compromised. The potential consequences of an anthropogenic light source in the Operational Area are likely to be insignificant in nature and restricted to turtle, fish and bird species. The scale of the anticipated impacts is not expected to be significant, with a small number of individual turtles, fish and birds that may potentially be affected in the immediate area of moving marine vessels; the nature of the impact will generally be restricted to localised behavioural effects in the offshore waters of the Operational Area. The Operational Area is located approximately 127 km from the nearest nesting beaches (Cape Domett) and impacts to nesting marine turtles from artificial lighting are not expected. Given the temporary

	nature of the Activity, as well as the anticipated negligible consequences of lighting from the Activity, the Activity is considered to be conducted in a manner that is consistent with the National Light Pollution Guidelines and the Recovery Plan for Marine Turtles in Australia, and the impacts of lighting to the receiving environment are considered acceptable.		
Are performance standards consistent with the Environmental Management Policy?	Yes – Aligns with the Environmental Management Policy.		
Are performance outcomes and standards consistent with stakeholder expectations?	Yes – No concerns raised.		
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – Based on available information and the proposed control measures, Santos considers artificial light impacts to marine fauna to be at an acceptable level.		
Defined Acceptable Levels			
Does the predicted impact meet the defined acceptable level of impact (refer to Section 5.7)?	**Defined Acceptable Level of Impact**	**Comparison with Predicted Levels of Impact**	**EPO**
	Light emissions are not inconsistent with recovery plans or wildlife conservation plans/ advice that are in force for protected EPBC Act listed threatened and migratory species. Santos considers it acceptable to have a Negligible (I) or Minor (II) consequence to a marine fauna population or ecological community. As defined within *Santos' Offshore Division Environmental Hazard Identification and Assessment Procedure* (EA-91-IG-00004_5), a Minor consequence is defined as a 'Potentially detectable but insignificant change to a local population, industry or ecosystem factor. Localised effect, lasting weeks up to 12 months.	Santos considers the level of impact from light emissions to be of an acceptable level. Given the temporary nature of the activity and because the survey vessels will be moving, lighting impacts will be Negligible. Wildlife Potentially vulnerable to artificial light (e.g. turtles and seabirds) will not be disrupted, nor displaced from important habitat and will be able to undertake critical behaviours such as foraging, reproduction and dispersal. The Activity will not compromise the objectives set out in applicable recovery plans or wildlife conservation plans/advice that are in force for threatened and migratory species.	EPO-18

6.6 Planned operational discharges

6.6.1 Description of event

Planned Operational Discharges	
Aspect	During the seismic survey, the vessels will routinely discharge non-toxic substances to the marine environment as described below. The vessels will not be stationary during the Activity, so the discharge location will be constantly changing. *Sewage/greywater* The volume of sewage is directly proportional to the number of persons on-board the vessels. Approximately 170 L of sewage/greywater will be generated per person per day from domestic processes such as ablution, laundry and galley activities. Treated sewage will be disposed in accordance with MARPOL Annex IV and AMSA Marine Order 96. *Food waste* Putrescible waste will consist of approximately 1 L of food waste per person per day. Food waste will be disposed of in accordance with MARPOL Annex V. *Brine* Brine generated from the water supply systems on-board the vessels will be discharged to the ocean at a salinity of approximately 10% higher than seawater. The volume of the discharge is dependent on the requirement for fresh (or potable) water and would vary between vessels and the number of people on-board. *Cooling water* Seawater is used as a heat exchange medium for the cooling of machinery engines. Seawater is drawn from the ocean and flows counter-current through closed-circuit heat exchangers, transferring heat from the vessel engines and machinery to the seawater. The seawater is then discharged to the ocean (i.e. it is a once-through system). Cooling water temperatures vary depending upon the vessel's engine workload and activity. *Deck drainage* Deck drainage from sea spray, rainfall or wash-down operations would discharge to the marine environment. The deck drainage would contain particulate matter and residual chemicals such as cleaning chemicals, oil and grease. Assessment of an unplanned spillage of other environmentally hazardous chemicals and liquid waste are discussed in Section 7.4. *Oily water* While in the Operational Area, the vessels may discharge oily water after treatment to <15 ppm oil-in-water content in a MARPOL approved oily water filter system separator.
Extent	The small volumes discharged may cause localised nutrient enrichment, organic and particulate loading, toxic impacts to marine fauna, thermal impacts and increased salinity.
Duration	During the Activity, localised impacts to water quality will occur; however, water quality conditions will return to normal within minutes to hours of cessation of discharges.

6.6.2 Nature and scale of environmental impacts

The potential environmental impacts from routine operational discharges include:

Temporary localised decline in water quality in the immediate vicinity of the discharge

Localised increase in biological oxygen demand (BOD)

Localised increase in turbidity of surrounding waters

Temporary toxicity to marine flora and fauna (bilge water discharges)

Temporary and localised increase in sea surface water temperature

Temporary and localised increase in sea surface salinity.

The waters within and adjacent to the Operational Area are generally oligotrophic (i.e. low nutrient levels) except where localised and sporadic and short-lived upwellings occur in the region (e.g. at the shelf break, where deeper, cooler nutrient rich water is brought to the surface).

Potential receptors include water quality, fish (pelagic) and sharks, marine mammals, marine turtles and seabirds.

Planned discharges associated with the Activity will be small and intermittent, with volumes dependent on a range of variables. The discharge point will be 'moving', as the vessels are not stationary. The discharge of non-hazardous wastes to the marine environment may result in a localised reduction in water quality in the vicinity of the release location. This would be expected to be temporary (minutes to hours) and localised. The discharges are expected to be dispersed and diluted rapidly, with concentrations of discharges significantly dropping within a short

distance from the discharge point. Changes to ambient water quality outside of the Operational Area is considered unlikely to occur.

6.6.2.1 Eutrophication

The discharges of treated sewage and grey water will occur when vessels are transient, resulting in the discharges dispersing rapidly in the predominantly open oceanic location of the Operational Area. Discharges may result in localised increases in nutrient concentrations, exert BOD on the receiving waters and may promote localised elevated levels of phytoplankton and bacteria activity due to nutrient inputs. However, dispersion and dilution of discharges is expected to be rapid as the discharges are of low volume and short duration, and the Operational Area is located in water depths of between 60 and 115 m dominated by open ocean currents, resulting in highly localised and short-term changes to the surface water quality within the Operational Area.

6.6.2.2 Salinity increases

The desalination of seawater results in a discharge of brine with a slightly elevated salinity (around 10% higher than seawater). Once discharged to the marine environment, the desalination brine, being of greater density than seawater, will sink and disperse in the currents. On average, seawater has a salt concentration of 35 ppt. The volume of the discharge is dependent on the requirement for fresh (or potable) water and the number of people on board the vessel.

Most marine species are able to tolerate short-term fluctuations in salinity in the order of 20–30% (Walker and McComb 1990), and it is expected that most pelagic species would be able to tolerate short-term exposure to the slight increase in salinity caused by the discharged brine.

Given the relatively low volume of discharge, low salinity increases and, open water surrounding the vessels, impact on the water quality in the Operational Area is expected to be negligible, temporary and localised.

6.6.2.3 Changes in temperature

Cooling water will be discharged at a temperature above ambient seawater temperature. Upon discharge, it will be subjected to turbulent mixing and transfer of heat to the surrounding waters.

Temperature dispersion modelling shows that the water temperature of discharged water will decrease rapidly as it mixes with the receiving waters, with discharge waters being less than 1 C above background levels within less than 100 m (horizontally) of the discharge point. Vertically, the discharge will be within background levels within 10 m (Woodside 2008).

Given the relatively short duration of the Activity (60 days), low volume of cooling water, temperature differential, the deep open water surrounding the vessels, impact on water quality is expected to be low and short-term and within the immediate vicinity of the discharge.

6.6.2.4 Oily water

Oily water discharged from vessels will be treated to a concentration (<15 ppm of oil-in-water content) that is unlikely to lead to any impacts to the receiving environment. The low concentrations of any oil and grease residues in deck drainage and bilge water discharged to the marine environment, will rapidly dilute and disperse, therefore the potential for toxicity from hydrocarbon residues is considered low.

6.6.3 Environmental performance outcomes and control measures

Environmental Performance Outcomes relating to this hazard include:

EPO-19: Discharges to sea meet legislated permissible discharge requirements

EPO-20: No unplanned objects, emissions or discharges to sea or air.

The Control Measures considered for this Activity are shown in Table 6-24, with Environmental Performance Standards and Measurement Criteria for the EPOs described in Section 8.6.1.

Table 6-24: Control measures evaluation for planned operational discharges

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard control measures				
Eliminate				
None identified.				
Substitute				
None identified.				
Engineering				
CM-29	Sewage treatment system.	Reduces potential impacts of inappropriate discharge of sewage. Ensure compliance with Marine Order 96 and MARPOL requirements as appropriate for vessel class.	Personnel cost in ensuring vessel certificates are in place during vessel contracting and in pre-mobilisation audits and inspections, and in reporting discharge levels.	**Adopted –** benefits of ensuring vessel is compliant outweigh the minimal costs.
CM-30	Oily water treatment system.	Reduces potential impacts of planned discharge of oily water to the environment. Ensure compliance with Marine Order 91 and MARPOL requirements as appropriate for vessel class.	Additional time and personnel costs in maintaining oil record book.	**Adopted –** benefits of ensuring vessel is compliant outweigh the minimal costs.
Isolation				
None identified.				
Administration				
CM-31	General chemical management procedures.	Potential impacts to the environment are reduced through following correct procedures for the safe handling and storage of chemicals.	Personnel costs associated with ensuring procedures are in place and implemented during inspections.	**Adopted –** benefits of ensuring procedures are followed and measures implemented outweigh the costs.
CM-32	Hazardous chemical management procedures.	Reduces the risk of spills and leaks (discharges) of hazardous chemicals to the sea by controlling the storage, handling and clean up.	Cost associated with permanent or temporary storage areas.	**Adopted –** benefits of ensuring procedures are followed and measures implemented outweigh the costs.
CM-33	Waste (garbage) management procedure.	Reduces probability of garbage being discharged to sea, reducing potential impacts to marine fauna. Stipulates putrescible waste disposal conditions and limitations. Ensure compliance with Marine Order 95 and MARPOL requirements as appropriate for vessel class.	Personnel cost of pre-mobilisation audits and inspections, and in reporting discharge levels.	**Adopted –** benefits of ensuring vessel is compliant outweigh the minimal costs.
CM-34	Deck cleaning product selection procedure.	Improves water quality discharge (reduces toxicity) to the marine environment.	Personnel costs of implementing procedure. Potential additional	**Adopted –** Benefits of ensuring discharges have negligible impact outweigh costs.

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
		Only environmentally acceptable chemicals would be released overboard.	cost and delays of deck cleaning product substitution.	
Protective				
CM-35	Clean up of oil/ lubricant spills to deck in accordance with vessel Shipboard Oil Pollution Emergency Plan (SOPEP).	Improves water quality discharge (reduces toxicity) to the marine environment.	Personnel costs of implementing procedure.	**Adopted –** Benefits of ensuring discharges have negligible impact outweigh costs.
Additional control measures				
Eliminate				
N/A	Scupper plugs continuously in place to prevent deck drainage.	Would eliminate potential impacts of contaminants being discharged to sea in rainwater.	Increased health and safety risks from wet deck not draining. Large amounts of water on a seismic or support vessel deck can also cause stability issues (free-surface effect).	**Not Adopted** – safety considerations outweigh the benefit given small volumes of contaminants.
N/A	Mandatory closed drain system to prevent deck drainage discharged overboard.	Would eliminate any discharge to sea, reducing potential impacts to the marine environment.	Increased cost due to treatment system required, modifications to vessels, storage space required for containment of drained liquids, increase in transfers to vessels resulting in increased potential impacts and risks. Increased transfers result in increased fuel usage and exhaust emissions, increased safety risks to personnel during transfer (e.g. crushing between skips), increase in crane movements.	**Not Adopted** – Cost outweighs the benefit given the low impact expected from planned discharges and high potential impacts from risk transfer.
Substitute				
None identified.				
Engineering				
N/A	Re-design desalination plant discharge system.	Limited benefit to be gained given low environmental impact from brine discharge.	High costs associated with modifications to vessels and may not be feasible on the vessels.	**Not Adopted** – Cost outweighs the benefit given the low impact expected from planned discharges.
Isolation				
None identified.				

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Administration				
None identified.				
Protective				
N/A	Storage of all wastes on-board (e.g. oily water and sewage) for disposal onshore.	Would eliminate any discharge to sea, reducing potential impacts to the marine environment.	Storage space required for containment of waste. Requirement for transfers to vessels resulting in increased potential impacts and risks. Increased transfers may result in increased fuel usage and exhaust emissions, increased safety risks to personnel during transfer (e.g. crushing between skips), increase in crane movements.	**Not Adopted** – Cost outweighs the benefit given the low impact expected from planned discharges and high potential impacts from risk transfer.
N/A	Discharge cooling water above sea level to allow it to cool further before mixing at sea surface.	Reduce potential impacts associated with discharge of higher temperature water into the marine environment.	High costs to alter vessels to allow for discharge of cooling water at different height, not feasible. Reduction in temperature would be minimal compared to cost of altering the discharge height.	**Not Adopted** – Cost outweighs the benefit given the low impact expected from planned discharges
N/A	Storage of cooling water on-board, prior to discharge onshore	Reduce potential impacts associated with discharge of higher temperature water into the marine environment.	Storage space required for containment of cooling water.	**Not Adopted** – Cost outweighs the benefit given the low impact expected from planned discharges.
N/A	Restrict use of desalination plant.	Limited benefit to be gained given low environmental impact from brine discharge.	Health risks associated with limited potable water as well as high costs associated with modifications to vessels and may not be feasible.	**Not Adopted** – Health risks and cost outweighs the benefit given the low impact expected from planned discharges.
N/A	Storage of brine on-board prior to discharge onshore.	Would eliminate any discharge to sea, reducing potential impacts to the marine environment.	High costs associated with modifications to vessels and may not be feasible.	**Not Adopted** – Cost outweighs the benefit given the low impact expected from planned discharges.

6.6.4 Environmental impact assessment

Receptor	Consequence level
Operational discharges	
Threatened / Migratory Fauna	Operational discharges may result in localised water quality perturbations and alteration to marine fauna behaviour, however, given that vessels will be continually moving within the Operational Area, any effect will be temporary in nature. Sensitive receptors that may be impacted include pelagic fish and sharks at the sea surface, marine turtles, and marine mammals, and seabirds. Given that the Activity will be for a limited duration (50 days) from a moving discharge point, in deep waters (60 m – 115 m), impacts will be limited to short-term water quality impacts and temporary behavioural effects observed in fish and seabirds. Impacts to water quality will be experienced in the discharge mixing zone, which will be localised and will occur only as long as the discharges occur (i.e. no sustained impacts), therefore, recovery will be measured in hours to days. Only short-term behavioural impacts are expected with no decrease in local population size / area of occupancy of species / loss or disruption of habitat critical / disruption to the breeding cycle / introduction of disease. Planned operational discharges are therefore not expected to significantly impact marine fauna within the receiving environment nor compromise the objectives of Recovery Plans for threatened and migratory marine fauna.
Physical Environment/ Habitat	
Socio-economic receptors	Not applicable – operational discharges are not expected to impact on socio-economic receptors.
Threatened ecological communities	Not applicable – no physical environments and/or habitats identified in the area where operational discharges are expected to disperse other than open water, which will not be impacted.
Protected Areas	Not applicable – no protected areas are identified in the area where operational discharges could occur.
Overall worst-case consequence	I – Negligible Given the distance offshore, the small volumes discharged, the moving discharge point and the well-mixed waters of the Operational Area.

6.6.5 ALARP evaluation

Vessels are required to undertake the seismic survey. On-board treatment of most wastes and subsequent discharge to the marine environment, are the most environmentally sound method of disposal.

Considering that the discharge streams will either be treated to a level unlikely to cause significant environmental harm or will be of a nature not considered to pose significant risk to the receiving environment; the assessed residual consequence for this impact is negligible and cannot be reduced further. Vessels will operate in accordance with relevant regulations and legislation as detailed in Section 6.6.3. No reasonably practicable additional controls were identified in the evaluation of control measures in Section 6.6.3 that would further increase the environmental benefit without a grossly disproportionate cost / sacrifice. The proposed control measures are considered appropriate to manage the risk to ALARP.

6.6.6 Acceptability evaluation

Is the consequence ranked as I (Negligible) or II (Minor)?	Yes – maximum planned operational discharge consequence is rated I (Negligible).
Is further information required in the consequence assessment?	No – potential impacts and risks well understood through the information available.
Are the risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' Offshore Division Environmental Hazard Identification and Assessment Procedure which considers principles of ecologically sustainable development. Based on the impact assessment in Section 6.6.4, planned operational discharges are predicted to result in temporary and insignificant localised water quality perturbations. Reduced water quality is not expected to be a threat to marine species or the integrity of ecological communities. No significant short term or long-term impacts are predicted. Therefore, in the context of the principles of ESD: • There is no threat of serious or irreversible environmental damage • The health, diversity and productivity of the environment will be maintained • The biological diversity and ecological integrity of the marine environment will be conserved.
Are performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – Management consistent with *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*, MARPOL Annex I, Annex IV and Annex V, and/or Marine Orders 94, 95 and 96 as appropriate; and relevant recovery plans and conservation advice. The potential impacts of routine discharges from vessels to the marine environment are well understood and there are legislative requirements in place to manage risks. The application of legislative requirements is considered appropriate to manage the impact; particularly due to the well-mixed offshore marine waters (60–115 m) of the Operational Area. Small volumes of wastewaters discharged into open ocean conditions will be rapidly diluted and dispersed. Release of non-hazardous discharges into the sea from vessels in Australian waters is permissible under the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*, which reflects MARPOL Annex I, IV and V and Marine Orders 91, 95 and 96. The operational discharges are not expected to significantly impact the receiving environment with control measures proposed and compliance with legislative requirements. The MARPOL standard is considered to be the most appropriate standard given the nature and scale of the Activity. These standards are internationally accepted and used industry-wide, therefore compliance with the relevant and appropriate MARPOL requirements and standards is expected to reduce the potential for environmental impacts to a level which is considered environmentally acceptable. Deteriorating water quality is identified as a potential threat to turtles, some birds and shark species according to their relevant recovery plan or approved conservation advice (Table 3-12). However, the operational discharges are not expected to significantly impact the receiving environment, resulting in short term and localised water quality deterioration only. The Activity will be conducted in a manner that is considered acceptable and consistent with identified Recovery Plans and conservation advice.
Are performance standards consistent with the Environmental Management Policy?	Yes – Aligns with the Environmental Management Policy.
Are performance outcomes and standards consistent with stakeholder expectations?	Yes – No concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes (see ALARP evaluation above).

Defined Acceptable Levels			
Does the predicted impact meet the defined acceptable level of impact (refer to Section 5.7)?	**Defined Acceptable Level of Impact**	**Comparison with Predicted Levels of Impact**	**EPO**
	Operational discharges to sea meet legislated permissible discharge requirements. Operational discharges are not inconsistent with recovery plans or wildlife conservation plans/advice that are in force for protected EPBC Act listed threatened and migratory species. Santos considers it acceptable to have Negligible (I) or Minor (II) consequence to a marine fauna population or ecological community. As defined within *Santos' Offshore Division Environmental Hazard Identification and Assessment Procedure* (EA-91-IG-00004_5), a Minor consequence is defined as a 'Potentially detectable but insignificant change to a local population, industry or ecosystem factor. Localised effect, lasting weeks up to 12 months.	Santos considers the level of impact from operational discharges to be of an acceptable level. Potential impacts of typical marine vessel operational discharges to the sea are expected to be limited to temporary and insignificant localised water quality perturbations. Reduced water quality is not expected to be a threat to marine turtles, birds or shark species and will not be inconsistent with relevant recovery plans or approved conservation advice. Santos considers the application of internationally recognised legislative as appropriate to manage operational discharges and the receiving marine environment.	EPO-19 EPO-20

6.7 Atmospheric emissions

6.7.1 Description of event

Atmospheric emissions	
Aspect	The use of fuel (specifically MDO) to power vessel engines, generators, mobile and fixed plant and equipment, and helicopters will result in emissions of greenhouse gases (GHG) such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), along with non-GHG such as sulphur oxides (SO_x) and nitrogen oxides (NO_x). Vessels may also use an incinerator for waste combustion during the Activity. Vessels may use ozone-depleting substances (ODS) in closed-system rechargeable refrigeration systems.
Extent	Gaseous emissions, under normal circumstances, may cause localised reduction in air quality, quickly dissipating into the surrounding atmosphere.
Duration	During the Activity, localised and temporary impacts to air quality will occur.

6.7.2 Nature and scale of environmental impacts

The seismic survey vessel, support vessels and helicopters present in the Operational Area will generate atmospheric emissions from power generation and waste incineration. Hydrocarbon combustion may result in atmospheric emissions of GHG (such as CO_2, CH_4 and N_2O) and non-GHG (such as NO_X and SO_X). Air emissions will be similar to other vessels operating in the region for both petroleum and non-petroleum activities.

Potential receptors include seabirds and migratory shorebirds, and humans.

Atmospheric emissions have the potential to result in a temporary, localised reduction of air quality in the environment immediately surrounding the discharge point (e.g. vessel exhaust) during the Activity which could affect seabirds and humans in the immediate vicinity. Atmospheric emissions also have the potential to add to the national GHG loadings.

As the activities will occur in offshore waters (approximately 102 km from the mainland coastline), any emissions from the combustion of fuels and incineration are expected to disperse rapidly in the open oceanic conditions and background levels of atmospheric pollutants are expected to be low. The quantities of gaseous emissions are relatively small and will quickly dissipate into the surrounding atmosphere. Emissions will not impact on the air quality in mainland towns given the distance offshore. Seabirds may traverse the Operational Area, however, are not expected in large numbers. Given the potential reduction in air quality will be highly localised, any impacts to individual or populations are not expected. Given the low level of emissions anticipated, survey emissions only represent a very small contribution to overall Australian and global GHG emissions to the atmosphere.

Accidental release and fugitive emissions of ODS has the potential to contribute to ozone layer depletion. Maintenance of refrigeration systems containing ODS is on a routine, but infrequent basis, and with controls implemented, the likelihood of an accidental ODS release of material volume is considered rare.

6.7.3 Environmental performance outcomes and control measures

Environmental Performance Outcomes relating to this hazard include:

EPO-20: No unplanned objects, emissions or discharges to sea or air.

EPO-21: Emissions to air meet legislated requirements.

The Control Measures considered for this Activity are shown in Table 6-25, with Environmental Performance Standards and Measurement Criteria for the EPOs described in Section 8.6.1.

Table 6-25: Control measures evaluation for atmospheric emissions

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard control measures				
Eliminate				
None identified.				
Substitute				
CM-36	MARPOL-compliant fuel oil (MDO) will be used during the Activity.	Use of MDO reduces the potential impacts to marine environment in the event of unplanned hydrocarbon spills or leaks during bunkering.	Additional personnel costs of ensuring vessels are using the required fuel.	**Adopted** – benefits of ensuring procedures are followed outweighs the minimal costs of personnel time.
Engineering				
CM-37	Waste incineration managed in accordance MARPOL and Marine Orders as appropriate.	Reduces potential impacts due to inappropriate incineration (e.g. wastes not burning correctly), inadequately maintained machinery.	Cost of maintaining and using incinerators in compliance with MARPOL. Increase in health risk from storage of wastes. Increase in risk due to transfers (increased fuel usage resulting in increased atmospheric emissions, potential increase in collision risk, disposal on land).	**Adopted** – benefit to air quality outweighs the costs associated with MARPOL certification.
CM-38	All vessel engines to be maintained in accordance with manufacturers specifications.	Ensures engines are operating efficiently to design specifications.	Personnel costs associated with undertaking maintenance as per the Planned Maintenance System (PMS).	**Adopted** – benefits of ensuring vessel engines are maintained outweigh the minimal costs.
Isolation				
None identified.				
Administration				
CM-39	Air pollution prevention certification.	Reduces probability of potential impacts to air quality due to ODS emissions, high NOx, SOx and incineration emissions.	Personnel cost of ensuring vessels have current International Air Pollution Prevention (IAPP) certificate or equivalent during vessel contracting procedure and in pre-mobilisation audits/ inspections.	**Adopted** – benefits of ensuring vessels are compliant outweighs the minimal costs.
CM-40	Ozone-depleting substance handling procedures.	Reduces probability of potential impacts to air quality due to ODS emissions.	Personnel cost of maintaining ODS record book/recording system.	**Adopted** – benefits of ensuring vessels are compliant outweighs the minimal costs.
Protective				
None identified.				

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Additional control measures				
Eliminate				
N/A	Removal of all ODS containing equipment prior to undertaking activities.	Eliminates potential of ODS emissions occurring and impacting on air quality.	Lack of refrigeration systems on board the vessel would lead to unacceptable workplace conditions. ODS is rarely found on vessels. If there are ODS containing equipment would be costly to replace for a short duration activity.	**Not Adopted** – based on cost to replace all equipment and low potential for ODS releases.
N/A	No incineration during Activity.	Eliminate the potential for emissions due to waste incineration to impact air quality.	Increase in health risk from storage of wastes. Increase in risk due to transfers (increased fuel usage, potential increase in collision risk, disposal on land).	**Not Adopted** – Health and safety risks outweigh the benefit given the offshore location. Cost associated with transporting waste to shore for landfill and/or incineration outweighs on-board incineration.
Substitute				
N/A	Alternative fuel type selected for all vessels and helicopters.	Could reduce level of pollutants released to the environment during fuel combustion.	Practical and reliable alternative fuel types and power sources for the helicopters and support vessels have not been identified. If an alternative was available, vessels have fuel specification for equipment, change of fuel may require further modifications to equipment.	**Not Adopted** – not feasible.
Engineering				
N/A	Use incinerators and engines with higher environmental efficiency.	Improves air quality by more efficient burning or fuel combustion.	Significant cost in changing unknown vessel equipment.	**Not Adopted** – Cost grossly disproportionate to low environmental benefit (impact rated negligible).
Isolation				
None identified.				
Administration				
None identified.				
Protective				
None identified.				

6.7.4 Environmental impact assessment

Receptor	Consequence level
Air emissions	
Threatened / Migratory Fauna	Short term behavioural impacts to seabirds and migratory shorebirds could be expected if they overfly the vessels; they may avoid the area. No decrease in local population size / area of occupancy of species / loss or disruption of habitat critical / disruption to the breeding cycle / introduction of disease.
Physical Environment / Habitat	No or negligible reduction in physical environment/ habitat area/ function.
Threatened ecological communities	Not applicable – these receptors will not be impacted by air emissions.
Protected Areas	
Socio-economic receptors	As the activities occur in offshore waters (102 km from the mainland coastline), the combustion of fuels and any ODS releases in these remote locations will not impact on air quality in coastal towns. The quantities of gaseous emissions are relatively small and will under normal circumstances, quickly dissipate into the surrounding atmosphere. The highly dispersive nature of local winds (i.e. strong and consistent) is expected to reduce potentially harmful or 'noticeable' gaseous concentrations within a short distance from the vessels.
Overall worst-case consequence level	I – Negligible Given the short duration of the survey, and constant movement of the vessel, emissions from the combustion of fuel and any ODS releases on board the vessels, will be localised and rapidly disperse and not affect sensitive receptors in the vicinity of the survey area (including the health or amenity of the nearest towns).

6.7.5 ALARP evaluation

Power generation through combustion of fossil fuels is essential to undertaking the Activity to power the vessels and equipment on-board. Given the routine maintenance of these closed systems by suitably qualified personnel, all practicable management measures are considered to have been implemented and the likelihood of significant impacts occurring have been reduced to ALARP.

No reasonably practicable additional controls were identified in the evaluation of control measures in Section 6.7.3 that would further increase the environmental benefit without a grossly disproportionate cost/sacrifice. The proposed control measures are considered appropriate to manage the risk to ALARP.

6.7.6 Acceptability evaluation

Is the consequence ranked as I (Negligible) or II (Minor)?	Yes – maximum consequence from atmospheric emissions is I (Negligible).
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are the risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' Offshore Division Environmental Hazard Identification and Assessment Procedure which considers principles of ecologically sustainable development. Based on the impact assessment in Section 6.7.2, the potential reduction in air quality will be highly localised and impacts to individual or populations are not expected. Given the low level of emissions anticipated, survey emissions only represent a very small contribution to overall Australian and global GHG emissions to the atmosphere. Based on the impact assessment, no significant short term or long term impacts are predicted. Therefore, in the context of the principles of ESD: • There is no threat of serious or irreversible environmental damage • The health, diversity and productivity of the environment will be maintained • The biological diversity and ecological integrity of the marine environment will be conserved.
Are performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – Management consistent with the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*, MARPOL Annex VI and/or Marine Order 97, as appropriate. Atmospheric emissions from vessels are permissible under the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*, which reflect MARPOL Annex VI and Marine Order 97 requirements. The vessels will use MDO, which is lower in sulphur compared to heavy fuel oil (HFO). The fuel oil will meet regulated sulphur content levels in order to control emission quality. As an internationally accepted standard that is used industry wide, compliance with MARPOL standards is considered to be an appropriate management measure in this case.
Are performance standards consistent with the Environmental Management Policy?	Yes – Aligns with the Environmental Management Policy.
Are performance outcomes and standards consistent with stakeholder expectations?	Yes – No concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes (see ALARP evaluation above).

Defined Acceptable Levels			
Does the predicted impact meet the defined acceptable level of impact (refer to Section 5.7)?	**Defined Acceptable Level of Impact**	**Comparison with Predicted Levels of Impact**	**EPO**
	Atmospheric emissions meet legislated permissible requirements. Santos considers it acceptable to have a Negligible (I) or Minor (II) consequence to a marine fauna population or ecological community. As defined within *Santos' Offshore Division Environmental Hazard Identification and Assessment Procedure* (EA-91-IG-00004_5), a Minor	Santos considers the level of impact from air emissions to be of an acceptable level. Atmospheric emissions will be standard marine vessel emissions, temporary in nature and with the potential for localised reduction of air quality at the point source (e.g. engine exhaust).	EPO-20 EPO-21

	consequence is defined as a 'Potentially detectable but insignificant change to a local population, industry or ecosystem factor. Localised effect, lasting weeks up to 12 months.	Contribution to regional air emissions, including greenhouse gases, will be negligible. Santos considers the application of legislative requirements appropriate to manage air emissions and the receiving environment.	

7. Environmental assessment for unplanned events

OPGGS(E)R 2023 Requirements
Section 21. Environmental assessment.
Evaluation of environmental impacts and risks (5) The environment plan must include: a) details of the environmental impacts and risks for the Activity; b) an evaluation of all the impacts and risks, appropriate to the nature and scale of each impact or risk; and c) details of the control measures that will be used to reduce the impacts and risks of the Activity to as low as reasonably practicable and an acceptable level. (6) To avoid doubt, the evaluation mentioned in paragraph (5)(b) must evaluate all the environmental impacts and risks arising directly or indirectly from: a) all operations of the Activity; and b) potential emergency conditions, whether resulting from accident or any other reason. Environmental performance outcomes and standards: (7) The environment plan must: a) set environmental performance standards for the control measures identified under paragraph (5)(c); b) set out the environmental performance outcomes against which the performance of the titleholder in protecting the environment is to be measured; and c) include measurement criteria that the titleholder will use to determine whether each environmental performance outcome and environmental performance standard is being met.

Santos' environmental assessment identified seven potential sources of environmental risks associated with the unplanned events for this Activity. The results of the environmental assessment are summarised in Table 7-1. A comprehensive risk and impact assessment for each of the unplanned events, and subsequent control measures proposed by Santos to reduce the risk and impacts to ALARP, are detailed in the following subsections.

Table 7-1: Summary of the environmental risks for events associated with unplanned events

Hazard	Consequence	Likelihood	Residual risk level
MDO/MGO release from vessel collision (surface)	III (Moderate)	a (Remote)	Very Low
Minor hydrocarbon release	I (Negligible)	c (Possible)	Very Low
Spill response operations	II (Minor)	b (Unlikely)	Very Low
Hazardous and non-hazardous unplanned discharges – liquid	I (Negligible)	b (Unlikely)	Very Low
Hazardous and non-hazardous unplanned discharges – solid	I (Negligible)	b (Unlikely)	Very Low
Marine fauna collisions	II (Minor)	b (Unlikely)	Very Low
Introduction of invasive marine species	III (Moderate)	b (Unlikely)	Low

7.1 Marine diesel oil (MDO) release from vessel collision (surface)

7.1.1 Description of event

Hydrocarbon spills from a ruptured vessel fuel tank as a result of collision	
Event	MDO spills have the potential to impact on the marine environment through reduction in water quality and exposure to fauna and habitats. *Worst-credible MDO Spill* There is a possibility of a vessel collision occurring within the Operational Area between an Activity vessel and a passing third party vessel. The worst-case environmental incident resulting from a vessel collision is the rupturing of a vessel fuel tank resulting in the release of MDO to the environment. Vessel collision could occur due to factors such as human error, poor navigation, vessel equipment failure or poor weather. The maximum credible spill from a collision can be determined from the usable volume of the largest single fuel tank. A maximum credible spill volume has been determined for the Activity to be 1,065 m^3 of MDO. It is noted that in addition to MDO, small volumes of unused IFO and HFO could be stored on the vessels. However, restrictions will be in place limiting volumes and requiring storage to be restricted to tanks that do not have direct exposure to the marine environment (as described in Section 7.1.4). Therefore, a spill of IFO/HFO is not considered credible for this assessment.
Extent	Environment that May be Affected A hypothetical instantaneous surface release of 1,065 m^3 of MDO following a vessel tank rupture has been modelled at two release sites, carefully selected based on proximity to shorelines and sensitive receptors. The EMBA is illustrated in Figure 3-1. While the EMBA represents the largest possible spatial extent that could be affected by the worst-case hydrocarbon spill event, it is important to understand that the stochastic modelling used to define the EMBA considers 100 different simulations for each of the three identified seasons at each of the two spill events (total of 600 simulations across both locations). An actual spill event is more realistically represented by only one of the simulations and hence, have a much smaller spatial footprint. *Modelled Extend of Spill* The potential extent of an MDO spill described here is based on the low hydrocarbon exposure values from the spill modelling for surface, total submerged (entrained), dissolved and accumulated shoreline hydrocarbons, as described in Section 7.1.2.3. The low exposure values are used to identify all values and sensitivities that may be contacted in the event of a spill. It is noted that moderate and high exposure values are used in this assessment to identify the potential for ecological impacts to sensitive receptors (Section 7.1.2.3). The potential extent of floating MDO at or above the low exposure value of 1 g/m^2, is predicted to be a maximum of approximately 123 km to the East. Total submerged hydrocarbons (entrained) in the water column above the low exposure value of 10 ppb is predicted to occur up to approximately 808 km to the southwest and 731 km to the west from the release locations 1 and 2, respectively. Dissolved hydrocarbons in the water column above the low exposure value of 10 ppb is predicted to occur up to approximately 380 km to the west and 283 km to the west from the release locations1 and 2, respectively. Accumulation of hydrocarbon on shorelines at the low exposure value (10 g/m^2) is predicted from both release locations. The highest probability for shoreline oil accumulation was forecast for the Joseph Bonaparte Gulf East Coast (4.33%), the Beagle Gulf Darwin Coast (1.67%) and the Tiwi Islands (1.33%) from location 2. Refer to Table 7-3 for the exposure threshold values used in the Spill Modelling. Section 7.1.2.3 further describes the environmental significance of the selected exposure values. Refer to Stochastic Spill Modelling Results summary (Section 7.1.2.5).
Duration	MDO fuel at the sea surface will spread rapidly in the direction of the prevailing wind and surface currents. Evaporation contributes to a substantial proportion of removal of the spilled MDO on the sea surface during calm conditions, while entrainment of droplets within the water column will increasingly contribute to removal of surface oil as wind speed increases. There is a very low chance for emulsion formation. Refer to Stochastic Spill Modelling Results summary (Section 7.1.2.5).

7.1.2 Quantitative spill modelling

7.1.2.1 Type of release

All vessels will use MDO, the largest usable volume within a fuel tank of any vessel used during the Activity will be 1,065 m^3. RPS (2023) used marine diesel oil (MDO) to inform the hydrocarbon characteristics for the modelling. The characteristics of the MDO, selected as the analogue for the MDO release is presented in Table 7-2. MDO is a mixture of predominantly semi-volatile and low-volatility hydrocarbons, with a low percentage of volatile C4 to C10 hydrocarbons (3%) and a greater proportion moderate to very low volatile C11 to C20 hydrocarbons (97%). MDO has no residual persistent hydrocarbons after weathering. The heavier (low volatile) components of the oil have a

tendency to entrain into the upper water column due to wind-generated waves but can subsequently resurface if wind waves abate.

Table 7-2: Characteristics of MDO

Oil type	Initial density (kg/m^3)	Viscosity (cP)	Component	Volatiles (%)	Semi-volatiles (%)	Low volatility (%)	Residual (%)
			Boiling points (°C)	<180	180–265	265–380	>380
				NON-PERSISTENT			PERSISTENT
MDO	829.1 @25 °C	4.0 @25 °C	% of total	6	34.6	54.4	5.0

Source: RPS 2023

7.1.2.2 Modelling inputs

To determine the spatial extent of a potential MDO hydrocarbon spill, RPS were commissioned to conduct modelling of a 1,065 m^3 MDO release. Modelling was conducted at two release sites; one on the perimeter of the Operational Area, and one towards the southern end of the Operational Area, which were carefully selected based on proximity to shorelines and sensitive receptors.

Key parameters considered for the MDO spill modelling are:

API gravity: 37.6°

Pour point: −14° C

Duration of spill: instantaneous

Location of release: Surface spill

Volume of hydrocarbon: 1,065 m^3

Time of year: simulations run for three identified seasons.

Stochastic modelling

Stochastic modelling was performed on an instantaneous release of 1,065 m^3 of MDO at the sea surface, with a simulation period of 50 days allowing sufficient duration for modelled hydrocarbon concentrations to drop below the minimum exposure values (refer to Section 7.1.2.3). Modelling was conducted for three identified seasons, ensuring conservatism in the modelling. It is noted that the EMBA from the stochastic modelling covers a larger area than the area that would be affected during any single spill event. The EMBA therefore represents the predicted maximum extent where exposure values could be exceeded from all modelling runs under the identified three different weather and metocean conditions (300 runs per release location in total).

7.1.2.3 Exposure values

The outputs of the quantitative hydrocarbon spill modelling are used to assess the environmental risk, if a credible hydrocarbon spill scenario occurred, by defining which areas of the marine environment could be exposed to hydrocarbon levels exceeding exposure values that may result in impact to sensitive receptors. The degree of impact will depend on the sensitivity of the biota contacted, the duration of the contact (exposure) and the toxicity of the hydrocarbon mixture making the contact. The toxicity of a hydrocarbon will change over time, due to weathering processes altering the composition of the hydrocarbon.

The modelling considered four key physical or chemical phases of hydrocarbons that pose differing environmental and socioeconomic risks: surface hydrocarbons, total submerged hydrocarbons, dissolved hydrocarbons and shoreline accumulated hydrocarbons. It is noted that the ‘total submerged hydrocarbons’ is comprised of both entrained (or droplets) and dissolved hydrocarbons and therefore provides a conservative (over) representation of entrained hydrocarbons.

The modelling used defined hydrocarbon exposure values, as relevant for risk assessment and oil spill planning, for the various hydrocarbon phases. To ensure conservatism in the environmental assessment process, the exposure values applied to the model are selected to adopt the most sensitive receptors that may be exposed, the longest likely exposure times and the more toxic hydrocarbons.

Exposure values applied for surface hydrocarbons, total submerged hydrocarbons (entrained), dissolved hydrocarbons and accumulated hydrocarbons ashore used in the modelling study are summarised in Table 7-3. The adopted exposure values are based primarily on the exposure values defined in NOPSEMA Bulletin Oil Spill Modelling (April 2019). The environmental significance of these exposure values is described in Table 7-3.

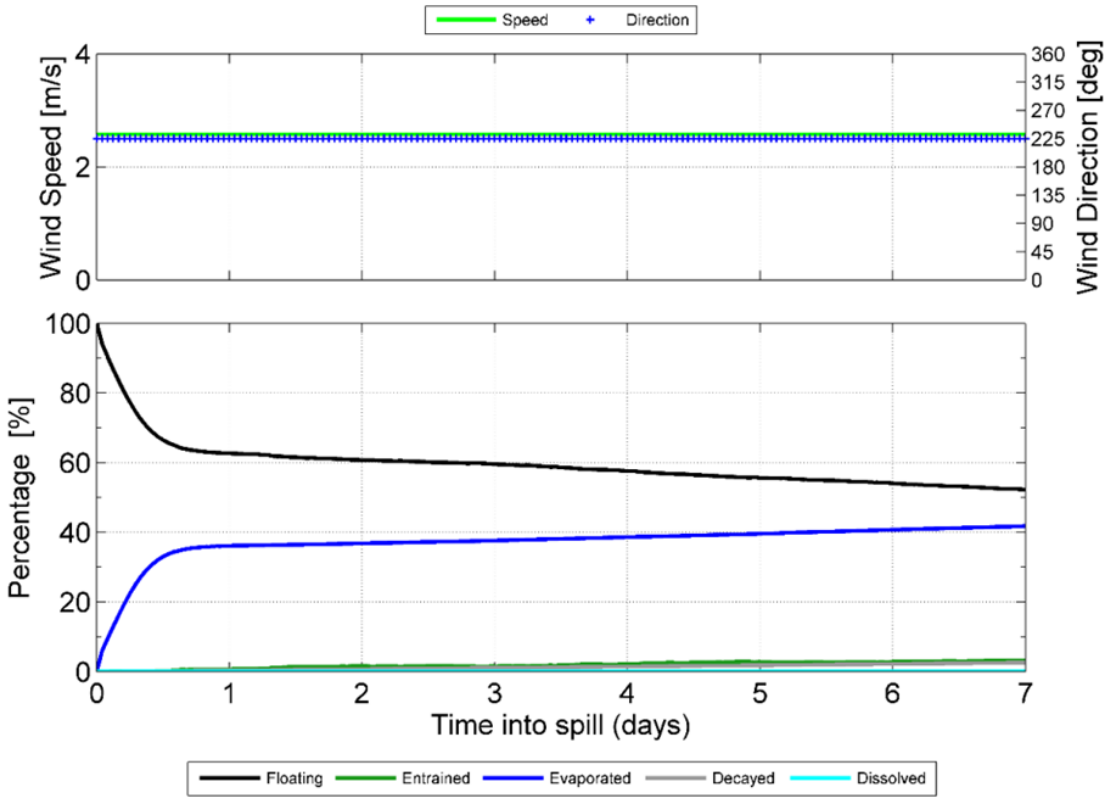
Table 7-3: Summary of the hydrocarbon exposure thresholds

Exposure type	Potential level of exposure	Hydrocarbon concentration	Description
Surface hydrocarbons (floating) (g/m^2) [1]	Low	1	This value represents the area where a visible sheen may be present on the surface but is below concentrations at which ecological impacts are expected to occur. It is indicative of perceived impacts and areas that may be temporarily closed as a precautionary measure. It predicts the potential for some socio-economic impact (visual/aesthetic).
	Moderate	10	This represents the minimum oil thickness at which ecological impacts (e.g. to birds and marine mammals) are expected to occur. It is the lowest 'actionable' level where spill response may be possible.
	High	50	This value is the estimated minimum floating hydrocarbon threshold for containment and recovery and informs response planning.
Total submerged hydrocarbons (entrained) (ppb) [1]	Low	10	This value establishes the planning area for scientific monitoring based on potential for exceedance of water quality triggers.
	Moderate	100	This represents potential toxic effects, particularly sublethal effects to sensitive species and life stages.
	High	-	N/A
Dissolved hydrocarbons (ppb)[1]	Low	10	This value establishes the planning area for scientific monitoring based on potential for exceedance of water quality triggers.
	Moderate	50	This represents potential toxic effects, particularly sublethal effects to highly sensitive species and life stages of fish and invertebrates (e.g. larvae, plankton).
	High	400	This value represents toxic effects including lethal effects to sensitive species.
Accumulated hydrocarbons (shoreline) (g/m^2) [1]	Low	10	This value represents light oiling (equivalent to 2 teaspoons of oil per m^2). It is indicative of perceived impacts and shorelines that may be temporarily closed as a precautionary measure and predicts the potential for some socio-economic impact (visual/aesthetic).
	Moderate	100	This represents the minimum oil thickness at which potential lethal ecological impacts (e.g. to intertidal invertebrates, shorebirds, mammals and reptiles) may occur. It also predicts areas likely to require clean-up effort.
	High	1000	This value predicts areas likely to require intensive clean-up effort. Potential significant impacts to coastal vegetation including mangroves and marshes.

[1] *Instantaneous exposure values sourced from NOPSEMA Bulletin #1 Oil Spill Modelling (April 2019)*

7.1.2.4 MDO weathering assessment

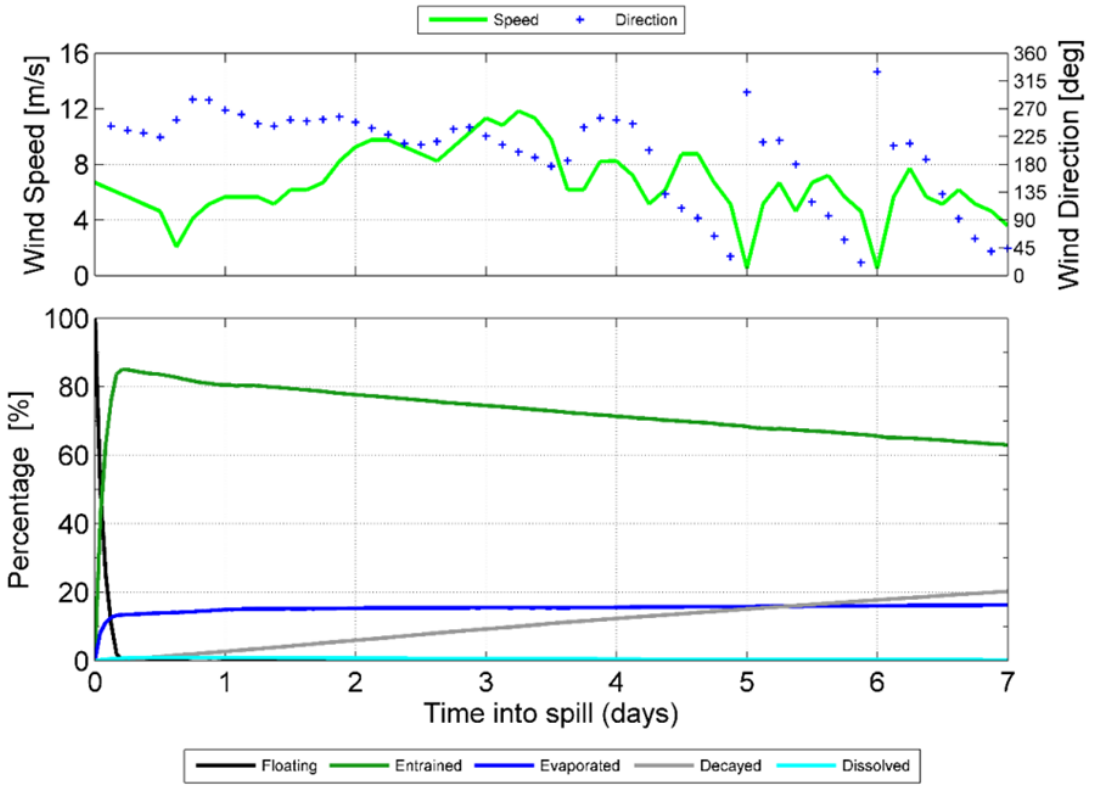
Figure 7-1 illustrates the weathering graph of an instantaneous surface spill of 1,065 m^3 of MDO under calm wind conditions and Figure 7-2 illustrate the weathering graph of the same scenario under variable wind conditions, where winds are on average stronger. The graphs illustrate greater persistence of MDO on the sea surface under calm wind speeds, which coincides with the occurrence of entrainment with variable wind speeds as increasing volumes of MDO forced into the water column. Additionally, the loss to evaporation after 24 hours was greatest during the calm wind speed, as more MDO remains on the sea surface instead of the water column. The proportion within the water column is expected to decay over several weeks.



Source: RPS 2023

Results are based on an instantaneous 1,065 m^3 surface release of MDO (tracked over 50 days)

Figure 7-1: Weathering and fates graph, as a function of volume (%), under constant calm wind condition (2.6 m/s)



Source: RPS 2023

Results are based on an instantaneous 1,065 m^3 surface release of MDO (tracked over 50 days)

Figure 7-2: Weathering and fates graph, as a function of volume (%), under variable wind condition

7.1.2.5 Stochastic spill modelling results

A summary of the stochastic spill modelling results is provided below, with a tabulated summary of the results provided in Table 7-4 to Table 7-6. The modelled EMBA for surface, total submerged (entrained) and dissolved hydrocarbons for each spill release location is presented in Figure 7-3 to Figure 7-4.

Sea surface hydrocarbons

Surface oiling was assessed at three exposure values representing low (1 g/m^2), moderate (10 g/m^2), and high (50 g/m^2) exposure levels. Modelling indicated in the event of a 1,065 m^3 spill of MDO, surface oil was predicted to extend up to a maximum of approximately 123 km, 69 km and 40 km from the spill release locations, for low, moderate and high exposure thresholds respectively.

The Van Cloon-Deep Shoals, JBG East Coast, JBG AMP, and the NT coastal waters were the only receptors predicted to be exposed to low threshold concentrations from spill trajectories. JBG AMP was the only receptor exposed to the moderate threshold concentrations from spill trajectories. No receptors were exposed to the high threshold concentrations from spill trajectories. Table 7-4 summarises the spill modelling results for surface hydrocarbons.

Table 7-4: Summary of oil spill modelling results for surface hydrocarbons, including sensitive receptors with predicted exposure above threshold concentrations

Release site	Distance and direction to sensitive receptor	Areas of potential sea surface exposure		
		>1 g/m^2	>10 g/m^2	>50 g/m^2
1	Maximum distance from release site (km)	74	69	34
	Direction	Southwest	West	West
	Probability of oil exposure to Van Cloon-Deep Shoals (%)	0.33	<0.33	<0.33
	Minimum time before oil exposure to the Van Cloon-Deep Shoals (hrs)	219	-	-
2	Maximum distance from release site (km)	123	56	40
	Direction	East	Southwest	East
	Probability of oil exposure to JBG East Coast (%)	0.33	<0.33	<0.33
	Minimum time before oil exposure to the JBG East Coast (hrs)	201	-	-
	Probability of oil exposure to the JBG AMP (%)	2%	0.67%	<0.33%
	Minimum time before oil exposure to the JBG AMP (hrs)	53	80	-
	Probability of oil exposure to Northern Territory State waters (%)	0.33	<0.33	<0.33
	Minimum time before oil exposure to the Northern Territory State waters (hrs)	201	-	-

A dash indicates that the threshold was not reached. The results were calculated from 300 possible spill trajectories and do not represent a single spill event.

Shoreline Accumulation

Shoreline oiling was assessed at three contact exposure values representing low (10 g/m^2), moderate (100 g/m^2), and high (1,000 g/m^2) exposure thresholds. The highest shoreline oil accumulation from the worst-case simulation is predicted at JBG East Coast from release location 2 with a maximum accumulation volume of 37 m^3. Table 7-5 summarises the spill modelling results for shoreline hydrocarbon accumulation.

Table 7-5: Summary of oil spill modelling results for shoreline hydrocarbon accumulation, including sensitive receptors with predicted exposure above threshold concentrations

Release site	Distance and direction to sensitive receptor	Areas of potential shoreline accumulation		
		>10 g/m^2	>100 g/m^2	>1,000 g/m^2
1	Probability of oil exposure to Beagle Gulf Darwin Coast (%)	0.66%	<0.33	<0.33
	Minimum time before oil exposure to the Beagle Gulf Darwin Coast (hrs)	417	-	-
	Probability of oil exposure to JBG East Coast (%)	0.99%	<0.33	<0.33
	Minimum time before oil exposure to the JBG East Coast (hrs)	621	-	-

Release site	Distance and direction to sensitive receptor	Areas of potential shoreline accumulation		
		>10 g/m²	>100 g/m²	>1,000 g/m²
	Probability of oil exposure to Kimberley Cast PMZ (%)	0.66%	<0.33	<0.33
	Minimum time before oil exposure to the Kimberley Cast PMZ (hrs)	575	-	-
	Probability of oil exposure to Tiwi Islands (%)	0.66%	<0.33	<0.33
	Minimum time before oil exposure to the Tiwi Islands (hrs)	402	-	-
	Probability of oil exposure to Vernon Islands CR (%)	0.33%	<0.33	<0.33
	Minimum time before oil exposure to the Vernon Islands CR (hrs)	586	-	-
2	Probability of oil exposure to Beagle Gulf-Darwin Coast (%)	1.67%	0.33%	<0.33%
	Minimum time before oil exposure to the Beagle Gulf-Darwin Coast (hrs)	327	396	-
	Probability of oil exposure to JBG East Coast (%)	4.33%	1.67%	<0.33%
	Minimum time before oil exposure to the JBG East Coast (hrs)	155	164	-
	Probability of oil exposure to the JBG South Coast (%)	0.33%	<0.33%	<0.33%
	Minimum time before oil exposure to the JBG South Coast (hrs)	625	-	-
	Probability of oil exposure to JBG West Coast (%)	0.67%	<0.33%	<0.33%
	Minimum time before oil exposure to the JBG West Coast (hrs)	432	-	-
	Probability of oil exposure to Tiwi Islands (%)	1.33%	0.33%	<0.33%
	Minimum time before oil exposure to the Tiwi Islands (hrs)	248	253	-

Total Submerged Hydrocarbons (Entrained)

Total submerged hydrocarbons were assessed at two contact exposure values representing low (10 ppb) and moderate exposure (100 ppb) for entrained hydrocarbons. Modelling of entrained hydrocarbons considered exposure to receptors at 0–10 m and 10–20 m water depths.

A range of receptors were predicted to be exposed to entrained hydrocarbons above exposure value concentrations, including AMPs, reefs and shoals. Table 7-6 summarises the maximum entrained hydrocarbon exposure (over 1 hour) for each threshold to individual receptors in the 0–10 m depth layer. There was no predicted exposure to any of the receptors from any release site within the 10–20 m water depth layer.

The probabilities of exposure for concentrations equal to or greater than 10 ppb for spills originating from Release Location 1 and 2 were predicted to be highest at the Kimberley AMP (18.00% and 19.33%, respectively). Additionally, the highest probabilities of exposure for concentrations exceeding 100 ppb for Release Location 1 and 2 was predicted for the Kimberley AMP (7.00%) and Joseph Bonaparte Gulf AMP (9.33%), respectively. The quickest time before exposure at or above 10 ppb to any receptor was 41 hours for the JBG AMP for a spill originating from Release Location 2.

Table 7-6: Maximum entrained hydrocarbon exposure levels and probability for each threshold to individual sensitive receptors

Sensitive receptor location	Entrained hydrocarbon exposure (over 1 hour)			
	Total contact probability (%)			
	Release site 1		Release site 2	
	>10 ppb	>100 ppb	>10 ppb	>100 ppb
Afghan Shoal	1.67	0.33	3.00	1.00
Ashmore-Cartier – Outer	0.67	<0.33	0.33	<0.33
Barracouta Shoals	1.67	<0.33	-	-
Beagle Gulf-Darwin Coast	2.67	0.33	7.00	1.33
Browse Island	5.67	<0.33	2.67	<0.33
Cartier Island AMP	0.67	<0.33	-	-
Cobourg Peninsula-Nhulunbuy	0.33	<0.33	0.33	<0.33

Sensitive receptor location	Entrained hydrocarbon exposure (over 1 hour)			
	Total contact probability (%)			
	Release site 1		Release site 2	
	>10 ppb	>100 ppb	>10 ppb	>100 ppb
Djukbinj NP	0.33	<0.33	0.33	<0.33
Echuca Shoals	8.33	0.67	5.00	<0.33
Eugene McDermott Shoal	1.33	<0.33	-	-
Flat Top Bank	3.00	1.00	-	-
Gale Bank	14.00	4.67	6.33	1.00
Hancox Shoal	1.00	<0.33	1.33	<0.33
Harris Reef	1.00	<0.33	1.67	<0.33
Heywood Shoals	3.33	<0.33	1.00	<0.33
Holothuria Banks North	15.67	6.67	16.33	1.67
JBG East Coast	3.33	1.00	10.33	4.00
JBG South Coast	1.00	<0.33	5.67	2.00
JBG West Coast	5.00	1.67	9.67	2.33
Joseph Bonaparte Gulf AMP	6.00	0.67	17.67	9.33
Kimberley AMP	18.00	7.00	19.33	5.67
Kimberley Coast PMZ	11.33	3.00	10.00	1.33
Lowry Shoal	1.00	<0.33	1.33	<0.33
Marsh Shoal	1.00	<0.33	0.67	<0.33
Moresby Shoals	1.67	<0.33	1.67	<0.33
Newby Shoal	2.67	0.67	-	-
Northern Territory State waters	3.33	1.00	10.67	4.00
Outer Oceanic Shoals AMP	8.00	2.00	2.00	<0.33
Penguin Shoal	14.67	4.33	11.67	2.33
Scott Reef South	0.33	<0.33	-	-
Shepparton Shoal	2.67	0.67	3.67	1.00
Skottowe Shoal	1.67	<0.33	1.67	<0.33
State Waters	11.33	3.00	10.00	2.33
The Boxers Area	2.33	0.67	2.00	0.67
Tiwi Islands	2.33	0.33	3.00	1.00
Van Cloon-Deep Shoals	12.67	6.67	1.33	0.33
Van Diemen Gulf Coast	-	-	0.33	<0.33
Van Diemen Gulf Shoals	0.33	<0.33	0.67	<0.33
Vernon Islands CR	1.00	<0.33	1.67	<0.33
Vulcan Shoals	0.67	<0.33	-	-
Western Australian State waters	11.33	3.00	10.00	2.33

A dash indicates that the threshold was not reached. The results were calculated from 300 possible spill trajectories and do not represent a single spill event.

Dissolved Hydrocarbons

Dissolved hydrocarbons were assessed at three contact exposure values representing low (10 ppb), medium (50 ppb) and high (400 ppb) exposure thresholds. Dissolved hydrocarbon concentrations exceeding 10 ppb are

predicted to travel up to 380 km from Release Location 1, with the distances reducing to 137 km and 14 km from Release Location 1 as the exposure thresholds increases to 50 ppb and 400 ppb.

Van Cloon-Deep Shoals and JBG AMP recorded the highest probabilities of exposure at concentrations equal to, or greater, than 10 ppb at 1% for Release Location 1 and 2, respectively.

Table 7-7 summarises the predicted dissolved hydrocarbon exposure for environmental value areas from Release Location 1 and 2. There was no exposure to any receptor at or above the 50 ppb threshold from spills at either release location.

Table 7-7: Maximum dissolved hydrocarbon exposure levels and probability for each threshold to individual sensitive receptors

Sensitive receptor location	Dissolved hydrocarbon exposure (over 1 hour)					
	Total contact probability (%)					
	Release site 1			Release site 2		
	>10 ppb	>50 ppb	>400 ppb	>10 ppb	>50 ppb	>400 ppb
Flat Top Bank	0.33	<0.33	<0.33	-	-	-
Gale Bank	0.33	<0.33	<0.33	0.33	<0.33	<0.33
Holothuria Banks North	0.33	<0.33	<0.33	-	-	-
JBG East Coast	-	-	-	0.33	<0.33	<0.33
JBG West Coast	0.33	<0.33	<0.33	-	-	-
Kimberley AMP	0.67	<0.33	<0.33	-	-	-
Northern Territory State Waters	-	-	-	0.33	<0.33	<0.33
Outer Oceanic Shoals AMP	0.33	<0.33	<0.33	-	-	-
Van Cloon-Deep Shoals	1.00	<0.33	<0.33	-	-	-
Western Australia State Waters	0.33	<0.33	<0.33	0.33	<0.33	<0.33

A dash indicates that the threshold was not reached. The results were calculated from 300 possible spill trajectories and do not represent a single spill event.

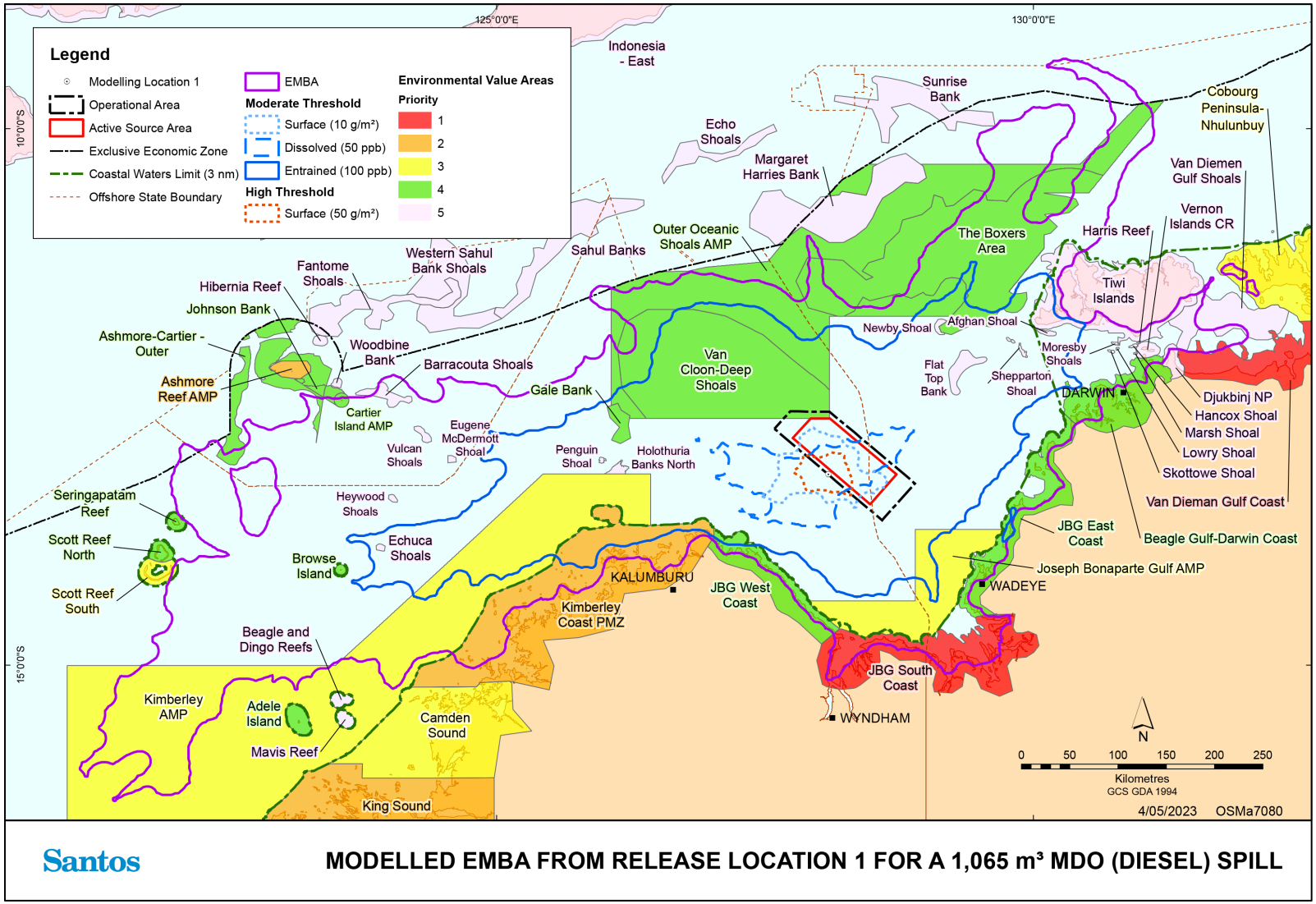


Figure 7-3: Modelled EMBA from Release Location 1 for 1,065 m³ MDO (diesel) spill

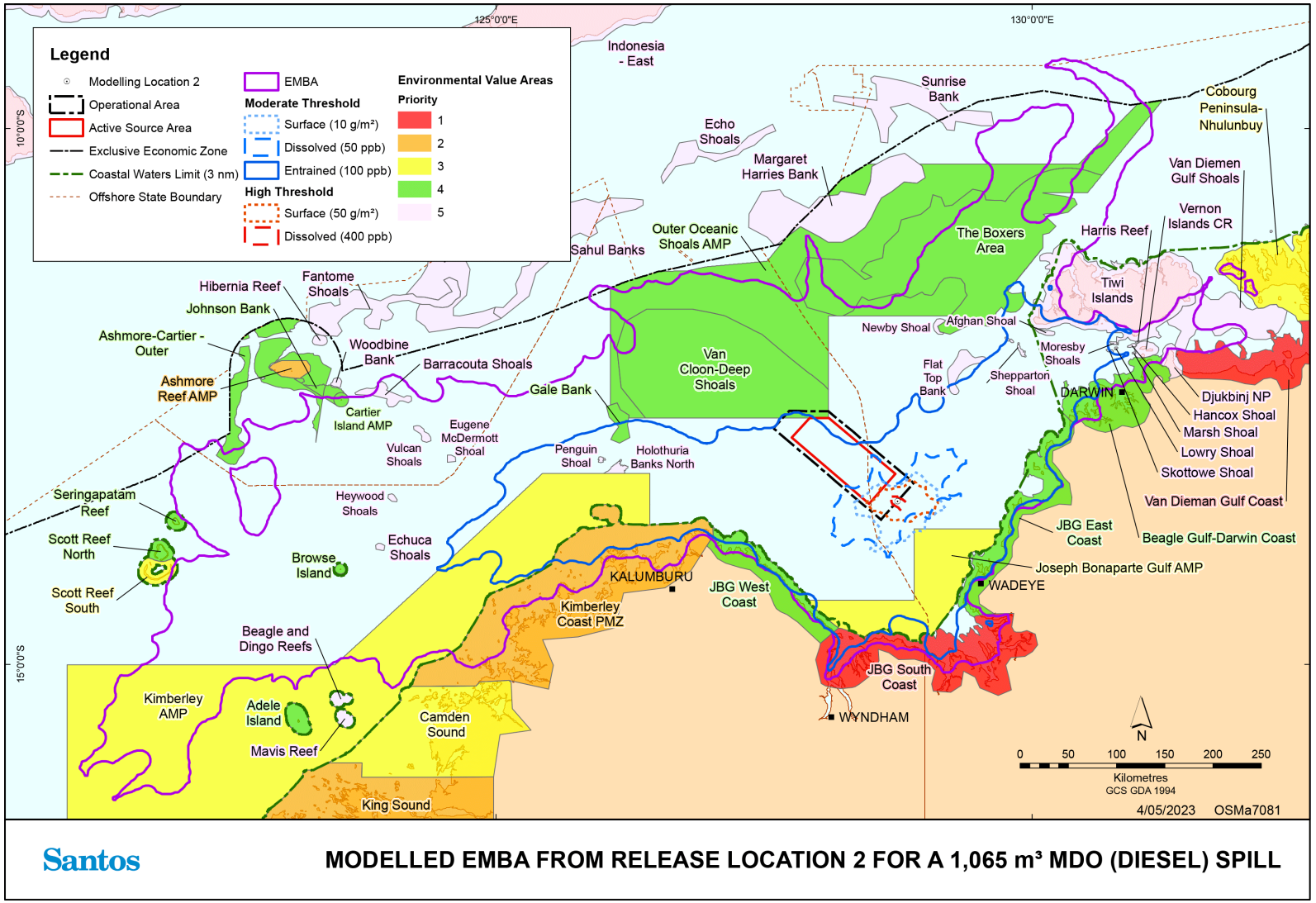


Figure 7-4: Modelled EMBA from Release Location 2 for a 1,065 m^3 MDO (diesel) spill

7.1.3 Spill risk assessment approach

A consistent risk assessment approach is applied to the unplanned hydrocarbon release scenario based on Santos' *Oil Spill Risk Assessment and Response Planning Procedure* (QE-91-II-20003). The procedure describes the spill risk assessment process as follows:

Identify the spatial extent of the EMBA. This has been completed for this EP as part of the assessment of the existing environment and receptors that are known to occur or may occur within the EMBA and are described in Section 3

Identify areas of high environmental value (HEV) within the EMBA (HEVs are described in Section 7.1.3.2)

Identify and then risk assess hot spots. Hotspots are effectively a subset of HEVs and their determination is described in Section 7.1.3.3)

Identifies priorities for protection (for consideration of spill response strategies in the Eos OPEP (7710-650-ERP-0004).

7.1.3.1 Spill EMBA

Defining the EMBA by an oil spill is the first step in oil spill risk assessment. For activities where there is the potential for multiple spill scenarios, the spill scenario, or combination of spill scenarios, resulting in the greatest spatial extent of impacts is used to define the overall EMBA for the activity. The EMBA is further described in Section 3.1.2.

7.1.3.2 Areas of high environmental value

Santos has predetermined area of HEV (Figure 7-3 and Figure 7-4) along the Western Australia Coastline by ranking these areas based on:

Protected area status – This is used as an indicator of the biodiversity values contained within that area, where a World Heritage Area, Ramsar Wetland and Marine Protected Area will score higher than areas with no protection assigned

BIAs of listed threatened species – These are spatially defined areas where aggregations of individuals of a species are known to display biologically important behaviour, such as breeding, feeding, resting or migration. Each one of these within the predefined areas contributes to the score.

Further input to determine areas of HEV included:

Sensitivity of habitats to impact from hydrocarbons in accordance with the guidance document Sensitivity Mapping for Oil Spill Response produced by IPIECA (1992), the International Maritime Organisation and International Association of Oil and Gas Producers

Sensitivities of receptors with respect to hydrocarbon-impact pathways

Status of zones within protected areas (i.e. IUCN (1a) and sanctuary zones compared to IUCN (VI) and multiple use zones)

Listed species status and predominant habitat (surface versus subsurface)

Social values; i.e. socio-economic and heritage features (e.g. commercial fishing, recreational fishing, amenities, aquaculture).

Tallied scores for each predefined area along the WA and NT coastline were then ranked from 1 to 5, with an assignment of 1 representing areas of the highest environmental value and those with 5 representing the areas of the lowest environmental value.

7.1.3.3 Hot spots

While the entire EMBA will be considered during risk assessment and spill response planning, it is best practice to concentrate greatest effort and level of detail on those parts of the EMBA that have:

The greatest intrinsic environmental value – i.e. HEV areas ranked 1–3

The highest probability of contact by oil (either floating, entrained or dissolved aromatic)

The greatest potential concentration or volume of oil arriving at the area.

These areas are termed 'Hot Spots'. Defining Hot Spots is typically the first step in undertaking detailed spill risk assessment and spill response planning. Hot Spots are a subset of HEV areas that:

Have the highest probability of contact (at least higher than 5%) above the impact assessment

Exposure values for surface hydrocarbons and shoreline accumulation based on modelling results

Receive the greatest concentration or volume of oil, either floating or stranded oil, entrained hydrocarbon or DAHs above contact exposure values described in Section 7.1.2.3.

7.1.3.4 Priorities for protection

For the purpose of a spill response preparedness strategy, it is not necessary for all Hot spots to have detailed planning. For example, wholly submerged Hot Spots may only be contacted by entrained hydrocarbon, and the response would be largely to implement scientific monitoring to determine impact and recovery. Hot Spots with features that are not wholly submerged (i.e. emergent features) should have specific spill response planning conducted. This final determination of 'Priority for Protection Areas' (PPAs), for the oil spill response strategy, is based on the worst-case estimate of surface oil concentration, shoreline loading and minimum contact time at exposure value concentrations.

Further detail on the process for selection of Priority for Protection sites is detailed in the *Oil Spill Risk Assessment and Response Planning Procedure* (QE-91-II-20003).

The oil spill response strategies for PPAs are undertaken within the activity OPEP.

An assessment of each protection priority will be undertaken to determine the most appropriate spill response strategies based on the type of oil and the values of the protection priority area. This can be done through a strategic Net Environmental Benefit Analysis (NEBA) approach.

7.1.3.5 Potential hydrocarbon impact pathways

To help inform the hydrocarbon spill risk assessment receptors within the EMBA, the potential physical and chemical pathways have been defined. Physical pathways include contact from surface oil, accumulated shoreline oil, or entrained hydrocarbon droplets from an MDO. Chemical pathways include ingestion, inhalation or contact from any hydrocarbon phase. These are summarised in Table 7-8 and the information is drawn upon within the hydrocarbon risk assessment for each release scenario. Table 7-9 further describes the nature and scale of the hydrocarbon spills associated with the Activity on marine fauna and socio-economic receptors found.

Table 7-8: Physical and chemical pathways and oil impacts to marine organisms

Receptor	Physical pathway		Chemical pathway	
	Exposure	Potential impacts	Exposure	Potential impacts
Mangroves	Coating of root system reducing air and salt exchange. Degree of coating is dependent upon the energy and tidal reach of the shoreline, the type of the substrate and continual weathering of the MDO.	Yellowing of leaves. Defoliation. Increased sensitivity to stressors. Tree death. Reduced growth. Reduced reproductive output. Reduced seed viability.	External contact by oil and adsorption across cellular membranes.	Yellowing of leaves. Defoliation. Increased sensitivity to stressors. Tree death. Reduced growth. Reduced reproductive output. Reduced seed viability. Growth abnormalities.
Algae and seagrass	Coating of leaves/thalli reducing light availability and gas exchange. Degree of coating is dependent upon the energy and tidal reach of the shoreline, the type of the receptor and continual weathering of the MDO.	Bleaching or blackening of leaves. Defoliation. Reduced growth.	External contact by oil and adsorption across cellular membranes.	Mortality. Bleaching or blackening of leaves. Defoliation. Disease. Reduced growth. Reduced reproductive output. Reduced seed/ propagule viability.
Hard corals	Coating of polyps, shading resulting in reduction on light availability. Degree of coating is dependent upon the metocean conditions, dilution, if corals are emergent at all	Bleaching. Increased mucous production. Reduced growth.	External contact by oil and adsorption across cellular membranes.	Mortality. Cell damage. Reduced metabolic capacity. Reduced immune response.

Receptor	Physical pathway		Chemical pathway	
	Exposure	Potential impacts	Exposure	Potential impacts
	and continual weathering of the MDO.			Disease. Reduced growth. Reduced reproductive output. Reduced egg/larval success. Growth abnormalities.
Invertebrates	Coating of adults, eggs and larvae. Degree of coating is dependent upon the energy and tidal reach of the shoreline, the type of the receptor and continual weathering of the MDO.	Mortality Behavioural disruption Impaired growth	Ingestion and inhalation. External contact and adsorption across exposed skin and cellular membranes. Uptake of dissolved aromatic hydrocarbons across cellular membranes. Reduced mobility and capacity for oxygen exchange.	Mortality. Cell damage. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced reproductive output. Reduced egg/larval success. Growth abnormalities. Behavioural disruption.
Fish, sharks and rays	Coating of adults but primarily eggs and larvae – Reduced mobility and capacity for oxygen exchange.	Mortality. Oxygen debt. Starvation. Dehydration. Increased predation. Behavioural disruption.	Ingestion. External contact and adsorption across exposed skin and cellular membranes. Uptake of dissolved aromatic hydrocarbons across cellular membranes (e.g. gills).	Mortality. Cell damage. Flesh taint. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced reproductive output. Reduced egg/larval success. Growth abnormalities. Behavioural disruption.
Birds	Light coating. Degree of coating is dependent upon the energy and tidal reach of the shoreline, the type of the receptor and continual weathering of the MDO.	Feather and skin irritation and damage. It is commonly thought that MDO does not cause problems to wildlife due to the lack of visible oiling, however, may be toxic (WAOWRP 2014).	Ingestion (during feeding or preening). External contact and adsorption across exposed skin and membranes.	Mortality. Cell damage, lesions. Secondary infections. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced reproductive output. Growth abnormalities. Behavioural disruption.
Marine reptiles	Light coating. Degree of coating is dependent upon the energy and tidal reach of the shoreline, the type of the receptor and	Behavioural disruption. It is commonly thought that MDO does not cause problems to wildlife due to the lack of	Inhalation. Ingestion. External contact and adsorption across exposed skin and membranes.	Mortality. Cell damage, lesions. Secondary infections. Reduced metabolic capacity.

Receptor	Physical pathway		Chemical pathway	
	Exposure	Potential impacts	Exposure	Potential impacts
	continual weathering of the MDO.	visible oiling, however, may be toxic (WAOWRP 2014).		Reduced immune response. Disease. Reduced growth. Reduced hatchling success. Reduced reproductive output. Growth abnormalities. Behavioural disruption.
Marine mammals	Light coating – fur damage and matting, reduced mobility and buoyancy (for applicable species). Coating of feeding apparatus in some species (i.e. baleen whales).	It is commonly thought that MDO does not cause problems to wildlife due to the lack of visible oiling, however, may be toxic (WAOWRP 2014).	Inhalation. Ingestion. External contact and adsorption across exposed skin and membranes.	Mortality. Cell damage, lesions. Secondary infections. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth Reduced reproductive output. Growth abnormalities. Behavioural disruption.

7.1.3.6 Summary of potential impacts

Table 7-9 provides a summary of the potential impacts of hydrocarbon releases to sensitive receptors and values at the moderate exposure values (see Section 7.1.2.3).

Table 7-9: Potential for exposure of sensitive receptors found within the overall EMBA to hydrocarbons

Receptor	Impacts of MDO
Marine fauna	
Plankton (including zooplankton; fish and coral eggs and larvae)	The hydrocarbon spill EMBA has the potential to overlap with spawning of some fish species given the year round spawning of some species, and overlap in peak spawning periods of others. Coral spawning also occurs in the region during the proposed Activity. There is potential for a hydrocarbon spill to result in localised mortality of plankton due to reduced water quality and toxicity from entrained hydrocarbons. Effects will be greatest in the upper 10 m of the water column and areas close to the spill source where hydrocarbon concentrations are likely to be highest. In the unlikely event of a spill occurring, plankton may be impacted by MDO entrained in the water column. However, following release, the MDO will rapidly evaporate and disperse in the offshore environment, reducing the concentration and toxicity of the spill. Given duration of fish spawning periods, lack of suitable habitat for aggregating fish populations near the surface, combined with the quick evaporation and dispersion of MDO, impacts to overall fish populations are not expected to be significant. Any planktonic communities (including fish and coral eggs and larvae) impacted by entrained hydrocarbons are expected to recover quickly (weeks/months) due to fast population turnover (ITOPF 2011), and high rates of natural mortality. Given the fast population turnover of open water planktonic populations it is considered that any potential impacts will be low and temporary in nature.
Marine mammals	Eleven migratory marine mammal species were identified by the EPBC Protected Matters search within the EMBA (Table 3-14). Of these, one is listed as endangered (blue whale (considered to be the pygmy blue whale sub-species)) and two as vulnerable (fin whale and sei whale). Additionally, the Omura's whale is reported to occur year-round in the JBG (McCauley 2009, 2014). The hydrocarbon spill EMBA overlaps breeding, calving, resting and foraging BIAs for Australian snubfin dolphins and breeding, foraging and calving for Indo-Pacific humpback dolphins. The EMBA also overlaps the migration and foraging BIAs for pygmy blue whales and the breeding/calving/nursing/resting and migration BIAs for humpback whales (Figure 3-7). These species are expected to be present in the EMBA in low numbers and limited to isolated individuals or small pods. Therefore, marine mammals within the EMBA are expected to be transient and in the unlikely event of a spill occurring, they are not expected to remain in the vicinity of spilled hydrocarbons for extended periods. For environmental impacts through hydrocarbon exposure and toxicity to marine mammals, refer to Table 7-8.
Marine reptiles	Eight species of threatened marine reptile and one migratory species were identified as possibly being impacted by a spill. Short-nosed seasnake, leaf-scaled seasnake, flatback, hawksbill, leatherback, green, olive ridley and loggerhead turtles and salt-water crocodiles are widely dispersed at low densities across the region and in the unlikely event of a MDO spill occurring, individuals traversing open water may come into contact with water column or surface MDO. The hydrocarbon spill EMBA overlaps with flatback, green, hawksbill, loggerhead and olive ridley turtle foraging BIAs (refer to Section 3.7.4). Oil spill modelling predicted that the foraging BIAs may be partially exposed to high concentrations of sea surface hydrocarbons (50 g/m^3), high concentrations of dissolved hydrocarbons (400 ppb) and high concentrations of entrained hydrocarbons (100 ppb). The EMBA also overlaps with 'habitat critical' for internesting for flatback, green and olive ridley turtles, and internesting BIAs for flatback, green, hawksbill and olive ridley turtles. Spill modelling predicted shoreline contact at or above both the low (10 g/m^2) and moderate threshold (100 g/m^2) exposure values to reach the internesting BIAs for flatback turtles in the JBG and at Melville Island (Tiwi Islands), green turtles at Melville Island (Tiwi Island) and olive ridleys at Fog Bay. Therefore, there is a risk of transient adults encountering surface and submerged MDO, as well as nesting individuals encountering shoreline hydrocarbons. A hydrocarbon spill within the Operational Area may result in impacts to individual marine turtles and a potential disruption to a portion of the foraging/internesting habitat; however this is not expected to result in a threat to the overall population viability due to the rapid dispersion of MDO. For environmental impacts through hydrocarbon exposure and increased toxicity to marine reptiles, refer to Table 7-8. The Recovery Plan for Marine Turtles in Australia: 2017-2027 (DoEE 2017) highlights acute chemical discharge as one of several threats to marine turtles.
Seabirds and migratory shorebirds	Twenty-six threatened bird species, as identified by the EPBC Protected Matters database search may be encountered during the Activity (refer to Table 3-17). Three of the threatened bird species may occur in the Operational Area, with the remaining species potentially present within the EMBA. The EMBA overlaps breeding BIAs for 10 bird species, foraging area for nine species and a resting BIA for one species (refer to Section 3.7.6). All the BIAs are located a minimum distance of 75 km away and therefore, are only predicted to be impacted by surface oil at or above the lowest threshold (1 g/m^2) exposure values. Oil spill modelling predicted both shoreline contact at or above the lowest (10 g/m^2) and moderate (100 g/m^2) thresholds, and floating oil at or above the lowest threshold (1 g/m^2) to reach territory waters. Therefore, surface and shoreline MDO may impact nesting or egg laying individuals in colonies. Breeding individuals

Receptor	Impacts of MDO
	may also come into contact with surface or submerged MDO while foraging (diving and skim feeding). Although breeding oceanic seabird species can travel long distances to forage in offshore waters, most breeding seabirds tend to forage in nearshore waters near their breeding colony, resulting in intensive feeding by higher seabird densities in these areas during the breeding season and making these areas particularly sensitive in the event of a spill. However, given the rapid evaporation and dispersion of MDO, significant impacts at the population level are not anticipated and therefore the risk of surface and submerged MDO to seabirds is considered low. Potential impacts to seabirds/shorebirds from exposure/contact with MDO are further detailed in Table 7-8.
Fish, sharks and rays	The JBG supports a diverse assemblage of fish, particularly in shallower water near the mainland and islands. Fifteen threatened and/or migratory species of sharks, fish and rays identified by the EPBC PMST Report including the great white shark, oceanic whitetip shark, scalloped hammerhead, northern river shark, speartooth shark, shortfin and longfin mako shark, whale shark, green, freshwater, dwarf and narrow sawfish, southern blue fin tuna, giant manta ray and reef manta ray may be present in the affected area (refer to Table 3-16). Given the absence of critical habitat for most of these species, significant numbers are not expected to be impacted. The western portion of the EMBA overlaps with a whale shark foraging BIA (approximately 205 km from the Operational Area). This BIA represents waters where solitary whale sharks may forage during the migration from Ningaloo, which occurs primarily in Spring (September to November). Therefore, any whale sharks located in offshore waters within the JBG are most likely transiting the region. Oil spill modelling predicted that the BIA will be exposed to both to low (10 ppb) and moderate (100 ppb) concentrations of entrained hydrocarbons (refer to Section 7.1.2.5). Other species of sharks and rays could be present at low densities all year round within the Operational Area and EMBA, however, the absence of any known feeding, resting or breeding areas means significant numbers are unlikely to be impacted if an unplanned release were to occur. Fish populations in the open water, offshore environment of the Operational Area and EMBA are highly mobile and have the ability to move away from a marine diesel spill. The spill affected area will likely be confined to the upper surface layers (0-10 m). It is therefore unlikely that fish populations would be exposed to hydrocarbon contamination. Fish populations are likely to be distributed over a wide geographical area so impacts on populations or species level are considered to be negligible. Combined with these factors and the rapid dispersion of marine diesel, it is considered that any potential impacts will be negligible. For further detailed environmental impacts through hydrocarbon exposure and toxicity effects, refer to Table 7-8.
Socio-economic	
Fisheries	MDO in the water column can have toxic effects on fish (as outlined above) reducing catch rates and rendering fish unsafe for consumption. In addition to the effects of total submerged and dissolved hydrocarbons, exclusion zones surrounding a spill can directly affect fisheries by restricting access for fishers. Both water column and surface MDO have the potential to lead to temporary financial losses.
Tourism	Tourism and recreational activities in the region occur predominantly in State/Territory waters adjacent to population centres, such as Broome and Darwin. Charter vessels may occasionally transit through the Operational Area and EMBA between Darwin and the northern Kimberley coastline, however interactions with the Eos 3D MSS are considered unlikely due to the remoteness and predominantly deep waters of the Operational Area. In the unlikely event of a marine diesel spill, there is the potential for specific sites close to the spill or areas affected by visible hydrocarbons to be temporarily closed to recreational activities, which may inconvenience tourism and charter boat operators that may have to conduct their activities elsewhere.
Shipping	Vessel traffic passes through the southern part of the Operational Area between Darwin and Kalumburu, and through the northern part of the Operational Area between Darwin and the INPEX Ichthys and Shell Prelude offshore LNG facilities (Figure 3-26). In the event of a vessel collision and significant marine diesel spill, the AMSA Joint Rescue Coordination Centre may issue a warning to shipping traffic in the area to avoid the incident location. Exclusion zones surrounding a spill will reduce access for shipping vessels for the duration of the response undertaken for spill clean-up (if applicable); vessel may have to take large detours leading to potential delays and increased costs.
Defence	The Operational Area overlaps with the North Australian Exercise Area (NAXA). In the unlikely event of a marine diesel spill, there is the potential for some interference with defence activities in the NAXA. This may include the immediate area of the incident and an area where volatile aromatic vapours evaporating from the sea surface may present a safety hazard.
Shipwrecks	Surface hydrocarbons will have no impact on shipwrecks. Hydrocarbons in the water column from a vessel collision will remain in the surface waters and are therefore unlikely to have an impact on shipwrecks.

Receptor	Impacts of MDO
Indigenous	The level of activities undertaken by indigenous users is expected to be low, if any, therefore interference due to an MDO spill are likely to be minimal.
Existing oil and gas activity	The Bonaparte Basin is an established hydrocarbon province with a number of commercial operations including other Santos' activities. Exclusion zones surrounding spills will reduce access potentially leading to delays to work schedules with subsequent financial implications.
KEFs	KEFs overlapping the EMBA are described in Section 3.6.1 and are summarised below. • Pinnacles of the Bonaparte Basin – Areas of hard substrate in an otherwise soft sediment environment – Rise steeply from depths of about 80 m to emergent within 30 m of the water's surface – Important for sessile species and allow light dependent organisms to thrive – Support communities of benthic invertebrates and aggregations of demersal fish species – Biodiversity hotspot for sponges • Carbonate bank and terrace system of the Sahul Shelf – Unique seafloor feature supporting relatively high species diversity – Enhances biodiversity and local productivity relative to its surrounds – Areas of hard substrate in an otherwise soft sediment environment – Rise steeply from depths of about 80 m to emergent within 30 m of the water's surface – Important for sessile species and allow light dependent organisms to thrive – Biodiversity hotspot for sponges – Known foraging area for flatback, olive ridley and leatherback turtles. • Carbonate bank and terrace system of Van Diemen Rise – Areas of hard substrate in an otherwise soft sediment environment; banks, ridges and terraces – Enhances biodiversity and local productivity relative to its surrounds – Biodiversity hotspot for sponges – Known foraging area for olive ridley turtles, seasnakes and sharks. • Shelf break and slope of the Arafura Shelf – Unique biogeographic province – Oceanographic and atmospheric processes that influence pelagic nutrients dispersion – High ecological significance associated with productivity emanating from the slope of the Arafura Shelf Drives long-term patterns of larvae and juvenile dispersal across the area. • Ancient coastline at 125 m depth contour – Areas of hard substrate in an otherwise soft sediment environment – Contributes to higher diversity and enhanced species richness – Attracts opportunistic feeding by larger marine life including humpback whales, whale sharks and large pelagic fish. • Continental slope demersal fish communities – High level of endemism and diversity of demersal fish – Attracts high order consumers including carnivorous fish, deepwater sharks, large squid and toothed whales.

Receptor	Impacts of MDO
	• Ashmore Reef and Cartier Island and surrounding Commonwealth Waters – Biodiversity hotspot supporting a diverse array of pelagic and benthic marine species – Enhanced primarily productivity in an otherwise low-nutrient environment, attracting aggregations of marine life – Regionally important for feeding and breeding aggregations of birds and other marine life, including an unusually high diversity of seasnakes, a genetically distinct breeding population of green turtles and foraging grounds for green, loggerhead and hawksbill turtles. • Seringapatam Reef and Commonwealth Waters in the Scott Reef Complex – Consists of two separate reef formations with an area of approximately 2,418 km² – High primary productivity and high species richness associated with the reefs – Coral communities play a key role in maintaining species abundance and the aggregation of marine life in the region – Green and hawksbill turtles nest during the summer months on Sandy Islet on South Scott Reef. Both species also internest and forage in the surrounding areas – Provides foraging areas for seabird species such as the lesser frigatebird, wedge-tailed shearwater, brown booby and roseate tern. The Carbonate Bank and Terrace System of the Sahul Shelf, the Carbonate Bank and Terrace System of the Van Diemen Rise, and the Ancient Coastline at 125 m depth contour are the only KEFs predicted to be exposed to concentrations of entrained hydrocarbons above the moderate exposure values. The other KEFs have a low probability of contact with entrained hydrocarbons above the low exposure value only. The values and sensitivities of the KEFs are generally related to benthic habitats and communities which support areas of enhanced diversity and productivity. A loss of MDO to the marine environment would result in a localised reduction in water quality in the upper surface waters of the water column and therefore impacts to the habitats of the KEFs is not considered likely. Impacts to sensitivities within the upper waters above the KEFs are outlined above.
Australian Marine Parks	Australian Marine Parks are described in Section 3.5.1 and potential impacts to protected areas are discussed in Section 7.1.6. Marine Protected Areas within the EMBA include: • JBG AMP • Oceanic Shoals AMP • Kimberley AMP • Cartier Island AMP. Also, Ashmore Reef AMP is 10 km from the EMBA. The JBG AMP is the only AMP predicted to be exposed to concentrations of both surface and entrained hydrocarbons above the moderate exposure values, predicted from release Location 2, located south of the Operational Area. However the modelling predicts only a 0.67% probability of surface exposure and 9.33% probability of entrained exposure at this threshold. The Kimberley AMP and Oceanic Shoals AMP are also predicted to have a 7% and 2% chance, respectively, of being exposed to entrained hydrocarbons above the moderate exposure value. The other AMPs have a low probability (<0.33%) of contact with entrained hydrocarbons above the low exposure value only. The EMBA partially overlaps with the Multiple Use Zone (IUCN VI) and Special Purpose Zone (IUCN VI) of the JBG AMP. The designated natural values of the JBG AMP include a range of species (including species listed as threatened, migratory, marine or cetacean under the EPBC Act), and foraging habitat for marine turtles and the Australian snubfin dolphin. Potential impacts to these values from a worst-case marine diesel spill within the Operational Area are assessed in the subsections above. Additionally, exposure to hydrocarbons at the JBG AMP was only predicted from release Location 2, located south of the Operational Area, and therefore the probability of oil exposure is considered conservative. The EMBA partially overlaps with the Multiple Use Zone (IUCN VI) and Special Purpose Zone (IUCN VI) of the Oceanic Shoals AMP. The designated natural values of the Oceanic Shoals AMP include a range of species (including species listed as threatened, migratory, marine or cetacean under the EPBC Act), and foraging and internesting habitat for marine turtles. Potential impacts to these values from a worst-case marine diesel spill within the Operational Area are assessed in the subsections above. Potential impacts to commercial fisheries occurring within the Multiple Use Zone of the Oceanic Shoals AMP are assessed below.

Receptor	Impacts of MDO
	The EMBA partially overlaps with the Multiple Use Zone (IUCN VI) of the Kimberley AMP. The designated natural values of the marine park include a range of species (including species listed as threatened, migratory, marine or cetacean under the EPBC Act), and foraging and nesting habitat for dolphin species (including Australian snub-fin dolphin, Indo-Pacific humpback dolphin and spotted bottlenose dolphin). Potential impacts to these values from a worst-case marine diesel spill within the Operational Area are assessed in the subsections above. The EMBA partially overlaps with the Sanctuary Zone (IUCN Ia) of the Cartier Island AMP. The designated natural values of the marine park include a range of species (including species listed as threatened, migratory, marine or cetacean under the EPBC Act), and foraging and nesting habitat for marine turtle and seabird and migratory shorebird species. Potential impacts to these values from a worst-case marine diesel spill within the Operational Area are assessed in the subsections above. The EMBA is approximately 10 km offshore from the Sanctuary Zone (IUCN Ia) and Recreational Use Zone (IUCN IV) of the Ashmore Reef Marine Park. The designated natural values of the marine park include a range of species (including species listed as threatened, migratory, marine or cetacean under the EPBC Act), and foraging and nesting habitat for marine turtles, dugongs and seabird and migratory shorebird species. Potential impacts to these values from a worst-case marine diesel spill within the Operational Area are assessed in the subsections above.

7.1.4 Environmental performance outcomes and control measures

Environmental Performance Outcomes relating to this hazard include:

EPO-16: Protect and maintain biological diversity and other natural, cultural and heritage values of the North-west Marine Parks Network and North Marine Parks Network.

EPO-20: No unplanned objects, emissions or discharges to sea or air.

EPO-22: No injury to marine fauna during the Activity.

EPO-23: No long-term environmental impact in the event of an unplanned hydrocarbon release to sea.

The Control Measures considered for this Activity are shown below; Environmental Performance Standards and Measurement Criteria for the EPOs are described in Section 8.6.1.

Table 7-10: Control measures evaluation for an MDO release from vessel collision

CM Ref.	Control measure (CM)	Environmental benefit	Potential cost/issues	Evaluation
Standard control measures				
Eliminate				
None identified.				
Substitute				
CM-36	MARPOL-compliant fuel oil (MDO) will be used during the Activity	Use of MDO reduces the potential impacts to marine environment in the event of unplanned hydrocarbon spills or leaks during bunkering.	Additional personnel costs of ensuring vessels are using the required fuel.	**Adopted** – benefits of ensuring procedures are followed outweighs the minimal costs of personnel time.
Engineering				
CM-2	Vessels fitted with AIS systems and radars (virtual or installed) to mark the location of seismic streamer tail buoys.	Reduces risk of impact from vessel collisions.	Negligible as the seismic vessel should be fitted with AIS.	**Adopted** – The safety benefits of having AIS outweigh any costs. This is a maritime requirement.
Isolation				
CM-3	Exclusion (safety) zone established to reduce potential for collision or interference with other marine user activities.	Requested 3 nm (5.6 km) exclusion (safety) zone around the seismic vessel and trailing streamers prevents other vessels from getting too close and causing damage to equipment of either party.	No additional costs to Santos. Other marine users may be temporarily excluded from areas, disrupting their activities.	**Adopted** – The requested exclusion of other marine users is temporary. Marine users will still be able to access the Operational Area. Normal navigation at sea process whereby shipping vessels avoid navigational risks. Hence, the safety benefits to all marine users outweighs any potential costs.
Administration				
CM-4	Maritime notices (Notice to Mariners and AUSCOAST warnings)	Ensures other marine users are aware of the presence of the seismic vessel and trailing streamers, and the relatively slow speed and restricted manoeuvrability of the seismic vessel.	Costs associated with the personnel time in issuing notifications and closing out queries and responses	**Adopted** – benefits considered to outweigh negligible costs. Maritime requirement to issue marine notices.
CM-1	Navigation equipment and procedures	Reduces the risk of interference and collisions with other marine users.	Negligible costs of acquiring and operating navigation equipment, as required by maritime law.	**Adopted** – The safety benefits of having navigation equipment and procedures outweighs any cost. This is a maritime requirement.

CM Ref.	Control measure (CM)	Environmental benefit	Potential cost/issues	Evaluation
Protective				
CM-8	Support vessel and/or chase vessel in place during Activity to reduce potential for collision or interference with other marine users.	Identifies and communicates with approaching third-party vessels to ensure exclusion (safety) zone is observed, preventing potential interaction or interference.	Additional costs of contracting a support vessel.	**Adopted** – the benefits from having a support vessel and chase vessel during the Activity to assist with managing third-party vessels outweighs the cost.
CM-9	Constant bridge watch	Crew of support vessels and the seismic vessel will maintain constant bridge watch, including for third party vessels which may be approaching or enter the exclusion (safety) zone.	No additional costs.	**Adopted** – no additional costs. This is a maritime requirement.
CM-41	Restrictions on how small volumes of unused IFO and HFO must be stored on a vessel, including restricting volumes and limiting storage to tanks that do not have direct exposure to the marine environment. If IFO or HFO is proposed to be on board then this will be risk assessed. For the vessel to store IFO or HFO then the risk assessment must conclude that the high cost of removing and disposing of the IFO or HFO onshore is grossly disproportionate to the low risk of a vessel collision and rupture of an in-board fuel tank containing small volumes of the fuel.	Restricting volumes of unused IFO and HFO and limiting storage to tanks that do not have direct exposure to the marine environment minimises the risk of a spill. Retaining the fuel oil on-board eliminates the need to transfer the fuel onshore as a waste product.	Additional costs associated with removal and disposal of IFO or HFO onshore if requirements for onboard are unable to be met.	**Adopted** – benefits of restricting volumes of unused IFO and HFO stored onboard and limiting storage to tanks that do not have direct exposure to the marine environment outweighs the potential costs of removal for onshore disposal if these requirements are unable to be met.
CM-42	Oil pollution emergency plan (OPEP)	The OPEP outlines response plans to be implemented in the event of an unplanned hydrocarbon release quickly and efficiently in order to reduce impacts to the marine environment.	Administrative costs of preparing documents and large costs of preparing for and implementing response strategies.	**Adopted** – benefits of ensuring procedures are developed and followed and measures implemented outweighs the costs.
CM-43	Vessel spill response plans (SOPEP/SMPEP)	Vessel spill response plans (SOPEP/SMPEP) outline responses to be implemented in the event of an unplanned release quickly and efficiently in order to reduce impacts to the marine environment.	Administrative costs of preparing documents and large costs of implementing response strategies.	**Adopted** – benefits of ensuring procedures are followed and measures implemented, and that the vessel is compliant outweighs the costs.

CM Ref.	Control measure (CM)	Environmental benefit	Potential cost/issues	Evaluation
Additional control measures				
Eliminate				
None identified.				
Substitute				
None identified.				
Engineering				
None identified.				
Isolation				
CM-44	Maximum volume of fuel stored in a single tank of vessels used for the Activity will not exceed 1,065 m^3.	Reduces the volume of MDO that can be lost to the marine environment in event of a vessel collision.	Limits the vessels that can be contracted to undertake the Activity, could result in additional bunkering during the Activity if largest volume stored in a single fuel tank is limited to 1,065 m^3 and the tanks are larger in volume (therefore less tanks in the vessel).	**Adopted** – benefits of ensuring volume is less than 1,065 m^3 outweighs the potential to not be able to contract a vessel.
Administration				
None identified.				
Protective				
N/A	Dedicated resources (e.g. dedicated spill response facilities on location) in the event of loss of hydrocarbons to allow rapid response	May allow for quicker response to a spill as resources will be within close proximity.	Large costs associated with mobilising a dedicated resource at the location. Modelling predicts 80% of the hydrocarbon will entrain and 15% will evaporate within 24 hours under variable winds (Figure 7-2). Therefore, dedicated response resources are unlikely to offer a net environmental benefit.	**Not Adopted** – Large cost associated with dedicated resources.

7.1.5 Spill response strategies for MDO release from vessel collision

There are numerous oil spill response strategies available to be implemented in the event of a spill. These are generally strategies which have been implemented in the past or considered good industry practice. Table 7-11 is the outcome of the first level screening undertaken based on the suitability of the broad response strategies available.

The evaluation of the suitable response strategies was conducted based on the credible spill scenarios identified. Below are the key considerations that were taken into account for the evaluation:

The properties and weathering profile of the spilled oil

The philosophy of the responses

The nature and scale of the credible spill scenario

The potential safety and environmental aspects, and impacts involved with the selected responses.

Table 7-11: Spill response strategies considered for the mitigation of contact from MDO release from vessel collision

Strategy	Description	Evaluation	Adopt/ Reject
Source Control	A vessel collision may result in the release of all or part of a storage tank or fuel tank contents, releasing hydrocarbons to the marine environment. In the event that a vessel fuel tank is ruptured, cargo of the affected tank is to be secured via transfer to another storage area on-board the vessel, transfer to another vessel, or through pumping in water to affected tank to create a water cushion (tank water bottom). Trimming the vessel may also be used to avoid further damage to intact tanks.	Through the implementation of these actions, the volume of hydrocarbons released to the marine environment may be reduced. However, there are several influencing factors that would result in delay or inability to implement controls, potentially resulting in a full discharge of a fuel tank compartment; such as a high sea state, a significantly large rupture, or injuries to personnel.	**Adopted**
Monitor and Evaluate / Surveillance	Operational monitoring is a fundamental aspect of a spill response and used to gain situational awareness of the incident through various surveillance actions. Monitoring is used to assess the nature and scale of the spill, the current and projected movement of the spill, the physical and chemical properties of the spill over time and the actual and potential contact of the spill with sensitive receptors. There are various specific control measures (vessel/aerial surveillance, tracking buoys, operational water quality monitoring, oil spill modelling, remote sensing/satellite imagery) within this response strategy which may be suitable.	The use of various operational monitoring techniques, in combination or individually, will be determined based on the spill distribution as well as other considerations such as access to locations, environmental and metocean conditions. This strategy is vital to ensure that there is sufficient information to gain situational awareness and make informed decisions on response planning and execution. Data from monitor and surveillance activities will be used to inform the NEBA and used to assist in escalating or de-escalating response strategies as required.	**Adopted**
Chemical Dispersant	Chemical dispersant is applied, either by vessel or aircraft, to break down the hydrocarbons and allow/enhance dispersion into the water column, potentially preventing/reducing shoreline contact and increasing natural rates of biodegradation.	Removes/disperses hydrocarbons from the surface and encourages entrainment into the water column, thereby enhancing biodegradation and dilution. This potentially results in increased volumes of hydrocarbon in the water column, but less on the sea surface. Therefore, there is the potential to prevent/reduce shoreline contact to sensitive receptors and a potential to result in higher entrained hydrocarbon concentrations, which may impact organisms in the water column. MDO is not considered a persistent hydrocarbon and has high natural rates of evaporation and dispersion in the marine environment (95% of the hydrocarbon expected to evaporate or disperse after 24 hours under variable winds). This has been assessed through spill modelling of conservative worst-case scenarios. All spill scenarios are short term releases and oil will undergo rapid weathering of those components that dispersants are most effective on. MDO slicks will break apart into wind rows with low surface thickness (rainbow and metallic sheens) given the very low viscosity of the hydrocarbon. Chemical dispersants have a window of opportunity, after which effectiveness decreases. Modelling indicates that 95% of the hydrocarbon with naturally disperse or evaporate over 24 hours under variable winds. Therefore, surface dispersant application is unlikely to provide any benefit over natural attrition and evaporation. Dispersant use is not considered to be effective on the spill scenarios given they are not continuous releases and slick characteristics amenable to	**Rejected**

Strategy	Description	Evaluation	Adopt/ Reject
		dispersant operations will unlikely be present by the time dispersant operations are mobilised. This reasoning is consistent with ITOPF guidance (ITOPF 2011) which advises against the use of dispersant on light products such as MDO given the high natural rates of evaporation/dissipation and rapid spreading.	
Mechanical Dispersion	Physical dispersion is undertaken by running support vessels through the hydrocarbon plume and using the turbulence developed by the propellers or hydroblasting from vessel hydrants to break up the slick. Once dispersed in the water column in the form of smaller droplet sizes, biodegradation processes are enhanced.	MDO is a light oil that can be easily dispersed in the water column by running vessels through the plume and using the turbulence developed by the propellers to break up the slick. Once dispersed in the water column the smaller droplet sizes enhance the biodegradation process. Caution must be applied during the volatilisation period of the oil due to potential safety and human health issues.	**Adopted**
Containment and Recovery	Containment and recovery of hydrocarbons through the use of offshore boom and skimmers from vessels can prevent oil from reaching sensitive features. This strategy is only effective in calm conditions and may not be an effective use of resources if oil cannot be thickened to a point where worthwhile volumes are collected.	Given the fast spreading nature of MDO/MGO and the expected moderate to high sea states of the area causing the slick to break up and disperse, this response is not considered to be effective in reducing the net environmental impacts of an MDO/MGO spill. The ability to contain and recover these spreading oils (i.e. surface sheens) on the sea surface is extremely limited due the very low viscosity of the fuel.	**Rejected**
Shoreline Protection and Deflection	Shoreline protection and deflection activities involve the use of booms to: • Protect sensitive receptors • Deflect spills away from sensitive receptors or shorelines; or • Deflect spills to an area that provides increased opportunity for recovery activities. This strategy is typically not effective in areas experiencing large tidal variations and associated currents.	Modelling predicted shoreline contact above the low and moderate exposure threshold from a spill at either of the two release locations. Therefore, shoreline protection and deflection may be a relevant strategy for the purposes of this EP. The tactics and suitability of this response strategy will rely on the monitoring and modelling outcomes to indicate that shoreline sensitivities may be impacted at the time of the response.	**Adopted**
Shoreline Clean-Up	During a spill response, clean-up of the oiled shorelines will be implemented using suitable methods, provided it will be beneficial to the environment based on the NEBA performed on the affected areas based on actual site conditions.	Modelling predicted shoreline contact above the moderate exposure threshold (actionable) from a spill at either of the two release locations. Therefore, shoreline clean-up is considered a relevant strategy for the purposes of this EP. The tactics and suitability of this response strategy will rely on the monitoring and modelling outcomes to indicate that shoreline sensitivities may be impacted at the time of the response.	**Adopted**
In-Situ Burning	In-situ burning is a technique sometimes used in responding to an oil spill. In-situ burning involves the controlled burning of oil that has spilled at the location of the spill. When conditions are favourable and conducted properly, in-situ burning will reduce the amount of oil on the water.	MDO/MGO disperses and entrains rapidly and is not suitable to be contained by in-situ burning (as described above for containment and recovery). In addition, as the slick thins, its insulating capacity weakens and more heat is lost to the water beneath the slick, eventually resulting in insufficient heat to continue to vaporise the oil and sustain combustion.	**Rejected**
Oiled Wildlife Response (OWR)	Responding to an oiled wildlife incident will involve an attempt to prevent wildlife from becoming oiled and/or the treatment of animals that do become oiled.	The Protection Priorities identified for spill response include sensitive fauna (e.g. protected birds and turtles) that may be seasonally abundant and undertake key lifecycle processes near shorelines. Mobilisation of experts, trained work forces, facilities and equipment will likely be needed if oil	**Adopted**

Strategy	Description	Evaluation	Adopt/ Reject
		reaches shorelines and nearshore waters. Wildlife response activities may take place at sea, on shorelines and in specialised facilities further inland. Options for wildlife management have to be considered and a strategy determined guided by the WA Oiled Wildlife Response Plan (WAOWRP) and NT Oiled Wildlife Response Plan.	
Scientific Monitoring	This is the main tool for determining the extent, severity and persistence of environmental impacts from an oil spill and allows operators to determine whether their environmental protection outcomes have been met (via scientific monitoring activities). This strategy also evaluates the recovery from the spill.	Scientific monitoring is especially beneficial for the purpose of monitoring entrained and dissolved oil impacts as response strategies are generally targeted to manage the floating oil impacts.	**Adopted**

7.1.6 Identification of hotspots for consequence analysis

While the entire EMBA is considered during risk assessment and spill response planning, it is best practice to concentrate the greatest effort and level of detail on the HEVs – i.e. those parts of the EMBA that have greatest intrinsic environmental value and are impacted by high probability and/or concentration of oil (the approach is summarised in Section 7.1.3).

All receptors within the EMBA (low exposure value) are listed in Table 7-12. These have been filtered to identify the hot spots where they meet the criteria described in Section 7.1.3. Any hotspots that deviate from the process (i.e. discretionary hotspots) have been indicated as such, and further information on the rationale provided. The values and sensitivities associated with these receptors have been described in Appendix I.

Table 7-12: Identified hotspots receptors – Eos 3D MSS MDO vessel spill

Receptor	EV ranking	Exposure value			Hotspot[1]	Hotspot selection rationale
		Low	Moderate	High		
JBG South Coast	1	✓				
Van Dieman Gulf Coast	1	✓				
Kimberley Coast PMZ	2	✓				
Camden Sound	3	✓				
Cobourg Peninsula-Nhulunbuy	3	✓				
Joseph Bonaparte Gulf AMP*[2]	3	✓		✓	Yes	Meets default criteria
Kimberley AMP*[2]	3	✓		✓	Yes	Meets default criteria
Scott Reef South	3	✓				
Adele Island	4	✓				
Ashmore-Cartier – Outer*	4	✓				
Beagle Gulf-Darwin Coast	4	✓				
Browse Island	4	✓				
Cartier Island AMP	4	✓				
Gale Bank*	4	✓				
JBG East Coast	4	✓	✓	✓	Yes	Discretionary hotspot: 37 m^3 maximum accumulated shoreline volume and 10 km shoreline oiling (≥100 g/m^2). 164 hours (~6 days, 20 hours) until shoreline accumulation (≥100 g/m^2) at 1.7% probability.
JBG West Coast	4	✓				
Johnson Bank*	4	✓				
Outer Oceanic Shoals AMP*	4	✓				
Scott Reef North	4	✓				
Seringapatam Reef	4	✓				
The Boxers Area*	4	✓				
Van Cloon-Deep Shoals*[2]	4	✓		✓	Yes	Meets default criteria
Afghan Shoal*	5	✓				
Barracouta Shoals*	5	✓				
Beagle and Dingo Reefs	5	✓				
Djukbinj NP	5	✓				

Receptor	EV ranking	Exposure value			Hotspot[1]	Hotspot selection rationale
		Low	Moderate	High		
Echuca Shoals*	5	✓				
Eugene McDermott Shoal*	5	✓				
Flat Top Bank*	5	✓				
Hancox Shoal*	5	✓				
Harris Reef	5	✓				
Heywood Shoals*	5	✓				
Holothuria Banks North*	5	✓				
Lowry Shoal*	5	✓				
Margaret Harries Bank*	5	✓				
Marsh Shoal*	5	✓				
Mavis Reef	5	✓				
Moresby Shoals*	5	✓				
Newby Shoal*	5	✓				
Penguin Shoal*	5	✓				
Shepparton Shoal*	5	✓				
Skottowe Shoal*	5	✓				
Sunrise Bank*	5	✓				
Tiwi Islands	5	✓	✓	✓	Yes	Discretionary hotspot on basis of cultural heritage significance.17 m^3 maximum accumulated shoreline volume and 5 km of shoreline oiled (≥100 g/m^2). 253 hours (~10 days, 12 hours) until shoreline accumulation (100 g/m^2), albeit at very low (0.33%) probability.
Van Diemen Gulf Shoals	5	✓				
Vernon Islands CR	5	✓				
Vulcan Shoals*	5	✓				
Woodbine Bank*	5	✓				

1: >5% probability of contact at the medium/high exposure value, or discretionary hotspot, for consideration for further Hot Spot assessment.

2: No contact at moderate exposure threshold because entrained oil does not have a moderate exposure value.

**: Submerged receptor*

This process identified the following hot spots:

- Joseph Bonaparte Gulf AMP
- Kimberley AMP
- JBG East Coast
- Van Cloon Deep Shoals
- Tiwi Islands.

Table 7-13 provides a simplified summary of the consequence assessment results for each of the hot spots for the two sets of model outputs. The consequence assessment was based on predicted contact and concentration of

surface oil, accumulated oil, entrained hydrocarbon and dissolved hydrocarbons. For each hot spot area the consequence to the key values were assessed using the methodology described in Section 7.1.3.

Table 7-13: Hotspot consequence assessment results from surface release of MDO

Receptor name	HEV ranking	Values	Oil spill modelling parameter		Eos	Consequence category	Worst-case consequence ranking	Total
JBG East Coast	4	**Habitats** • Hard substrate, • Beaches, • Mudflats, • Saltmarshes • Fish and sponge habitat **Marine Fauna** • Benthic invertebrates • Demersal fish aggregations • Turtle Habitats • Migratory whales and marine mammals • Threatened and Migratory Birds	Probability of contact by surface oil at 10 g/m^2	(%)	<0.33	• Physical habitat • Protected Areas	II – Minor II – Minor	II – Minor
			Minimum time to contact by surface oil 10 g/m^2	Time (d)	NC			
			Maximum oil loading on shorelines >100g/m^2	(tonnes)	26			
			Maximum accumulated concentration >100g/m^2	(g/m^2)	541			
			Maximum length of shoreline oiled (>100 g/m^2)	(km)	10			
			Maximum concentration of entrained hydrocarbon >100 ppb	(ppb)	789			
			Maximum concentration of dissolved aromatic hydrocarbon >10 ppb	(ppb)	31			
JBG AMP (submerged receptor)	3	**Habitats** • Reefs, shoals and sand banks • Fish and sponge habitat **Marine Fauna** • Benthic invertebrates • Demersal fish aggregations • Turtle Habitats • Migratory whales and marine mammals	Probability of contact by surface oil at 10 g/m^2	(%)	0.667	• Physical habitat • Threatened / Migratory Fauna • Protected Areas • Socio-economic and heritage receptors	II – Minor II – Minor II – Minor II – Minor	II – Minor
			Minimum time to contact by surface oil 10 g/m^2	Time (d)	3			
			Maximum oil loading on shorelines >100g/m^2	(tonnes)	NA			
			Maximum accumulated concentration >100g/m^2	(g/m^2)	NA			
			Maximum length of shoreline oiled (>100 g/m^2)	(km)	NA			
			Maximum concentration of entrained hydrocarbon >100 ppb	(ppb)	2,166			
			Maximum concentration of dissolved aromatic hydrocarbon >10 ppb	(ppb)	38			

Receptor name	HEV ranking	Values	Oil spill modelling parameter		Eos	Consequence category	Worst-case consequence ranking	Total
Kimberley AMP (submerged receptor)	3	**Habitats** • Hard substrate • Benthic invertebrates and habitats • Mangroves **Marine Fauna** • Benthic habitats and communities • Migratory whales and marine mammals • Turtle Habitats and nesting • Threatened and Migratory Birds	Probability of contact by surface oil at 10 g/m^2	(%)	<0.33	• Physical habitat • Threatened / Migratory Fauna • Socio-economic and heritage receptors	II – Minor II – Minor II – Minor	II – Minor
			Minimum time to contact by surface oil 10 g/m^2	Time (d)	NC			
			Maximum oil loading on shorelines >100g/m^2	(tonnes)	NA			
			Maximum accumulated concentration >100g/m^2	(g/m^2)	NA			
			Maximum length of shoreline oiled (>100 g/m^2)	(km)	NA			
			Maximum concentration of entrained hydrocarbon >100 ppb	(ppb)	1,044			
			Maximum concentration of dissolved aromatic hydrocarbon >10 ppb	(ppb)	21			
Van Cloon Deep Shoals (submerged receptor)	4	**Habitats** • Non-coral benthic habitats (filter feeders, sponges, crinoids) **Marine Fauna** • Benthic habitats and communities • Turtle habitats – Loggerhead, flatback and olive ridley turtle foraging area (BIA)	Probability of contact by surface oil at 10 g/m^2	(%)	<0.33	• Threatened / migratory / local fauna • Physical habitat • Protected areas • Socio-economic receptors	II – Minor II – Minor II – Minor II – Minor	II – Minor
			Minimum time to contact by surface oil 10 g/m^2	Time (d)	NC			
			Maximum oil loading on shorelines >100g/m^2	(tonnes)	NA			
			Maximum accumulated concentration >100g/m^2	(g/m^2)	NA			
			Maximum length of shoreline oiled (>100 g/m^2)	(km)	NA			
			Maximum concentration of entrained hydrocarbon >100 ppb	(ppb)	1,573			
			Maximum concentration of dissolved aromatic hydrocarbon >10 ppb	(ppb)	38			

Receptor name	HEV ranking	Values	Oil spill modelling parameter		Eos	Consequence category	Worst-case consequence ranking	Total
Tiwi Islands	5	**Habitats** • Hard substrate, • Benthic invertebrates and habitats • Mangroves **Marine Fauna** • Benthic habitats and communities • Turtle Habitats and nesting • Threatened and Migratory Birds	Probability of contact by surface oil at 10 g/m^2	(%)	<0.33	• Physical habitat • Protected areas • Threatened / Migratory Fauna	II – Minor II – Minor II – Minor	II – Minor
			Minimum time to contact by surface oil 10 g/m^2	Time (d)	NC			
			Maximum oil loading on shorelines >100g/m^2	(tonnes)	6			
			Maximum accumulated concentration >100g/m^2	(g/m^2)	152			
			Maximum length of shoreline oiled (>100 g/m^2)	(km)	5			
			Maximum concentration of entrained hydrocarbon >100 ppb	(ppb)	416			
			Maximum concentration of dissolved aromatic hydrocarbon >10 ppb	(ppb)	7			

7.1.7 Environmental risk assessment

Receptors	• Marine fauna – plankton, fish, sharks and rays, marine mammals, marine reptiles, seabirds and shorebirds • Physical environment/habitats • Marine Protected Areas • Socio-economic and heritage receptors
Consequence	III – Moderate
In the event of a vessel collision, the volume of hydrocarbons released would be a finite amount limited to the maximum credible spill of a full tank inventory release (1,065 m^3). Given the nature of the MDO and the distance from shorelines, dilution and dispersion from natural weathering processes such as ocean currents will occur. Habitat modification/degradation/disruption/loss, deteriorating water quality and marine pollution are identified as potential threats to a number of marine fauna species in relevant Recovery Plans and Conservation Advice. The potential for impacts to marine fauna is summarised in Table 7-8 and Table 7-9. In the unlikely event that a vessel collision did occur within the Operational Area, the potential impacts to the environment would be greatest within several kilometres from the spill when the toxic aromatic components of the fuel will be at their highest concentration and when the hydrocarbon is at its thickest on the surface of the receiving waters. The MDO will also rapidly lose toxicity with time and spread thinner as evaporation continues. The potential sensitive receptors in the surrounding areas of the spill will include fishes and elasmobranchs, marine mammals, marine reptiles and seabirds and shorebirds at the sea surface, as discussed in Table 7-9. Exposure to marine fauna from this hazard is it expected to be limited to a small number of individuals, with no impacts to regional populations. Marine habitats may also be impacted as discussed in Table 7-8 and Table 7-9. Potential impacts to protected areas identified as areas of High Environmental Value (HEV) within the EMBA, including socio-economic and heritage values, are assessed in detail in Section 7.1.6. An overall consequence ranking of Moderate was assigned to this scenario based on the potential impacts to HEV areas as described in Table 7-12. This is due to the potential for: • Surface oil and entrained oil impacts on the AMP values within the JBG AMP. However, exposure to hydrocarbons at the JBG AMP was only predicted from the release sites to the south of the Operational Area, and therefore the probability of oil exposure is considered conservative. It is noted that potential impacts identified are based on stochastic modelling of 600 spill trajectories from two release locations (three seasons). For any single spill trajectory, impacts would not occur at all locations.	
Likelihood	A – Remote
A hydrocarbon release resulting from a vessel collision is unlikely to have widespread ecological effects given the nature of the hydrocarbons on-board, the finite volumes that could be released and the depth and transient nature of marine fauna in this area. The likelihood of a hydrocarbon release occurring due to a vessel collision is limited given the set of mitigation and management controls in place for this Activity. Consequently, the likelihood of a vessel collision releasing hydrocarbons to the environment that results in a moderate consequence is considered to be remote.	
Residual Risk	The residual risk associated with this hazard is Very Low.

7.1.8 ALARP evaluation

Vessels are required to undertake the Activity. There are no suitable alternatives to the use and number of vessels to complete the Activity. It is considered that the industry standard and activity-specific controls to reduce collision risks that have been proposed and the contingencies in place in the event of the hazard occurring reduce the likelihood and potential impacts from a loss of fuel as a result of a vessel collision to ALARP. Alternative and additional controls were considered but not adopted as detailed in Section 7.1.4. The proposed control measures are considered appropriate to manage the risk to ALARP.

Spill response measures

The state of spill response readiness Santos adopts for operational activities across the NWS is considered commensurate for the spill risk associated with the Activity based on the likelihood of a worst-case spill (Remote) and the level of potential impact associated with worst case spills (Moderate). That is, the spill risk for the Activity fits within the profile covered through existing arrangements.

Pre-deploying existing equipment/ personnel, or adding to existing readiness, in terms of additional capability or administrative planning is considered appropriate where the scale of the spill and the extent/timeframe of environmental impacts cannot be effectively mitigated through existing capacity or when the benefit of adding to readiness outweighs the cost/effort. For the spill risks associated with the current Activity, this is not considered to apply and thus the existing state of readiness is considered to reduce this risk to ALARP.

In terms of spill response activities, Santos will implement oil spill response as specified within the OPEP. This includes the use of resources (equipment and personnel) owned by Santos or available through third party providers through contracts, agreements or MOUs. The proposed spill response strategies, refer to Section 7.1.5 (Response Strategy Selection), consider relevant values and include completion of a NEBA in the event of a spill which includes the relevant values and receptors present in the area, including AMPs. This will limit impacts to the identified AMPs thereby protecting and conserving the ecosystems, habitats and native species, consistent with the park values.

A summary of the ALARP assessment for the level of resourcing required for each of the spill response strategies adopted is provided in Appendix B of the OPEP. This provides the incremental benefit of increasing resourcing levels for each spill response strategy and the associated upfront costs.

From this assessment it is considered that through the resourcing arrangements outlined within the OPEP (including spill response equipment and personnel from internal and external sources including Santos, AMOSC, AMSA, other operators, OSRL, and other national and international suppliers) the spill response strategies and control measures reduce spill risk to ALARP.

7.1.9 Acceptability evaluation

Is the risk ranked between Very Low to Medium?	Yes – Maximum hydrocarbon spill – MDO residual risk is ranked Very Low.
Is further information required in the consequence assessment?	Yes – Hydrocarbon spill modelling results were used to determine consequence and risk.
Are control measures and performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – Management consistent with International Convention of the Safety of Life at Sea (SOLAS) 1974, *Navigation Act 2012*, *MARPOL Annex III-Prevention of Pollution by Harmful Substances*, and relevant recovery plans for threatened species. Management is also consistent with the zoning of the AMPs, in that risks have been reduced to ALARP, e.g. implementation of spill response activities will limit impacts, thereby conserving the marine park values.
Are the risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' Offshore Division Environmental Hazard Identification and Assessment Procedure which considers principles of ecologically sustainable development. Based on the risk assessment in Section 7.1.7, the residual risk of an unplanned hydrocarbon spill is considered to be very low due to the proposed control measures and resultant low likelihood of a vessel collision and significant hydrocarbon spill. A hydrocarbon release resulting from a vessel collision is unlikely to have widespread or long-term ecological impacts given the nature of the hydrocarbons on-board, the finite volumes that could be released, the depth and open ocean location, and transient nature of marine fauna in this area. Based on the risk assessment in Section 7.1.77.1.3 and the proposed control measures, significant long-term impacts are unlikely to occur. Therefore, in the context of the principles of ESD: • There is no threat of serious or irreversible environmental damage • The health, diversity and productivity of the environment will be maintained • The biological diversity and ecological integrity of the marine environment will be conserved.
Are control measures and performance standards consistent with the Santos Environmental Management Policy?	Yes – Aligns with the Environmental Management Policy.
Are performance outcomes and standards consistent with stakeholder expectations?	Yes – No concerns raised.
Are control measures and performance standards such that the impact or risk is considered to be ALARP?	Yes (see ALARP evaluation above).

Defined Acceptable Levels

Does the predicted risk level meet defined acceptable levels of risk (refer to Section 5.7)?	**Defined Acceptable Level**	**Comparison with Predicted Levels of Risk**	**EPO**
	No unplanned discharge of hydrocarbons to sea. No long-term environmental impact in the event of an unplanned hydrocarbon release to sea. The risk of an impact from an unplanned hydrocarbon spill must be ranked Very Low to Medium according to the *Santos Offshore Division Environmental Hazard Identification and Assessment Procedure* (EA-91-IG-00004_5).	The residual risk of an unplanned hydrocarbon spill is considered to be Very Low and acceptable This is due to the proposed control measures and resultant low likelihood of a vessel collision and significant hydrocarbon spill. Additionally, through the application of mitigation measures detailed in spill response plans (SOPEP and OPEP).	EPO-16 EPO-20 EPO-22 EPO-23

7.2 Minor hydrocarbon release

7.2.1 Description of event

Minor hydrocarbon release	
Event	A minor spill (37.5 m^3) of MDO could occur during vessel refuelling resulting in a loss of hydrocarbons to the marine environment at sea surface. Spills of MDO during refuelling events have the potential to cause impacts to the marine environment through a reduction in water quality and marine fauna exposure. Spills during refuelling can occur through several pathways, including fuel hose breaks, coupling failure or tank overfilling. Spills resulting from overfilling will be contained within the vessel drains and slops tank system. In the event that the refuelling hose is ruptured, the fuel bunkering activity will cease by turning off the pump; the fuel remaining in the transfer line will escape to the environment as well as fuel released prior to the transfer operation being stopped. The AMSA (2015) *Technical Guidelines for Preparing Contingency Plans for Marine and Coastal Facilities* provides guidance for calculating a maximum credible spill volume for a refuelling spill. The guidance provided by AMSA (2015) for a refuelling spill under continuous supervision is considered appropriate given refuelling will be constantly supervised. The maximum credible spill volume during refuelling is calculated as: transfer rate (150 m^3/h) × 15 minutes of flow. The detection time of 15 minutes is seen as conservative but applicable following failure of multiple barriers, followed by manual detection and isolation of the fuel supply. Minor accidental loss of other hydrocarbon-based liquids (e.g. used lubricating oils, cooking oil, and hydraulic oil) to the marine environment could also occur via tank pipework failure or rupture, hydraulic hose failure, inadequate bunding and/or storage, insufficient fastening or inadequate handling. Seal oil could potentially leak from the vessel thruster/propeller stern tube directly to sea as a result of leaking seals or mechanical damage. The header tank for stern tube oil is approximately 1 m^3 and is equipped with limit switches in the event of a leak, thus preventing complete loss (the release of <1 m^3 of stern tube oil (non-hydrocarbon based lube oil) event is discussed further in Section 7.6). There will be no need to refuel helicopters on the seismic survey vessel.
Extent	Refer to Section 7.1 for the hydrocarbon characteristics of the MDO refuelling release. A surface spill of MDO during refuelling is considered relatively small in comparison to a surface spill of MDO during a vessel collision. It is therefore assumed that the extent of a hydrocarbon spill during refuelling would remain within the extent of the worst case spill trajectory of MDO from a vessel collision as detailed in Section 7.1.
Duration	MDO fuel at the sea surface will spread rapidly in the direction of the prevailing wind and surface currents. Evaporation is the dominant process that would contribute to the fate of spilled MDO from the sea surface during calm conditions while entrainment of droplets within the water column would increasingly contribute to removal of surface oil as wind speed increases.

7.2.2 Nature and scale of environmental impacts

The nature and scale of an accidental release of 37.5 m^3 of MDO during refuelling fits well within the expected impact and extent for the MDO release associated with a vessel collision detailed in Section 7.1. Therefore, no further modelling is required.

7.2.3 Environmental performance outcomes and control measures

Environmental Performance Outcomes relating to this hazard include:

EPO-20: No unplanned objects, emissions or discharges to sea or air.

EPO-22: No injury to marine fauna during the Activity.

EPO-23: No long-term environmental impact in the event of an unplanned hydrocarbon release to sea.

The Control Measures considered for this Activity are shown in Table 7-14, with Environmental Performance Standards and Measurement Criteria for the EPOs described in Section 8.6.1.

Table 7-14: Control measures evaluation for minor hydrocarbon releases

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard control measures				
Eliminate				
None identified.				
Substitute				
CM-36	MARPOL-compliant fuel oil (MDO) will be used during the Activity.	Use of MDO reduces the potential impacts to marine environment in the event of unplanned hydrocarbon spills or leaks during bunkering.	Additional personnel costs of ensuring vessels are using the required fuel.	**Adopted –** benefits of ensuring procedures are followed outweighs the minimal costs of personnel time.
Engineering				
CM-45	Deck drainage control measures (such as scupper plugs) in areas where chemicals and hydrocarbons are stored and frequently handled.	Reduces potential for hydrocarbon release to the marine environment.	Additional personnel costs of ensuring deck drainage procedures are followed.	**Adopted –** benefits of ensuring vessel is compliant outweighs the minimal costs.
Isolation				
None identified.				
Administration				
CM-31	General chemical management procedures.	Potential impacts to the environment are reduced through following correct procedures for the safe handling and storage of chemicals.	Personnel costs associated with ensuring procedures are in place and implemented during inspections.	**Adopted –** benefits of ensuring procedures are followed and measures implemented outweigh the costs.
CM-32	Hazardous chemical management procedures.	Reduces the risk of spills and leaks (discharges) of hazardous chemicals to the sea by controlling the storage, handling and clean up.	Cost associated with permanent or temporary storage areas.	**Adopted –** benefits of ensuring procedures are followed and measures implemented outweigh the costs.
CM-46	Maritime dangerous goods code.	Dangerous goods managed in accordance with International Maritime Dangerous Goods Code (IMDG Code) to reduce the risk of an environmental incident, such as an accidental release to sea or unintended chemical reaction.	Cost associated with implementation of code/procedure.	**Adopted –** benefits of ensuring procedures are followed and measures implemented outweighs the costs.
CM-47	Bulk fuel transferred in accordance with the vessel contractor procedures.	Prevents probability of unplanned hydrocarbon spills or leaks occurring during bunkering leading to negative impacts to the marine environment.	Additional personnel costs of ensuring procedures in place and followed.	**Adopted –** benefits of ensuring procedures are followed outweighs the minimal costs of personnel time.

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Protective				
CM-42	Oil pollution emergency plan (OPEP).	Implements response plans to deal with an unplanned hydrocarbon release quickly and efficiently in order to reduce impacts to the marine environment.	Administrative costs of preparing documents and large costs of implementing response strategies.	**Adopted –** benefits of ensuring procedures are followed and measures implemented, and that the vessel is compliant outweighs the costs.
CM-43	Vessel spill response plans (SOPEP/SMPEP).			
Additional control measures				
Eliminate				
N/A	No bunkering in the Operational Area.	Eliminates the probability of a hydrocarbon spill or leak occurring during bunkering in the Operational Area.	Cost associated with vessel transits and risk transfer to Health and Safety issues with additional trips to port instead. Would significantly increase the schedule to include multiple trips.	**Not Adopted** – Cost outweighs the environmental benefit.
CM-48	Undertake bunkering / bunkering drill prior to the Activity.	Ensures the controls can be implemented and there is familiarity with the process.	Associated cost with the time spent testing bunkering during mobilisation.	**Adopted –** Benefit of conducting bunkering / bunkering drill prior to arrival in the Operational Area outweighs the cost in lost time.
Substitute				
None identified.				
Engineering				
None identified.				
Isolation				
None identified.				
Administration				
None identified.				
Protective				
None identified.				

7.2.4 Environmental risk assessment

Receptors	Marine fauna – plankton, fish, sharks and rays, marine mammals, marine reptiles
Consequence	I – Negligible
In the event of a minor hydrocarbon spill, the quantities would be limited to 37.5 m^3. The small volumes and dilution and dispersion from natural weathering processes such as ocean currents indicate that the extent of exposure will be limited in area and duration (i.e. 5 km over 6 hours). The number of receptors present at the Activity location is expected to be limited to a small number of transient individuals. No shoreline receptors are expected to be impacted. The susceptibility of marine fauna to hydrocarbons is dependent on hydrocarbon type and exposure duration however given that exposures would be limited in extent and duration, exposure to marine fauna from this hazard is considered to be low. As the MDO is a moderately volatile substance, the impacts to receptors will decline rapidly with time and distance at the sea surface. Rapid dilution would also result in the impacts to receptors declining with time and distance. Deteriorating water quality and marine pollution are identified as potential threats to a number of marine fauna species in relevant Recovery Plans and Approved Conservation Advice (Table 3-12). For marine mammals that may be exposed to the more toxic aromatic components of the MDO, chemical effects are considered unlikely since these species are mobile and therefore will not be exposed for extended durations that would be required to cause any major toxic effects. Toxic impacts are not expected to the benthic community due to the water depths of the Operational Area (minimum depth of 60 m). Near the sea surface, fish are able to detect and avoid contact with surface slicks and as a result, fish mortalities rarely occur in open waters from surface spills (Kennish 1997; Scholz et al. 1992). Pelagic fish species are therefore generally not highly susceptible to impacts from hydrocarbon spills. In offshore waters near to the release point, pelagic fish are at risk of exposure to the more toxic aromatic components of the MDO. Pelagic fish in offshore waters are highly mobile and comprise species such as tunas, sharks and mackerel. Due to their mobility, it is unlikely that pelagic fish would be exposed to toxic components for long periods in this spill scenario. The more toxic components would also rapidly evaporate, and concentrations would significantly diminish with distance from the spill site, limiting the potential area of impact. Adult marine turtles exhibit no avoidance behaviour when they encounter hydrocarbon slicks (Odell and MacMurray 1986). Contact with surface slicks, or entrained hydrocarbons, can therefore result in hydrocarbon adherence to body surfaces (Gagnon and Rawson 2011) causing irritation of mucous membranes in the nose, throat and eyes leading to inflammation and infection (NOAA 2010). Hydrocarbons in surface waters may also impact turtles when they surface to breathe and inhale toxic aromatic components of the MDO, resulting in damage to their respiratory systems. Impacts to seasnakes from direct contact with surface hydrocarbons are likely to result in similar physical effects to those recorded for marine turtles (ITOPF 2011). It is unlikely that marine reptiles would be exposed to toxic components for long periods, given the more toxic components of MDO would rapidly evaporate and concentrations would significantly diminish from the spill site, limiting the potential for impact. Given that a small hydrocarbon spill would not result in a decreased population size at a local or regional scale, it is expected that a spill of this nature would result in a ***Negligible*** consequence.	
Likelihood	b – Unlikely
The likelihood of a small hydrocarbon release occurring is limited given the set of management controls in place for this Activity. The likelihood of a refuelling incident with subsequent release to the marine environment is considered to be unlikely.	
Residual Risk	The residual risk associated with this hazard is Very Low.

7.2.5 ALARP evaluation

Offshore refuelling is standard industry practice and oil pollution legislation (*Protection of the Sea (Prevention of Pollution from Ships) Act 1983*) and MARPOL (Annex I) has been developed to safeguard against the risk of a hydrocarbon spill occurring during refuelling. Other hydrocarbon types such as heavy fuel oil (HFO) or intermediate fuel oil (IFO) have specifically not been selected for this Activity (only MDO will be used in the Operational Area) to ensure that potential environmental impacts are reduced to ALARP. Alternative and additional controls were considered but not adopted as detailed in Section 7.2.3. The implementation of these control measures would require a disproportionate level of cost/effort in order to reduce the level of impact or risk. The proposed control measures are considered appropriate to manage the risk to ALARP.

7.2.6 Acceptability evaluation

Is the risk ranked between Very Low to Medium?	Yes – Residual risk is ranked Very Low.		
Is further information required in the consequence assessment?	No – Potential impacts and risks are well understood through the information available.		
Are the risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' Offshore Division Environmental Hazard Identification and Assessment Procedure which considers principles of ecologically sustainable development. Based on the risk assessment in Section 7.2.2, the residual risk of an unplanned minor hydrocarbon spill is considered to be very low due to the proposed control measures and given it is unlikely that a release will occur. A small hydrocarbon spill would not result in a decreased population size at a local or regional scale. Based on the risk assessment and the proposed control measures, significant long term impacts are unlikely to occur. Therefore, in the context of the principles of ESD: • There is no threat of serious or irreversible environmental damage • The health, diversity and productivity of the environment will be maintained • The biological diversity and ecological integrity of the marine environment will be conserved.		
Are control measures and performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – Management consistent with International Convention of the Safety of Life at Sea (SOLAS) 1974*, Navigation Act 2012*, *MARPOL Annex I – Prevention of Pollution from Ships*, and relevant recovery plans (Table 3-12).		
Are control measures and performance standards consistent with the Santos Environmental Management Policy?	Yes – Aligns with the Environmental Management Policy.		
Are performance outcomes and standards consistent with stakeholder expectations?	Yes – No concerns raised.		
Are control measures and performance standards such that the impact or risk is considered to be ALARP?	Yes (see ALARP evaluation above).		
Defined Acceptable Levels			
Does the predicted risk level meet defined acceptable levels of risk (refer to Section 5.7)?	**Defined Acceptable Level**	**Comparison with Predicted Levels of Risk**	**EPO**
	No unplanned discharge of hydrocarbons to sea. No long-term environmental impact in the event of an unplanned hydrocarbon release to sea. The risk of an impact from an unplanned hydrocarbon spill must be ranked Very Low to Medium according to the *Santos Offshore Division Environmental Hazard Identification and Assessment Procedure* (EA-91-IG-00004_5).	The residual risk of an unplanned minor hydrocarbon spill is considered to be Very Low and acceptable. This is due to the proposed control measures and resultant low likelihood of a significant hydrocarbon spill to sea. Additionally, through the application of mitigation measures detailed in spill response plans (SOPEP and OPEP).	EPO-20 EPO-22 EPO-23

7.3 Spill response operations

7.3.1 Description of event

Spill response operations	
Event	In the event of a hydrocarbon spill, response strategies will be implemented where possible to reduce environmental impacts to ALARP. The selection of strategies will be undertaken through the Net Environmental Benefit Analysis (NEBA) process, outlined in Section 6.7 of the OPEP. Spill response will be under the direction of the relevant Control Agency, as defined within the Section 4.2 of the OPEP. The response strategies and supporting activities deemed appropriate for the worst-case oil spill scenarios identified for the Activity are detailed in Sections 9 to 14 of the OPEP and comprise: • Source control • Monitor and evaluate • Mechanical dispersion • Shoreline protection and deflection • Shoreline clean-up • Oiled wildlife response • Waste management • Scientific monitoring. While response strategies are intended to reduce the environmental consequences of a hydrocarbon spill, poorly planned and coordinated response activities can result in a lack of, or inadequate, information being available upon which poor decisions can be made, exacerbating or causing further environmental harm. An inadequate level of training and guidance during the implementation of spill response strategies can also result in environmental harm over and above that already caused by the spill. The greatest potential for impacts additional to those described for routine operations is from shoreline protection and clean-up, and oiled wildlife response operations where coastal and shoreline habitat damage and fauna disturbance may occur.
Extent	Extent of the hydrocarbon release
Duration	As required.

7.3.2 Details of the environmental impacts and risks for the activities

Light emissions	
Spill response activities will involve the use of vessels which are required at a minimum, to display navigational lighting. Vessels may operate in close proximity to shoreline areas during spill response activities. Spill response activities will also involve onshore operations including the use of vehicles and temporary camps which may require lighting.	
Potential receptors:	• Fauna (including Threatened/Migratory/Local fauna) • Protected Areas • Socio-economic receptors
Lighting may cause behavioural changes to fish (including sharks), birds and marine turtles, which can have a heightened consequence during key life-cycle activities, for example turtle nesting and hatching. Turtles and birds, which includes threatened and migratory fauna, have been identified as key fauna susceptible to lighting impacts. Refer to Section 6.5 for further detail on the impacts of light to fish, birds and marine turtles. Spill response activities that require lighting may take place in protected areas important to turtles, for example foraging, breeding and interesting BIAs. During nesting and hatching season (primarily over summer months) lighting may cause behavioural impacts to turtles including aborted nesting attempts and mis-orientation of newly hatched turtles which may increase mortality rates. Spill response activities may also occur on shorelines used by nesting and feeding birds including seabirds and shorebirds. Lighting can cause disorientation in flying birds, disrupting nesting and breeding behaviours and impact on the ability of birds to forage. Disturbance to feeding migratory shorebirds may reduce their ability to replenish energy reserves and alter the timing and success of migratory flights. Because of impacts to fauna, lighting has the potential to impact supported industries such as tourism and indirect impacts on the values of protected areas.	
Noise emissions	
Spill response activities will involve the use of aircraft and vessels, which will generate noise both offshore and in proximity to sensitive receptors in coastal areas.	

Spill response activities may also involve the use of equipment on coastal areas during clean-up of shorelines (e.g. pumps and vehicles), for accessing shoreline areas (e.g. vehicles) and for supporting temporary camps (e.g. diesel generators).	
Potential receptors:	• Fauna (including Threatened/Migratory/Local fauna) • Protected Areas • Socio-economic receptors
Underwater noise from the use of vessels may impact marine fauna, such as fish (including commercial species), marine reptiles and marine mammals, in the worst instance causing physical injury to hearing organs, but more likely causing short term behavioural changes, e.g. temporary avoidance of the area, which may impact key life-cycle process (e.g. spawning, breeding, calving). Underwater noise can also mask communication or echolocation used by cetaceans. Refer to Section 6.3.3 for further detail on the environmental impact of noise attributed to vessel operations. Cetaceans have been identified as the key concern for vessel noise within the EMBA. In the NWMR, four species occur regularly within EMBA, including the pygmy blue whale, the Humpback whale, the Indo-Pacific humpback dolphin and the Australian snubfin dolphin (DSEWPAC 2012a). The pygmy blue whale migration and foraging BIA intersects overlaps the EMBA and there are foraging BIAs for several marine turtle species within the EMBA. Spill response activities using vessels have the potential to impact fauna in protected areas. Noise and vibration from terrestrial activities on shorelines has the potential to cause behavioural disturbance to coastal fauna including protected seabirds and turtles. Shoreline activities involving the use of noise generating equipment may take place in important nesting areas for turtles and / or roosting / feeding areas for shorebirds. As a consequence of impacts to fauna (including shorebirds, marine mammals and fish), noise has the potential to impact supported industries such as tourism and commercial fishing.	
Atmospheric emissions	
The use of fuels to power vessel engines, generators and mobile equipment used during spill response activities will result in emissions of greenhouse gases (GHG) such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), along with non-GHG such as sulphur oxides (SO_x) and nitrogen oxides (NO_x). Emissions will result in localised decrease in air quality.	
Potential receptors:	• Physical Environment/Habitat • Fauna (including Threatened/Migratory/Local fauna) • Protected Areas
Atmospheric emissions from spill response equipment will be localised and while there is potential for fauna impacts, the use of mobile equipment, vessels and vehicles is not considered to create emissions on a scale where noticeable impacts would be predicted. Emissions may occur in protected areas; however, the scale of the impact relative to potential oil spill impacts is not considered to be significant.	
Operational discharges and waste	
Operational discharges include those routine discharges from vessels used during spill response which may include: • Bilge water • Deck drainage • Putrescible waste and sewage • Cooling water from operation of engines • Desalination plant effluent (brine) and backwash water discharge. In addition, there are specific spill response discharges and waste creation that may occur, including: • Cleaning of oily equipment/vessels and vehicles • Flushing water for the cleaning of shoreline habitats • Sewage/putrescible and municipal waste at camp areas • Creation, storage and transport of oily waste and contaminated organics.	
Potential receptors:	• Fauna (including Threatened/Migratory/Local fauna) • Physical Environment/Habitat • Protected Areas • Socio-economic receptors
Operational discharges from vessels may create a localised and temporary reduction in marine water quality. Effects include nutrient enrichment, toxicity, turbidity, temperature and salinity increases, as detailed in Section 6.6. These may impact a different set of receptors than previously described in that section given vessel use may occur in shallower coastal waters during spill response activities. Discharge could potentially occur adjacent to marine habitats such as corals, seagrass, macroalgae, and in protected areas (i.e. receptors anywhere within the EMBA), which support a more diverse faunal community. Discharges are expected to be very localised and temporary. Cleaning of oil contaminated equipment, vehicles and vessels, has the potential to spread oil from contaminated areas to those areas not impacted by a spill, potentially spreading the impact area and moving oil into a more sensitive environment.	

Flushing of oil from shoreline habitats is a clean-up technique designed to remove oil from the receptor that has been oiled and remobilise back into the marine environment and result in further dispersion of the oil. The process of flushing has the potential to physically damage shoreline receptors such as mangroves and rocky shoreline communities, increase levels of erosion, and create an additional, and potentially higher, level of impact than if the habitat was left to bio-remediate. This response strategy may only be suitable for a small fraction of the 600 scenarios modelled as the highest predicted amount of shoreline oil is expected to be low at 37 m^3 with a 1.67% chance of contact >100 g/m^2.

Sewage, putrescible and municipal waste could be generated from onshore activities at temporary camps which may include toilet and washing facilities. These wastes have the potential to attract fauna, impact habitats, flora and fauna and reduce the aesthetic value of the environment, which may be within protected areas. The creation, storage and transport of oily waste and contaminated organics has the potential to spread impacts of oil to areas, habitats and fauna not previously contaminated.

Physical presence and disturbance

The movement and operation of vessels, personnel and equipment, undertaking spill response activities has the potential to disturb the physical environment and marine habitats and fauna, which may include those habitats and fauna within protected areas. Disturbance may also impact cultural values of an area. The movement of vessels could potentially introduce invasive marine species attached as biofouling to nearshore areas, while vehicle and equipment movement could spread non-indigenous flora and fauna.

Oiled wildlife response activities may involve deliberate disturbance (hazing), capture, handling, cleaning, rehabilitation and release of wildlife, which could lead to additional impacts to wildlife.

Potential receptors:	• Fauna (including Threatened/Migratory/Local fauna) • Physical Environment/Habitat • Protected Areas • Socio-economic receptors

There are only three receptors where shoreline contact is predicted to occur at the high threshold (i.e. above the actionable level) – JBG East Coast (1.67% likelihood of shoreline contact with maximum of 37 m^3), the Tiwi Islands (<0.33% likelihood of shoreline contact with maximum of 17 m^3), and Beagle Gulf-Darwin Coast (<0.33% likelihood of shoreline contact with maximum of 11 m^3).

The use of vessels may disturb benthic habitats in coastal waters including corals, seagrass, macroalgae and mangroves more than they could alleviate the potential onshore oiling. Impacts to habitats from vessels include damage through the deployment of anchor/chain, nearshore booms and grounding. Vessel use in coastal waters also increases the chance of contact or physical disturbance with marine megafauna such as turtles and dugongs. Booms create a physical barrier on the surface waters that has the potential to injure or entangle passing marine fauna that are either surface breathing or feeding.

Vehicles, equipment, personnel used and cleaning activities during shoreline response activities have the potential to damage coastal habitats such as dune vegetation, mangroves and habitats important to threatened and migratory fauna including nests of turtles and birds and bird roosting/feeding areas. Shoreline clean-up may involve the physical removal of substrates that could cause impact to habitats and coastal hydrodynamics and alter erosion/accretion rates.

The presence of camp areas, although relatively short-term, may disrupt normal behaviour of coastal species such as shorebirds and turtles, and could potentially interfere with nesting and feeding behaviours.

Oiled wildlife response may include the hazing, capture, handling, transportation, cleaning and release of wildlife susceptible to oiling such as birds and marine turtles. While oiled wildlife response is aimed at having a net benefit, poor responses can potentially create additional stress and exacerbate impacts from oiling, interfering with life-cycle processes, hampering recovery and in the worst instance increasing levels of mortality.

Impacts from invasive marine species are described in Section 7.7 and are not described further in this section.

Impacts from invasive terrestrial species are similar in that the invasive species can out-compete local species (e.g. weeds) and interfere with ecosystem processes. Non-native species may be transported attached to equipment, vehicles and clothing. Such an introduction would be especially detrimental to wilderness areas or protected terrestrial reserves which may have a relatively undisturbed flora and fauna community.

The disturbance to marine and coastal natural habitat, as well as the potential for disruption to culturally sensitive areas, which may occur in specially protected areas, may have flow on impacts to socio-economic values and industry (e.g. tourism, fisheries).

Disruption to other users of marine and coastal areas

Spill response activities may involve the use of vessels, equipment, vehicles and aircraft, and the establishment of temporary camps in areas used by the general public or industry.

There are only three receptors where shoreline contact is predicted to occur at the high threshold (i.e. above the actionable level) – JBG East Coast (1.67% likelihood of shoreline contact with maximum of 37 m^3), the Tiwi Islands (<0.33% likelihood of shoreline contact with maximum of 17 m^3), and Beagle Gulf-Darwin Coast (<0.33% likelihood of shoreline contact with maximum of 11 m^3). These locations are all remote and not close to large population centres.

The mobilisation of spill response personnel into an affected are may also place increased demands on local accommodation and other businesses, reducing the availability of services to members of the public.

Potential receptors:	• Socio-economic receptors

The use of vessels in the nearshore and offshore environment and the undertaking of spill response activities at shoreline locations may exclude the general public and industry use of the affected environment. As well as impacting leisure activities

of the general public, this may impact on revenue with respect to industries such as tourism and commercial fishing, although the areas of impact are occurring within a more remote region.

The mobilisation of personnel to small communities has the potential to affect the local community through demands on local accommodation and business, reducing the availability of services to members of the public; though a relatively small-scale shoreline response is expected for a MDO spill.

7.3.3 Environmental performance outcomes and control measures

For EPOs, EPSs and Measurement Criteria relating to spill response in the event of a spill during this Activity, refer to the OPEP.

Control measures considered for this Activity are provided in Table 7-15.

Table 7-15: Control measures evaluation for spill response operations

Control measure	Environmental benefit	Evaluation
Competent Incident Management Team (IMT) and Oil Spill Responder personnel	Ensures that spill response strategy selection and operational activities consider the potential for additional environmental impacts	**Adopted–** Considered a standard spill response control
Use of competent vessel crew/personnel	Reduces potential for environmental impacts from vessel usage	**Adopted –** Considered a standard spill response control
Spill response activities selected on basis of a NEBA.	Provides a systematic and repeatable process for evaluating strategies with net least environmental impact	**Adopted –** Considered a standard spill response control
Noise Emissions		
Vessels and aircraft compliant with Santos' *Protected Marine Fauna Interaction and Sighting Procedure* (EA-91-11-00003)	Reduces potential for behavioural disturbance to cetaceans	**Adopted –** Considered a standard spill response control (regulatory requirement)
Atmospheric Emissions		
If required under MARPOL, vessels will maintain a current International Air Pollution Prevention (IAPP) Certificate.	Reduces level of air quality impacts	**Adopted –** Considered a standard spill response control (regulatory requirement)
Light Emissions		
Select temporary base camps in consultation with WA Department of Transport (DoT) and Department of Biodiversity, Conservation and Attractions (DBCA) and relevant NT Control Agency.	Reduce coastal habitat and fauna disturbance.	**Adopted –** Considered a standard spill response control (regulatory requirement)
Disruption to Other Marine Users		
Stakeholder consultation	Promotes awareness and reduces potential impacts from response to socio-economic activities	**Adopted –** Considered a standard spill response control (regulatory requirement)
Utility resource assessment and support to be conducted if activity is of significant size in comparison to the size of the coastal community	Reduces potential impact due to higher utility demands causing disruptions to local community.	**Adopted –** Considered a standard spill response control
Accommodation assessment	Reduces strain on accommodation.	**Adopted –** Considered a standard spill response control
Transport Management Plan	Reduces potential for traffic disruptions.	**Adopted –** Considered a standard spill response control for large scale deployment in highly populated areas
Operational discharges and waste		
Vessels meet applicable MARPOL sewage disposal requirements as appropriate for vessel class	Reduces potential for water quality impacts	**Adopted –** Considered a standard spill response control (regulatory requirement)
Vessels meet applicable MARPOL requirements for oily water (bilge) discharges as appropriate for vessel class	Reduces potential for water quality impacts	**Adopted –** Considered a standard spill response control (regulatory requirement)

Control measure	Environmental benefit	Evaluation
Ballast water management plan for international vessels	Improves water quality discharge to marine environment to ALARP. Reduces risk of introduced marine species.	**Adopted –** Considered a standard spill response control (regulatory requirement)
Compliance with controlled waste, unauthorised discharge and landfill regulations	Ensures correct handling and disposal of oily wastes	**Adopted –** Considered a standard control (regulatory requirement)
Physical Presence and Disturbance		
Spill response activities selected on basis of a net environmental benefit analysis.	Provides a systematic and repeatable process for evaluating strategies with net least environmental impact.	**Adopted** – Considered a standard spill response control.
Vessels and aircraft compliant with Santos' *Protected Marine Fauna Interaction and Sighting Procedure* (EA-91-11-00003).	Reduces potential for behavioural disturbance to cetaceans.	**Adopted** – Ensures compliance with Part 8 of the EPBC Regulations 2000, which is considered a standard spill response control (regulatory requirement).
Use of shallow draft vessels for shoreline and nearshore operations.	Reduce seabed and shoreline disturbance.	**Adopted** – Considered a standard control.
OSR Team Leader assesses and selects vehicles appropriate to shoreline conditions.	Reduce coastal habitat and fauna disturbance.	**Adopted** – Considered a standard control.
Conduct shoreline, nearshore habitat, bathymetry assessment.	Reduce shoreline habitat disturbance.	**Adopted** – Considered a standard control.
Establish demarcation zones for vehicle and personnel movement considering sensitive vegetation, bird nesting and roosting areas and turtle nesting habitat.	Reduce coastal habitat and fauna disturbance.	**Adopt** – Considered a standard control.
Operational restriction of vehicle and personnel movement to limit erosion and compaction.	Reduce coastal habitat erosion and compaction.	**Adopted** – Considered a standard control.
Prioritise use of existing roads and tracks.	Reduce coastal habitat and fauna disturbance.	**Adopted** – Considered a standard control.
Select temporary base camps in consultation with DoT and DBCA.	Reduce coastal habitat and fauna disturbance.	**Adopted –** Considered a standard control to be adopted by the relevant Control Agency.
Soil profile assessment prior to earthworks.	Reduce habitat disruption and erosion.	**Adopted** – Considered a standard control.
Use of Heritage Advisor if spill response activities overlap with potential areas of cultural significance.	Reduce disturbance to culturally significant sites.	**Adopted** – Considered a standard control to be adopted by the relevant Control Agency.
Pre-cleaning and inspection of equipment (quarantine).	Reduces potential for invasive species to offshore islands	**Adopted** – Considered a standard control.
Adhere to WA Oiled Wildlife Response Plan and Pilbara Regional Oiled Wildlife Response Plan.	Oiled wildlife hazing, capture, handling and rehabilitation meet minimum standards as outlined within the WA Oiled Wildlife Response Plan.	**Adopted –** Considered a standard control to be adopted by the relevant Control Agency.

7.3.4 Environmental risk assessment

Light emissions	
Potential receptors	• Fauna (including Threatened/Migratory/Local fauna): seabirds and shorebirds, turtles, including foraging, internesting and nesting marine turtles and breeding seabirds/shorebirds. • Protected Areas • Socio-economic receptors
Consequence	• Fauna (including Threatened/Migratory/Local fauna): I (Negligible) – Short term behavioural impacts only to small proportion of local population and not during critical lifecycle activity. No decrease in local population size/area of occupancy of species/loss or disruption of habitat critical/disruption to the breeding cycle/introduction of disease. • Protected Areas: I (Negligible) – No or negligible impact on protected area values. No decline of species population within a protected area. No or negligible alteration, modification, obscuring or diminishing of protected area values. • Socio-economic receptors: I (Negligible) – No or negligible loss of value of the local industry. No or negligible reduction in key natural features or populations supporting the Activity.
The receptors considered most sensitive to lighting from vessel are seabirds and marine turtles, particularly over spring/summer months with respect to marine turtles where emerging hatchlings are sensitive to light spill onto beaches. Following restrictions on night-time operations by spill response vessels, which will demobilise to mooring areas offshore with safety lighting only, impacts from vessels are considered to be ***Negligible***. The positioning of temporary camps will be done at direction of WA DoT / DBCA and the relevant NT Control Agency following control measures on lighting colour and direction the consequence of shoreline lighting is considered ***Negligible***. These species are likely to be values of the protected areas in which they occur and the impact to the protected area from light is also considered ***Negligible***. As a consequence of impacts to fauna, lighting has the potential to impact supported industries such as tourism, however as impacts to fauna are considered negligible any indirect impacts on tourism will also be ***Negligible***.	
Noise emissions	
Potential receptors	• Fauna (including Threatened/Migratory/Local fauna): marine mammals • Protected Areas • Socio-economic receptors
Consequence	• Fauna (including Threatened/Migratory/Local fauna): I (Negligible) – Short term behavioural impacts only to small proportion of local population and not during critical lifecycle activity. No decrease in local population size/area of occupancy of species/loss or disruption of habitat critical/disruption to the breeding cycle/introduction of disease. • Protected Areas: I (Negligible) – No or negligible impact on protected area values. No decline of species population within a protected area. No or negligible alteration, modification, obscuring or diminishing of protected area values. • Socio-economic receptors: I (Negligible) – No or negligible loss of value of the local industry. No or negligible reduction in key natural features or populations supporting the Activity.
Receptors considered most sensitive to vessel noise disturbance are migrating cetacean species. A distribution BIA exists for the pygmy blue whale on the far western corner of the EMBA. There are also foraging, breeding and internesting BIAs for several marine turtle species within the EMBA. However, following the adoption of control measures to limit close interaction with protected fauna (i.e. Santos Protected Marine Fauna Interaction and Sighting Procedure), a temporary behavioural disturbance is expected only with a consequence of ***Negligible***. With respect to noise from onshore operations (mobile equipment and vehicles), nesting, roosting or feeding birds are considered to be the most sensitive to noise. The equipment used is not considered to have excessive sound levels and following direction by WA DoT/DBCA and relevant NT Control Agency on the location of temporary camp areas, the consequence to birds from noise is expected to be ***Negligible***. Shorebirds may be official values of the protected area they occur in, and the impact to the protected area from noise is also considered ***Negligible***. As a consequence of impacts to fauna, noise emissions has the potential to impact supported industries such as tourism, however as impacts to fauna are considered negligible any indirect impacts on tourism will also be ***Negligible***.	

Atmospheric emissions	
Potential receptors	• Physical Environment/Habitat: air quality • Fauna (including Threatened/Migratory/Local fauna): seabirds and shorebirds • Protected Areas
Consequence	• Physical Environment/Habitat: I (Negligible) – No or negligible reduction in habitat area/function. • Fauna (including Threatened/Migratory/Local fauna): I (Negligible) – Short term behavioural impacts only to small proportion of local population and not during critical lifecycle activity. No decrease in local population size/area of occupancy of species/loss or disruption of habitat critical/disruption to the breeding cycle/introduction of disease. • Protected Areas: I (Negligible) – No or negligible impact on protected area values. No decline of species population within a protected area. No or negligible alteration, modification, obscuring or diminishing of protected area values.
Atmospheric emissions from spill response equipment will be localised and impacts to even the most sensitive fauna, such as birds, are expected to be ***Negligible***. Because of the localised and low level of emissions, impacts to protected area values and the physical environment are predicted to be ***Negligible***.	
Operational discharges and waste	
Potential receptors	• Physical Environment/Habitat: coastal vegetation, intertidal and shallow habitats (corals, mangroves, seagrass, macroalgae) • Fauna (including Threatened/Migratory/Local fauna): fish, marine reptiles, marine mammals, seabirds and shorebirds • Protected Areas • Socio-economic receptors
Consequence	• Physical Environment/Habitat: I (Negligible) – No or negligible reduction in habitat area/function. • Fauna (including Threatened/Migratory/Local fauna): I (Negligible) – Short term behavioural impacts only to small proportion of local population and not during critical lifecycle activity. No decrease in local population size/area of occupancy of species/loss or disruption of habitat critical/disruption to the breeding cycle/introduction of disease. • Protected Areas: I (Negligible) – No or negligible impact on protected area values. No decline of species population within a protected area. No or negligible alteration, modification, obscuring or diminishing of protected area values. • Socio-economic receptors: I (Negligible) – No or negligible loss of value of the local industry. No or negligible reduction in key natural features or populations supporting the Activity.
Operational discharges from vessels may create a localised and temporary reduction in marine water quality, which has the potential to impact shallow coastal habitats in particular, however, following the adoption of regulatory requirements for vessel discharges, which prevent discharges close to shorelines, discharges will have a ***Negligible*** impact to habitats, fauna or protected area values. Furthermore, washing of vessels and equipment will take place only in defined offshore hot zones preventing impacts to shallow coastal habitats. As a consequence of impacts to fauna, operational discharges from vessels has the potential to impact supported industries such as tourism and commercial fishing however as impacts to fauna are considered negligible any indirect impacts on socio-economic receptors will also be ***Negligible***. Onshore, the use of flushing water has the potential to damage sensitive shoreline and intertidal habitats, e.g. mangroves, however low pressure flushing only will be used, preventing further damage to habitats or erosion of sediments. For sensitive habitats the deployment of booms will be considered to retain flushed hydrocarbons, if this presents a net benefit. Following these control measures the use of flushing to clean shorelines and intertidal habitats is seen to have a ***Negligible*** additional impact to habitats, fauna or protected area values. The cleaning of contaminated vehicles and equipment onshore has the potential to spread oily waste and damage habitats if not contained. Decontamination units will be in used during the spill response thus containing waste and preventing any secondary contamination. The consequence of cleaning discharges is therefore ranked as ***Negligible*** in terms of impacts to habitats, fauna or protected area values. Sewage, putrescible and municipal waste generated onshore will be stored and disposed of at approved locations. The storage, transport and disposal of hydrocarbon contaminated waste arising from spill response operation actions such as shoreline clean up, will be managed by a Santos appointed waste management contractor and dedicated waste containment areas will prevent the spreading or leaching of hydrocarbon contamination.	

Physical presence and disturbance	
Potential receptors	• Fauna (including Threatened/Migratory/Local fauna): marine mammals, turtles • Protected Areas • Physical Environment/Habitat: offshore and shallow habitats (corals, mangroves, seagrass, macroalgae) • Socio-economic receptors
Consequence	• Fauna (including Threatened/Migratory/Local fauna): II (Minor) – Detectable, but insignificant, decrease in local population size. Insignificant reduction in area of occupancy of species. Insignificant loss/disruption of habitat critical to survival of a species. Insignificant disruption to the breeding cycle of local population. • Protected Areas: I (Negligible) – No or negligible impact on protected area values. No decline of species population within a protected area. No or negligible alteration, modification, obscuring or diminishing of protected area values. • Physical Environment/Habitat: I (Negligible) – No or negligible reduction in habitat area/function. • Socio-economic receptors: I (Negligible) – No or negligible loss of value of the local industry. No or negligible reduction in key natural features or populations supporting the Activity.

The use of vessels and nearshore booms has the potential to disturb benthic habitats including sensitive habitats in coastal waters such as corals, seagrass, macroalgae and mangroves. A review of shallow water habitats, and bathymetry, using existing moorings and establishing demarcated areas anchoring will reduce the level of impact to ***Negligible***.

There are only three receptors where shoreline contact is predicted to occur at the high threshold (i.e. above the actionable level) – JBG East Coast (1.67% likelihood of shoreline contact with maximum of 37 m^3), the Tiwi Islands (<0.33% likelihood of shoreline contact with maximum of 17 m^3), and Beagle Gulf-Darwin Coast (<0.33% likelihood of shoreline contact with maximum of 11 m^3). These locations are all remote and not close to large population centres.

The use and movement of vehicles, equipment and personnel during shoreline response activities has the potential to disturb coastal habitats such as dune vegetation, samphire and mangroves, and important habitats of threatened and migratory fauna including nests of turtles and birds and bird roosting areas. Furthermore, clean-up can involve physical removal of substrates that could cause impacts to habitats, fauna and alter coastal hydrodynamics. As with vessel use, an assessment of appropriate vehicles and equipment to reduce habitat damage, along with the establishment of access routes / demarcation zones, and operational restrictions on equipment/vehicle use will limit sensitive habitat damage and damage to important fauna areas.

The establishment of temporary camp areas will be done under direction of WA DoT/DBCA and relevant NT Control Agency with suitable advice sought if access is needed to culturally significant areas. Following these and other control measures the resultant consequence to the physical environment and habitat is assessed as ***Minor***, indicating that there may be a detectable reduction in habitat area from response activities (as separate from spill impacts), but recovery will be relatively rapid once spill response activities cease. As with all spill response activities this disturbance will only occur if there is a net benefit to accessing and cleaning shoreline areas.

The main direct disturbance to fauna would be the hazing, capture, handling, transportation, cleaning and release of wildlife susceptible to oiling impacts, such as birds and marine turtles. This would only be done if this intervention were to deliver a net benefit to the species but may result in a ***Minor*** consequence following compliance with the WAOWRP, the East Kimberley Region Oiled Wildlife Response Plan, and the NTOWRP.

These habitats/environments are likely to be values of the protected area they occur in, and the impact to the protected area from physical disturbance is considered ***Minor***.

The disturbance to marine and coastal habitat, as well as the potential for disruption to culturally sensitive areas, which may occur in specially protected areas, may have flow on impacts to socio-economic values and industry (e.g. tourism, fisheries).This impact is considered ***Minor***.

Disruption to other users of marine and coastal areas and townships	
Potential receptors	Socio-economic receptors: fisheries, fisheries and aquaculture, tourism
Consequence	II (Minor) – Detectable but insignificant short-term loss of value of the local industry.

The use of vessels in the nearshore and offshore environment may exclude general public and industry use. Although, there are only three remote receptors where shoreline contact has low probability. The mobilisation of personnel to coastal areas and townships may occur although the areas of risk are expected to be remote; however, a small-scale shoreline response is expected for a MDO spill resulting in a response scenario.

There are only three receptors where shoreline contact is predicted to occur at the high threshold (i.e. above the actionable level) – JBG East Coast (1.67% likelihood of shoreline contact with maximum of 37 m^3), the Tiwi Islands (<0.33% likelihood of shoreline contact with maximum of 17 m^3), and Beagle Gulf-Darwin Coast (<0.33% likelihood of shoreline contact with maximum of 11 m^3).

It should be noted that this is distinct from the socio-economic impact of a spill itself which could have a greater detrimental impact to industry and recreation. Following the application of control measures, it is considered that the additional impact of spill response activities on affected industries would be ***Minor***.

Likelihood	b – Unlikely
The likelihood of spill response being required is limited given the set of management controls in place for this Activity. The likelihood of spill response being required is considered to be unlikely.	
Residual Risk	The residual risk associated with this hazard is Very Low.

7.3.5 ALARP evaluation

A Net Environmental Benefit Analysis (NEBA) is the primary tool used during spill response to evaluate response strategies with the goal of selecting strategies that results in the least net impact to key environmental sensitivities. The NEBA process will identify and compare net environmental benefits of alternative spill response options. The NEBA will effectively determine whether an environmental benefit will be achieved through implementing a response strategy compared to undertaking no response. NEBA will be undertaken by the relevant Control Agency for the Activity. For those activities under the control of Santos, the Incident Management Team (IMT) Environmental Team Leader will be responsible for reviewing the priority receptors and selected response strategies identified within this EP and coordinating the NEBA for each operational period. This will ensure that at the strategy level, the response operations reduce additional environmental impacts to ALARP.

Spill response activities will be conducted in offshore and coastal waters using vessels and aircraft. The greatest potential for additional impacts from implementing spill response is considered to be to wildlife in offshore waters from oiled wildlife response activities, and to shoreline habitats and fauna receptors within shallow waters or on shorelines from shoreline clean-up activities.

Given the types of activities considered appropriate to responding to a worse-case spill and the scale of operations, standard control measures adopted by Santos for spill response to reduce the level of additional impacts are considered to reduce these impacts to ALARP. This includes working with the relevant Control Agency for spill response and applying the process and standards e.g. for oiled wildlife response as included within the WA and NT Oiled Wildlife Response Plans.

Santos considers the actions prescribed in the Recovery Plan for Marine Turtles in Australia (DoEE 2017) and Approved Conservation Advice for other threatened fauna (Table 3-12) relevant to spill responses for the activities to minimise noise and light impacts on marine cetaceans, fish and marine turtles. The proposed Activity will not result in significant impacts on these species and implementation of identified control measures is in line with the relevant Conservation Advice and Recovery Plans. Pollution events (such as hydrocarbon spills) could impact on fauna (as described in Section 7.1), and the use of vessels and equipment during the spill response could result in potential impacts as described within this EP. Control measures in place for vessel and helicopter use will reduce potential impacts to marine fauna and these are consistent with current conservation advice. The assessed residual consequence for this impact is minor and cannot be reduced further without disproportionate costs. It is considered therefore that the impact of the activities conducted are ALARP.

7.3.6 Acceptability evaluation

Is the risk ranked between Very Low to Medium?	Yes – Residual risk is ranked Very Low.		
Is further information required in the consequence assessment?	No – Potential impacts and risks are well understood through the information available.		
Are the risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' Offshore Division Environmental Hazard Identification and Assessment Procedure which considers principles of ecologically sustainable development. Spill response operations will be undertaken for the purpose of providing a net environmental benefit in the unlikely event of hydrocarbon spill. Based on the risk assessment in Section 7.3.2, impacts resulting from response operations are predicted to be limited to no or negligible reduction in habitat area/function and short-term behavioural impacts to fauna. Based on the risk assessment and the proposed control measures, significant long-term impacts are unlikely to occur. Therefore, in the context of the principles of ESD: • There is no threat of serious or irreversible environmental damage • The health, diversity and productivity of the environment will be maintained • The biological diversity and ecological integrity of the marine environment will be conserved.		
Are control measures and performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – Management consistent with industry standards and regulatory requirements. Oil spill response activities will be undertaken in a manner consistent with the applicable objectives and actions of Conservation Advice, Recovery Plans or Guidelines; and AMP management plans.		
Are control measures and performance standards consistent with the Santos Environmental Management Policy?	Yes – Aligns with the Environmental Management Policy.		
Are performance outcomes and standards consistent with stakeholder expectations?	Yes – No concerns raised. During any spill response, a close working relationship with relevant regulatory bodies (e.g. DoT, DBCA, and AMSA) will occur and thus there will be ongoing consultation with relevant stakeholders on the acceptability of response operations. Wildlife response will be conducted in accordance with the WA and NT Oiled Wildlife Response Plans.		
Are control measures and performance standards such that the impact or risk is considered to be ALARP?	Yes (see ALARP evaluation above).		
Defined Acceptable Levels			
Does the predicted risk level meet defined acceptable levels of risk (refer to Section 5.7)?	**Defined Acceptable Level**	**Comparison with Predicted Levels of Risk**	**EPO**
	The net environmental benefit of a spill response strategy must be greater than no response. The environmental risk of spill response strategies must be ranked Very Low to Medium according to the *Santos Offshore Division Environmental Hazard Identification and Assessment* Procedure (EA-91-IG-00004_5).	The residual risk of spill response is considered to be Very Low and acceptable. This is due to the nature of the oil spill (i.e. marine diesel); the maintenance of a competent and prepared incident management team and the measures available to select an appropriate response. Strategies based on (NEBA) and implementation of the OPEP.	Refer to the OPEP.

7.4 Hazardous and non-hazardous unplanned discharges – liquid

7.4.1 Description of event

Hazardous and Non-Hazardous Unplanned Discharges – Liquid	
Event	Hazardous liquids, including miscellaneous chemicals and waste streams (cleaning and cooling agents, stored or spent chemicals and leftover paint materials), are used or stored on board the vessel during the Activity. The main engines and equipment such as pumps, cranes, winches, power packs and generators require MDO for fuel and a variety of hydraulic fluids and lubricating oils for efficient operation and maintenance of moving parts. These products are present within the equipment and also held in storage containers and tanks on the vessels. Small hydrocarbon leaks could occur, and potential impacts are covered under Section 7.2, chemical leaks are discussed further in this section. Outside the vessel, the largest credible spill would be a release of up to 1 m^3 of stern tube oil (non-hydrocarbon-based lube oil) from the vessel thruster/propeller stern tube. Accidental loss of liquid wastes to the marine environment could occur via tank pipework failure or rupture, inadequate bunding and/or storage, insufficient fastening or inadequate handling leading to dropped objects, which may result in impacts to water quality and hence sensitive environmental receptors. The seismic streamers that will be used for the survey are gel-filled, which has the characteristics of a 'flexible' solid and will not flow into the marine environment if the streamer skin is punctured. Therefore, there is no possibility of a loss of liquid from the in-water seismic equipment.
Extent	The maximum volume of hazardous chemical that could be released during routine operations is likely to be small and limited to the volume of individual containers (e.g. drums etc.) stored on-deck. The most credible worst-case spill scenario on-board is considered to be released from an on-deck hydraulic hose (loss of 200 L), however the worst case overall is up to 1 m^3 of stern tube oil. In the event that the spill is not contained on deck, there would be a release to the marine environment, which would be likely to rapidly disperse and evaporate.
Duration	Instantaneous release during the Activity.

7.4.2 Nature and scale of environmental impacts

Potential receptors include fish, sharks and rays, marine mammals, marine reptiles, seabirds and migratory shorebirds.

Environmentally hazardous chemicals and liquid wastes (hazardous / non-hazardous liquids) lost to the marine environment from a vessel may lead to contamination of the water column in the vicinity of the vessel.

The potential impacts would be highly localised and restricted to the immediate area surrounding the spill, with rapid dispersal to concentrations below impact thresholds likely to occur in the open area of ocean (high energy environment that facilitates rapid dispersion and dilution to non-toxic concentrations). This is unlikely to lead to widespread ecological effects.

The changes to water quality that may result could potentially lead to toxicity effects to marine fauna and fish in the immediate vicinity of the spill release location, through direct contact or accidental ingestion. However, given the open water, high dispersion location of the Operational Area, the extent and duration of potential exposures, impacts to marine fauna (e.g. pelagic/benthic fish, epifauna, marine mammals, marine reptiles and seabirds) are expected to be highly localised (within the vicinity of the point of release) and short term. Chronic impacts are considered unlikely due to the expected low concentrations and short exposure times.

There are no emergent or inter-tidal habitats within the Operational Area that could be impacted by the release of hazardous and non-hazardous liquids. Impacts from the release of hazardous and non-hazardous liquids are unlikely to reach any of the demersal species or benthic habitats at the seabed. Sub-lethal or lethal effects from toxic hazardous/non-hazardous liquids on marine fauna, is considered unlikely given the expected low concentrations and short exposure times.

7.4.3 Environmental performance outcomes and control measures

Environmental Performance Outcomes relating to this hazard include:

EPO-20: No unplanned objects, emissions or discharges to sea or air

EPO-22: No injury to marine fauna during the Activity

EPO-23: No long-term environmental impact in the event of an unplanned hydrocarbon release to sea.

The Control Measures considered for this Activity are shown in Table 7-16, with Environmental Performance Standards and Measurement Criteria for the EPOs described in Section 8.6.1.

Table 7-16: Control measures evaluation for hazardous and non-hazardous unplanned discharges – liquid

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard control measures				
Eliminate				
None identified.				
Substitute				
None identified.				
Engineering				
CM-49	Equipment maintenance in accordance with PMS.	Ensures that lifting equipment is maintained and certified, and that lifting procedures are followed reducing probability of dropped objects occurring with the potential to result in hazardous/non-hazardous liquids release.	Additional personnel costs of ensuring equipment is maintained and certified as appropriate and that procedures are in place and followed.	**Adopted** – benefits of ensuring procedures are followed and equipment is compliant outweighs the minimal costs of personnel time.
CM-30	Oily water treatment system	Reduces potential impacts of planned discharge of oily water to the environment. Provides compliance with MARPOL and Marine Order 91 requirements as appropriate for vessel class.	Additional time and personnel costs in maintaining oil record book.	**Adopted** – Benefits of ensuring vessels are compliant outweigh the minimal costs of personnel time, and it is a legislated requirement.
Isolation				
None identified.				
Administration				
CM-31	General chemical management procedures.	Potential impacts to the environment are reduced through following correct procedures for the safe handling and storage of chemicals, including requirements of MARPOL Annex III and Marine Orders 94 as appropriate for vessel class.	Personnel costs associated with ensuring procedures are in place and implemented during inspections.	**Adopted** – benefits of ensuring procedures are followed and measures implemented outweigh the costs.
CM-32	Hazardous chemical management procedures.	Reduces the risk of spills and leaks (discharges) to the sea by controlling the storage, handling and clean-up of hazardous chemicals.	Cost associated with permanent or temporary storage areas.	**Adopted** – benefits of ensuring procedures are followed and measures implemented outweighs the costs.
CM-46	Maritime dangerous goods code.	Dangerous goods managed in accordance with International Maritime Dangerous Goods Code (IMDG Code) to reduce the risk of an environmental incident, such as an accidental release to sea or unintended chemical reaction	Cost associated with implementation of code/procedure.	**Adopted** – benefits of ensuring procedures are followed and measures implemented outweighs the costs.
CM-50	Dropped object prevention procedure.	Minimises dropped object risk during vessel lifting operations that may cause secondary spill (discharges) resulting in reduction in water quality.	Cost to maintain lifting equipment and implement procedure.	**Adopted** – benefits of ensuring procedures are followed and measures implemented outweighs the costs.

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Protective				
CM-43	Vessel spill response plans (SOPEP/ Shipboard Marine Pollution Emergency Plan (SMPEP)).	Implements response plans to deal with an unplanned release quickly and efficiently in order to reduce impacts to the marine environment.	Administrative costs of preparing documents and large costs of implementing response strategies.	**Adopted –** benefits of ensuring procedures are followed and measures implemented, and that the vessel is compliant outweighs the costs.
Additional control measures				
Eliminate				
None identified.				
Substitute				
None identified.				
Engineering				
None identified.				
Isolation				
None identified.				
Administration				
None identified.				
Protective				
None identified.				

7.4.4 Environmental risk assessment

Receptors	Marine fauna: fish, sharks and rays, marine mammals, marine reptiles, seabirds and migratory shorebirds
Consequence	I – Negligible
In the event of a hazardous/ non-hazardous liquid spill, the worst-case quantity would be limited to up to 1 m^3 of stern tube oil. The small volumes, dilution and dispersion from natural weathering processes such as ocean currents indicate that the extent of exposure will be limited in area and duration. The susceptibility of marine fauna to hazardous/non-hazardous liquids is dependent on the type and exposure duration. Given that exposures would be limited in extent and duration, exposure to marine fauna from this hazard is not expected to result in a fatality. Potential impacts from small volumes (up to 1 m^3) of hazardous/non-hazardous liquids on water quality would be short-term and localised, due to the nature and behaviour of the hazardous/non-hazardous liquids. Pelagic fauna present in the immediate vicinity of the spill would most likely be at risk. Deteriorating water quality and marine pollution are identified as potential threats to a number of marine fauna species in relevant Recovery Plans and Conservation Advice (Table 3-12). However, the potential release of hazardous/non-hazardous liquids is not expected to significantly impact the receiving environment. Through the management controls proposed to prevent releases, the Activity will be conducted in a manner that is considered acceptable. Given that a small spill (up to 1 m^3) of hazardous/non-hazardous liquids would not result in a decreased population size at a local or regional scale, it is expected that a spill of this nature would result in a ***Negligible*** consequence.	
Likelihood	b – Unlikely
A small liquid release is unlikely to have widespread ecological effects given the nature of the chemicals on-board, the small volumes that could be released, the water depth, transient nature of marine fauna in this area and the prevention and management procedures in place to clean up a spill. Santos records indicate that although spills and leaks from equipment and machinery (due to split hoses, small leaks, or handling errors) have occurred, most of the spills and leaks reported occurred within bunded areas, were all less than 100 L and cleaned up immediately and therefore did not reach the marine environment. The likelihood of a small hazardous/ non-hazardous liquid release occurring is limited given the mitigation and management controls in place for this Activity. Consequently, the likelihood of releasing hazardous/ non-hazardous liquids to the environment which results in a negligible consequence is considered to be unlikely.	
Residual Risk	The residual risk associated with this hazard is Very Low.

7.4.5 ALARP evaluation

Hazardous/non-hazardous liquids are required to operate the vessels and carry out the Activity or may be a resultant waste of the Activity/vessel operation, so their removal is not viable. No reasonably practicable additional controls were identified in the evaluation of control measures in Section 7.4.3 that would further increase the environmental benefit without a grossly disproportionate cost / sacrifice. The management and mitigation controls outlined reduce the risk to a level considered ALARP by Santos.

7.4.6 Acceptability evaluation

Is the risk ranked between Very Low to Medium?	Yes – Maximum hazardous/non-hazardous liquid release residual risk is ranked Very Low.		
Is further information required in the consequence assessment?	No – Potential impacts and risks are well understood through the information available.		
Are the risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' Offshore Division Environmental Hazard Identification and Assessment Procedure which considers principles of ecologically sustainable development. Based on the risk assessment in Section 7.4.2, a small spill (up to 1 m^3) of hazardous/non-hazardous liquids is unlikely to occur and would not result in population level impacts at a local or regional scale or have widespread or lasting ecological effects. Based on the risk assessment and the proposed control measures, no significant short term or long term impacts are predicted. Therefore, in the context of the principles of ESD: • There is no threat of serious or irreversible environmental damage • The health, diversity and productivity of the environment will be maintained • The biological diversity and ecological integrity of the marine environment will be conserved.		
Are control measures and performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – Management consistent with MARPOL Annex III – Prevention of Pollution by Harmful Substances, International Maritime Dangerous Goods Code, and relevant Recovery Plans and Approved Conservation Advice (Table 3-12).		
Are control measures and performance standards consistent with the Santos Environmental Management Policy?	Yes – Aligns with the Environmental Management Policy.		
Are performance outcomes and standards consistent with stakeholder expectations?	Yes – No concerns raised.		
Are control measures and performance standards such that the impact or risk is considered to be ALARP?	Yes (see ALARP evaluation above).		
Defined Acceptable Levels			
Does the predicted risk level meet defined acceptable levels of risk (refer to Section 5.7)?	**Defined Acceptable Level**	**Comparison with Predicted Levels of Risk**	**EPO**
	No unplanned discharge of hazardous or non-hazardous liquid to sea. The risk of an unplanned discharge must be ranked Very Low to Medium according to the *Santos Offshore Division Environmental Hazard Identification and Assessment Procedure* (EA-91-IG-00004_5).	The residual risk of an unplanned discharge is considered to be Very Low and acceptable. This is due to application of maritime regulatory requirements and best practices.	EPO-20 EPO-22 EPO-23

7.5 Hazardous and non-hazardous unplanned discharges – solid

7.5.1 Description of event

Hazardous and non-hazardous unplanned discharges – solid	
Aspect	Non-hazardous solid wastes (including paper, plastics and packaging) and hazardous solid wastes (such as batteries, fluorescent tubes, medical wastes, and aerosol cans) may be dropped unintentionally to the marine environment, potentially impacting on sensitive receptors. Release of these waste streams may occur as a result of overfull and/or uncovered bins, incorrectly disposed items or spills during transfers of waste. Dropped objects/lost equipment such as a streamer could also result in seabed disturbance or floating obstacles. The largest potential dropped object would be a crate of supplies being transferred from a support vessel to a seismic survey vessel. Several seismic streamers (up to approximately 8 km in length) will be used during the Activity. The streamers are gel-filled, which has the characteristics of a 'flexible' solid and will not flow into the marine environment if the streamer skin is punctured, however if the streamer is lost, it will remain buoyant (due to floatation devices) and potentially be a floating obstacle. Other potential objects could include the fenders that are on vessels, should this detach, it will remain buoyant, and potentially be a floating obstacle.
Extent	Localised as all non-buoyant waste material or dropped objects are expected to remain within the Operational Area. Buoyant waste material or dropped objects could potentially move beyond the Operational Area under wave action.
Duration	Temporary (duration of the Activity as described in Section 2) or until the solid waste degrades or is retrieved.

7.5.2 Nature and scale of environmental impacts

Potential receptors include benthic habitats, fish, sharks and rays, marine mammals, marine reptiles, seabirds and migratory shorebirds, and socio-economic receptors.

The seismic survey vessel and support vessel(s) will generate a variety of solid waste including non-hazardous wastes (e.g. paper, plastics, waste metal and glass) and/or hazardous wastes (e.g. batteries and oil filters). Of relevance to this Activity is the legislation for the prevention of garbage disposal from vessels, which Santos implements through adherence to MARPOL. Solid wastes will not be discharged to sea but rather will be stored on board the vessels prior to transfer to a support vessel for onshore recycling or disposal.

If solid wastes on board vessels are not managed or disposed of appropriately, small quantities may be released with the potential to impact the environment. All domestic waste discharge will be managed in accordance with the requirements of MARPOL 73/78 and the AMSA Marine Orders made under the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*.

Loss of solid wastes to the marine environment have the potential to:

Temporarily create a localised change in water/sediment quality resulting in localised, minor and temporary ecological impacts

Cause injury, ingestion or entanglement by marine fauna.

Non-hazardous solids such as plastics have the potential to smother benthic environments and harm marine fauna through entanglement or ingestion. Marine turtles, seabirds and migratory shorebirds are particularly at risk from entanglement. Marine turtles may mistake plastics for food; once ingested, plastics can damage internal tissues and inhibit physiological processes, which can both potentially result in fatality. Marine debris has been highlighted as a threat to marine turtles, humpback whales and whale sharks in the Recovery Plan for Marine Turtles in Australia (DoEE 2017), Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) and Approved Conservation Advice for *Rhincodon typus* (whale shark) (refer to Table 3-12). The Recovery Plans and Approved Conservation Advices have specified a number of recovery actions to help combat this threat.

Release of hazardous solids (e.g. wastes such as batteries) may result in the pollution of the immediate receiving environment, which may lead to impacts to marine flora and fauna. Physiological damage, through ingestion or absorption may occur to individual fish, sharks and rays, marine mammals, marine reptiles, seabirds and migratory shorebirds.

The area of potential disturbance due to a non-buoyant dropped object would be restricted to the Operational Area. The seabed within the Operational Area is primarily soft sediments with infrequent localised rocky outcrops, gravel deposits and sandy banks. The muddy substrates that cover the majority of the Operational Area support relatively little seabed structure or sessile epibenthos. Seabed habitat is expected to be sparsely covered by sessile filter-

feeding organisms (e.g. gorgonians, sponges, ascidians and bryozoans) and mobile invertebrates (e.g. echinoderms, prawns and detritus-feeding crabs). Such habitats are well represented throughout the region.

A portion of the Carbonate Bank and Terrace System of the Sahul Shelf KEF partially overlap with the Operational Area. The KEFs provide areas of hard substrate that are important for sessile species benthic invertebrates including hard and soft corals, sponges, whips, fans, bryozoans and aggregations of demersal fish species such as snappers, emperors and groupers (Brewer et al. 2007; Nichol et al. 2013).

In the unlikely event that an object is dropped, damage to substrates and associated fauna is expected to be restricted to the size of the dropped object, and overall impacts will be negligible. While soft sediment benthic habits will not be destroyed, disturbance of the communities on and within them (i.e. the epifauna) may occur in the event of a dropped object and depressions may remain on the seabed for some time after removal of the dropped object as it gradually infills over time. Impacts to benthic habitats such as shelf and slope habitats and the KEFs are not expected. Given the water depths of the Operational Area, benthic impacts from the loss of a streamer are not considered credible.

In the unlikely event of damage to or loss of a seismic streamer, potential environmental effects could be limited to physical impacts on benthic communities arising from the streamer and associated equipment potentially sinking and dragging along the seabed. Seismic streamers are fitted with floatation devices (pressure-activated, self-inflating buoys) that are designed to bring the equipment to the surface if lost accidentally during a seismic survey. As the equipment sinks it passes a certain water depth at which point the buoys inflate (compressed CO_2 gas cartridge) and bring the equipment back to the surface where it can be retrieved by the seismic or support vessel.

Impacts to socio-economic receptors could occur should hazardous/non-hazardous solids cause a safety hazard to other marine users or potentially damage their equipment (e.g. fishing nets). Buoyant objects may cause interference with commercial fisheries and other marine users depending on the size of the object(s). Loss of a streamer (or part of) could create marine debris potentially interfering with other marine users by snagging equipment. Should disruption occur, it is only expected to affect individual users and cause temporary disruption through avoidance of a highly localised area. The potential for such interactions will be limited to a short period of time while the equipment is retrieved (if possible). Given the nature and size of the equipment to be used during the survey, lost equipment is not expected to result in a navigational hazard.

7.5.3 Environmental performance outcomes and control measures

Environmental Performance Outcomes relating to this hazard include:

EPO-20: No unplanned objects, emissions or discharges to sea or air

EPO-22: No injury to marine fauna during the Activity

EPO-24: No unplanned seabed disturbance.

The Control Measures considered for this Activity are shown in Table 7-17, with Environmental Performance Standards and Measurement Criteria for the EPOs described in Section 8.6.1.

Table 7-17: Control measures evaluation for hazardous and non-hazardous unplanned discharges – solid

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard control measures				
Eliminate				
None identified.				
Substitute				
None identified.				
Engineering				
CM-49	Equipment maintenance in accordance with PMS.	Ensures that lifting equipment is maintained and certified, and that lifting procedures are followed reducing probability of dropped objects occurring.	Additional personnel costs of ensuring equipment is maintained and certified as appropriate and that procedures are in place and followed.	**Adopted –** benefits of ensuring procedures are followed and equipment is compliant outweighs the minimal costs of personnel time.
CM-51	Streamers are fitted with streamer recovery devices (SRD).	Reduced potential impacts to the marine environment due to streamer loss or damage.	Costs to fit with floatation devices, adds to weight of streamers so vessel uses more fuel.	**Adopted** – benefits outweigh the costs of personnel time, and increased fuel usage.
Isolation				
None identified.				
Administration				
CM-33	Waste (garbage) management procedure.	Reduces probability of waste being discharged to sea, reducing potential impacts to marine fauna. Ensures food waste is discharged in manner that does not pose risk to the environment. Ensures compliance with Marine Orders (94 and 95) and MARPOL (Annex III and V) requirements as appropriate for vessel class.	Personnel cost of vessel audits and inspections, and in recording and reporting waste management.	**Adopted –** benefits of ensuring vessel is compliant outweighs the costs.
CM-50	Dropped object prevention procedure.	Impacts to environment are reduced by preventing dropped object and by retrieving dropped objects where possible.	Personnel costs involved in implementing procedures and in incident reporting.	**Adopted –** benefits of ensuring procedures are followed and measures implemented outweighs the costs of personnel time.
CM-52	Streamer deployment / retrieval procedure.	Reduced potential impacts to the marine environment due to streamer loss or damage.	Personnel costs involved in implementing procedures, maintaining logs / reporting and undertaking training.	**Adopted** – benefits of ensuring procedures are followed and measures implemented outweighs the costs of personnel time.
Protective				
None identified.				

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Additional control measures				
Eliminate				
None identified.				
Substitute				
None identified.				
Engineering				
CM-53	Streamers have locating devices fitted.	Enables location and retrieval of streamers if they are lost.	None identified.	**Adopted** – benefits outweigh operational constraints.
Isolation				
CM-54	Streamer tow depth.	Reduced risk of interaction with the seabed and seabed disturbance.	None identified. Streamer tow depths will already be managed for the purposes of data acquisition and tow depths are not constrained by the water depths in the Operational Area.	**Adopted** – benefits outweigh operational constraints.
Administration				
None identified.				
Protective				
None identified.				

7.5.4 Environmental risk assessment

Receptors	• Physical Environment – benthic habitats • Marine Fauna – cetaceans, marine turtles, fish, sharks and rays, seabirds • Socio-economic receptors – other marine users (fisheries, shipping, oil and gas operators)
Consequence	I – Negligible
Physical Environment – seabed disturbance In the event of lost equipment/ dropped object, it is expected that it may result in localised damage to the seabed. The extent of the impact is limited to the size of the dropped object and given the size of standard materials transferred, any impact is expected to be very small. Surveys of previous seabed disturbances following drilling activities indicate that recovery of benthic fauna in soft sediment substrates occurs between 6 and 12 months after the Activity ceases (URS 2001), suggesting any impacts are short term in duration, and result in a ***Negligible*** reduction in habitat area/function.	
Marine Fauna – marine mammals, marine turtles, fish, sharks and rays, seabirds and migratory shorebirds In the event of a hazardous/non-hazardous solid release, the quantities would be limited. This unplanned release could cause localised impacts to water quality and the benthic environment if the solid can degrade, which may lead to impacts on marine flora and fauna species. Solid wastes have the potential to result in fauna mortality or injury through ingestion or entanglement. Any impacts would be restricted to a small number of individuals in close proximity to the unplanned release. Small volumes of the solid waste stream would be generated during the Activity and with the management measures in place, any accidental loss to the environment would be small in size. Marine debris is identified as a potential threat to a number of marine fauna species in relevant Recovery Plans and Conservation Advice (Table 3-12). The controls implemented demonstrate that the Activity will be conducted in a manner that reduces marine debris and therefore potential impacts are reduced to ALARP and of an acceptable level. The limited quantities of accidental hazardous/ non-hazardous solid release associated with this event indicate that, in a worst-case release, fatalities would be limited to individuals and is not expected to result in a decrease of the local population size and the consequence level is therefore, ***Negligible***.	
Socio-economic receptors – Interference from a buoyant object In the event of a release of a buoyant object that cannot be recovered, it could present an obstacle to other marine users. Eventually the buoyant object may become non-buoyant and sink to the seabed where it may degrade over time. The time taken for this is dependent on the material released and any impacts to marine fauna and the seabed are described above. This may present a risk to commercial trawling activities and damage their equipment, so fishers may be required to avoid a highly localised area to avoid interaction. Given the likely size of buoyant equipment (i.e. seismic streamers), it will drift with the currents. It is considered unlikely to present a significant hazard to other marine users and the consequence level is therefore ***Negligible***.	
Likelihood	b – Unlikely
A set of control measures and checks have been proposed to ensure that the risks of dropped objects, lost equipment or release of hazardous/ non-hazardous solid waste to the environment has been minimised. The likelihood of transient marine fauna occurring in the Operational Area is limited and given the controls in place, the likelihood of releasing hazardous and non-hazardous solids to the environment resulting in a negligible consequence is considered unlikely (assumes potential for a single loss of solid waste incident during the Activity).	
Residual Risk	The risk associated with this hazard is Very Low.

7.5.5 ALARP evaluation

Hazardous/non-hazardous solid waste will be generated during the Activity and managed through the proposed control measures. Equipment loss and dropped objects, which might occur during vessel to vessel transfers in the field will be managed through transfer procedures and equipment management. The control measures proposed are considered sufficient to reduce the risk of hazardous/ non-hazardous solid releases to a level that is ALARP. The proposed control measures are considered appropriate to manage the risk to ALARP.

7.5.6 Acceptability evaluation

Is the risk ranked between Very Low to Medium?	Yes – Residual risk is ranked Very Low.
Is further information required in the consequence assessment?	No – Potential impacts and risks are well understood through the information available.
Are the risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' Offshore Division Environmental Hazard Identification and Assessment Procedure which considers principles of ecologically sustainable development. Based on the risk assessment in Section 7.5.2, lost equipment/ dropped objects are predicted to have highly localised impacts to fauna and ecological communities. Lost equipment or objects could present an obstacle to other marine users but it is It is unlikely to present a significant hazard. Based on the risk assessment and the proposed control measures, no significant short term or long term impacts are predicted. Therefore, in the context of the principles of ESD: • There is no threat of serious or irreversible environmental damage • The health, diversity and productivity of the environment will be maintained • The biological diversity and ecological integrity of the marine environment will be conserved.
Are control measures and performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – Management consistent with MARPOL Annex V. Controls implemented will minimise the potential impacts from the Activity to species identified in relevant Recovery Plans and Approved Conservation Advice (Table 3-12) as having the potential to be impacted by marine debris (solid hazardous/ non-hazardous releases).
Are control measures and performance standards consistent with the Santos Environmental Management Policy?	Yes – Aligns with the Environmental Management Policy.
Are performance outcomes and standards consistent with stakeholder expectations?	Yes – No concerns raised.
Are control measures and performance standards such that the impact or risk is considered to be ALARP?	Yes (see ALARP evaluation above).

Defined Acceptable Levels			
Does the predicted risk level meet defined acceptable levels of risk (refer to Section 5.7)?	**Defined Acceptable Level**	**Comparison with Predicted Levels of Risk**	**EPO**
	No unplanned discharge of hazardous or non-hazardous solid object to sea. The risk of an unplanned discharge must be ranked Very Low to Medium according to the *Santos Environmental Offshore Division Hazard Identification and Assessment Procedure* (EA-91-IG-00004_5).	The residual risk of an unplanned discharge is considered to be Very Low and acceptable. This is due to application of maritime regulatory requirements and best practices.	EPO-20 EPO-22 EPO-24

7.6 Marine fauna collisions

7.6.1 Description of event

Marine fauna collisions	
Aspect	There is the potential for vessels and/or equipment involved in the Activity to collide with marine fauna including cetaceans, fish, sharks and rays, marine reptiles and seabirds and migratory shorebirds. The main collision risk associated with the Activity is through vessel collision or equipment collision (i.e. streamers and seismic source) with large, slow moving cetaceans; or turtle entrapment in tail buoys, potentially resulting in severe injury or mortality.
Extent	Within the Operational Area, in the immediate vicinity of the seismic and support vessel(s). There is also the potential for vessels and/or equipment involved in the Activity to collide with marine fauna outside of the Operational Area if the seismic vessel is required to depart the Operational Area with towed equipment deployed e.g. emergency demobilisation in the event of a cyclone or technical issues.
Duration	For the duration of the Activity as described in Section 2.

7.6.2 Nature and scale of environmental impacts

Potential receptors include marine mammals, marine reptiles, fish, sharks, rays, seabirds and migratory shorebirds.

Vessel movements can result in collisions between the vessel (hull, propellers and streamer array) and marine fauna. Vessel collisions have the potential to result in superficial injury, serious injury that may affect life functions (e.g. movement and reproduction) or cause mortality to marine fauna. The risk of a vessel collision or entanglement with marine fauna is limited to the footprint of the vessels, which is temporary in nature at any one position, as the vessels transits within the Operational Area for the acquisition period. The factors that contribute to the frequency and severity of impacts due to collisions vary greatly due to vessel type, vessel operation (specific activity, speed), physical environment (e.g. water depth), and the type of fauna potentially present and their behaviours. Research shows that faster vessels have a greater risk of collision with marine fauna than slower-moving vessels. To date, there have been no reported cases of marine fauna becoming entangled in seismic equipment in Australian waters.

Cetaceans are naturally inquisitive marine mammals that are often attracted to offshore vessels, and dolphins commonly ‘bow ride’ with offshore vessels. The reaction of whales to the approach of a vessel is quite variable. Some species remain motionless when close to a vessel while others are known to be curious and often approach ships that have stopped or are slow moving, although they generally do not approach, and sometimes avoid, faster moving ships (Richardson et al. 1995). In Australia, the majority of vessel strikes to known cetacean species involved humpback, southern right whale and sperm whales, in descending order (Peel et al. 2016). Van Warebeek et al. (2007) report just five blue whale ship strikes in the Southern Hemisphere. No vessel strikes were reported in the Northern coast of Australia (Peel et al. 2016).

Several species of cetaceans are known to occur in the NWMR and NMR and have wide distributions that are associated with feeding and migration patterns linked to reproductive cycles. However, there are no known important cetacean habitats within or nearby the Operational Area. The closest marine mammal BIA is the breeding/ foraging/ calving/ resting BIAs for the Australian snubfin dolphin (located approximately 101 km south of the Operational Area). The Operational Area may represent an area of foraging, breeding, calving and/or resting habitat for the Omura’s whale, with year-round presence documented (McCauley 2009, 2014). The occurrence of marine mammals within the Operational Area is expected to be infrequent and limited to infrequent occurrences of individuals or small groups. For example, four Indo-pacific bottlenose dolphins in one pod were observed swimming during the Petrel Sub-Basin South-West 3D MSS undertaken between 29 February to 23 March 2022 in the JBG (Santos 2022).

Marine turtles are at potential risk from vessel strike and entanglement with the in-water seismic equipment. Hazel and Gyuris (2006) reviewed vessel strike data from 1999-2002 on the Queensland east coast and found that during that period at least 65 turtles were killed annually as a result of collisions with vessels. Green turtles, followed by loggerhead turtles comprised the majority of vessel related records, and 72% of cases were adult or sub-adult turtles (Hazel and Gyuris 2006). In Australian waters, all species of marine turtle have been involved in vessel strikes (DoEE 2016). Marine turtles appear to be more vulnerable to boat strike in areas of high urban population where incidents of pleasure crafts are higher.

The effect of vessel speed and turtle flee response can be significant. A study by Hazel et al. (2007) found that 60% of green turtles fled from vessels travelling at 2.2 knots (4 km/h) while only 4% fled from vessels travelling at 10.2 knots (19 km/h). When fleeing 75% of turtles moved away from the vessel’s track, 8% swam along the vessel track and 18% crossed in front of the vessel. The study concluded that most turtles would be unlikely to avoid vessels travelling at speeds greater than around 2.2 knots (Hazel et al. 2007; DoEE 2017).

There is no published literature on marine turtle entanglement with seismic equipment during seismic surveys, however Nelms et al. (2016) state that they received anecdotal reports of turtle entrapments in tail buoys and airgun strings during several offshore seismic surveys off the west coast of Africa, and media reports of eight Olive Ridley turtles becoming entangled in ocean bottom cable. Additionally, there is evidence of marine turtles becoming entangled in discarded seismic cable (Duncan et al. 2017).

The NWMR and NMR are considered to be significant for supporting large feeding and nesting turtle populations. The Operational Area overlaps with BIAs for foraging marine turtles (loggerhead, flatback, green and olive ridley). A portion of the Carbonate Bank and Terrace System of the Sahul Shelf KEF and pinnacles of the Bonaparte Basin KEF partially overlaps with the Operational Area and has been identified as foraging areas for loggerhead, olive ridley and flatback turtles (DEWHA 2008b). Bycatch records from the NPF within the southern portion of the Operational Area and EMBA identified that turtle catches varied with water depth: the highest catch rates were from trawls in water depths between 20 and 30 m deep, relatively few turtles (10%) were captured in water deeper than 40 m (Poiner and Harris 1996). It is unlikely that the marine environment within the Operational Area is a predominant foraging area for turtles. The majority of the Operational Area is in water depths greater than 60 m, typically outside of the preferred depth range for foraging marine turtles. The occurrence of marine turtles within the Operational Area is expected to be low. To illustrate the low probability of marine turtles incidence in the Operational Area, two unidentified turtles were observed for the Petrel Sub-Basin South-West 3D MSS undertaken between 29 February to 23 March 2022 in the JBG (Santos 2022).

Whale sharks are at risk from vessel strikes when feeding at the surface or in shallow waters (where there is limited option to dive). Whale sharks may traverse the offshore waters of the Operational Area during their migrations to and from Ningaloo Reef. A foraging BIA for the whale shark overlaps with the western portion of the EMBA, approximately 210 km from the Operational Area. The foraging route follows the continental shelf within the 200 m isobath and extends from Ningaloo to waters in the north Kimberley region. Individuals tagged at Ningaloo Reef have been shown to migrate north, north-east or north-west into Indonesian waters, using both inshore and offshore habitats (Reynolds et al. 2017; Sleeman et al. 2010; Wilson et al. 2006). The foraging BIA that overlaps the EMBA represents waters where solitary whale sharks may forage during the migration from Ningaloo, which occurs primarily in spring (September to November). It is expected that whale shark presence in the Operational Area would not comprise of significant numbers, given main aggregations are recorded in coastal waters (MPRA 2005; Sleeman et al. 2010) and their presence would be transitory and of a short duration.

Vessels will be moving at slow speeds (4-5 knots) in the Operational Area, reducing the likelihood that a collision between a seismic or support vessel and marine fauna will occur, and, should a collision occur, that it would result in serious injury. Additionally, while the seismic source is in operation it is unlikely that marine fauna would become entangled in the array or collide with the seismic equipment, as the sound generated during operations would act as a deterrent. During line turns, when typically the seismic source is not in full operation, the source is activated at low power in accordance with industry standards as a precautionary measure to reduce the likelihood of entanglement or contact during line turns. Close-range encounters with marine fauna are expected to be infrequent and limited to isolated individuals in the vicinity of the operating vessels and survey area.

7.6.2.1 Threatened/Migratory fauna

Marine Mammals and Fish and Sharks

The Approved Conservation Advice and Conservation Management Plans for the blue whale, fin whale, sei whale and humpback whale lists vessel strike as a threat to these threatened species. The Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC 2015d) indicates that humpback whales are one of the most frequently reported whale species involved in vessel strikes worldwide (Laist et al. 2001; Jensen & Silber 2003). This observation is supported by Australian studies referenced in The National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (DoEE 2017). The increase in vessel numbers (Silber & Bettridge 2012) is not only a threat to humpback whales in relation to vessel strikes but also in relation to disturbance and displacement from key habitats. Similarly, vessel strike is also recognised by the Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC 2015a) as one of the threats to the recovery of whale sharks. Whale sharks are at risk from vessel strikes when feeding at the surface or in shallow waters (where options to dive are limited).

The worst potential impact from vessel collision would be mortality or serious injury of an individual. Collisions between vessels and cetaceans are most frequent on continental shelf areas where high vessel traffic and cetacean habitat occur simultaneously (WDCS 2006). Instances of cetacean deaths as a result of vessel collisions in Australian waters have been recorded (e.g. a Bryde's whale in Bass Strait in 1992) (WDCS 2006), although the data indicates this is likely to be associated with container ships and fast ferries. The Whale and Dolphin Conservation Society also indicates that some cetacean species, such as humpback whales, can detect and change course to avoid a vessel (WDCS 2006). The reaction of whales to the approach of a ship is quite variable. Some species remain motionless when in the vicinity of a ship while others are known to be curious and often approach ships that have stopped or are slow-moving, although they generally do not approach and sometimes avoid faster-moving ships (Richardson et al. 1995).

No constraints within the operational areas (e.g. shallow water or shorelines) would prevent whale sharks from moving away from vessels. Vessel speed has been demonstrated to be a key factor in relation to collision with marine fauna, particularly cetaceans, with faster-moving vessels posing a greater collision risk than slower vessels (Laist et.al. 2001; Jensen & Silber 2003; Hazel 2009). Laist et al. (2001) suggest that the most severe and lethal injuries to cetaceans are caused by vessels travelling at 14 knots or faster.

There are no BIAs for marine mammals, fish or sharks within the operational area.

Marine Turtles

Marine turtle and vessel interactions arising from increased vessel traffic is recognised as one of a number of key threats to marine turtles in the Recovery Plan for Marine Turtles (DoEE 2017). It is likely that flatback, green, loggerhead and Olive Ridley turtles may be transient within the operational area due to the presence of foraging BIAs.

Marine turtle mortality due to vessel strike has been identified as an issue in Queensland waters in the Recovery Plan for Marine Turtles in Australia (DoEE 2017). However, turtles appear to be more vulnerable to vessel strike in areas of high urban population where incidents of pleasure crafts are higher. WA turtle populations have not been highlighted as those most affected by vessel strike, possibly due to the relatively low human population density of the North West Shelf coastline.

Turtles will typically avoid vessels by rapidly diving; however, their ability to respond varies greatly depending on the speed of the vessel. Hazel (2009) reported that the number of turtles that fled vessels decreased significantly as vessel speed increased. Turtles are also adapted to detect sound in water (Popper et al. 2014) and will generally move from anthropogenic noise-generating sources, including vessels, within their detection range.

7.6.2.2 Protected and significant areas and Socio-economic receptors

The Operational Area overlaps the Oceanic Shoals Marine Park and the Pinnacles of the Bonaparte Basin KEF, which provide suitable habitat for turtle foraging.

7.6.3 Environmental performance outcomes and control measures

The Environmental Performance Outcome relating to this event is:

EPO-22: No injury to marine fauna during the Activity.

The Control Measures considered for this Activity are shown in Table 7-18, with Environmental Performance Standards and Measurement Criteria for the EPOs described in Section 8.6.1.

Table 7-18: Control measures evaluation for marine fauna collisions

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard control measures				
Eliminate				
CM-52	Streamer deployment / retrieval procedure.	Reduced potential impacts to the marine environment due to streamer loss or damage.	Personnel costs involved in implementing procedures, maintaining logs / reporting and undertaking training.	**Adopted** – benefits of ensuring procedures are followed and measures implemented outweighs the costs of personnel time.
Substitute				
None identified.				
Engineering				
CM-55	Use of a 'turtle friendly' tail buoy	Reduce likelihood of entanglement of marine turtles.	May increase activity costs or limit number of potential contractors available leading to survey delays.	**Adopted** – based on risk outweighing cost. Turtle guards are commonplace equipment and therefore contractor selection will not be significantly impacted.
Isolation				
None identified.				
Administration				
CM-16	EPBC Regulations (Part 8) for interacting with cetaceans.	Reduces risk of physical and behavioural impacts to cetaceans from support vessels, helicopters and seismic survey vessel (when not operating).	Potential additional costs in not being able to recommence activity (if not acquiring the seismic survey) increasing survey duration and costs to Santos. Personnel costs involved in reporting sightings to authorities.	**Adopted** – benefits in reducing impacts to cetaceans and other marine fauna outweigh the costs incurred by Santos implementing EPBC Regulations (Part 8).
Protective				
None identified				
Additional control measures				
Eliminate				
N/A	No night-time / low visibility operations.	Eliminate/reduce likelihood and consequence of impact.	Lengthens time (doubles) of survey as operations only occur for approximately 10 hours/day. Increase cost due to increased survey time (more than double cost).	**Not Adopted** – Cost outweighs the environmental benefit given the low numbers of marine fauna which may be in the area (due to survey shutdown for peak whale migration).
N/A	Towed streamers and seismic source array recovered if the seismic vessel	Recovering towed equipment reduces the risk of interactions with marine fauna in the event that the seismic vessel is required to	Recovery of towed equipment can take in the order of 3-4 days to recover on board the seismic vessel and a similar amount of time to redeploy and test equipment.	**Not Adopted** – While it is acknowledged that this would provide a reduction in risk

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
	is required to transit outside of the Operational Area.	sail outside of the Operational Area while under contract to Santos.	Therefore, recovery of towed equipment may result in significant lost time during the survey window and is a significant cost (1.5–2 million USD) to Santos. In addition, in the event that the seismic vessel is required to depart the Operational Area urgently due to weather or mechanical issues, recovery may not be possible. The Vessel Master will take whatever action they feel necessary to prevent threats to life on board the vessel or damage to the vessel or equipment. Recovery of equipment is therefore the Vessel Master's decision, not Santos'.	to marine fauna, it is not practicable or feasible to implement.
Substitute				
None identified.				
Engineering				
None identified.				
Isolation				
None identified.				
Administration				
CM-17	Implementation of control measures consistent with EPBC Policy Statement 2.1 Part B: Two MFOs (MMOs) and 1 SEA on board the seismic survey vessel.	The use of dedicated observers ie. MFOs/MMOs and SEA, is expected to achieve a higher standard of marine fauna activity surveillance, when compared to assigning vessel crew members to perform marine fauna observations in addition to other core duties.	Activity cost of MFOs on board survey. vessels	**Adopted**– observations to assist in avoidance and compliance with regulations outweighs minor activity cost.
Protective				
CM-9	Constant bridge watch.	Crew of support vessels and the seismic survey vessel will maintain constant bridge watch, including for third party vessels which may enter the exclusion (safety) zone.	No additional costs; industry practice and regulated by AMSA.	**Adopted –** no additional costs.

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-15	Marine fauna observations undertaken to minimise the disturbance to fauna caused by the Activity.	Eliminate / reduce impact potential for collision or unwanted interactions.	Increased activity cost.	**Adopted** – benefit outweighs cost. Support vessels will already be in place as a safety requirement to manage interactions with third party vessels.
N/A	Spotter planes / vessels sent ahead to planned night-time Operational Area.	Eliminate/reduce likelihood and consequence of impact.	Marine fauna may have moved away from the area by the time the operating seismic survey vessel arrives, or other marine fauna entered the area rendering the pre survey check invalid. Diving cetaceans may not be observed during pre-survey check. Cost of specialist aircraft with good downward visibility, or cost of an additional spotter vessel and additional MFOs required on aboard aircraft/vessels. Additional risks to environment through use of vessels/airplanes, increased safety risks to personnel on board additional vessels.	**Not Adopted** – based on cost outweighing benefits.

7.6.4 Environmental risk assessment

Receptors	Marine Fauna – marine mammals, marine reptiles, fish, sharks and rays
Consequence	I – Negligible
In the event of a collision with marine fauna, there is the potential for injury or death to an individual. The receptors present in the Operational Area are expected to be limited to a small number of transient individuals. Boat strike and vessel disturbance are identified as potential threats to a number of marine fauna species in relevant Recovery Plans and Approved Conservation Advice (Table 3-12). The information above demonstrates that the Activity will be conducted in a manner that reduces potential impacts to ALARP and of acceptable level. In addition, all vessel strikes will be reported by Santos in the National Ship Strike Database. There is the potential for death or injury of EPBC listed individual species, however as they would represent a small proportion of the local population it is not expected that it would result in a decreased population size over what would usually occur due to natural variation, at a local or regional scale. In addition, given the vessels will be moving slowly during the Activity, it is expected that a collision with an individual would result in a minor injury only. Overall, the consequence of a striking an individual marine fauna is not expected to decrease the local population size and therefore is assessed as Negligible.	
Likelihood	b – Unlikely
The Australian National Marine Safety Committee (NMSC) reports that during 2009, there was one report of a vessel collision with a marine animal (species not defined) (NMSC 2010). Vessels will be moving slowly whilst inside the Operational Area, posing a low risk of collision with marine fauna. Consequently, the likelihood of a collision with marine fauna resulting in a minor consequence is considered to be unlikely.	
Residual risk	The residual risk associated with this hazard is Very Low

7.6.5 ALARP evaluation

No alternative options to the use of vessels and streamers for the Activity are possible in order to undertake the Activity. If the control measures are adhered to then the risk of marine fauna collisions will have been reduced to ALARP.

The assessed residual risk for this impact is low. Additional controls were identified and some have been adopted, as detailed in Section 7.6.3. The implementation of the control measures which were not adopted would require a disproportionate level of cost/effort in order to reduce the level of impact or risk. The proposed control measures are considered appropriate to manage the risk to ALARP.

7.6.6 Acceptability evaluation

Is the risk ranked between Very Low to Medium?	Yes – Residual risk is ranked Very Low.		
Is further information required in the consequence assessment?	No – Potential impacts and risks are well understood through the information available.		
Are the risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' Offshore Division Environmental Hazard Identification and Assessment Procedure which considers principles of ecologically sustainable development. Based on the risk assessment in Section 7.6.2, in the event of a collision with marine fauna, there is the potential for injury or death to individuals, but no population level impacts are expected. Based on the risk assessment and the proposed control measures, no significant short term or long term impacts are predicted. Therefore, in the context of the principles of ESD: • There is no threat of serious or irreversible environmental damage • The health, diversity and productivity of the environment will be maintained • The biological diversity and ecological integrity of the marine environment will be conserved.		
Are control measures and performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – Management consistent with Part 8 of the EPBC Regulations. Controls implemented will minimise the potential impacts from the Activity to species identified in relevant Recovery Plans and Approved Conservation Advice as having the potential to be impacted by vessel strike (Table 3-12).		
Are control measures and performance standards consistent with the Santos Environmental Management Policy?	Yes – Aligns with the Environmental Management Policy.		
Are performance outcomes and standards consistent with stakeholder expectations?	Yes – No concerns raised.		
Are control measures and performance standards such that the impact or risk is considered to be ALARP?	Yes (see ALARP evaluation above).		
Defined Acceptable Levels			
Does the predicted risk level meet defined acceptable levels of risk (refer to Section 5.7)?	**Defined Acceptable Level**	**Comparison with Predicted Levels of Risk**	**EPO**
	No collision that results in injury marine fauna. The risk of a collision with marine fauna must be ranked Very Low to Medium according to the *Santos Offshore Division Environmental Hazard Identification and Assessment Procedure* (EA-91-IG-00004_5).	The residual risk of colliding with marine fauna is considered to be Very Low and acceptable. This is due to the low vessel speeds, compliance with Part 8 of the EPBC Regulations and presence of marine fauna observers.	EPO-22

7.7 Introduction of invasive marine species

7.7.1 Description of event

Introduction of invasive marine species	
Aspect	Invasive marine species (IMS) have been introduced and translocated around Australia by a variety of natural and human means including biofouling and ballast water. IMS could be introduced into the Operational Area and surrounds by vessels carrying IMS on external biological fouling, internal systems (sea chests, seawater systems etc.), on marine equipment such as seismic streamers, or through ballast water exchange.
Extent	Localised (seabed and water column near the Operational Area) to widespread, if successfully translocated to new areas via ocean currents or survey equipment transit.
Duration	Temporary (duration of the Activity as described in Section 2) to long-term (in the event of successful translocation).

7.7.2 Nature and scale of environmental impacts

Potential receptors include marine ecosystem as a whole and commercial/recreational users of the marine environment.

IMS are non-indigenous marine plants, animals and algae that have been introduced into a region that is beyond their natural range but have the ability to survive, and possibly thrive (DAFF 2011). Shallow coastal marine environments in particular, are thought to be amongst the ecosystems most susceptible to the establishment of IMS, which largely reflects the accidental transport of IMS by international shipping to marinas and ports (Commonwealth of Australia 2009; Wells et al. 2009).

Some IMS pose a significant risk to environmental values, biodiversity, ecosystem health, human health, fisheries, aquaculture, shipping, ports and tourism (Wells et al. 2009). IMS can cause a variety of adverse effects in a receiving environment, including:

Over-predation of native flora and fauna

Out-competing of native flora and fauna for food

Changing the nature of the environment, resulting in an alteration to the structure (species biodiversity and abundance) and the functioning of ecological communities

Human illness through released toxins

Depletion of viable fishing areas and aquaculture stock

Reduction of coastal aesthetics

Damage to marine and industrial equipment and infrastructure.

Species of concern are those that are not native to the region which can be spread by human mediated or natural means and are likely to survive and establish in the region. Species of concern vary from one region to another depending on various environmental factors such as water temperature, salinity, nutrient levels and habitat type. These factors dictate their survival and invasive capabilities.

It is recognised that artificial, disturbed and/or polluted habitats in tropical regions are susceptible to invasive marine species being introduced. Hence ports are often areas of higher IMS risk (Neil et al. 2005).

Once established, it is often difficult to eradicate IMS populations, and management options tend to be limited to ongoing control or impact minimisation. Eradication is dependent on environmental conditions and species. For this reason, Commonwealth and State regulatory agencies have implemented increased management requirements in recent years.

Ballast water exchange and biofouling on vessel hulls and other external niche areas, internal niches, and on equipment routinely immersed in water all pose a potential risk of introducing IMS into Australia. The potential biofouling risk presented by the vessels is linked to the length of time that the vessel has already been operating in Australian waters. If the vessels have been operating outside of Australian waters, the biofouling risk is a combination of the following factors:

Location of previous operations

Length of time spent at these location/s

Completion of hull inspections, cleaning and application of new anti-foulant coating prior to returning to Australian waters.

7.7.3 Environmental performance outcomes and control measures

Environmental Performance Outcomes relating to this event include:

EPO-25: No introduction of marine pest species.

The Control Measures considered for this Activity are shown in Table 7-19, with Environmental Performance Standards and Measurement Criteria for the EPOs described in Section 8.6.1.

Table 7-19: Control measures evaluation for invasive marine species

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard control measures				
Eliminate				
None identified.				
Substitute				
None identified.				
Engineering				
CM-56	Anti-foulant system.	The risk of introducing IMS is reduced due to anti-foulant systems.	Could lead to potential delays and therefore costs, in vessel contracting process due to availability of vessel with appropriate anti-foulant systems.	**Adopted** – Potential delays or costs to Activity are considered to outweigh the benefits of reducing the risk of IMS.
Isolation				
None identified.				
Administration				
CM-57	Aquatic Biosecurity Solution vessel check tool (applied to vessels), and immersible equipment clean.	The risk of introducing IMS is reduced through implementation of the vessel check tool and requirement for immersible equipment to be cleaned.	Personnel costs involved in demonstrating vessel(s) are of 'low risk' of introducing IMS through completion of Aquatic Biosecurity Solution vessel check tool as well as the requirement for equipment to be cleaned could lead to potential delays in Activity schedule should remediation activities (e.g. additional cleaning and inspections) be required, potentially affecting vessel contracting process.	**Adopted** – Personnel costs and potential delays or costs to Activity are considered outweighed by the benefits of reducing the risk of IMS.
CM-58	Biosecurity risk management.	Reduces the level of biosecurity risk.	Personnel costs involved in demonstrating the seismic survey vessels level of biosecurity risk is assessed as 'low risk' prior to interacting with domestic support vessels and aircraft. Could lead to potential delays and costs.	**Adopted –** Personnel costs and potential delays to the Activity are considered outweighed by the benefits of reducing the level of biosecurity risk.
CM-59	Ballast water management plan.	Reduces the risk of introducing IMS through procedures managing ballast water exchange and identifying high risk ballast water.	Personnel costs in producing and implementing ballast water management plan and in maintaining record books and logs.	**Adopted** – Potential costs are considered outweighed by the benefits of reducing the risk of IMS.
Protective				
None identified.				

CM Ref.	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Additional control measures				
Eliminate				
N/A	Mandatory dry docking prior to entering field to clean vessel and/or equipment and remove biofouling.	Eliminate invasive marine species.	Significant cost for this to occur and would lead to scheduling delays.	**Not Adopted –** Given other controls in place already reducing the risk, cost outweighs risk.
Substitute				
N/A	Use an alternative ballast system to avoid uptake/discharge of water.	Eliminate need for ballast water exchange therefore decreasing risk of introducing IMS through ballast water.	Vessels suitable for the Activity may not have options for alternative ballast therefore would require modification at significant cost.	**Not Adopted** – Cost outweighs benefit.
Engineering				
None identified.				
Isolation				
N/A	Contract vessels only operating in local, state or National waters to reduce potential for IMS.	Eliminate likelihood of invasive marine species.	Appropriate seismic survey vessels required for the Activity are not currently working in Australian waters only. The survey objectives would not be met if vessel selection was restricted to those operating in only Australian waters.	**Not Adopted** – not feasible to restrict vessels due to availability.
Administration				
None identified.				
Protective				
N/A	Mandatory independent IMS survey.	Eliminate invasive marine species.	Cost is high compared to existing risk.	**Not Adopted** – Based on cost outweighing risk.
N/A	Pre-mobilisation chemical dosage of ballast water to eliminate IMS.	Would reduce potential for IMS to establish by eliminating individuals present in ballast water.	High cost compared to existing risk; introduction of additional chemical to the marine environment which would likely be toxic to native marine species.	**Not Adopted** – Based on risk to marine environment from release of chemicals and high cost considered disproportionate compared to base case risk.
N/A	Heat treatment of ballast water to eliminate IMS.	Would reduce potential for IMS to establish by eliminating individuals present in ballast water.	High cost compared to existing risk; introduction of water at much higher temperature than surrounding marine environment would likely result in death of native marine species.	**Not Adopted** – based on increased risk to marine environment compared to base case risk.

7.7.4 Environmental risk assessment

Receptors	Marine Fauna (including Threatened/Migratory/Local fauna) Physical Environment/Habitat Socio-economic receptors
Consequence	III – Moderate
Ballast water is responsible for up to 30% of all IMS incursions into Australian waters; however, research indicates that biofouling (the accumulation of aquatic micro-organisms, algae, plants and animals on vessel hulls and submerged surfaces) has been responsible for more foreign marine introductions than ballast water (DAWR 2017). IMS, if they successfully establish, can out-compete native species for food or space, preying on native species or changing the nature of the environment and can subsequently impact on fisheries or aquaculture. If an IMS is introduced, they have been known to colonise areas outside of the areas they are introduced to. In the event that an IMS is introduced into the Operational Area, given the lack of diversity and extensiveness of similar benthic habitat in the region, there would only be a minor reduction in the physical environment. The overall consequence level was assessed as ***Moderate***.	
Likelihood	a – Remote
The pathways for IMS introductions are well known, and consequently standard preventative measures are proposed. The ability for invasive marine species to colonise a habitat is dependent on a number of environmental conditions. It has been found that highly disturbed environments (such as marinas) are more susceptible to colonisation than open water environments where the number of dilutions and the degree of dispersal are high (Paulay et al. 2002). Given the water depths of in the Operational Area (60–115 m), the likelihood that an IMS would be able to successfully translocate from the Operational Area to surrounding shallower habitats is reduced. With controls in place to reduce the risk of introduction of IMS the likelihood of introducing an IMS is considered remote.	
Residual risk	The residual risk associated with this hazard is Very Low

7.7.5 ALARP evaluation

Santos will forward the most current WA Prevention List for Introduced Marine Pests to all vessel operators prior to the survey to ensure they are aware of potential invasive marine pest species and the reporting requirements.

Ballast water will be managed through a Ballast Water Management Plan, and a vessel biosecurity risk assessment undertaken on all vessels planned for use for the Activity (using the Aquatic Biosecurity Solution vessel check tool) to minimise the risk of introduction of a marine pest species.

Completion of the Aquatic Biosecurity Solution vessel check tool prior to movement/ transit into a Santos petroleum permit, demonstrating vessels are low risk of introducing IMS reduces the risk of IMS. Given the water depths in the Operational Area, the potential for IMS establishing is considered very low.

Immersible equipment will be cleaned to ‘low risk’ prior to submerging, this ensures the equipment operates efficiently and also reduces the risk of introducing IMS.

Accepted control measures will ensure the risk of IMS introduction is consistent with outcomes outlined in DPIRD’s Aquatic Biosecurity Policy (2017).

Through the use of the Aquatic Biosecurity Solution vessel check tool, and cleaning of immersible equipment, Santos is confident that the potential risk of introducing IMS through biofouling will be ALARP.

No reasonably practicable additional controls were identified in the evaluation of control measures in Section 7.7.3 that would further increase the environmental benefit without a grossly disproportionate cost/sacrifice. The proposed control measures are considered appropriate to manage the risk to ALARP.

7.7.6 Acceptability evaluation

Is the risk ranked between Very Low to Medium?	Yes – Residual risk is ranked Very Low.		
Is further information required in the consequence assessment?	No – Potential impacts and risks are well understood through the information available.		
Are the risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' Offshore Division Environmental Hazard Identification and Assessment Procedure which considers principles of ecologically sustainable development. The pathways for IMS introductions are well known, and consequently standard preventative measures are proposed. Given the water depths of the Operational Area (60–115 m), the likelihood that an IMS would be able to successfully translocate from the Operational Area to surrounding shallower habitats is reduced. With controls in place to reduce the risk of introduction of IMS the likelihood of introducing an IMS is considered remote. Based on the risk assessment in Section 7.7.4, and the proposed control measures, no significant short term or long term impacts are predicted. Therefore, in the context of the principles of ESD: • There is no threat of serious or irreversible environmental damage • The health, diversity and productivity of the environment will be maintained • The biological diversity and ecological integrity of the marine environment will be conserved.		
Are control measures and performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – Management will meet Commonwealth *Biosecurity Act 2015*, Offshore Installations Biosecurity Guide (DAWR 2019), National Biofouling Guidance for the Petroleum Industry (Australian Government 2009) and Australian Ballast Water Management Requirements 2017; and WA *Fish Resources Management Act 1994* and DPIRD's Aquatic Biosecurity Policy (2017).		
Are control measures and performance standards consistent with the Santos Environmental Management Policy?	Yes – Aligns with the Environmental Management Policy.		
Are performance outcomes and standards consistent with stakeholder expectations?	Yes – No concerns raised.		
Are control measures and performance standards such that the impact or risk is considered to be ALARP?	Yes (see ALARP evaluation above).		
Defined Acceptable Level			
Does the predicted risk level meet defined acceptable levels of risk (refer to Section 5.7)?	**Defined Acceptable Level**	**Comparison with Predicted Levels of Risk**	**EPO**
	No introduction of an invasive marine species. The risk of introducing invasive marine species must be ranked Very Low to Medium according to the *Santos Offshore Division Environmental Hazard Identification and Assessment Procedure* (EA-91-IG-00004_5).	The residual risk of introducing invasive marine species is considered to be Very Low and acceptable. This is due to the proposed control measures which comply with Commonwealth and State legislation and are consistent with regulatory and industry guidance.	EPO-25

8. Implementation strategy

OPGGS(E)R 2023 Requirements
Section 22(1)
The environment plan must contain an implementation strategy for the activity in accordance with this regulation.
Section 22(16)
The implementation strategy must comply with the Act, the regulations and any other environmental legislation applying to the activity.

The specific measures and arrangements that will be implemented in the event of an oil pollution emergency are detailed within the OPEP.

Stakeholder engagement is assessed separately for the requirements of the activities. Ongoing stakeholder management strategies are discussed in Section 4.

8.1 Environmental management system

OPGGS(E)R 2023 Requirements
Section 22(2)
The implementation strategy must contain a description of the environmental management system for the activity, including specific measures to be used to ensure that, for the duration of the activity: a) the environmental impacts and risks of the activity continue to be identified and reduced to a level that is as low as reasonably practicable; and b) control measures detailed in the environment plan are effective in reducing the environmental impacts and risks of the activity to as low as reasonably practicable and an acceptable level; and c) environmental performance outcomes and standards set out in the environment plan are being met.

The Santos Management System (SMS) exists to support its moral, professional and legal obligations to undertake work in a manner that does not cause harm to people or the environment. The SMS is a framework of policies, standards, processes, procedures, tools and control measures that, when used together by a properly resourced and competent organisation, ensure that:

A common HSE approach is followed across the organisation

HSE is proactively managed and maintained

The mandatory requirements of HSE management are implemented and are auditable

HSE management performance is measured and corrective actions are taken

Opportunities for improvement are recognised and implemented

Workforce commitments are understood and demonstrated.

This implementation strategy is designed to meet the requirements of the EP to require that:

Environmental impacts and risks continue to be identified for the duration of the Activity and reduced to ALARP

Control measures are effective in reducing environmental impacts and risks to ALARP and acceptable levels

Environmental performance outcomes and standards set out in this EP are met

Stakeholder consultation is maintained throughout the Activity as appropriate.

8.2 Environment Operating Standard

Santos' Environment Operating Standard (Appendix A) clearly sets out Santos' strategic environmental objectives and the commitment of the management team to continuous environmental performance improvement. This EP has been prepared in accordance with the fundamentals of this policy. By accepting employment with Santos, each employee and contractor is made aware during the recruitment process that he or she is responsible for the application of this policy.

8.3 Leadership, accountability and responsibility

OPGGS(E)R 2023 Requirements
Section 22(3)
The implementation strategy must establish a clear chain of command, setting out the roles and responsibilities of personnel in relation to the implementation, management and review of the environment plan, including during emergencies or potential emergencies.

While Santos' Executive Vice President has the overall accountability for the implementation of the SMS, the General Manager Subsurface and Technical Upstream Western Australia is responsible for ensuring implementation, management and review of this EP.

Effective implementation of this EP will require collaboration and cooperation amongst Santos and its contractors. This is reflected in Table 8-1, which sets out the roles and responsibilities of personnel in relation to the implementation, management and review of the EP.

Table 8-1: Chain of command, key leadership roles and responsibilities

Role	Responsibilities
General Manager Subsurface and Technical Upstream Western Australia	• Ensures Santos policies and standards are adhered to and communicated to all employees and contractors • Promotes HSE as a core value integral with how Santos does its business • Empowers personnel to 'stop-the-job' due to HSE concerns • Provides resources for HSE management • Ensures a high level of HSE performance and drives improvement opportunities • Ensures emergency response plans are in place • Maintains communication with company personnel, government agencies and the media • Approves Management of Change (MoC) documents, if acceptable and ALARP.
Manager Subsurface Operations	• Ensures conformance with environmental performance outcomes and standards in the EP • Delegates HSE responsibilities to ensure the EP is implemented • Empowers personnel to 'stop-the-job' due to HSE concerns • Ensures HSE incidents are reported, investigated, corrected and communicated • Ensures HSE inspections and audits are completed and corrective actions implemented • Reviews Management of Change (MoC) documents • Ensures personnel on the facility have the necessary qualifications, training and/or supervision.
Contractor Vessel Manager	• Ensures vessel meets quarantine requirements to operate in Australian waters • Ensures subcontractors are communicated the EP requirements • Ensures the Activity risks are assessed and HSE Plan is created, including the requirements of this EP • Ensures personnel on the vessels have the necessary qualifications, training and/or supervision.
Marine Fauna Observer (MFO)s	In addition to the requirements of vessel crew, the MFOs will: • Undertake visual observations for marine fauna as per this EP • Responsible for compliance with the standard management procedures, as outlined in the EPBC Policy Statement 2.1 – interactions between offshore seismic exploration and whales, including adequate fauna monitoring and operational response • Advise Chief Observer to delay or shut down seismic source if required • Record all sightings of marine fauna • Advise vessel master to delay or shut down seismic source if required • Provide additional training to crew in fauna observations as required.
Survey Environmental Advisor (SEA)	In addition to the requirements of vessel crew, the SEA: • May undertake visual observations for marine fauna as per this EP • May advise Chief Observer to delay or shut down seismic source if required • Record all sightings of marine fauna • Ensures compliance with operating procedures and this EP • Ensures conformance with environmental performance outcomes and standards in the EP. • Ensures Vessels crew comply with environmental performance standards

Role	Responsibilities
	• Maintains records of compliance with this EP • Responsible for compliance with the standard management procedures, as outlined in the EPBC Policy Statement 2.1 – interactions between offshore seismic exploration and whales, including adequate fauna monitoring and operational response • Ensures EP compliance / incidents are reported, investigated, corrected and communicated.
Vessel Masters	• Overall authority for the safety of vessel and crew. • Ensures compliance with applicable local and international regulations • Responsible for ensuring implementation of the following documents: Vessel SOPEP/SMPEP, Waste Management Procedure, Bunkering Procedure, Emergency Response Plan and communication with authorities (AMSA) • Ensures vessel equipment is kept according to the preventative maintenance schedule • Responsible for training all crew to ensure they are competent to perform their duties during an Emergency Response situation • Ensures implementation of MoC documents and distribution to relevant personnel • Investigates all incidents and near misses and reports these to Santos representative • Comply with operating procedures and this EP.
On board Representatives	• Ensures compliance with operating procedures and this EP • Ensures conformance with environmental performance outcomes and standards in the EP. • Facilitates communication between Santos onshore management and Vessel Master • Carries out induction with offshore crew and with any new personnel joining the Vessel • Maintains records of compliance with this EP • Reviews MoC documents and ensures compliance with any MoC • Ensures HSE incidents are reported, investigated, corrected and communicated • Ensures HSE inspections and audits are completed and corrective actions implemented • Provides daily reports, incident reports and any Marine Fauna reports to Santos.
Vessel Party Manager	• Communicates operating policies and procedures to all vessel personnel ensuring their compliance • Communicates all relevant MoC requirements to appropriate personnel • Monitors crew compliance with the EP and relevant environmental legislative requirements • Facilitates communication between the Santos Representative on board and the crew • Maintains records of daily logs and environmental events and HSE key performance indicators.
Vessel Crew	• Adheres to HSE obligations • Complies with operating procedures and this EP • Follows good housekeeping procedures and work practices • Reports immediately any HSE events to the Vessel Master • Carries out duties in accordance with defined work systems and procedures • Reports sightings of marine fauna and incidents of marine pollution • Identifies HSE improvement opportunities wherever possible • Reports HSE incidents, hazards or non-conformances to supervisors in a timely manner • Obligation to ‘stop-the-job’ due to HSE concerns • Adheres to any MoC requirements.
Senior Advisor – Oil Spill Response	• Ensures that personnel with OPEP responsibilities are aware of their obligations • Monitors and guides oil spill responses to ensure obligations as stated in OPEP are implemented • Maintains a state of preparedness by: – Manages oil spill response equipment and personnel – Manages contracts with response equipment and personnel suppliers – Manages agreements with national regulatory agencies for support in oil spill response – Ensures Santos’ oil spill response exercise and training schedule is implemented.
HSE Manager and Team Leads	• Ensures EP is managed and reviewed: monitors conformance with environmental performance outcomes and standards, and the implementation strategy in the EP • Prepares, maintains and distributes the environmental compliance register • Completes regular HSE reports, inspections and audits • Completes HSE inductions and promotes general awareness

Role	Responsibilities
	• Collates HSE data and records • Contributes to HSE incident management and investigations • Provides operational HSE oversight and advice • Facilitates the development and implementation of MoC documents • Provides incident reports, compliance reports and notifications to NOPSEMA • Ensures stakeholder consultation and communication requirements have been fulfilled • Ensures vessel meets quarantine requirements to operate in Australian waters • Ensures subcontractors are communicated the EP requirements • Ensures the Activity risks are assessed and HSE Plan is created including the requirements of this EP • Responsible for notifying the Manager Subsurface Operations of any known or potential non-compliance issues.

8.4 Workforce training and competency

OPGGS(E)R 2023 Requirements
Section 22(4)
The implementation strategy must include measures to ensure each employee or contractor working on, or in connection with, the activity is aware of his or her responsibilities in relation to the environment plan, including during emergencies or potential emergencies, and has the appropriate competencies and training.

This section describes the mechanisms that will be in place so each employee and contractor is aware of his or her responsibilities in relation to the EP and has appropriate training and competencies.

8.4.1 Activity inductions

All offshore personnel on the vessels will complete an induction that addresses their EP responsibilities. Induction attendance records for all personnel will be maintained. Inductions will include information on:

Santos' Environment, Health and Safety Policy

Regulatory regime (OPGGS (E) Regulations)

EPBC Act Policy Statement 2.1 and how it applies to the activity

Operating environment (e.g. nearby protected marine areas, sensitive environmental periods)

Interaction with other marine users (e.g. topic to reinforce the importance of marine communications regarding any potential interactions with active commercial fishing)

Activities with highest risk (e.g. invasive marine species and hydrocarbon releases)

EP commitments (e.g. Table 8-2 and Table 8-3)

Incident reporting and notifications

Regulatory compliance reporting

Management of change process for changes to EP activities

Oil pollution emergency response (e.g. OPEP requirements).

8.4.2 Training and competency

All offshore personnel will complete relevant training and hold qualifications and certificates for their role. Santos and its contractors are individually responsible for ensuring their personnel are qualified and trained. The systems, procedures and responsible persons will vary and will be managed through the use of online databases, staff on-boarding process and training departments etc.

Personnel qualifications and training records will be sampled before and / or during an activity. Such checks will be performed during the contracting process, facility acceptance testing, inductions, crew change and operational inspections and audits.

At least one MFO will have previous experience on a seismic survey vessel as an MFO.

8.5 Hazard identification, risk and impact assessment and controls

Hazards and associated environmental risks and impacts for the proposed activities have been systematically identified and assessed in this EP (refer to Sections 6 and 7). The control measures and environmental performance standards that will be implemented to manage the identified risks and impacts, and the environmental performance outcomes that will be achieved, are detailed below.

To ensure that environmental risks and impacts remain ALARP and of an acceptable level during the Activity and for the duration of this EP, hazards will continue to be identified, assessed and controlled as described in Management of Change (Section 8.9) and Reviews, Audits and Inspections (Section 8.14).

Any new, or proposed amendment to a control measure or environmental performance standard or outcome will be managed in accordance with the MoC procedure (Section 8.9).

Oil spill response control measures and environmental performance standards and outcomes are listed in the OPEP.

8.6 Environmental performance outcomes

To ensure environmental risks and impacts will be of an acceptable level, environmental performance outcomes have been defined and are listed in Table 8-2 for planned activities and unplanned events. Those relating to oil spill response are listed in the OPEP. These outcomes will be achieved by implementing the identified control measures to the defined environmental performance standards.

Table 8-2: Environmental performance outcomes

Reference	Environmental performance outcomes
EPO-1	Survey information provided to regulatory authorities and marine users directly affected by planned activities prior to commencement of the survey.
EPO-2	No unplanned interactions with commercial fishers.
EPO-3	Commercial fishing licence holders are no worse off as a result of the seismic survey.
EPO-4	No unplanned interactions with other marine users.
EPO-5	Undertake seismic acquisition in a manner that prevents serious or irreversible impacts to plankton communities or fauna dependent on plankton as a food source within the Operational Area.
EPO-6	No serious or irreversible impacts to listed marine fish (including sharks) due to noise associated with the operation of seismic source, consistent with the MNES Significant Impact Guideline 1.1.
EPO-7	Undertake seismic acquisition in a manner that prevents serious or irreversible impacts to marine invertebrate populations due to noise associated with the operation of seismic source.
EPO-8	No injury to cetaceans due to noise associated with the operation of seismic sources.
EPO-9	Seismic activities are undertaken in a manner that prevents injury and interference to Omura's whales.
EPO-10	Seismic activities are undertaken in a manner that prevents disruption to sensitive life stages and displacement of Australian snubfin dolphins from the foraging/ resting/ calving/ breeding BIA.
EPO-11	No injury to turtles due to noise associated with the operation of seismic sources.
EPO-12	Undertake seismic acquisition in a manner consistent with the Recovery Plan for Marine Turtles in Australia 2017-2027.
EPO-13	No serious or irreversible impact to the sustainability of indicator commercial fish stocks for the following commercial fisheries due to noise associated with the operation of the seismic source: • Commonwealth Northern Prawn Fishery (NPF) • WA Northern Demersal Scalefish Managed Fishery (NDSMF) • WA Mackerel Managed Fishery (MMF). • NT Demersal Fishery (DF) • NT Spanish Mackerel Fishery (SMF) • NT Offshore Net and Line Fishery (ONLF) • NT Aquarium Fishery (AF)
EPO-14	Seismic acquisition is undertaken in a manner that prevents impacts to divers.

Reference	Environmental performance outcomes
EPO-15	Far-field source levels for the selected seismic source for the Eos 3D MSS are consistent with levels assessed in this EP.
EPO-16	Protect and maintain biological diversity and other natural, cultural and heritage values of the North-west Marine Parks Network and North Marine Parks Network.
EPO-17	Potential cumulative and additive impacts resulting from the Eos 3D MSS and other petroleum activities are identified and reduced as far as reasonably practicable.
EPO-18	Reduce impacts to marine fauna from lighting on project vessels through limiting light to that required by safety and navigational lighting requirements.
EPO-19	Discharges to sea meet legislated permissible discharge requirements.
EPO-20	No unplanned objects, emissions or discharges to sea or air.
EPO-21	Emissions to air meet legislated requirements.
EPO-22	No injury to marine fauna during the Activity.
EPO-23	No long-term environmental impact in the event of an unplanned hydrocarbon release to sea.
EPO-24	No unplanned seabed disturbance.
EPO-25	No introduction of marine pest species.

8.6.1 Control measures and performance standards

The control measures that will be used to manage identified environmental impacts and risks and the associated statements of performance required of the control measure (i.e. EPSs) are listed in Table 8-3. Measurement criteria outlining how compliance with the control measure and the expected environmental performance could be evidenced are also listed.

All CMs and EPS and associated measurement criteria relating to preparedness and response operations are contained within the Eos 3D MSS OPEP (7710-650-EMP-0011-1).

Table 8-3: Control Measures and Environmental Performance Standards for the Activity

CM Ref.	Control measure	Environmental performance standards	EPS Ref.	Measurement criteria	EPO Ref.
CM-1	Navigation equipment and procedures.	Vessels undergo an International Marine Contractors Association (IMCA), Common Marine Inspection Audit (CMID) or Offshore Vessel Inspection Document (OVID) inspections within 12 months of the Activity commencing to confirm that they meet international HSE and maintenance standards.	CM-1-EPS-1	All vessels have a current (<12 months) IMCA or CMID or OVID certificate prior to mobilisation.	EPO-2 EPO-4 EPO-20 EPO-23
		Seismic survey vessel equipped with an automatic radar plotting aid (ARPA) system.	CM-1-EPS-2	Completed Inspection report or vessel statement of conformance.	
CM-2	Vessels fitted with AIS systems and radars, and AIS (virtual or installed) to mark the location of seismic streamer tail buoys.	Support vessels and the seismic survey vessel will be equipped with an automatic identification system (AIS) and radar, and virtual or installed AIS shall be used to mark the location of seismic streamer tail buoys.	CM-2-EPS-1	Written confirmation from vessel contractor that the correct equipment is on-board.	EPO-2 EPO-4 EPO-20 EPO-23
CM-3	Exclusion (safety) zone established to reduce potential for collision or interference with other marine user activities.	A minimum 3 nm (5.6 km) exclusion (safety) zone is defined around the seismic survey vessel and streamers.	CM-3-EPS-1	Stakeholder consultation. Vessel communication records.	EPO-1 EPO-2 EPO-4
CM-4	Maritime Notices – Notices to Mariners (NTM) and AUSCOAST warnings.	A notification will be provided prior to vessel arrival in the Operational Area and following vessel departure (within one week) to the following, so the maritime industry is aware of seismic survey activities: • Australian Maritime Safety Authority (AMSA) Joint Rescue Coordination Centre (JRCC) (minimum two days prior) • Australian Hydrographic Office (AHO) (where practicable minimum four weeks prior) • the Kimberley Ports Authority (minimum one week prior).	CM-4-EPS-1	Notice to stakeholder.	EPO-1 EPO-2 EPO-3
CM-5	Stakeholder consultation	Relevant persons for the survey operations identified in Section 4 are provided a commencement notification at least two weeks prior to the Activity commencing.	CM-5-EPS-1	Santos correspondence to relevant stakeholders.	EPO-1 EPO-2 EPO-4

CM Ref.	Control measure	Environmental performance standards	EPS Ref.	Measurement criteria	EPO Ref.
		All correspondence with external stakeholders is recorded by Santos.	CM-5-EPS-2	Stakeholder database.	
		Santos Consultation Coordinator remains available before, during and after the Activity to ensure stakeholder feedback is evaluated and considered during the operational phase.	CM-5-EPS-3	Consultation Coordinator contact details provided to relevant persons in all correspondence.	
CM-6	Concurrent operations planning with relevant commercial fishers	Santos will develop and implement a protocol for communications between survey vessels and fishing vessels.	CM-6-EPS-1	Development of a communication protocol. Documented correspondence with commercial fishing licence holders.	EPO-3
		If requested by a commercial fishing licence holder Santos will provide operational survey plans, commencement and cessation notifications, and daily operational reports. At a minimum the daily operational reports will include: • Current seismic survey vessel position. • Look ahead seismic survey activities and vessel positions. • Support vessel activities and positions. • Vessel contact details. • Santos management contact details.	CM-6-EPS-2	Documented correspondence with commercial fishing licence holders. Completed daily reports, if requested by commercial fishing licence holders	EPO-2 EPO-3
CM-7	Commercial fishery payment claims (further details are provided in Section 8.6.2)	All evidence-based payment claims made by a commercial fishing licence holder that the survey caused a temporary loss of fish catch from within the Operational Area will be assessed for merit by Santos.	CM-7-EPS-1	Santos' merit assessment of commercial fishing licence holder claim. Documented correspondence with commercial fishing licence holders.	EPO-3
		Payment to a commercial fishing licence holder for each month there is a loss of catch will be based on an assessment of what the commercial fishing licence holder would have caught in that month from within all areas fished during the period of the survey based on these criteria: • To be eligible to claim loss of catch adjustment, a fishing licence holder must be able to show previous fishing history for a minimum of two out of the previous five years within the Operational Area.	CM-7-EPS-2	Records of payment to commercial fishing licence holders.	

CM Ref.	Control measure	Environmental performance standards	EPS Ref.	Measurement criteria	EPO Ref.
		• The fishing licence holder must demonstrate an established previous fishing history for a minimum of two out of the previous five years, for all block(s) or fishing event(s) for which they wish to make a claim for loss of catch or displacement adjustment. • For each month where a displacement adjustment is claimed, the licensed fishing vessel must conduct fishing within an Operational Area, unless a fishing trip spans two months where each month will be considered to have satisfied this requirement.			
		A claim for payment for loss of catch will be assessed using actual versus average historical landed catch per days fished. Santos' preference is for 10 years' of data to determine the average historical catch per unit of effort. However, this will be assessed on a case-by-case basis.	CM-7-EPS-3	Documented loss of catch assessment and supporting fishing data.	
		If a loss of catch is substantiated, payments will be calculated based on the reduced kilograms per species caught, multiplied by market price per kilogram at the time the catch would have been sold.	CM-7-EPS-4	Documented payment calculations and supporting fishing and market data.	
		Loss of catch payments will be assessed for the months of each survey stage and for up to 6 months from the completion date of each survey stage. The 6 months is considered a reasonable time to claim for a temporary loss of catch and to minimise overlap between survey stages.	CM-7-EPS-5	Records of payment to commercial fishing licence holders, if there are claims.	
		Where a commercial fishing licence holder wants to receive a loss of catch payment, they will need to provide Santos with monthly catch disposal records and multiple years of historical data to allow average monthly catch rates per species to be determined. Santos' preference is for 10 years of historical data.	CM-7-EPS-6	Commercial fishing licence holder payment claim and multiple years of fish catch disposal records.	

CM Ref.	Control measure	Environmental performance standards	EPS Ref.	Measurement criteria	EPO Ref.
		However, this will be assessed on a case-by-case basis.			
		Where a commercial fishing licence holder is displaced from the operational area such that it is required to relocate their operations to another area during a survey stage, Santos will make a one-off payment to reimburse operational expenses which are in addition to those the commercial fishing licence holder would have borne 'but for' the seismic survey stage. Consideration for a similar one-off payment will be made for increased time searching or travelling due to reduced catch rates.	CM-7-EPS-7	Records of payment to commercial fishing licence holders.	
		Where a commercial fishing licence holder intends to make an operational expense claim for relocation, they will need to notify Santos as soon as practicable and prior to relocating, and state why the seismic survey has caused them to relocate. The notification can be via radio between the fishing and survey vessel.	CM-7-EPS-8	Relocation notification from commercial fishing licence holder and Santos acknowledgement.	
		Where a commercial fishing licence holder wants to be reimbursed for any relocation operational expenses, they will need to provide Santos with evidence of the operating costs of bait, fuel, wages and any other costs that are additional to the costs that would have been incurred to catch the fish 'but for' the relocation.	CM-7-EPS-9	Commercial fishing licence holder historical operating cost records and relocation cost records.	
		Where a commercial fishing licence holder wants to receive any payment for loss of catch or relocation, they will need to lodge a claim with Santos within 8 months of the survey stage completion. The 8 months is intended to give fishers reasonable time to prepare a claim and to minimise overlap between subsequent survey stages. Noting Santos' preparedness to provide administrative support to collate fishing data for fishers.	CM-7-EPS-10	Commercial fishing licence holder claim and supporting evidence.	
		Santos will not accept a claim under this Environment Plan for loss of catch and/or	CM-7-EPS-11	Correspondence records.	

CM Ref.	Control measure	Environmental performance standards	EPS Ref.	Measurement criteria	EPO Ref.
		relocation if the claim covers the same time, area and fishing activity made in another claim for a different seismic survey.			
		If there are any issues with the required evidence, loss of catch determination or payment amount, Santos may, in consultation with the commercial fishing licence holder, engage an independent relevant expert to determine the issue at any stage of the process.	CM-7-EPS-12	Consultation with commercial fishing licence holders about appointment of independent expert (if required). Independent relevant expert assessment record (if required).	
		The loss of catch and relocation payment control measures will apply unless Santos enters into an agreement with a commercial fishing operator in relation to the potential impact of the survey on them. In the event of an agreement, the agreement will replace the loss of catch and/or relocation payment as the control measure.	CM-7-EPS-13	Agreement with commercial fishing licence holder. Evidence of Santos adherence to terms of the agreement.	
		In the event that the seismic vessel is required to transit outside of the Operational Area while under contract to Santos, all evidence-based payment claims made by a commercial fishing licence holder that the survey caused fishing equipment located outside the Operational Area to be damaged or lost at a cost to the licence holder will be assessed for merit by Santos.	CM-7-EPS-14	Santos' merit assessment of commercial fishing licence holder claim. Documented correspondence with commercial fishing licence holders.	
CM-8	Support vessel and/or chase vessel is present and operational during Activity to reduce potential for collision or interference with other marine users	At least one support vessel on standby at all times to monitor the seismic survey vessel exclusion (safety) zone to identify approaching third-party vessels and communicate with the vessels. During times when the support vessel's radar is not operational, the seismic survey vessel will monitor at all times for approaching third-party vessels using an Automatic Identification System (AIS).	CM-8-EPS-1	Daily vessel report.	EPO-2 EPO-4 EPO-20 EPO-23
CM-9	Constant bridge watch	Competent crew shall maintain constant bridge-watch.	CM-9-EPS-1	Vessel log of times and persons on watch. Crew training records. Completed vessel statement of conformance.	EPO-2 EPO-4 EPO-20 EPO-22

CM Ref.	Control measure	Environmental performance standards	EPS Ref.	Measurement criteria	EPO Ref.
					EPO-23
CM-10	Recreational fishing restrictions	Seismic survey and support vessels are prohibited from fishing	CM-10 EPS-1	Induction records: no recorded breaches.	EPO-3
CM-11	Decision making and communications protocol implemented in the event that the seismic vessel and towed equipment are required to leave the Operational Area during the survey.	A decision making and communications protocol exists that will be implemented if the seismic vessel is required to leave the Operational Area. In this event the following will take place: • A decision on recovery of the towed streamers will be assessed based on: – Reason for leaving the Operational Area (e.g. weather, mechanical issues, bunkering). – The urgency of the departure. – The likely duration outside the Operational Area. – Vessel safety, as determined by the vessel master. • Seismic source will be recovered unless unsafe to do so. • Standard notifications will be issued to AMSA and AHO. • Notifications will be issued to previously identified on-the-water stakeholders (fishers, tourist vessel operators). • The vessel master will advise Santos of the planned route and Santos will undertake an assessment of the planned route for other marine users / stakeholders within 10 km of the route and will issue urgent communications. • The seismic vessel will be escorted by at least one support vessel unless the Vessel Master deems unsafe to do so.	CM-11 EPS-1	Records kept of notifications sent / meetings / discussions. Records kept of reason why streamer array can or cannot be recovered. Records kept of planned route and consideration of environmentally sensitive areas. Records kept of all consultation undertaken including an assessment of additional stakeholders.	EPO-2 EPO-3 EPO-4
CM-12	Santos will ensure the seismic contractor has a protocol in place for handling entangled fishing gear.	Seismic contractor will implement their protocol for handling entangled fishing gear in the event of an incident.	CM-12 EPS-1	Records which establish confirmation the seismic contractor has such a procedure in place during the procurement process.	EPO-3

CM Ref.	Control measure	Environmental performance standards	EPS Ref.	Measurement criteria	EPO Ref.
CM-13	Notices to Department of Defence (DoD)	A notification will be provided to DoD four weeks prior to seismic survey commencement concerning timing of acquisition of the Eos 3D MSS.	CM-13 EPS-1	Documented correspondence with DoD.	EPO-4
CM-14	Implementation of EPBC Policy Statement 2.1 (Part A): • pre start-up visual observation • Soft start procedures • Start-up delay procedure • Operations procedure • Shut-down procedure • Night-time and low visibility procedures	Implementation of Part A of the EPBC Policy Statement 2.1 with the below cautionary zones observed. Compliance with the following policy statement sections: • A1: Pre-survey planning (this EP) • A2: Trained crew • A3.1: Pre start-up visual observation • A3.2: Soft start procedures • A3.2: Start-up delay procedure • A3.4: Operations procedure • A3.5: Stop work procedure • A3.6: Night-time and low visibility procedures • A4: Compliance and sighting report provided to DoE The following precaution zones will be implemented for whales: • Observation zone: 3+ km horizontal radius from the acoustic source. • Power down (Low power) zone: 2 km horizontal radius from the acoustic source. • Shutdown zone: 500 m horizontal radius from the acoustic source.	CM-14-EPS-1	Completed marine fauna sighting datasheet. Vessel logs with records of all soft starts, shut down procedures and timing of acquisition. MFO records/reports (daily, weekly) show that marine fauna interaction procedures are followed during survey including precaution zones, soft starts and recommencement procedures. Completed sightings report within 2 months of survey (refer Section 8.12). Induction records confirm that vessel crew and survey personnel have been briefed on the implementation requirements of Part A of the EPBC Policy Statement 2.1.	EPO-5 EPO-6 EPO-7 EPO-8 EPO-9 EPO-10 EPO-11 EPO-12 EPO-16 EPO-22
CM-15	Marine fauna observations undertaken to minimise the disturbance to fauna caused by the Activity.	Binoculars and Marine Fauna Sighting Datasheet available on all vessels.	CM-15-EPS-1	Binoculars and Marine Fauna Sighting Datasheets present.	EPO-6 EPO-8 EPO-9 EPO-10 EPO-11 EPO-12 EPO-16 EPO-22
		All vessels note any marine fauna observations and at the time of the sighting communicates findings with the seismic survey vessel.	CM-15-EPS-2	Marine Fauna Sighting Database.	

CM Ref.	Control measure	Environmental performance standards	EPS Ref.	Measurement criteria	EPO Ref.
CM-16	EPBC Regulations (Part 8) for interacting with cetaceans	Vessels comply with Santos *Protected Marine Fauna Interaction and Sighting Procedure* (EA-91-11-00003) which ensures compliance with Part 8 of the Environment Protection and Biodiversity Conservation Regulations 2000 which includes controls for minimising the risk of collision with marine fauna including: • Travel at less than 6 knots within the marine turtle foraging BIA. • Travel at less than 6 knots within 500 m of a whale, dolphin or turtle. • Do not approach closer than the caution zones of a 300 m for a cetacean or 150 m of a dolphin or turtle. . • If cetacean or turtle shows signs of disturbance move away at a constant speed less than 6 knots.	CM-16-EPS-1	Vessel contractor procedures align with Part 8 of EPBC Regulations. Records of breaches of the requirements outlined in Santos' Protected Marine Fauna Interaction and Sighting Procedure (EA-91-11-00003), reported via Monthly Recordable Incident Report and Environmental Performance Report. Vessel Statement of conformance.	EPO-8 EPO-9 EPO-10 EPO-16 EPO-22
		Any vessel strikes with cetaceans will be reported in the National Ship Strike Database.	CM-16-EPS-2	Documented correspondence.	
		Helicopters comply with Santos *Protected Marine Fauna Interaction and Sighting Procedure* (EA-91-11-00003) which ensures compliance with Part 8 of the Environment Protection and Biodiversity Conservation Regulations 2000, which includes controls for minimising interaction with marine fauna: • Contractor must not operate a helicopter lower than 1650 ft (502 m) or within a horizontal radius of 500 m of a cetacean), unless taking off or landing because they are taking reasonable actions necessary to reduce safety risk to humans.	CM-16-EPS-3	Helicopter contractor procedures align with Part 8 of EPBC Regulations. Records of breaches of the requirements outlined in Santos' *Protected Marine Fauna Interaction and Sighting Procedure* (EA-91-11-00003), reported via Monthly Recordable Incident Report and Environmental Performance Report.	
CM-17	Implementation of control measures consistent with EPBC Policy Statement 2.1 Part B:	Two MFOs and one Survey Environment Advisor to be onboard the seismic vessel. Two observers (which may be one MFO and one SEA) will be on watch at all times during daylight hours. Both MFOs to be trained	CM-17-EPS-1	Vessel POB lists. MFO training and competency records. MFO Report.	EPO-6 EPO-8 EPO-9 EPO-10 EPO-11

CM Ref.	Control measure	Environmental performance standards	EPS Ref.	Measurement criteria	EPO Ref.
	2 MFOs (MMOs) and one SEA on board the seismic survey vessel.	At least one MFO will have previous experience on a seismic survey vessel as an MFO.	CM-17-EPS-2	Vessel POB lists. MFO training and competency records.	EPO-12 EPO-16 EPO-22
CM-18	Shutdown procedures for turtles	A 500 m shutdown zone from the operating source will be applied to turtles. The seismic source will be shut-down if a turtle is observed within the 500 m shutdown zone during start-up or full power operation of the seismic source. The seismic source will be shut down, or start-up will be delayed, for 15 minutes if a turtle is observed within the shutdown zone. Operation of the seismic source using soft-start shall only resume when 15 minutes have lapsed since the turtle sighting or the turtle has been observed to move outside the shutdown zone.	CM-18-EPS-1	Completed marine fauna sighting datasheet Vessel logs with records of all shut down procedures. MFO records/reports (daily, weekly) show that marine fauna interaction procedures are followed during survey.	EPO-11 EPO-16 EPO-22
CM-19	Adaptive management procedures for marine turtles	Relocating to another part of the Active Source Zone line will result in a move of at least 7 km if 3 turtles are sighted in a 24-hour period .	CM-19-EPS-1	Vessel logs with records of all source operations.	EPO-11 EPO-16 EPO-22
CM-20	Seismic source validation	If the seismic source selected for the Activity is greater than the 3,050 in^3 seismic source modelled, then additional acoustic modelling will be undertaken to confirm whether the sound levels are consistent with the levels assessed as acceptable in this EP. Sound propagation modelling (Appendix G) and the risk assessment was based upon a 3,050 in^3 source with a far-field source specification of 248.3 dB re 1 µPa m PK in the broadside direction. Therefore, if modelling of the selected seismic source confirms that it does not exceed peak source pressure levels of 250 dB re 1 µPa m PK in the horizontal plane, it can be concluded that the acoustic output is consistent with the seismic source evaluated and provides reasonable confidence that propagated sound levels will be comparable to those assessed and found to be acceptable in this EP. This	CM-20-EPS-1	Acoustic source modelling report.	EPO-15

CM Ref.	Control measure	Environmental performance standards	EPS Ref.	Measurement criteria	EPO Ref.
		provides confidence in the impact assessment which was based on the acoustic modelling results.			
CM-21	Increased duration of pre-start visual observations	An MFO will undertake marine fauna observations in daylight hours during the deployment of the seismic source and streamers.	CM-21-EPS-1	Completed marine fauna sighting datasheet MFO records/reports.	EPO-9
CM-22	Implementation of EPBC Policy Statement 2.1 (partial part B.6 – adaptive management): Adaptive management measures for Omura's whales.	• In the event that there are three confirmed, potential/suspected Omura's whale sightings, in a 24-hour period, the seismic source will be shut down for 24 hours. • If, during the 24-hour shutdown period, there are three confirmed or potential/suspected Omura's whale is sighted, then the seismic source will remain shut down until there has been 24 hours of no confirmed, or potential/suspected Omura's whale sightings. • Operations may recommence provided there has been no confirmed, or potential/suspected Omura's whale sightings for 24 hours since the last sighting event, and start-up of the seismic source will commence according to A.3.2 Soft-Start Procedure.	CM-22-EPS-1	Seismic observer logs / records of all soft starts, shut down procedures and timing of acquisition. MFO sighting records/reports (daily, weekly, final) with evidence that adaptive management procedures are followed (if required) during the survey Adaptive management measures mitigation table MFO Final Report	EPO-8 EPO-9 EPO-22
CM-23	Night time and low-visibility procedures for whales or turtles.	Start-up of the seismic source (according to the A.3.2 Soft-Start Procedure) may only commence at night-time or at other times of low-visibility provided: • There have not been 3 or more shut-downs for whales and turtles during the preceding 24-hour period • If operations were not previously underway during the preceding 24 hours, the vessel has been in the vicinity (approximately 10 km) of the proposed start up position for at least 2 hours (under good visibility conditions) within the preceding 24-hour period, and no whales or turtles have been sighted.	CM-23-EPS-1	Completed marine fauna sighting datasheet Vessel logs with records of all soft starts, shut down procedures and timing of acquisition. MFO records/reports (daily, weekly) show that night time and low visibility procedures are followed.	EPO-11 EPO-12 EPO-16 EPO-22

CM Ref.	Control measure	Environmental performance standards	EPS Ref.	Measurement criteria	EPO Ref.
CM-24	Adopt UK Diving Medical Advisory Committee Guidance Note DMAC 12 (DMAC 2020).	Eni and the WA and NT pearl oyster and aquarium fisheries will be engaged prior (minimum 4 weeks) to commencement of the Eos 3D MSS to identify any overlap within the area where received levels reach 145 dB re 1 µPa SPL and diving activities	CM-24-EPS-1	Consultation records.	EPO-14
		Where an overlap is identified a joint risk assessment will be conducted, and planning/mitigation agreed between parties.	CM-24-EPS-2	Consultation records and record of joint risk assessment completed where relevant.	
CM-25	Seismic source separation distance during concurrent surveys: minimum 40 km while operating.	During operation of the seismic sources, a minimum separation distance of 40 km shall be maintained between the Eos seismic source and a third-party seismic source.	CM-25-EPS-1	Daily operational reports.	EPO-17
CM-26	Management of concurrent seismic surveys within the commercial fisheries.	If concurrent seismic surveys with Eos are expected within the same commercial fisheries, Santos will: • Consult with the seismic survey operator on ways to minimise interference with relevant commercial fishers. • Provide the survey operator proposed survey plans, vessel contact details and the details of any agreed on-water vessel interaction protocols with commercial fishers. • Provide the survey operator commencement and cessation notifications, and daily operational reports.	CM-26-EPS-1	Consultation records.	EPO-2 EPO-3 EPO-17
CM-27	Identification and risk assessment of other concurrent petroleum activities within 20 km of the operating seismic source.	If other petroleum activities are identified in the JBG that may occur at the same time as the Eos 3D MSS, Santos will: • Assess the activities and consult with the other titleholder on ways to minimise additive noise effects. • Provide the titleholder with proposed survey plans and vessel contact details. • Provide the titleholder with commencement and cessation notifications, and daily operational reports.	CM-27-EPS-1	Consultation records, risk assessment and the prepared SIMOPS protocols (if necessary).	EPO-2 EPO-3 EPO-17

CM Ref.	Control measure	Environmental performance standards	EPS Ref.	Measurement criteria	EPO Ref.
CM-28	Lighting will be used as required for safe work conditions and navigational purposes. HSE induction to crew includes minimising light emissions from vessel during night hours, where possible.	Vessel navigation lighting and equipment is compliant with COLREGS/Marine Orders 30: Prevention of Collisions, Marine Orders 21: Safety of Navigation and Emergency Procedures, *Navigation Act 2012* and Chapter 5 of the International Convention on the Safety of Life at Sea (SOLAS Convention). Work lighting will be the minimum required to maintain safe working conditions for all areas where the crew are operating on the deck.	CM-28-EPS-1	Vessel certification confirms compliance with applicable regulations.	EPO-18
CM-29	Sewage treatment system.	Pursuant to MARPOL Annex IV, vessel has a current International Sewage Pollution Prevention (ISPP) Certificate or equivalent which confirms that required measures to reduce impacts from sewage disposal are in place.	CM-29-EPS-1	Current ISPP certificate or equivalent.	EPO-19 EPO-20
		Sewage discharged in accordance with MARPOL Annex IV.	CM-29-EPS-2	Completed weekly environmental inspection checklist.	
		Preventive maintenance on sewage treatment equipment is completed as scheduled.	CM-29-EPS-3	Maintenance records.	
CM-30	Oily water treatment system.	Oily mixtures only discharged to sea in accordance with MARPOL Annex I.	CM-30-EPS-1	Completed inspection checklist Oil record book.	EPO-19 EPO-20
		Preventative maintenance on oil filtering equipment completed as scheduled.	CM-30-EPS-2	Maintenance records or evidence of maintenance in operational reports.	
		Pursuant to MARPOL Annex I, as relevant to class, vessel will have an International Oil Pollution Prevention (IOPP) Certificate which confirms that required measures to reduce impacts of planned oil discharges are in place.	CM-30-EPS-3	Current IOPP certificate or equivalent.	
CM-31	General chemical management procedures.	Safety data sheet (SDS7F[6]) available for all chemicals to aid in the process of hazard identification and chemical management.	CM-31-EPS-1	Completed inspection checklist.	EPO-19 EPO-20
		Chemicals managed in accordance with SDS in relation to safe handling and storage, spill-	CM-31-EPS-2		

CM Ref.	Control measure	Environmental performance standards	EPS Ref.	Measurement criteria	EPO Ref.
		response and emergency procedures, and disposal considerations.			
CM-32	Hazardous chemical management procedures.	For hazardous chemicals including hydrocarbons, the following standards apply to reduce the risk of an accidental release to sea: • Storage containers closed when the product is not being used • Storage containers managed in a manner that provides for secondary containment in the event of a spill or leak • Storage containers labelled with the technical product name as per the safety data sheet (SDS) • Spills and leaks to deck, excluding storage bunds and drip trays, immediately cleaned up • Storage bunds and drip trays do not contain free flowing volumes of liquid • Spill response equipment readily available.	CM-32-EPS-1	Completed inspection checklist.	EPO-19 EPO-20
CM-33	Waste (garbage) management procedure.	Waste management procedure implemented to reduce the risk of unplanned release of waste to sea. The procedure includes standards for: • Bin types • Lids and covers • Waste segregation • Bin storage.	CM-33-EPS-1	Completed weekly environmental inspection checklist.	EPO-19 EPO-20
		Food waste is disposed in accordance with MARPOL Annex V.	CM-33-EPS-2	Completed garbage disposal record book or recording system.	
		Vessel's garbage record book maintained to record quantities and types of waste in accordance with MARPOL.	CM-33-EPS-3	Up-to-date Garbage Record Book.	
CM-34	Deck cleaning product selection procedure.	Deck cleaning products planned to be released to sea meet the criteria for not being harmful to the marine environment according to MARPOL Annex V; or Gold/Silver/D or E rated through OCNS; or have a completed Santos eco-toxicological risk assessment so that only environmentally acceptable products are used.	CM-34-EPS-1	Safety data sheet (SDS) and product supplier supplementary data as required. Santos eco-toxicological risk assessment.	EPO-19 EPO-20

CM Ref.	Control measure	Environmental performance standards	EPS Ref.	Measurement criteria	EPO Ref.
CM-35	Clean up of oil/ lubricant spills to deck in accordance with vessel Shipboard Oil Pollution Emergency Plan (SOPEP).	Reported spills to deck are cleaned up as per the vessel SOPEP.	CM-35-EPS-1	Incident report details spill clean up.	EPO-19 EPO-20
CM-36	MARPOL compliant fuel oil (MDO) will be used during the Activity.	MARPOL-compliant fuel oil (MDO) will be used during the Activity.	CM-36-EPS-1	Fuel bunkering records.	EPO-21
CM-37	Waste incineration managed in accordance MARPOL and Marine Orders as appropriate.	Waste incineration managed in accordance with MARPOL Annex VI.	CM-37-EPS-1	Completed waste record book or recording system.	EPO-20 EPO-21
CM-38	All vessel engines to be maintained in accordance with manufacturers specifications.	Documented maintenance program is in place for equipment on vessels, that provides a status on the maintenance of equipment.	CM-38-EPS-1	Vessel maintenance records show that there are no outstanding maintenance activities for emission generating equipment.	EPO-20 EPO-21
CM-39	Air pollution prevention certification.	Pursuant to MARPOL Annex VI, vessel will maintain a current International Air Pollution Prevention (IAPP) Certificate or equivalent which confirms that measures to prevent ozone-depleting substance (ODS) emissions, and reduce NOx, SOx and incineration emissions during the Activity are in place.	CM-39-EPS-1	Current IAPP certificate or equivalent.	EPO-20 EPO-21
CM-40	Ozone-depleting substance handling procedures.	Ozone-depleting substances (ODS) managed in accordance with MARPOL Annex VI to reduce the risk of an accidental release of ODS to air.	CM-40-EPS-1	Completed ODS record book or recording system.	EPO-20 EPO-21
CM-41	Restrictions on how small volumes of unused IFO and HFO must be stored on a vessel, including restricting volumes and limiting storage to tanks that do not have direct exposure to the marine environment.	IFO and HFO will not be used as the fuel source during the survey.	CM-41-EPS-1	Vessel operational logs.	EPO-20 EPO-23
		If IFO and/or HFO is proposed to be on board a vessel then a risk assessment shall be completed. For the vessel to store IFO and/or HFO then the risk assessment must conclude that the high cost of removing and disposing of the IFO and/or HFO onshore is grossly disproportionate to the low risk of a vessel collision and rupture of a fuel tank containing small volumes of the fuel.	CM-41-EPS-2	Completed risk assessment.	

CM Ref.	Control measure	Environmental performance standards	EPS Ref.	Measurement criteria	EPO Ref.
	If IFO or HFO is proposed to be on board then this will be risk assessed. For the vessel to store IFO or HFO then the risk assessment must conclude that the high cost of removing and disposing of the IFO or HFO onshore is grossly disproportionate to the low risk of a vessel collision and rupture of an in-board fuel tank containing small volumes of the fuel.	IFO and/or HFO stored on a vessel must not be stored in tanks that are against the external hull of the vessel.	CM-41-EPS-3	Vessel operational logs.	
CM-42	Oil pollution emergency plan (OPEP)	In the event of a hydrocarbon spill to sea, the Santos OPEP requirements are implemented to mitigate environmental impacts.	CM-42-EPS-1	Completed incident documentation.	EPO-23
CM-43	Vessel spill response plans (SOPEP/SMPEP)	Vessels have, and implement, a Shipboard Marine Pollution Emergency Plan (SMPEP) or SOPEP pursuant to MARPOL Annex I, as appropriate for vessel class.	CM-43-EPS-1	Approved SMPEP or SOPEP.	EPO-20 EPO-23
		SMPEP/SOPEP spill response exercises conducted not less often than every three months to ensure personnel are prepared.	CM-43-EPS-2	Spill exercise records or evidence of a spill exercise in an operational report.	
CM-44	Maximum volume of fuel stored in a single tank of vessels used for the Activity will not exceed 1,065 m^3	The maximum volume of MDO stored in a single tank shall not exceed 1,065 m^3.	CM-44-EPS-1	Written directive to vessel contractor.	EPO-23
CM-45	Deck drainage control measures (such as scupper plugs) in areas where chemicals and hydrocarbons are stored and frequently handled.	Scupper plugs or equivalent deck drainage control measures available where chemicals and hydrocarbons are stored and frequently handled.	CM-45-EPS-1	Weekly environmental inspection checklist.	EPO-20

CM Ref.	Control measure	Environmental performance standards	EPS Ref.	Measurement criteria	EPO Ref.
CM-46	Maritime dangerous goods code	For hazardous chemicals including hydrocarbons, the following standards apply to reduce the risk of an accidental release to sea: • Storage containers closed when the product is not being used • Storage containers managed in a manner that provides for secondary containment in the event of a spill or leak • Storage containers labelled with the technical product name as per the safety data sheet (SDS) • Spills and leaks to deck, excluding storage bunds and drip trays, immediately cleaned up • Storage bunds and drip trays do not contain free flowing volumes of liquid • Spill response equipment readily available.	CM-46-EPS-1	Completed inspection checklist	EPO-19 EPO-20
		Dangerous goods managed in accordance with International Maritime Dangerous Goods Code (IMDG Code) to reduce the risk of an environmental incident, such as an accidental release to sea or unintended chemical reaction.	CM-46-EPS-2	Completed Multimodal Dangerous Goods Form	
CM-47	Bulk refuelling transfer procedures	Bulk fuel transferred in accordance with the vessel contractor procedures to reduce the risk of a release to sea.	CM-47-EPS-1	Completed procedural documents, for example work permits, job safety analysis forms, checklists, etc. Spill details contained in incident documentation.	EPO-20
CM-48	Undertake bunkering / bunkering drill prior to the Activity.	Bunkering drill undertaken by seismic survey vessel prior to arrival in the Operational Area, unless bunkering completed within the previous three months in Australian waters.	CM-48-EPS-1	Vessel logs record bunkering undertaken.	EPO-20
CM-49	Equipment maintenance in accordance with PMS	Documented maintenance program is in place for equipment on vessels, that provides a status on the maintenance of equipment.	CM-49-EPS-1	Vessel equipment maintenance records show that there are no outstanding maintenance activities for equipment.	EPO-20 EPO-24
CM-50	Dropped object prevention procedure	Vessels lifting procedures include the following control measures to reduce the risk of objects entering the marine environment:	CM-50-EPS-1	Completed inspection checklist.	EPO-20 EPO-24

CM Ref.	Control measure	Environmental performance standards	EPS Ref.	Measurement criteria	EPO Ref.
		• Lifting equipment certification and inspection. • Lifting crew competencies. • Preventative maintenance on cranes.			
		Objects dropped overboard are recovered (if possible) to mitigate the environmental consequences from objects remaining in the marine environment, unless the environmental consequences are negligible, or safety risks are disproportionate to the environmental consequences.	CM-50-EPS-2	Fate of dropped objects detailed in incident documents.	
		Material handling and lifting equipment and remediation equipment maintained in accordance with the PMS.	CM-50-EPS-3	Vessel PMS schedule and maintenance records.	
		Lifting equipment maintained and certified.	CM-50-EPS-4	Lifting equipment certification valid and current.	
CM-51	Streamers are fitted with floatation devices	Solid-filled seismic streamer contains buoyancy devices and is fitted with marker buoys.	CM-51-EPS-1	End of survey report provides diagrams and report of streamers.	EPO-20 EPO-24
CM-52	Streamer deployment / retrieval procedure	Seismic streamers undergo regular inspection, at least every 7 days weather permitting, and planned maintenance system checks on streamer towing systems for wear and damaged components. These components are replaced on an ‘as required’ basis.	CM-52-EPS-1	Seismic streamers maintenance log.	EPO-20 EPO-24
		A secondary retaining/ attachment device is used.	CM-52-EPS-2	End of survey report provides diagrams and report of streamers.	
		Vessel crew involved in streamer deployment/retrieval are trained in the requirements of the procedures for streamer deployment and retrieval.	CM-52-EPS-3	Training records.	
CM-53	Streamers have locating devices fitted	Deployed streamers will be fitted with locating devices and tracked on the seismic survey vessel.	CM-53-EPS-1	Vessel streamer specifications. Streamer location tracking on boarding vessel.	EPO-24
CM-54	Streamer tow depth	Streamers are towed at least 10 m above the seabed to avoid seabed disturbance.	CM-54-EPS-1	Streamer deployment procedure includes streamers must be towed at a minimum of 10 m above the seabed.	EPO-24

CM Ref.	Control measure	Environmental performance standards	EPS Ref.	Measurement criteria	EPO Ref.
CM-55	Use of turtle guards / a 'turtle friendly' tail buoy	Tail buoys on the streamers will be fitted with turtle guards or be of another design that minimise the risk of entrapment of marine fauna.	CM-55-EPS-1	Vessel streamer specifications	EPO-11 EPO-22
CM-56	Anti-foulant system	Anti-foulant systems are maintained in compliance with International Convention on the Control of Harmful Anti-Fouling Systems on Ships.	CM-56-EPS-1	Current International Anti-Fouling System Certificate.	EPO-25
CM-57	Aquatic Biosecurity Solution vessel check tool (applied to vessels), and immersible equipment clean. Exception: If concurrent surveys are conducted within the same Bioregion, then immersible equipment does not need to be cleaned when moving from one survey area to another.	Vessels to be risk assessed using the Aquatic Biosecurity Solution vessel check tool demonstrating vessel is at 'low risk' of introducing invasive marine species.	CM-57-EPS-1	Completed Aquatic Biosecurity Solution vessel check report demonstrating vessels are low risk.	EPO-25
		Immersible equipment to be cleaned to 'low risk' of introducing invasive marine species if being deployed to sea during the Activity.	CM-57-EPS-2	Verification that immersible equipment was cleaned to low risk (e.g. photos, inspection reports).	
		Vessel operators will be provided with the most current WA Prevention List for Introduced Marine Pests to ensure they are aware of potential invasive marine pest species and the reporting requirements	CM-57-EPS-3	Verification that current WA Prevention List has been provided to vessel operators.	
CM-58	Biosecurity risk management	Pursuant to the Biosecurity Amendment (Biofouling Management) Regulations 2021 entered into force on 15 June 2022, Operators of all international vessels will be required to provide information on how biofouling has been managed prior to arrival in Australian territorial seas. Requirements may include a biofouling management plan; or cleaning within 30 days prior to arrival; or implementation of alternative biofouling management methods.	CM-58-EPS-1	Written evidence that the seismic survey vessel meets the requirements set out in the Determination. Inspections records confirm seismic vessel is compliant with Mandatory biofouling management requirements.	EPO-25
CM-59	Ballast water management plan	Pursuant to the *Biosecurity Act 2015* and Australian Ballast Water Management Requirements 2017, vessels carrying ballast water and engaged in international voyages shall manage ballast water in accordance with a Ballast Water Management Plan so that marine pest species are not introduced. The plan shall include: • Ballast water exchange	CM-59-EPS-1	Administrator-approved ballast water management plan. Completed ballast water record book or log	EPO-25

CM Ref.	Control measure	Environmental performance standards	EPS Ref.	Measurement criteria	EPO Ref.
		• Ballast water management systems • Sediment management • Duties of officers and crew • Coordination with local authorities • Record keeping.			
CM-60	Activity assurance reviews	If a survey has not been conducted within 6 months of the EP acceptance, Santos will conduct a Pre-activity Assurance Review following the review process outlined in Section 8.14.1 to ensure that environmental impact and risk levels remain acceptable and ALARP for the duration of this EP.	CM-60-EPS-1	Completed assurance review	All

8.6.2 Commercial fishers payment claim protocol

Santos has made an overarching commitment that commercial fishing licence holders will be no worse off as a result of the seismic survey and propose measures that enable commercial fishers to lodge a claim ('make good' payment) if applicable (refer to Table 8-2 and Table 8-3).

'Make good' payments to commercial fishing licence holders will be assessed for loss of catch and relocation expenses should concurrent fishing and seismic vessel operations not be practicable.

Santos will also assess requests for administrative support to help fishers collate historical fishing data required for make good payment claims.

Santos believes that the principles of the model presented in Section 8.6 are sufficiently clear and will assess any payment claims in good faith. Commercial fishers are encouraged to contact Santos to discuss the proposed fishery payment claim model.

The CM and EPS identified in Table 8-3 (CM-7-EPS-1 to CM-7-EPS-14) will identify how the potentially competing demands of commercial fishing operators and Santos' seismic survey will be managed. The management objective is to ensure commercial fishing licence holders are no worse off as a result of the seismic survey.

8.7 Workforce Involvement and Stakeholder Communication

Daily operational meetings will be held offshore at which HSE will be a standing agenda item. It is a requirement that supervisors attend daily operational meetings, and all personnel attend daily toolbox/ pre-shift meetings.

Toolbox meetings will be regularly held offshore to plan jobs and discuss work tasks, including HSE risks and controls.

HSE performance will be monitored and reported during the Activity, and performance metrics (such as the number of environmental incidents) will be regularly communicated to the workforce.

Workforce involvement and environmental awareness will also be promoted by encouraging offshore personnel to report marine fauna sightings and marine pollution (e.g. oil on water, dropped objects).

8.8 Information management and document control

This EP and OPEP, as well as approved management of change documents, are controlled documents and current versions will be available on Santos' intranet. Santos' contractors are also required to maintain current versions of these documents.

Environmental performance outcomes and standards will be measured based on the measurement criteria listed in Table 8-3. Such records will be maintained for a period of five years. Contractors are required to make these records available upon request. Collectively, these represent a comprehensive and integrated system through which operational control measures (e.g. refuelling) described in this EP will be implemented.

8.9 Management of change

The management of change (MoC) process provides a systematic approach to initiate, assess, document, approve, communicate and implement changes to EPs and OPEPs.

The MoC process considers sections 18, 19, 38 and 39 of the OPGGS(E)R 2023 and determines if a proposed change can proceed and the manner in which it can proceed. The MoC procedure will determine whether a revision of the EP is required and whether that revision is to be submitted to NOPSEMA. For a change to proceed, the associated environmental impacts and risks must be demonstrated to be acceptable and ALARP. Additional stakeholder consultation may be required, depending on the nature and scale of the change. Additional information about the MoC process is provided in Figure 8-1.

The MoC procedure also allows for the assessment of new information that may become available after EP acceptance, such as new management plans for AMPs, new recovery plans or conservation advice for species, and changes to the EPBC Protected Matters Search results. If a review identifies new information, this is treated as a 'Change that has an impact on EP', and the MoC process is followed accordingly.

Accepted MoCs become part of the in-force EP or OPEP, are tracked on a register and are made available on Santos' intranet. Where appropriate, the EP compliance register will be updated so CM or EPS changes are communicated to the workforce and implemented. Any MoC will be distributed to the relevant management personnel identified in Table 8-1 and the most relevant management position will ensure the MoC is communicated and implemented, which may include crew meetings, briefings or communications as appropriate for the change.

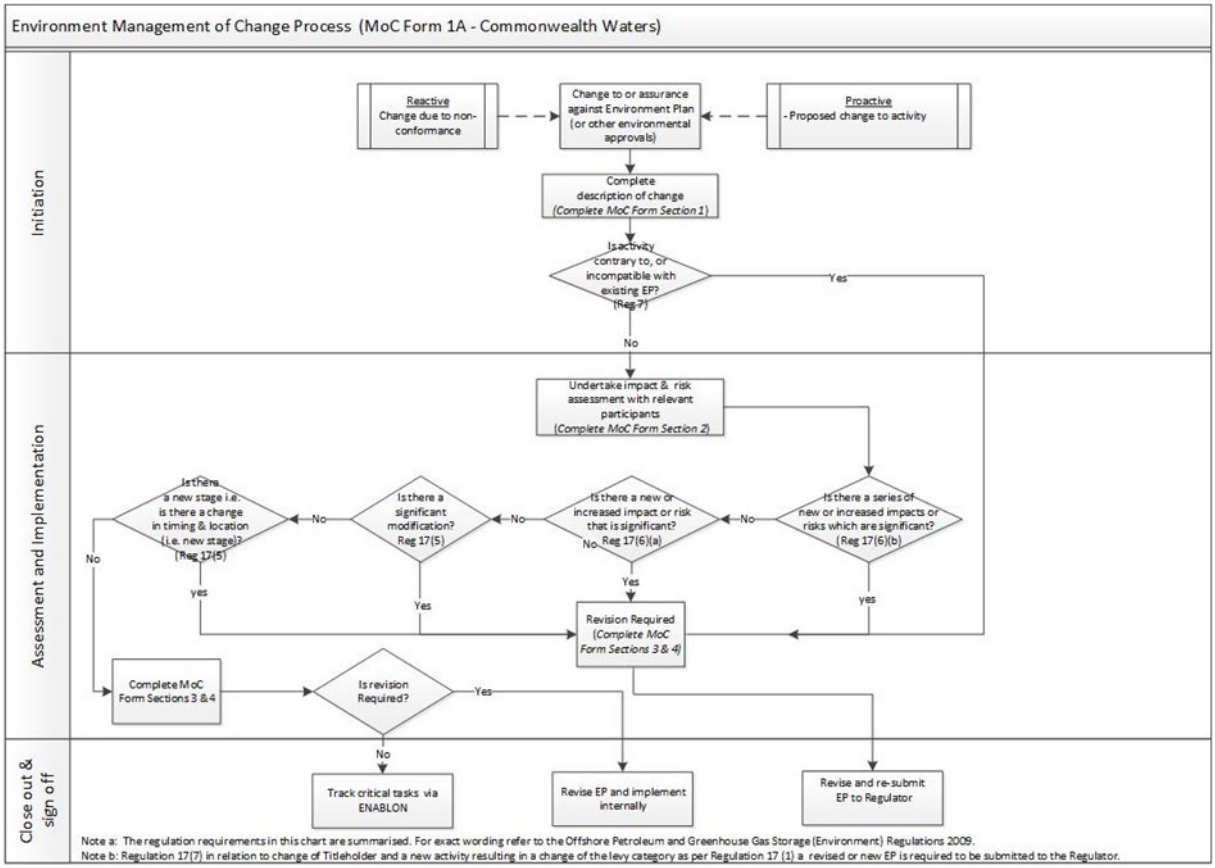


Figure 8-1: Environment management of change

8.10 Emergency preparedness and response

OPGGS(E)R 2023 Requirements
Section 22(8)
The implementation strategy must contain an oil pollution emergency plan and provide for updating the plan.

Vessels are required to have and implement incident response plans, such as an emergency response plan and SMPEP or SOPEP. Regular incident response drills and exercises (e.g. as defined in emergency response plan, SMPEP or SOPEP) will be carried out on support vessels to refresh the crew in using equipment and implementing incident response procedures.

Santos will implement the Eos 3D MSS OPEP (7710-650-EMP-0011-1) in the event of a hydrocarbon spill. The OPEP details how Santos will prepare and respond to a spill event and meets the requirement of the Regulations.

8.11 Incident reporting, investigation and follow-up

OPGGS(E)R 2023 Requirements
Section 22(6)
The implementation strategy must provide for sufficient monitoring of, and maintaining a quantitative record of, emissions and discharges (whether occurring during normal operations or otherwise), such that the record can be used to assess whether the environmental performance outcomes and standards in the environment plan are being met.
Section 22(7)
The implementation strategy must state when the titleholder will report to NOPSEMA in relation to the titleholder's environmental performance for the activity. The interval between reports must not be more than 12 months. Note: Section 51 requires a titleholder to report on environmental performance at the times or intervals set out in the environment plan.

All personnel will be informed through inductions and daily operational meetings of their duty to report HSE incidents and hazards. Reported HSE incidents and hazards will be shared during daily operational meetings, and HSE incidents and hazards will be documented in the incident management systems as appropriate. HSE incidents

will be investigated in accordance with the *Incident Reporting, Investigation and Learning Procedure* (SMS-HSS-OS07-PD01).

Environmental recordable and reportable incidents will be reported to NOPSEMA and to other regulators as required in accordance with Table 8-4. The incident reporting requirements will be provided to all crew on board the vessels during induction with special attention to the reporting time frames to provide for accurate and timely reporting.

For the purposes of this activity, in accordance with OPGGS(E)R 2023:

- a recordable incident, for an activity, means a breach of an EPO or EPS, in the EP that applies to the activity, that is not a reportable incident
- a reportable incident, for an activity, means an incident relating to the activity that has caused, or has the potential to cause, moderate to significant environmental damage.
- For the purposes of this EP, Reportable incidents that are a breach of EPO or EPS could include:
- Uncontrolled release of hydrocarbon or hazardous chemical to the marine environment
- Uncontrolled significant release of ozone depleting substance (ODS)
- Unrecovered container (e.g. 44-gallon drum) of hydrocarbon, chemical or waste to sea
- Harm or mortality to marine fauna whether attributable to the vessel or not
- Large oil slick or sheen on the sea surface whether attributable to the vessel or not
- Introduction of IMS to the Operational Area.

8.12 Regulatory notifications and compliance reporting

OPGGS(E)R 2023 Requirements
Section 22(7)
The implementation strategy must state when the titleholder will report to the Regulator in relation to the titleholder's environmental performance for the activity. The interval between reports must not be more than 12 months. Note: Section 51 requires a titleholder to report on environmental performance at the times or intervals set out in the environment plan.

Regulatory, other notification and compliance reporting requirements are summarised in Table 8-4.

Table 8-4: Activity notification and reporting requirements

Regulation	Requirement	Required information	Timing	Type	Recipient
Before the Activity					
Sections 54 and 55 – Notifications	NOPSEMA must be notified that the Activity is to commence.	Complete NOPSEMA's Section 54 and 55 Start or End of Activity Notification form for both notifications.	At least 10 days before the Activity commences.	Written	NOPSEMA
N/A	Australian Hydrographic Office (AHO)	Pre-start notification.	At least 4 weeks prior to Activity commencement.	Written	AHO
N/A	AMSA Joint Rescue Coordination Centre (JRCC) Notification		48 hours prior to Activity commencement.	Written	AMSA
N/A	DITT – Fisheries Division requested pre-start notification during consultation		At least 4 weeks prior to Activity commencement.	Written	DITT
N/A	Department of Defence (DoD)		At least 4 weeks prior to Activity commencement.	Written	DoD
N/A	Broome CCI		At least 4 weeks prior to Activity commencement.	Written	Broome CCI
N/A	Eni Australia		At least 4 weeks prior to Activity commencement.	Written	Eni Australia
N/A	INPEX		At least 4 weeks prior to Activity commencement.	Written	INPEX
N/A	Melbana Energy		At least 4 weeks prior to Activity commencement.	Written	Melbana Energy
N/A	Bradshaw Liaison Committee	Notification of EP submission to NOPSEMA.	To occur on submission of the EP to NOPSEMA.	Written	Bradshaw Liaison Committee
N/A	DoT	Notification of OPEP acceptance.	To occur on acceptance of the OPEP.	Written	DoT
Department of Agriculture, Fishery and Forestry, Compliance Division	Voluntary biosecurity risk assessment under the *Biosecurity Act 2015*	In the event a vessel contractor is unable to conduct an independent biosecurity risk assessment, then the department will work with installation representatives to assess the biosecurity risk of the installation and associated support conveyances (vessels and aircraft). To have risk status	At least one month before the survey as practicable.	Written	DAFF

Regulation	Requirement	Required information	Timing	Type	Recipient
		assessed, offshore installation projects must apply to the department at least one month prior to project commencement.			
Section 193 of the *Biosecurity Act 2015*.	Mandatory biosecurity risk assessment under the *Biosecurity Act 2015*	If the vessel intends to visit an Australian port the operator of a vessel is required to submit a Pre-Arrival Report through the Maritime Arrivals Reporting System.	Between 96 and 12 hours prior to the estimated time of arrival.	Written	DAFF
During the Activity					
Section 24(c), 47 and 48 – Reportable Incident	NOPSEMA must be notified of any reportable incidents. For the purposes of Section 24(c), a reportable incident is defined as: • An incident relating to the Activity that has caused, or has the potential to cause, moderate to significant environmental damage • In the event of an incident impacting on State waters, this will also be reported to DEMIRS. Any ship strike incident will also be reported to the National Ship Strike database.	The oral notification must contain: • All material facts and circumstances concerning the reportable incident known or by reasonable search or enquiry could be found out • Any action taken to avoid or mitigate an adverse environmental impact of the reportable incident • The corrective action that has been taken, or is proposed to be taken, to stop, control or remedy the reportable incident.	As soon as practicable, and in any case not later than 2 hours after the first occurrence of a reportable incident, or if the incident was not detected at the time of the first occurrence, at the time of becoming aware of the reportable incident.	Oral	NOPSEMA
		A written record of the oral notification must be submitted. The written record is not required to include anything that was not included in the oral notification.	As soon as practicable after the oral notification.	Written	NOPSEMA NOPTA WA DEMIRS/ NT DPIRD National Ship Strike Database
		A written report must contain: • All material facts and circumstances concerning the reportable incident known or by reasonable search or enquiry could be found out • Any action taken to avoid or mitigate an adverse environmental impact of the reportable incident • The corrective action that has been taken, or is proposed to be taken, to stop, control or remedy the reportable incident • The action that has been taken, or is proposed to be taken, to prevent a similar incident occurring in the future. Consider reporting using NOPSEMA's Report of an Accident, Dangerous Occurrence or Environmental Incident form: https://www.nopsema.gov.au/assets/Forms/N-03000-FM0831-Report-of-an-Accident-Dangerous-Occurrence-or-Environmental-Incident-Rev-8-Jan-2015-MS-Word-2010.docx	Must be submitted as soon as practicable, and in any case not later than 3 days after the first occurrence of the reportable incident unless NOPSEMA specifies otherwise. Same report to be submitted to NOPTA and WA DEMIRS/ NT DPIRD within 7 days after giving the written report to NOPSEMA.	Written	NOPSEMA NOPTA WA DEMIRS/ NT DPIRD

Regulation	Requirement	Required information	Timing	Type	Recipient
		Ship strike report: **https://data.marinemammals.gov.au/report/shipstrike**			
Director of National Parks Reporting	Notification of the event of an oil pollution incident which occurs within a marine park or is likely to impact on a marine park.	The notification should include: • titleholder details • time and location of the incident (including name of marine park likely to be affected) • proposed response arrangements as per the Oil Pollution Emergency Plan (e.g. dispersant, containment, etc.) • confirmation of providing access to relevant monitoring and evaluation reports when available • contact details for the response coordinator. Notification made to the Marine Compliance Duty Officer on 0419 293 465.	Within 24 hours	Oral	Director of National Parks
DTHFC Reporting	As requested during consultation	Notification if any underwater heritage is located during the activity.	As soon as practicable	Written	DTHFC
AMSA Reporting	In consultation AMSA requests notification of reportable vessel incidents under Marine *Safety (Domestic Commercial Vessel) National Law Act 2012, Schedule 1* including: • the loss of a vessel • a collision with another vessel or an object • the grounding, sinking, flooding or capsizing of a vessel • a fire • a loss of stability that affects the safety of the vessel	A written report must contain: • Incident details (date and time) • Location • Type of incident • Incident description • Vessels involved • Persons involved • Details of assistance rendered/received at incident. Consider reporting using AMSA's Incident Report: http://www.amsa.gov.au/domestic/vessels-operations-surveys/domestic-incident-reporting/	Within 72 hours of the incident.	Written	AMSA

Regulation	Requirement	Required information	Timing	Type	Recipient
	• a close quarters situation • the death or injury, or possible death or injury, of a person on board • the loss, or possible loss, of a person from a vessel.				
DPIRD Reporting	If marine pests or disease are suspected this must be reported to WA DPIRD or NT Fisheries.	Notification of any suspected marine pests or diseases including any organism listed in the WA Prevention List for Introduced Marine Pests and any other non-endemic organism that demonstrates invasive characteristics.	Within 24 hours.	Oral	WA DPIRD NT Fisheries
DCCEEW Reporting	Any harm or mortality to EPBC Act listed threatened marine fauna.	Notification of any harm or mortality to an EPBC listed species of marine fauna whether attributable to the Activity or not.	Within 48 hours to **compliance@environment.gov.au.**	Written	DCCEEW
	As requested during consultation	Notification of any UCH or suspected UCH identified or located during the Activity within 21 days of the discovery.	Within 21 days of discovery.	Written	DCCEEW
Wildlife Reporting	Impacts to marine mammals or turtles in reserves.	Notification of any incidence of entanglement, boat collisions and stranding of marine mammals in the reserves and any incident of turtle mortality and incidents of entanglement.	Within 48 hours.	Written	WA DBCA NT DLPE
Section 50– Recordable Incidents	NOPSEMA must be notified of a breach of an environmental performance outcome or standard, in the environment plan that applies to the Activity that is not a reportable incident.	Complete NOPSEMA's Recordable Environmental Incident Monthly Report form.	The report must be submitted as soon as practicable after the end of the calendar month, and in any case, not later than 15 days after the end of the calendar month.	Written	NOPSEMA
Section 22(7) and 51 Environmental Performance.	NOPSEMA must be notified of the environmental performance at the intervals provided for in the EP.	Report must contain sufficient information to determine whether or not environmental performance outcomes and standards in the EP have been met.	In accordance with Regulation 14(2), a detailed environmental performance report will be submitted at least annually.	Written	NOPSEMA

Regulation	Requirement	Required information	Timing	Type	Recipient
End of Activity					
Section 54 – Notifications	NOPSEMA must be notified that the Activity is completed.	Complete NOPSEMA's Section 54 Start or End of Activity Notification form.	Within 10 days after finishing.	Written	NOPSEMA
Section 22(7) and 51 – Environmental Performance.	NOPSEMA must be notified of the environmental performance at the intervals provided for in the EP.	Report must contain sufficient information to determine whether or not environmental performance outcomes and standards in the EP have been met.	Final environmental performance report submitted within 3 months of the end of the activity providing this reporting time frame is not more than 1 year from the previous environmental performance report.	Written	NOPSEMA
Section 46 Plan ends when titleholder notifies completion, and the Regulator accepts the notification.	NOPSEMA must be notified that the Activity has ended, and all EP obligations have been completed.	Notification advising NOPSEMA of end of all activities to which the EP relates and that all obligations have been completed.	Within six months of the final Section 54 notification.	Written	NOPSEMA
EPBC Policy Statement 2.1	Part A.4 Compliance and Sighting Reports	A report on the conduct of the survey, and any whale interactions, should be provided to DCCEEW within two months of survey completion. The report should, at a minimum, contain: • the location, date and start time of the survey; • name, qualifications and experience of any Marine Mammal Observers (or research scientists) involved in the survey; • the location, times and reasons when observations were hampered by poor visibility or high winds; • the location and time of any start-up delays, power downs or stop work procedures instigated as a result of whale sightings; • the location, time and distance of any whale sighting including species where possible; and • the date and time of survey completion.	Within two months of survey completion	Written	DCCEEW
N/A	DITT – Fisheries Division requested activity notifications during consultation.	Activity cessation notification.	Within ten days of survey completion.	Written	DITT
N/A	Eni Australia		Within 10 days of survey completion	Written	Eni Australia
N/A	Melbana Energy requested activity		Within ten days of survey completion.	Written	Melbana Energy

Regulation	Requirement	Required information	Timing	Type	Recipient
	notifications during consultation.				

8.13 Monitoring and recording emissions and discharges

OPGGS(E)R 2023 Requirements
Section 34(e)
Includes an appropriate implementation strategy and monitoring, recording and reporting arrangements.
Section 22(6)
The implementation strategy must provide for sufficient monitoring of, and maintaining a quantitative record of, emissions and discharges (whether occurring during normal operations or otherwise), such that the record can be used to assess whether the environmental performance outcomes and standards in the environment plan are being met.

Discharges associated with this Activity will be limited to those allowed for under maritime law. Therefore, all discharges will be recorded and controlled in accordance with maritime monitoring and recording requirements. Any non-compliance with discharge requirements will be included in the monthly recordable incident report to NOPSEMA.

8.14 Reviews, audits and inspections

OPGGS(E)R 2023 Requirements
Section 22(5)
The implementation strategy must provide for sufficient monitoring, recording, audit, management of nonconformance and review of the titleholder's environmental performance and the implementation strategy to ensure the environmental performance outcomes and standards in the environment plan are being met.

8.14.1 Reviews

It is recognised that over the validity of this EP things may change, such as:

legislation

businesses conditions, activities, systems, processes and people

industry practices

Petroleum industry survey, exploration and development activities

science and technology

societal and stakeholder expectations.

To ensure Santos maintains up-to-date knowledge of the industry, legislation and conservation advice, the following tasks are undertaken:

Maintain membership of AEP (Australian Energy Producers, formerly known as Australian Petroleum Production and Exploration Association), which provides a mechanism for communicating potential changes in legislation, industry practice and other issues that may affect EP implementation to relevant personnel in Santos.

Undertake annual spill response exercises to check spill response arrangements and capability are adequate.

Identify stakeholders prior to the activity commencing under this EP via the mechanisms outlined in Section 4.

Monitoring the AIMS North West Shoals to Shore Research Program, specifically the fish and pearl oyster impact studies.

Review the Values and Sensitivities within the EMBA which includes completing a new EPBC Protected Matters Search, reviewing Appendix I against relevant legislation to capture and review any relevant updates and incorporate as required, and reviewing any recently known published relevant scientific papers.

Subscribe to various regulator updates.

Have regular liaison meetings with Regulators.

Through maintenance of up-to-date knowledge, these changes are identified. If the changes have an impact on the activity or risks described and assessed in this EP, the EP will be reviewed and any changes required documented in accordance with Santos' MoC procedure (Section 8.9).

Additionally, if a survey has not been conducted within six months of the EP acceptance, Santos will conduct a Pre-Activity Assurance Review prior to the commencement of a seismic survey provided for in this EP. The review will

assess changes to the abovementioned parameters, and ensure that systems, procedures and people are in place for the proposed seismic survey to comply with the requirements of this EP. Through this process, Santos will demonstrate for each seismic survey that:

The environmental impacts and risks of the Activity continue to be identified and reduced to a level that is as low as reasonably practicable

Control measures detailed in the environment plan are effective in reducing the environmental impacts and risks of the Activity to as low as reasonably practicable and an acceptable level

Environmental performance outcomes and standards set out in the environment plan will be met.

8.14.2 Audits

Santos' audit plans and schedules are reviewed and updated at the beginning of each calendar year and cover all Santos facilities and activities. Santos' audit schedule may be amended to accommodate operational priorities, activity risk, personnel availability or high audit demand during certain periods (for example, regulatory audits, contractor audits). Santos will determine if a vessel audit is required following contract award and vessel confirmation.

Audits will be undertaken in a manner consistent with Santos' Management Standard for Assurance SMS MS15.

Audit scope typically includes a selection of CMs and EPSs and EPOs. However, audits may also include other parts of the EP.

Audit findings may include opportunities for improvement and non-conformances. Audit non-conformances are managed as described in Section 8.14.4.

8.14.3 Inspections

During an activity, HSE inspections (desktop or vessel based) will be conducted at least once during the activity to identify hazards, incidents and EP non-conformances. These inspections will also check compliance against all the EPOs and EPSs of this EP (Table 8-2 and Table 8-3) and inform end of activity reporting (Table 8-4). Any in-field opportunities for improvement or corrective actions will be discussed during the inspection with the Vessel Master.

8.14.4 Non-conformance management

EP non-conformances will be addressed and resolved by a systematic corrective action process as outlined in Santos' Management Standard for Assurance (MS15) and the Assurance Procedure (ST01). Non-conformances arising from audits and inspections will be entered into Santos' incident and action tracking management system (i.e. 'HSE Toolbox). Once entered, corrective actions, time frames and responsible persons (including action owners and event validators) will be assigned. Corrective action 'close out' will be monitored using a management escalation process.

8.14.5 Continuous Improvement

For this EP, continuous improvement will be driven by:

improvements identified from the review of business-level HSE key performance indicators

actions arising from Santos and departmental HSE improvement plans

corrective actions and feedback from HSE audits and inspections, incident investigations and after-action reviews

opportunities for improvement and changes identified during pre-activity reviews and MoC documents

actions taken to address concerns and issues raised during the ongoing stakeholder management process (Section 4).

Identified continuous improvement opportunities will be assessed in accordance with the MoC process to ensure any potential changes to this EP, or OPEP, are managed in accordance with the OPGGS(E)R 2023 and in a controlled manner.

8.15 Post acceptance consultation implementation strategy

8.15.1 Post-acceptance consultation implementation strategy – First Nations people and groups and local governments, communities and industry

Post-acceptance consultation activities for this EP will be principally supported by Santos' existing relationships with those relevant interested persons and organisations whose functions, interests and activities may be affected by the Activity.

Santos recognises and respects the preference of relevant government authorities and other relevant interested persons and organisations to determine the frequency and method of updates, in addition to the written quarterly updates outlined in this strategy below..

8.15.1.1 First Nations people and groups

Santos will undertake consultation over the life of the activity with Native Title Representative Bodies whose jurisdiction overlaps the Operational Area and those First Nations representative organisations with closest proximity to the Activity, these being:

Kimberley Land Council

Northern Land Council

Balanggarra Aboriginal Corporation

Miriuwung Gajerrong Aboriginal Corporation.

Having regard to Santos' experience consulting with First Nations groups, and feedback from First Nations relevant persons, Santos considers that consultation through representative bodies provides an appropriate mechanism for ongoing consultation with First Nations relevant interested persons.

Representative bodies provide for regular, culturally appropriate engagement, including processes for dissemination of information to First Nations Elders, cultural leaders and communities in a manner that is readily accessible and culturally appropriate.

8.15.1.2 Local governments, communities and industry

As part of Santos' community engagement efforts, Santos will provide quarterly written Activity updates to regional local government and associated communities, specifically those local governments whose jurisdictions have closest proximity to proposed activities, these being:

- Shire of Wyndham-East Kimberley (WA)
- Victoria Daly Regional Council (NT)
- West Daly Regional Council (NT)

Santos will also provide quarterly written Activity updates to the commercial fishing industry, which is the industry most likely to be affected by proposed offshore activities. Santos will provide quarterly written Activity updates to those representative organisations whose membership are most likely to be affected, specifically to:

Northern Prawn Fishery Industry

Western Australian Fishing Industry Council.

In addition, Santos will consult the Northern Prawn Fishery Industry once activity timing has been confirmed.

8.15.2 Post-acceptance consultation implementation strategy – approach

Santos will provide to those organisations identified above quarterly written Activity updates. The updates will also be posted on Santos' website, with notifications to registered/subscribed interested parties.

Activity notifications and reports will also be made in accordance with Table 8-4. The notifications and reports are based on legislative requirements, standing arrangements with particular Relevant Persons, Relevant Persons' requests for notification made during Section 25 of the OPGGS(E)R 2023 consultation, or as otherwise deemed appropriate by Santos.

Santos will apply its WA and NT regional engagement models to consider the preference of relevant government authorities and other relevant interested persons and organisations when determining the frequency and method of additional updates.

Records of any post acceptance consultation will be maintained in an appropriate Santos consultation database.

During the EP validity period, Santos will also:

- Review information sources that may give rise to additional or new relevant interested persons or organisations, as part of planned consultation activities to support future approvals.
- Request recipients of Santos' Quarterly Update to advise Santos of other organisations who may be relevant interested persons or organisations or who may be relevant Commonwealth, State or Territory authorities with respect to particular regional activities. The Quarterly Update is sent to a diverse range of organisations and provides information about Santos' proposed, existing and completed activities.

Additional new potentially relevant interested persons or organisations will be engaged and provided information about the accepted activity, as well as information about the post-acceptance consultation process and opportunities to provide input or receive activity updates.

Additional new relevant interested persons or organisations will also be added to the distribution list for its Quarterly Update, unless they request that they not be added.

If, during the course of post acceptance consultation, Santos receives information demonstrating a new or increased environmental impact or risk that is not provided for in this EP, as in force at the time, Santos will apply its Management of Change process outlined in Section 8.9.

Santos will maintain a database of relevant authorities, and other relevant interested persons and organisations for this Activity. This includes updating its database in light of post acceptance consultation, including identification of new relevant interested persons or organisations .

References

[ABARES] Australian Bureau of Agricultural and Resource Economics and Sciences 2018. Fishery Status Reports 2018. Available at: http://www.agriculture.gov.au/SiteCollectionDocuments/abares/publications/fsr2018.pdf.

[AFMA] Australian Fisheries Management Authority 2018a. Fisheries Management: Western Tuna and Billfish Fishery. Available at: https://www.afma.gov.au/fisheries/western-tuna-and-billfish-fishery.

[AFMA] Australian Fisheries Management Authority 2018b. Fisheries Management: Southern Bluefin Tuna Fishery. Available at: https://www.afma.gov.au/fisheries/southern-bluefin-tuna-fishery.

[AFMA] Australian Fisheries Management Authority 2018c. Fisheries Management: Western Skipjack Fishery. Available at: https://www.afma.gov.au/fisheries/skipjack-tuna-fishery.

[AFMA] Australian Fisheries Management Authority 2018d. Fisheries Management: Northern Prawn Fishery. Available at: https://www.afma.gov.au/fisheries/northern-prawn-fishery.

[AFMA] Australian Fisheries Management Authority, 2018d. Fisheries Management: Northern Prawn Fishery. Available at: https://www.afma.gov.au/fisheries/northern-prawn-fishery.

[AFMA] Australian Fisheries Management Authority, 2023a. Northern Prawn Fishery. Available at https://www.afma.gov.au/fisheries/northern-prawn-fishery.

[AFMA] Australian Fisheries Management Authority, 2023b. Southern Bluefish tuna. Available at https://www.afma.gov.au/species/southern-bluefin-tuna#referenced-section-2.

[AFMA] Australian Fisheries Management Authority, 2021. Northern Prawn Fishery Directions and Closures 2021. Canberra, Australia.

[AMSA] Australian Maritime Safety Authority, 2015. Technical Guidelines for the preparation of Marine Pollution Contingency Plans for Marine and Coastal Facilities. Available at: https://www.amsa.gov.au/sites/default/files/2015-04-np-gui012-contingency-planning.pdf.

[BoM] Bureau of Meteorology, 2019a. Climatology of Tropical Cyclones in Western Australia. Available at: http://www.bom.gov.au/cyclone/climatology/. Viewed on 8 October 2019.

[BoM] Bureau of Meteorology, 2019b. Climate Statistics for Australian Locations – Dum In Mirrie Airstrip. Available at: http://www.bom.gov.au/climate/averages/tables/cw_014253.shtml. Viewed on 8 October 2019.

[BoM] Bureau of Meteorology, 2019c. Climate Statistics for Australian Locations – Channel point. Available at: http://www.bom.gov.au/climate/averages/tables/cw_014277.shtml. Viewed on 8 October 2019.

[BoM] Bureau of Meteorology, 2019d. Climate Statistics for Australian Locations – Port Keats Airport. Available at: http://www.bom.gov.au/climate/averages/tables/cw_014948.shtml. Viewed on 8 October 2019.

[BoM] Bureau of Meteorology, 2019e. Climate Statistics for Australian Locations – Truscott. Available at: http://www.bom.gov.au/climate/averages/tables/cw_001020.shtml. Viewed on 8 October 2019.

[BoM] Bureau of Meteorology, 2019f. Tide Predictions for Australia, South Pacific and Antarctica –Rocky Island. Available at: http://www.bom.gov.au/australia/tides/. Viewed on 8 October 2019.

[CALM] Department of Conservation and Land Management (1984). Conservation and Management Act. Available at https://www.legislation.wa.gov.au/legislation/statutes.nsf/main_mrtitle_193_homepage.html. [Accessed June 2023]

[CALM] Department of Conservation and Land Management, 2005. Indicative Management Plan for the proposed Dampier Archipelago Marine Park and Cape Preston marine management area, Department of Conservation and Land Management, Perth, Australia. 145 pp.

[CCWA] Conservation Commission of Western Australia. 2010. Status Performance Assessment: Biodiversity Conservation on Western Australian Islands. Phase II – Kimberley Islands – Final Report.

[CSIRO] Commonwealth Scientific and Industrial Research Organisation, 2005. Collation and Analysis of Oceanographic Datasets for National Marine Bioregionalisation. The Northern Large Marine Domain. Available at: https://www.environment.gov.au/system/files/resources/51abf1da-40b7-4513-8fad-b4537e1fac62/files/nmb-northern-domain.pdf.

[DAFF] Department of Agriculture, Fisheries and Forestry, 2011. Fishery status reports 2011. Research by the Australian Bureau of Agricultural and Resource Economics and Sciences, published 2012.

[DAWE] Department of Agriculture, Water and the Environment, 2021a. Continental shelf and demersal fish communities. Commonwealth of Australia 2021. Available at: https://www.environment.gov.au/sprat.

[DAWE] Department of Agriculture, Water and the Environment, 2021b. Species Profile and Threats Database: Orcaella heinsohni — Australian Snubfin Dolphin. Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=81322

[DAWE] Department of Agriculture, Water and the Environment, 2016. Biologically Important Areas of Regionally Significant Marine Species. Available at: http://www.environment.gov.au/fed/catalog/search/resource/details.page?uuid=%7B2ed86f5a-4598-4ae9-924f-ac821c701003%7D

[DAWR] Department of Agriculture and Water Resources, 2017. Australian Ballast Water Management Requirements. Version 7. Available at: http://www.agriculture.gov.au/SiteCollectionDocuments/biosecurity/avm/vessels/ballast/australian-ballast-water-management-requirements.pdf.

[DBCA] Department of Biodiversity, Conservation and Attractions, 2018. Browse Island. A journey to Western Australia's most remote nature reserve. Available at https://library.dbca.wa.gov.au/static/Journals/080052/080052-34.014.pdf

[DBCA] Department of Biodiversity, Conservation and Attractions, 2019. Parks and reserves of the south-west Kimberley and north-west Pilbara joint management plan 2019. Management plan 91. Available at https://www.dbca.wa.gov.au/management/plans/parks-and-reserves-south-west-kimberley-and-north-west-pilbara [Accessed June 2023]

[DBCA] Department of Biodiversity, Conservation and Attractions, 2019. Proposed Niiwalarra Islands (Sir Graham Moore Islands) National Park and Lesueur Island Nature Reserve. https://www.dbca.wa.gov.au/management/plans/niiwalarra-islands-national-park-and-lesueur-island-nature-reserve. Accessed on 7 September 2023.

[DBCA] Department of Biodiversity, Conservation and Attractions. 2020. Biodiversity Survey, Mapping, Delineation and Assessment of Selected Organic Mound Springs of the Kimberley Region.

[DCCEEW] Department of Climate Change, Energy, the Environment and Water, 2012. Marine Key Ecological Features. Available at: https://www.environment.gov.au/fed/catalog/search/resource/details.page?uuid=%7B39FE3093-2E53-45C5-8F98-F8FDEB4AD77B%7D

[DCCEEW] Department of Climate Change, Energy, the Environment and Water. 2014a. Scott Reef and Surrounds. Available at http://www.environment.gov.au/cgi-bin/ahdb/search.pl. [Accessed June 2023]

[DCCEEW] Department of Environment. 2014b. Bradshaw Defence Area. Available at http://www.environment.gov.au/cgi-bin/ahdb/search.pl?mode=place_detail;place_id=105655 [Accessed June 2023]

[DCCEEW] Department of Climate Change, Energy, the Environment and Water, 2021. The Ramsar Convention on Wetlands. Available at: https://www.dcceew.gov.au/water/wetlands/ramsar

[DCCEEW] Department of Climate Change, Energy, the Environment and Water, 2022. Assessment of the Northern Territory Aquarium Fishery. Accessed from: https://www.dcceew.gov.au/sites/default/files/documents/nt-aquarium-assessment-2022.pdf

[DCCEEW] Department of Climate Change, Energy, the Environment and Water, 2023. Draft guidelines to protect underwater cultural heritage. Available at: https://consult.dcceew.gov.au/draft-guidelines-to-protect-uc-heritage

[DCCEEW] Department of Climate Change, Energy, the Environment and Water, 2023. National Light Pollution Guidelines for Wildlife, Department of Climate Change, Energy, the Environment and Water, Canberra.

[DCCEEW] Department of Climate Change, Energy, the Environment and Water, 2024. Conservation Advice for *Carettochelys insculpta (pig-nosed turtle).*Available at *https://www.environment.gov.au/biodiversity/threatened/species/pubs/1762-conservation-advice-16072024.pdf* [Accessed June 2025]

[DCCEEW] Department of Climate Change, Energy, the Environment and Water, 2023. Conservation advice for *Phaethon rubricauda westralis)* (Indian Ocean red-tailed tropicbird)(2023). Available at https://www.environment.gov.au/biodiversity/threatened/species/pubs/91824-conservation-advice-21122023.pdf [Accessed June 2025]

[DEC] WA Department of Environment and Conservation, 2012c. Ord River and Parry Lagoons Nature Reserves Management Plan. Available from: https://www.dpaw.wa.gov.au/images/documents/parks/management-plans/decarchive/ord-river-and-parry-lagoons-nature-reserves-management-plan-2012_webversion.pdf [Accessed April 2023].

[DEWHA] Department of the Environment, Water, Heritage and the Arts. 2007. Characterisation of the marine environment of the north marine region: outcomes of an expert workshop convened in Darwin., Northern Territory, 2-3 April 2007, DEWHA, Canberra. http://www.environment.gov.au/resource/characterisation-marine-environment-north-marine-region-outcomes-expert-workshop-2-3-april

[DEWHA] Department of the Environment, Water, Heritage and the Arts, 2008a. The North Marine Region Bioregional Plan Bioregional Profile. Commonwealth of Australia.

[DEWHA] Department of the Environment, Water, Heritage and the Arts 2008b. The North-west Marine Region Bioregional Plan Bioregional Profile. Commonwealth of Australia.

[DEWHA] Department of the Environment, Water, Heritage and the Arts, 2008c. EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales. Commonwealth of Australia.

[DFO] Department of Fisheries and Oceans, 2004. Review of Scientific Information on Impacts of Seismic Sound on Fish, Invertebrates, Marine Turtles and Marine Mammals. Canadian Science Advisory Secretariat (CSAS), Habitat Status Report 2004/002, 15 pp.

[DNREAS] Department of Natural Resources, Environment, the Arts and Sport, 2009. Sites of conservation significance: the Tiwi Islands. Northern Territory Government. Available at: https://web.archive.org/web/20090922200131/http://nt.gov.au/nreta/environment/conservation/pdf/09_tiwi.pdf.

[DNREAS] Department of Natural Resources, Environment, The Arts and Sport. (2011). Cobourg Marine Park Plan of Management. Available from: https://dtc.nt.gov.au/__data/assets/pdf_file/0006/249045/Cobourg-Marine-Park.pdf [Accessed April 2023]

[DoD] Department of Defence, 2023. Unexploded Ordnance (UXO) Mapping Application. Available at: http://www.defence.gov.au/UXO/Where/.

[DoE] Department of the Environment, 2010. Approved Conservation Advice for Aipysurus apraefrontalis (Short-nosed Seasnake). Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/1115-conservation-advice.pdf.

[DoE] Department of the Environment, 2013. Approved Conservation Advice for Rostratula Australia (Australian painted snipe). Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=77037.

[DoE] Department of the Environment, 2014a. Approved Conservation Advice for Glyphis garricki (northern river shark). Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/82454-conservation-advice.pdf.

[DoE] Department of the Environment, 2014b. Approved Conservation Advice for Pristis pristis (largetooth sawfish). Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/60756-conservation-advice.pdf.

[DoE] Department of the Environment, 2014c. Approved Conservation Advice for Glyphis glyphis (speartooth shark). Available at: http://environment.gov.au/biodiversity/threatened/species/pubs/82453-conservation-advice.pdf. [DoE] Department of the Environment, 2015a. Balaenoptra edeni in Species Profile and Threats Database. Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=35.

[DoE] Department of the Environment, 2015a. Conservation Advice: Megaptera novaeangliae humpback whale. Threatened Scientific Committee. Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/38-conservation-advice-10102015.pdf.

[DoE] Department of the Environment, 2015b. Conservation Management Plan for the Blue Whale—A Recovery Plan under the Environment Protection and Biodiversity Conservation Act 1999. Available at: https://www.environment.gov.au/system/files/resources/9c058c02-afd1-4e5d-abff-11cac2ebc486/files/blue-whale-conservation-management-plan.pdf

[DOE] Department of the Environment, 2015b. Dermochelys coriacea (Leatherback Turtle). Species Profile and Threats Database. Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1768.

[DoE] Department of the Environment, 2015c. Conservation Advice Balaenoptera borealis sei whale. Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/34-conservation-advice-01102015.pdf.

[DoE] Department of the Environment, 2015d. Conservation Advice Balaenoptera physalus fin whale. Threatened Scientific Committee. Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/37-conservation-advice-01102015.pdf

[DoE] Department of the Environment, 2015e.Conservation Advice Rhincodon typus (whale shark). Threatened Scientific Committee. Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/66680-conservation-advice-01102015.pdf.

[DoE] Department of the Environment, 2015f. Sawfish and River Sharks Multispecies Recovery Plan. Canberra, ACT: Commonwealth of Australia. Available at: http://www.environment.gov.au/biodiversity/threatened/publications/recovery/sawfish-river-sharks-multispecies-recovery-plan.

[DoE] Department of the Environment, 2015g. Conservation Advice: Numenius madagascariensis eastern curlew. Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/847-conservation-advice.pdf.

[DoE] Department of the Environment, 2015h. Conservation Advice Calidris ferruginea curlew sandpiper. Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/856-conservation-advice.pdf.

[DoE] Department of the Environment, 2015i. Conservation Advice: for Anous tenuirostris melanops (Australian lesser noddy). Threatened Scientific Committee. Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/38-conservation-advice-10102015.pdf.

[DoE] Department of the Environment, 2015j. Conservation Advice: for Erythrotriorchis radiates (red goshawk). Threatened Scientific Committee. Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/942-conservation-advice-31102015.pdf.

[DoE] Department of the Environment, 2015k. Wildlife Conservation Plan for Migratory Shorebirds. Available at: http://www.environment.gov.au/system/files/resources/9995c620-45c9-4574-af8e-a7cfb9571deb/files/widlife-conservation-plan-migratory-shorebirds.pdf.

[DoE] Department of the Environment, 2016a. Conservation Advice Limosa lapponica baueri (bar-tailed godwit northern Siberian). Threatened Species Scientific Committee. Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/86380-conservation-advice-05052016.pdf.

[DoE] Department of the Environment, 2016b. Conservation Advice Limosa lapponica menzbierri (bar-tailed godwit western Alaskan). Threatened Species Scientific Committee. Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/86432-conservation-advice-05052016.pdf.

[DoE] Department of the Environment, 2016c. Conservation Advice Calidris canutus Red knot. Threatened Species Scientific Committee. Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/855-conservation-advice-05052016.pdf.

[DoE] Department of the Environment, 2016d. Conservation Advice Calidris tenuirostris (Great Knot). Threatened Species Scientific Committee. Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/855-conservation-advice-05052016.pdf.

[DoE] Department of the Environment, 2016e. Conservation Advice Charadrius mongolus (lesser sand plover) Threatened Species Scientific Committee. Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/879-conservation-advice-05052016.pdf.

[DoE] Department of the Environment, 2016f. Conservation Advice Charadrius leschenaultia (greater sand plover) Threatened Species Scientific Committee. Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/877-conservation-advice-05052016.pdf.

[DoEE] Department of the Environment and Energy 2019a. SPRAT Profile http://www.environment.gov.au/cgi-bin/sprat/public/sprat.

[DoEE] Department of the Environment and Energy, 2016. National strategy for mitigating vessel strike of marine fauna. Commonwealth of Australia 2016.

[DoEE] Department of the Environment and Energy, 2017. Recovery Plan for Marine Turtles in Australia. Available at: http://www.environment.gov.au/system/files/resources/46eedcfc-204b-43de-99c5-4d6f6e72704f/files/recovery-plan-marine-turtles-2017.pdf.

[DoEE] Department of the Environment and Energy, 2019b. Pinnacles of the Bonaparte Basin. Species Profile and Threats Database. Available at: https://environment.gov.au/sprat-public/action/kef/view/62.

[DoEE] 2019c. Australian Heritage Database, Dampier Archipelago (including Burrup Peninsula), Karratha Dampier Rd, Dampier, WA, Australia. Available at http://www.environment.gov.au/cgi-bin/ahdb/search.pl?mode=place_detail;place_id=105727 [Accessed November 2019]

[DoEE] Department of the Environment and Energy, n.d. Marine Bioregional Plans. Commonwealth of Australia. Canberra. Available at: https://www.environment.gov.au/marine/marine-bioregional-plans.

[DoEE] Department of the Environment and Energy. n.d.g. Australian National Heritage List. Available at: https://www.environment.gov.au/heritage/places/national-heritage-list.

[DoF] Department of Fisheries (WA), 2013. Guidance Statement for Oil and Gas Industry Consultation with the Department of Fisheries. Fisheries Occasional Publication No. 113, 2013.

[DoF] Department of Fisheries, 2015a. Assessment of the status of red emperor (Lutjanus sebae) and goldband snapper (Pristipomoides multidens) in the Northern Demersal Scalefish Fishery. Government of Western Australia. September 2015.

[DoF] Department of Fisheries, 2015b. Harvest Strategy Policy and Operational Guidelines for the Aquatic Resources of Western Australia. Fisheries Management Paper No. 271. Government of Western Australia, June 2015.

[DNP] Director of National Parks, 2018a. North-west Marine Parks Network Management Plan 2018. Commonwealth of Australia, 2018.

[DNP] Director of National Parks, 2018b. North Marine Parks Network Management Plan 2018. Commonwealth of Australia, 2018.

DPIRD. 2018. Fisheries Management Paper No. 292: Marine Aquarium Fish Resource of Western Australia Harvest Strategy 2018-2022, Version 1.0. Department of Primary Industries and Regional Development. Accessed from: https://www.fish.wa.gov.au/Documents/management_papers/fmp292.pdf

[DNP] Director of National Parks, 2016. Kakadu National Park Management Plan 2016-2026. Available from: https://www.environment.gov.au/system/files/resources/1f88c5a3-409c-4ed9-9129-ea0aaddd4f33/files/kakadu-management-plan-2016-2026.pdf [Accessed April 2023]

[DPaW] Department of Parks and Wildlife (2013), Lalang-garram / Camden Sound Marine Park management plan 73 2013–2023, Department of Parks and Wildlife, Perth. Available at https://maps.northwestatlas.org/files/montara/links_to_plans/WA/6.%20Dambi%20&%20WG%20Lalang-garram_Camden_Sound_Marine_Park_MP_2013-2023_WEB.pdf. Accessed June 2023.

[DPAW] Department of Parks and Wildlife, 2014. WA Oiled Wildlife Response Plan Available at: https://www.dpaw.wa.gov.au/images/documents/conservation-management/marine/wildlife/West_Australian_Oiled_Wildlife_Response_Plan_V1.1.pdf.

[DPaW] Department of Parks and Wildlife, 2016a. Proposed North Kimberley Marine Park indicative joint management plan 2016. Department of Parks and Wildlife, Perth.

[DPaW] Department of Parks and Wildlife, 2016b. North Kimberley Marine Park joint management plan 2916 Uunguu, Balanggarra, Miriuwug and Wilinggin management areas. Plan No. 89, Department of Parks and Wildlife, Perth.

[DPaW] 2016c. Parks and reserves of the south-west Kimberley and north-west Pilbara Draft Management Plan (2016). Available at: https://www.dpaw.wa.gov.au/images/documents/parks/management-plans/20160400_swest_kimberley_draft_mp_v7.pdf

[DPIF] Fishery Status Reports 2012. Fishery Report No. 111. Northern Territory Government, Department of Primary Industry and Fisheries. Accessed 2023: https://dpir.nt.gov.au/__data/assets/pdf_file/0004/233527/fr111.pdf

[DPIR] Department of Primary Industry and Resources, 2016. NT Fisheries. Status of Key Northern Territory Fish Stocks Report 2016. Fishery Report No. 119. Available at: https://dpir.nt.gov.au/__data/assets/pdf_file/0007/546640/FR119.pdf.

[DPIR] Department of Primary Industry and Resources, 2018. NT Fisheries. Management Arrangements for the Northern Territory Offshore Net and Line Fishery. Available at: Available at: https://industry.nt.gov.au/industries/fisheries/management-arrangements-onlf

[DPIR] Department of Primary Industry and Resources, 2019a. NT Fisheries. Demersal Fishery and Licences. Available at: https://nt.gov.au/marine/commercial-fishing/fishery-licenses/demersal-fishery-and-licences.

[DPIR] Department of Primary Industry and Resources, 2019b. NT Fisheries. Spanish Mackerel Fishery and Licences. Available at: https://nt.gov.au/marine/commercial-fishing/fishery-licenses/spanish-mackerel-fishery-and-licences.

[DPIR] Department of Primary Industry and Resources, 2019c. NT Fisheries. Offshore Net and Line Fishery. Available at: https://nt.gov.au/marine/commercial-fishing/fishery-licenses/offshore-net-and-line-fishery.

[DPIR] Department of Primary Industry and Resources, 2019d. NT Fisheries. Pearl Oyster Fishery. Available at: https://nt.gov.au/marine/commercial-fishing/fishery-licenses/pearl-oyster-industry.

[DPIR] Department of Primary Industry and Resources, 2019e. NT Fisheries. Aquarium Fishery and Licences. Available at: https://nt.gov.au/marine/commercial-fishing/fishery-licenses/aquarium-fishery-and-licences.

[DPIR] Department of Primary Industry and Resources, 2019f. Status of key Northern Territory fish stocks report 2017. Fishery report no. 121. Available at: https://dpir.nt.gov.au/__data/assets/pdf_file/0005/744278/FR121.pdf. Accessed on 15 April 2020.

[DPIR] Department of Primary Industries and Regional Development, 2019g. Application for reassessment under the EPBC Act of the Northern Territory Timor Reef Fishery. Accessed from: https://www.dcceew.gov.au/sites/default/files/env/consultations/85663e49-8017-4f8e-abfe-ea78f742b339/files/nt-timor-reef-fishery-application-2019.pdf

[DPIRD] Department of Primary Industries and Regional Development, 2019. Finfish Spawning Table for some Key Species – Updated 5 June 2019. Perth, Western Australia

[DPIRD] Department of Primary Industries and Regional Development, 2017. North coast demersal scalefish resource harvest strategy 2017-2021, Version 1.0. Fisheries Management Paper No. 285. Perth, Western Australia.

[DPIRD] Department of Primary Industries and Regional Development. 2017. Aquatic Biosecurity Policy. Available at https://www.fish.wa.gov.au/Documents/biosecurity/aquatic_biosecurity_policy.pdf.

[DPIRD] Department of Primary Industries and regional Development, 2018. Commercial Fishing Guide. Available at https://www.fish.wa.gov.au/Fishing-and-Aquaculture/Commercial-Fishing/Pages/Commercial-Fishing-Guide.aspx. Accessed 10 October 2019.

[DSEWPaC] Department of Sustainability, Environment, Water, Population and Communities, 2010. Approved Conservation Advice for Aipysurus foliosquama (Leaf-scaled seasnake). Commonwealth of Australia, Canberra. Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/1118-conservation-advice.pdf.

[DSEWPaC] Department of Sustainability, Environment, Water, Population and Communities, 2012a. Marine bioregional plan for the North-west Marine Region. Department of Sustainability Environment, Water, Population and Communities. Commonwealth of Australia. Canberra.

[DSEWPaC] Department of Sustainability, Environment, Water, Population and Communities 2012b. Marine Bioregional Plan for the North Marine Region. Department of Sustainability Environment, Water, Population and Communities. Commonwealth of Australia. Canberra.

[DSEWPaC] Department of Sustainability, Environment, Water, Population and Communities 2012c Species group report card – Marine Reptiles. Supporting the marine bioregional plan for the North Marine Region

[DSEWPaC] Department of Sustainability, Environment, Water, Population and Communities 2012d. Species group report card – cetaceans. Supporting the marine bioregional plan for the North Marine Region

[DSEWPaC] Department of Sustainability, Environment, Water, Population and Communities, 2012e Species group report card – seabirds. Commonwealth of Australia, 2012.

[DSEWPaC] Department of Sustainability, Environment, Water, Population and Communities, 2012f. Species group report card – seabirds and migratory shorebirds. Commonwealth of Australia, 2012.

[ERM] Environmental Resources Management, 2011. GDF SUEZ – Marine Baseline Survey and Ecological Assessment. Report prepared for GDF SUEZ LNG, Perth, Western Australia.

[ERM] Environmental Resources Management, 2012. Marine Environmental Baseline Study: Field Survey Report. 0119757, Rev 1, July 2012, Final. Report prepared for PTTEP AA.

[ERM] Environmental Resources Management, 2017. Bethany 3D Survey Environment Plan – Seismic Airguns and Fish Mortality Literature Review. Final Report to Santos, Reference No. 0436696. 1 December 2017. 39 pp.

[FRDC] Fisheries Research and Development Corporation, 2021. Status of Australian Fish Stocks Reports.

[FRDC] Fisheries Research and Development Corporation, 2018. Seafood Assessment Report, Northern Territory Demersal Fishery. Available at: http://whichfish.com.au/wp-content/uploads/sites/4/2018/02/FRDC-SRA-NT-DF-Feb-2018.pdf.

[FRDC] Fisheries Research and Development Corporation. 2021a, Grey Mackerel Scomberomorus semifasciatus. Available at: https://fish.gov.au/report/397-Grey-Mackerel-2020.

[HESS] High Energy Seismic Survey, 1999. High energy seismic survey review process and interim operational guidelines for marine surveys offshore Southern California. Prepared for The California State Lands Commission and The United States Minerals Management Service Pacific Outer Continental Shelf Region. Camarillo, California: High Energy Seismic Survey Team.

[ITOPF] International Tanker Owners Pollution Federation, 2011. Effects of Oil Pollution on the Marine Environment. Technical Information Paper. Technical paper No. 13. The International Tank Owners Pollution Federation Limited.

[INPEX] G-7-AP Bessel Based Geophysical and Geotechnical Survey Environment Plan, March 2025. T075-AH-PLN-70000, Rev 0. Available at: https://info.nopsema.gov.au/environment_plans/609/show_public

[MPRA] Marine Parks and Reserves Authority, 2005. Management Plan for the Ningaloo Marine Park and Muiron Islands Marine Management Area 2005–2015. Marine Parks and Reserves Authority, Perth, Western Australia.

[NLPG

[NMFS] National Marine Fisheries Service, 2001 – Fisheries Statistics and Economics Division, Silver Spring, MD.

[NMFS] National Marine Fisheries Service, 2014. Marine Mammals: Interim Sound Threshold Guidance (webpage). National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

[NMFS] National Marine Fisheries Service, 2016. Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-55. 189 pp.

[NMFS] National Marine Fisheries Service, 2018. 2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-59. 167 pp.

[NMFS] National Marine Fisheries Service, 2019. Endangered Species Conservation Section 7 Consultation Tools for Marine Mammals on the West Coast: Marine Mammal Acoustic Thresholds. Available online: https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/esa-section-7-consultation-tools-marine-mammals-west Accessed 31 July 2020.

[NMFS] National Marine Fisheries Service, 2024. 2024 Update to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 3.0): Underwater and In-Air Criteria for Onset of Auditory Injury and Temporary Threshold Shifts. U.S. Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-71. 193 pp.

[NMSC] The Australian National Marine Safety Committee, 2010. Marine Incidents during 2009. Preliminary Data Analysis. A WWW database accessed during July 2012 at http://www.nmsc.gov.au

[NNTT] National Native Title Tribunal, 2019, Representative Aboriginal/Torres Strait Island Body Areas. Available at: http://www.nntt.gov.au/Maps/RATSIB_map.pdf.

[NOAA] National Oceanic and Atmospheric Administration (US), 2019. ESA Section 7 Consultation Tools for Marine Mammals on the West Coast (webpage), 27 Sep 2019. https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/esa-section-7-consultation-tools-marine-mammals-west. Accessed 10 March 2020.

[NOAA] National Oceanic and Atmospheric Administration (US), 2024. ESA Section 7 Consultation Tools for Marine Mammals on the West Coast (webpage), 30 Jan 2024. https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/esa-section-7-consultation-tools-marine-mammals-west. Accessed 24 June 2025.

[NOAA] National Oceanic and Atmospheric Administration, 2010. Oil and Sea Turtles: Biology Planning and Response, US Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, Office of Response and Restoration, pp. 116.

[NOAA] National Oceanic and Atmospheric Administration Fisheries. No Date [n.d.] Sei Whale. Available at: https://www.fisheries.noaa.gov/species/sei-whale#overview

[NOO] National Oceans Office, 2002. Sea Country – an Indigenous perspective; The South-east Regional Marine Plan Assessment Reports. Hobart.

[NOPSEMA] The National Offshore Petroleum Safety and Environmental Management Authority, 2019. Bulletin #1 Oil Spill Modelling, April 2019. Available at https://www.nopsema.gov.au/assets/Bulletins/A652993.pdf

[NSF] National Science Foundation (U.S.), U.S. Geological Survey, and [NOAA] National Oceanic and Atmospheric Administration (U.S.), 2011. Final Programmatic Environmental Impact Statement/Overseas. Environmental Impact

Statement for Marine Seismic Research Funded by the National Science Foundation or Conducted by the U.S. Geological Survey. National Science Foundation, Arlington, VA.

[NTG] Northern Territory Government, 2014. Fishery Status Reports 2012. Northern Territory Government Department of Primary Industry and Fisheries. Fishery Report No. 113.

[NTSC] Northern Territory Seafood Council, 2017. Aquarium fishery. Available at https://www.ntsc.com.au/content/about-our-fisheries/aquarium.

[TSSC] Threatened Species Scientific Committee. 2009. Commonwealth Listing Advice on Dermochelys coriacea. Threatened Species Scientific Committee. http://www.environment.gov.au/biodiversity/threatened/species/pubs/1768-listing-advice.pdf

[VAHC] Victorian Aboriginal Heritage Council, 2020. Taking care of culture; State of Victoria's Aboriginal Cultural Heritage Report, Discussion paper. East Melbourne.

[WA EPA] Environmental Protection Authority, 2010. Environmental Assessments Guidelines for protecting marine turtles from light impacts. Western Australia.

[WAFIC] Western Australian Fishing Industry Council. 2019. Beche-De-Mer Fishery. North coast bioregion. Available at: https://www.wafic.org.au/fishery/beche-de-mer-fishery/.

Accomando, A.W., Finneran, J.J., Henderson, E., Jenkins, K., Kotecki, S., Martin, C., Mulsow, J. and Zapetis, M. 2025. Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase 4). Revision 2025.1. Report by NIWC Pacific and National Marine Mammal Foundation for the US Navy. https://www.nepa.navy.mil/Portals/20/Documents/Phase%204%20Acoustic%20and%20Explosive%20Criteria%20Final%20APR2025.1.pdf.

Abdul Wahab, M.A., Radford, B., Cappo, M., Colquhoun, J., Stowar, M., Depczynski, M., Miller, K. and Heyward, A., 2018. Biodiversity and spatial patterns of benthic habitat and associated demersal fish communities at two tropical submerged reef ecosystems. Coral Reefs. 37. 327-343. https://doi.org/10.1007/s00338-017-1655-9

Aerts, L., Blees, M., Blackwell, S., Greene, C., Kim, K., Hannay, D.E. and Austin, M., 2008. Marine mammal monitoring and mitigation during BP Liberty OBC seismic survey in Foggy Island Bay, Beaufort Sea, July-August 2008: 90-day report. Document Number LGL Report P1011-1. Report by LGL Alaska Research Associates Inc., LGL Ltd., Greeneridge Sciences Inc. and JASCO Applied Sciences for BP Exploration Alaska. 199 pp. http://www.nmfs.noaa.gov/pr/pdfs/permits/bp_liberty_monitoring.pdf.

Allen, G.R. and Talbot, J.H., 1985. Review of the snappers of the genus Lutjanus (Pisces Lutjanidae) from the Indo-Pacific with the description of a new species. Indo-Pac. Fish. (11):87.

Allen, G.R., 2000. Personal communication – referenced in the Species Profile and Threats Database for the Pristis pristis — Freshwater Sawfish.

Amoser, S. and Ladich, F., 2003. Diversity in noise-induced temporary hearing loss in otophysine fishes. Journal of the Acoustical Society of America 113: 2170–2179.

Anderson, T.J., Nichol, S., Radke, L., Heap, A.D., Battershill, C., Hughes, M., Siwabessy, P.J., Barrie, V., Alvarez de Glasby, B., Tran, M., Daniell, J., Shipboard Party, 2011. Seabed environments of the eastern Joseph Bonaparte Gulf, northern Australia: GA0325/Sol5117-post survey report, record 2011/08, Geoscience Australia, Canberra.

Andriguetto-Filho, J.M., Ostrensky, A., Pie, M.R., Silva, U.A., Boeger, W.A., 2005. Evaluating the impact of seismic prospecting on artisanal shrimp fisheries. Continental Shelf Research 25(14): 1720-1727.

AS/NZS ISO 31000 Risk Management – Guidelines. 2018.

Au, W.W.L. and Hastings, M.C. 2008. Principles of Marine Bioacoustics. Springer, New York, USA.

Austin, D. and Pollom, R., 2019. The IUCN Red List of Threatened Species 2019. http://www.iucnredlist.org/ viewed 5/04/2019.

Austin, M. and Bailey, L., 2013. Sound Source Verification: TGS Chukchi Sea Seismic Survey Program 2013. Document Number 00706, Version 1.0. Technical report by JASCO Applied Sciences for TGS-NOPEC Geophysical Company.

Austin, M. and Li, Z., 2016. Marine Mammal Monitoring and Mitigation During Exploratory Drilling by Shell in the Alaskan Chukchi Sea, July–October 2015: Draft 90-day report. In: Ireland, D.S. and L.N. Bisson (eds.). Underwater Sound Measurements. LGL Rep. P1363D. Report from LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Applied Sciences Ltd. For Shell Gulf of Mexico Inc., National Marine Fisheries Service, and U.S. Fish and Wildlife Service. 188 pp + appendices pp.

Austin, M. and Warner, G., 2012. Sound Source Acoustic Measurements for Apache's 2012 Cook Inlet Seismic Survey. Version 2.0. Technical report for Fairweather LLC and Apache Corporation by JASCO Applied Sciences Ltd.

Austin, M., 2014. Underwater noise emissions from drillships in the Arctic. Underwater Acoustics 2014. Rhodes, Greece.

Austin, M., McCrodan, A., O'Neill, C., Li, Z. and MacGillivray, A.O., 2013. Marine mammal monitoring and mitigation during exploratory drilling by Shell in the Alaskan Chukchi and Beaufort Seas, July–November 2012: 90-Day Report. In: Funk, D.W., C.M. Reiser, and W.R. Koski (eds.). Underwater Sound Measurements. LGL Rep. P1272D–1. Report from LGL Alaska Research Associates Inc. and JASCO Applied Sciences, for Shell Offshore Inc., National Marine Fisheries Service (US), and U.S. Fish and Wildlife Service. 266 pp plus appendices.

Austin, M.A., Yurk, H. and Mills, R., 2015. Acoustic Measurements and Animal Exclusion Zone Distance Verification for Furie's 2015 Kitchen Light Pile Driving Operations in Cook Inlet. Version 2.0. Technical report for Jacobs LLC and Furie Alaska by JASCO Applied Sciences.

Australian Government, 2009. National Biofouling Guidance for the Petroleum Industry. Marine Pests, Commonwealth of Australia.

Australian Museum, 2014. Manta Ray, Manta birostris (Walbaum, 1792) http://australianmuseum.net.au/Manta-Ray-Manta-birostris

Baker, C., Potter, A., Tran, M. and Heap, A.D., 2008. Geomorphology and sedimentology of the North-west Marine Region of Australia., record 2008/07, Geoscience Australia, Canberra.

Bartol SM and Ketten DR. 2006. Turtle and tuna hearing. In: Swimmer, Y. and R. Brill. Volume December 2006. NOAA Technical Memorandum NMFS-PIFSC-7. 98-103 pp.

Beaman, R.J. 2018. High-resolution depth model for Northern Australia – 30 m. Geoscience Australia, Canberra. http://pid.geoscience.gov.au/dataset/ga/121620.

Beckley, L.E. (Ed), 2015. Final Report of Project 2.1.1 of the Kimberley Marine Research Program Node of the Western Australian Marine Science Institution, WAMSI, Perth, Western Australia. 121pp.

Begg, G.A., Chen, C.C.-M., O'Neill, M.F. and Rose, D.B., 2006. Stock assessment of the Torres Strait Spanish mackerel fishery. CRC Reef Research Centre Technical Report No. 66. CRC Reef Research Centre, Townsville, Queensland.

Benjamin, J., O'Leary, M., McDonald, J., Wiseman, C., McCarthy, J., Beckett, E., Morrison, P., Stankiewicz, F., Leach, J., Hacker, J., Baggaley, P., Jerbić, K., Fowler, M., Fairweather, J., Jeffries, P., Ulm, S., Bailey, G. 2020. Aboriginal artefacts on the continental shelf reveal ancient drowned cultural landscapes in northwest Australia. PLoS ONE 15(7).

Berry, O., England, P., Marriott, R.J., Burridge, C.P. and Newman S.J., 2012. Understanding age-specific dispersal in fishes through hydrodynamic modelling, genetic simulations and microsatellite DNA analysis. Molecular Ecology, 21, 2145–2159, doi:10.1111/j.1365-294X.2012.05520.x.

Bertrand, A. and Josse, E., 2000. Tuna target-strength related to fish length and swimbladder volume. ICES Journal of Marine Science 57: 1143-1146.

Best, P.B., Butterworth, D.S. and Rickett, L.H., 1984. An Assessment Cruise for the South African Inshore Atock of Bryde's Whales (Balaenoptera edeni). Report of the International Whaling Commission. vol. 34, pp. 403-423.

BirdLife International, 2019a. Species factsheet: Calonectris leucomelas. Downloaded from http://www.birdlife.org on 02/04/2019.

BirdLife International, 2019b. Species factsheet: Fregata ariel. Downloaded from http://www.birdlife.org on 02/04/2019.

BirdLife International, 2023. Important Bird Area factsheet: Low Rocks and Sterna Island (Kimberley). http://datazone.birdlife.org/site/factsheet/low-rocks-and-sterna-island-(kimberley)-iba-australia. Accessed on 8 September 2023.

Blaber, S.J.M., Dichmont, C.M., Buckworth, R.C., Badrudin, Sumiono, B., Nurhakim, S., Iskandar, B., Fegan, B., Ramm, D.C., Salini, J.P., 2005. Shared stocks of snappers (Lutjanidae) in Australia and Indonesia: integrating biology, population dynamics and socio-economics to examine management scenarios. Reviews in Fish Biology and Fisheries, 15: 111-27.

BMT WBM (2011) Ecological Character Description for Cobourg Peninsula Ramsar Site. Prepared for the Australian Government, Canberra. https://www.environment.gov.au/system/files/resources/21746527-9ee4-44eb-a2a6-aa08463d985b/files/1-ecd_0.pdf [Accessed June 2023].

Bolle, L.J., de Jong, C.A.F, Bierman, S.M., van Beek, P.J.G., van Keeken, O.A., Wessels, P.W., van Damme, C.J.G., Winter, H.V., de Hann, D., Dekeling, R.P.A., 2012. Common Sole Larvae Survive High Levels of Pile-Driving Sound in Controlled Exposure Experiments. PLoS ONE 7(3): e33052. doi:10.1371/journal.pone.0033052.

Braun, C.B. and Grande, T., 2008. Evolution of peripheral mechanisms for the enhancement of sound reception. In: Webb JF, Popper AN, Fay RR (eds.) Fish bioacoustics. Springer, New York, NY, pp 99-144.

Bray, D.J. and Thompson, V.J., 2019. Fishes of Australia. http://fishesofaustralia.net.au/home/species/ viewed 5/04/2019.

Brewer, D. Lyne, V. Skewes, T. and Rothlisberg, P. 2007. Trophic Systems of the Northwest Marine Region. Report to the Department of the Environment and Water Resources, CSIRO Marine and Atmospheric Research, Cleveland.

Browne, C.E., Erbe, C. and McCauley, R.D. 2024. Distribution and seasonality of the Omura's whale (*Balaenoptera omurai*) in Australia based on passive acoustic recordings. Animals 14: 2944. https://doi.org/10.3390/ani14202944

Bruce, B., Bradford, R., Foster, S., Lee, K., Lansdell, M., Cooper, S. and Przeslawski, R., 2018. Quantifying fish behaviour and commercial catch rates in relation to a marine seismic survey. Marine Environmental Research 140: 18-30.

Buckingham, M.J. 2005. Compressional and shear wave properties of marine sediments: Comparisons between theory and data. Journal of the Acoustical Society of America 117: 137-152. https://doi.org/10.1121/1.1810231.

Budelmann, B.U., 1992a. Hearing in Nonarthropod Invertebrates. (Chapter 10) In Webster, D.B., A.N. Popper, and R.R. Fay (eds.). The Evolutionary Biology of Hearing. Springer, New York. pp 141-155. https://doi.org/10.1007/978-1-4612-2784-7_10.

Budelmann, B.U., 1992b. Hearing in crustacea. In Webster, D.B., R.A. Fay, and A.N. Popper (eds.). The Evolutionary Biology of Hearing. Springer-Verlag, New York. pp 131-139.

Burbidge, A., Woinarski, J. and Harrison, P., 2014. The Action Plan for Australian Mammals 2012. CSIRO Publishing, Victoria.

Butler, I., Roelofs, A. and Kanga, M., 2021. Banana Prawns. Penaeus indicus & Penaeus meguiensis. Fisheries Research & Development Corporation. Available at: https://fish.gov.au/report/272-BANANA-PRAWNS-2020

Butler, I., Roelofs, A. and Kanga, M., 2020. Status of Australian Fish Stocks. Fisheries Research & Development Corporation. Available at: https://www.fish.gov.au/

Butler, I., Larcombe, J. and Curtotti, R., 2021. 2020. Northern Prawn Fishery. In: Fishery status reports 2020. Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. CC BY 4.0. pp. 65-86. Caiger, P.E., Montgomery, J.C. and Radford, C.A., 2012. Chronic low-intensity noise exposure affects the hearing thresholds of juvenile snapper. Marine Ecology Progress Series 466: 225‑232.

Butler, I. H. Patterson, D. Bromhead, D. Galeano, T. Timmiss, J. Woodhams, and R. Curtotti. 2023. Fishery Status Reports 2023, Australian Bureau of Agriculture and Resource Economics and Sciences, Canberra. CC BY 4.0. https://doi.org/10.25814/vgp4-xr81.

Cailliet, G.M., Cavanagh, R.D., Kulka, D.W., Stevens, J.D., Soldo, A., Clo, S., Macias, D., Baum, J., Kohin, S., Duarte, A., Holtzhausen, J.A., Acuña, E., Amorim, A., Domingo, A., 2009. Isurus oxyrinchus. The IUCN Red List of Threatened Species 2009.

Cameron, D. and Begg, G., 2002. Fisheries biology and interaction in the northern Australian small mackerel fishery. Final report to the Fisheries Research and Development Corporation, projects 92/144 and 92/144.02. Department of Primary Industries, Brisbane, Queensland.

Carroll, A.G., Przeslawski, R., Duncan, A., Gunning, M. and Bruce, B., 2017. A critical review of the potential impacts of marine seismic surveys on fish and invertebrates. Marine Pollution Bulletin 114: 9-24.

Casper, B.M., Halvorsen, M.B. and Popper, A.N., 2012. Are sharks even bothered by a noisy environment? Advances in Experimental Medicine and Biology 739: 93–97.

Castro, J.I., Woodley, C.M. and Brudek, R.L., 1999. A preliminary evaluation of the status of shark species. FAO Fisheries Technical Paper 380. FAO, Rome.

Celi, M., Filiciotto, F., Parrinello, D., Buscaino, G., Damiano, M.A., Cuttitta, A., D'Angelo, S., Mazzola, S., Vazzana, M., 2013. Physiological and agonistic behavioural response of Procambarus clarkii to an acoustic stimulus. Journal. Experimental Biology 216: 709–718.

Cerchio, S., Yamada, T.K. and Brownell, R.L. Jr., 2019. Global distribution of Omura's whales (Balaenoptera omurai) and assessment of range-wide threats. Frontiers in Marine Science 6: 67.

Chatto, R., 2001. The distribution and status of colonial breeding seabirds in the Northern Territory, technical report 70, Parks and Wildlife Commission of the Northern Territory, Palmerston.

Chatto, R., 2003. The Distribution and Status Of Shorebirds Around The Coast and Coastal Wetlands Of The Northern Territory – Parks and Wildlife Commission of the Northern Territory

Chatto, R. (2006). The distribution and status of waterbirds around the coast and coastal wetlands of the Northern Territory. Technical Report 76, Parks and Wildlife Commission of the Northern Territory, Palmerston. 254pp.

Chilvers, B. L. Delean, S. Gales, NJ. Holley, DK. Lawler, IR. Marsh, H. and Preen, A.R., 2004. Diving behaviour of dugongs, Dugong dugong. Journal of Experimental Marine Biology and Ecology 204: 203-224 Elsevier

Chorney, N.E., Warner, G.A., MacDonnell, J.T., McCrodan, A., Deveau, T.J., McPherson, C.M., O'Neil, C., Hannay, D.E., Rideout, B., 2011. Underwater Sound Measurements. In: Reiser, C.M., D.W. Funk, R. Rodrigues, and D.E. Hannay (eds.). Marine mammal monitoring and mitigation during marine geophysical surveys by Shell Offshore Inc. in the Alaskan Chukchi and Beaufort Seas, July-October 2010: 90-day report. LGL Report P1171E–1. Report from LGL Alaska Research Associates Inc. and JASCO Applied Sciences for Shell Offshore Inc., National Marine Fisheries Service (US), and US Fish and Wildlife Services. Available at: http://www.nmfs.noaa.gov/pr/pdfs/permits/shell_90day_report2010.pdf.

Christensen, Lewis. 2019. Spanish Mackerel, In: NT Government Status of Key Northern Territory Fish Stocks Report 2017. Northern Territory Government Department of Primary Industry and Resources. Fishery Report No. 121.

Christian J.R., Mathieu A., Thomson D.H., White D. and Buchanan R.A., 2003. Effect of seismic energy on snow crab (Chionoecetes opilio). Environmental Studies Research Funds Report 144, pp 1-92. Environmental Studies Research Funds.

Clark, C.W., Ellison, W.T., Southall, B.L., Hatch, L., Van Parijs, S.M., Frankel, A., Ponirakis, D., 2009. Acoustic masking in marine ecosystems: Intuitions, analysis, and implication. Marine Ecology Progress Series 395: 201-222. http://www.int-res.com/abstracts/meps/v395/p201-222/.

Clarke, R.H., 2010. The status of seabirds and shorebirds at Ashmore Reef, Cartier Island and Browse Island: monitoring program for the Montara well release – pre-impact assessment and first post-impact field survey. Prepared on behalf of PTTEP Australasia and the Department of the Environment, Water, Heritage and the Arts, Australia (now the Department of Sustainability, Environment, Water, Population and Communities).

Coate, K., Done, C. and Willing, T. (2004) Seabird Islands. No. 249: Sterna Island, Kimberley Region, Western Australia. Corella 28: 112-114.

Cohen, M.J., 1955. The function of receptors in the statocyst of the lobster Homarus americanus. Journal of Physiology 130(1): 9-34. https://doi.org/10.1113/jphysiol.1955.sp005389.

Cohen, M.J., Katsuki, Y. and Bullock, T.H., 1953. Oscillographic analysis of equilibrium receptors in Crustacea. Experientia 9(11): 434-435. https://doi.org/10.1007/BF02175537.

Colman, J.G., 1997. A review of the biology and ecology of the whale shark. Journal of Fish Biology. 51:1219-1234

Commonwealth of Australia, 2002. Ashmore Reef National Nature Reserve and Cartier Island Marine Reserve Management Plans. Environment Australia.

Commonwealth of Australia, 2009. National biofouling management guidelines for the petroleum production and exploration industry. Available at: https://www.marinepests.gov.au/sites/default/files/Documents/petroleum-exploration-biofouling-guidelines.pdf

Commonwealth of Australia, 2012. Sternula albifrons (Little Tern) Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=82849

Commonwealth of Australia, 2013. Recovery plan for the white shark (Carcharodon carcharias) Available at: http://www.environment.gov.au/biodiversity/threatened/recovery-plans/recovery-plan-white-shark-carcharodon-carcharias

Commonwealth of Australia, 2017. EPBC Act Policy Statement 3.21—Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species, Commonwealth of Australia 2017.

Commonwealth of Australia, 2019. National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds. Available at: https://www.environment.gov.au/biodiversity/publications/national-light-pollution-guidelines-wildlife

Compagno, L.J.V., 1984. FAO species catalogue. Vol. 4. Sharks of the world. An annotated and illustrated catalogue of shark species known to date. FAO Fisheries Synopsis No. 125, Volume 4, Part 1.

Corwin, J.T., 1981. Postembryonic production and aging in inner ear hair cells in sharks.4. 541-553. DOI: 10.1002/cne.902010406

Corwin, J.T., 1983. Postembryonic growth of the macula neglecta auditory detector in the ray Raja clavata: continual increases in hair cell number, neural convergence, and physiological sensitivity. J comp Neurol. 217:345-356.

Dale, J.J., Gray, M.D., Popper, A.N., Rogers, P.H. and Block, B.A., 2015. Hearing thresholds of swimming Pacific tuna Thunnus orientalis. Journal of Comparative Physiology A; DOI: 10.1007/s00359-015-0991-x.

Davis, T.L.O. and West, G.J., 1993. Maturation, reproduction seasonality, fecundity and spawning in Lutjanus vittus (Quoy and Gaimard) from the north West shelf of Australia. Fishery Bulletin, US. 91:244-236

Day, R.D., McCauley, R.D., Fitzgibbon, Q.P. and Semmens, J.M., 2016a. Seismic Air Gun Exposure during Early-Stage Embryonic Development Does Not Negatively Affect Spiny Lobster Jasus Edwardsii Larvae (Decapoda:Palinuridae)'. Scientific Reports 6 (7 March 2016): 22723. doi:10.1038/srep22723.

Day R.D., McCauley R.D., Fitzgibbon Q.P., Hartman K. and Semmens J.M., 2016b. Exposure to seismic air gun signals causes physiological harm and alters behavior in the scallop Pecten fumatus. Fisheries and Aquaculture Centre, Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, TAS 7001, Australia; and Centre for Marine Science and Technology, Curtin University, Perth, WA 6845, Australia.

Day, R.D., McCauley, R.D., Fitzgibbon, Q.P., Hartmann, K. and Semmens, J.M., 2017. Exposure to seismic air gun signals causes physiological harm and alters behavior in the scallop Pecten fumatus. Proceedings of the National Academy of Science of the United States of America, October 2017, 114 (40) E8537-E8546; DOI: 10.1073/pnas.1700564114.

Day, R.D., McCauley, R.D., Fitzgibbon, Q.P., Hartmann, K. and Semmens, J.M., 2019. Seismic air guns damage rock lobster mechanosensory organs and impair righting reflex. Proc. R. Soc. B. 286 2019142420191424.

Day, R.D., Fitzgibbon, Q.P., McCauley, R.D. and Semmens, J.M., 2021. Examining the potential impacts of seismic surveys on octopus and larval stages of southern rock lobster, Part A: southern rock lobster. FRDC project 2019-051. The Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania.

Dement'ev, G.P. and Gladkov, N.A. (eds.), 1951. Birds of the Soviet Union, Volume 3. Jerusalem: Israel Program for Scientific Translations.

Department of Fisheries, 2004. Final Application to the Australian Government Department of Environment and Heritage on the Pilbara Trap Managed Fishery

Department of Fisheries, 2017. Aquatic Biosecurity Policy. https://www.fish.wa.gov.au/Documents/biosecurity/aquatic_biosecurity_policy.pdf

Dichmont, C., Jarrett, A., Hill, F. and Brown, M., 2012. Harvest strategy for the Northern Prawn Fishery under input controls, Australian Fisheries Management Authority, Canberra

Director of National Park, 2018. North Marine Parks Network Management Plan 2018, Director of National Parks, Canberra.

Done TJ, Williams DMcB, Speare PJ, Davidson J, DeVantier LM, Newman SJ, Hutchins JB. 1994. Surveys of coral and fish communities at Scott Reef and Rowley Shoals. Australian Institute of Marine Science, Townsville

Donovan, A. Brewer, D. van der Velde, T and Skewes, T., 2008. Scientific descriptions of four selected key ecological features (key ecological features) in the North-west Bioregion: final report, report to the Australian Government Department of Environment, Water Heritage and the Arts, CSIRO Marine and Atmospheric Research, Cleveland.

Double, M.C. Andrews-Goff, V., Jenner, K.C.S., Jenner, M.N., Laverick, S.M., Branch, T.A., Gales, N.J., 2014. Migratory Movements of Pygmy Blue Whales (Balaenoptera musculus brevicauda) Between Australia and Indonesia as Revealed by Satellite Telemetry.

Dow Piniak, W.E., S.A. Eckert, C.A. Harms, and E.M. Stringer. 2012. Underwater hearing sensitivity of the leatherback sea turtle (Dermochelys coriacea): Assessing the potential effect of anthropogenic noise. US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2012-00156. 35 p.

Duncan, E.M., Botterell, Z.L.R., Broderick, A.C., Galloway, T.S., Lindeque, P.K., Nuno, A., Godley, B.J., 2017. A global review of marine turtle entanglement in anthropogenic debris: a baseline for further action. Endangered Species Research 34: 431-448.

Dubovskaya OP, Tang KW, Gladyshev MI, Kirillin G, Buseva Z, Kasprzak P, Tolomeev AP and Grossart HP. 2015. Estimating in situ zooplankton non-predation mortality in an oligomesotrophic lake from sediment trap data: caveats and reality check. PLoS ONE 10(7): e0131431.

Engås, A. and Løkkeborg, S., 2002. Effects of seismic shooting and vessel-generated noise on fish behaviour and catch rates. Bioacoustics 12: 313–316.

Engås, A., Løkkeborg, S., Ona, E. and Soldal, A.V., 1996. Effects of seismic shooting on local abundance and catch rates of cod (Gadus morhua) and haddock (Melanogrammus aeglefinus). Canadian Journal of Fisheries and Aquatic Sciences 53: 2238–2249.

Engineering-Environmental Management Inc., 2008. United States Coast Guard and Maritime Administration draft environmental impact statement for Port Dolphin LLC Deepwater Port licence application. Prepared by Engineering-Environmental Management, Inc, Kansas, USA for USCG Deepwater Ports Standards Division, Washington.

Eni Australia, 2021. Blacktip Offshore Environment Plan Summary. Available at: https://docs.nopsema.gov.au/A706151 Accessed 26/10/2021.

Enstipp, M.R., Ballorain, K., Ciccione, S., Narazaki, T., Sato, K. and Georges, J.Y. 2016, Energy expenditure of adult green turtles (Chelonia mydas) at their foraging grounds and during simulated oceanic migration. Funct Ecol, 30: 1810-1825. https://doi.org/10.1111/1365-2435.12667

Erbe, C., 2008. Critical ratios of beluga whales (Delphinapterus leucas) and masked signal duration. Journal of the Acoustical Society of America 124(4): 2216-2223.

Erbe, C., Dunlop, R., Jenner, K. C. S., Jenner, M. N., McCauley, R. D., Parnum, I., et al. (2017). Review of underwater and in-air sounds emitted by Australian and antarctic marine mammals. Acoust. Aust. 45, 179–241. doi: 10.1007/s40857-017-0101-z

Erbe, C. and Farmer, D.M., 1998. Masked hearing thresholds of a beluga whale (Delphinapterus leucas) in icebreaker noise. Deep-Sea Research Part II 45(7): 1373-1388.

Erbe, C., Reichmuth, C., Cunningham, K., Lucke, K. and Dooling, R., 2016. Communication masking in marine mammals: A review and research strategy. Marine Pollution Bulletin 103(1): 15-38.

Falkner I, Whiteway T, Przeslawski R, Heap AD. 2009. Review of ten key ecological features in the Northwest Marine Region. Record 2009/13, Geoscience Australia, Canberra

Farcas, A., Thompson, P.M., and Merchant, N.D., 2016.Underwater noise modelling for environmental impact assessment. Environmental Impact Assessment Review. 57. 114-122

Field, I.C., Charters, R., Buckworth, R.C., Meekan, M.G. and Bradshaw, C.J.A., 2008. Distribution and abundance of Glyphis and sawfishes in northern Australia and their potential interactions with commercial fisheries. Report to Australian Government, Department of the Environment, Water, Heritage and the Arts. Charles Darwin University: Darwin, Australia.

Fields, D. M., Handegard, N. O., Dalen, J., Eichner, C., Malde, K., Karlsen, Ø., Skiftesvik, A. B., Durif, C. M. F., and Browman, H. I., 2019. Airgun blasts used in marine seismic surveys have limited effects on mortality, and no sublethal effects on behaviour or gene expression, in the copepod Calanus finmarchicus. – ICES Journal of Marine Science, doi:10.1093/icesjms/fsz126.

Finneran, J., Henderson, E., Houser, D., Jenkins, K., Kotecki, S. and Mulsow, J., 2017. Criteria and thresholds for U.S. navy acoustic and explosive effects analysis (phase III). Department of Navy, San Diego, California, USA. 183 pp.

Finneran, J.J., 2015. Noise-induced hearing loss in marine mammals: A review of temporary threshold shift studies from 1996 to 2015. Journal of the Acoustical Society of America 138, 1702-1726. DOI: 10.1121/1.4927418.

Finneran, J.J., 2016. Auditory weighting functions and TTS/PTS exposure functions for marine mammals exposed to underwater noise. Technical Report. Space and Naval Warfare Systems Center Pacific, San Diego, USA.

Fishwell Consulting. 2020. FRDC Project 2019-072 Multiple – Before After Control Impact analysis of the effect of a 3D marine seismic survey on Danish Seine catch rates Summary Results: Phase I, II & I. October 2020.

Fletcher, W.J. and Santoro, K. (eds), 2014. Status Reports of the Fisheries and Aquatic Resources of Western Australia 2013/14.

Fletcher, W.J. and Santoro, K., 2015. Status Reports of the Fisheries and Aquatic Resources of Western Australia 2014/15: The State of the Fisheries. Department of Fisheries, Western Australia.

Fletcher, W.J., Mumme, M.D. and Webster, F.J. (eds), 2017. Status Reports of the Fisheries and Aquatic Resources of Western Australia 2015/16: The State of the Fisheries. Department of Fisheries, Western Australia.

Fossette, S., Ferriera, L.C., Whiting, S.D., King, J., Pendoley, K., Shimada, T., Speirs, M., Tucker, A.D., Wilson, P., Thums, M., 2021. Movements and distribution of hawksbill turtles in the Eastern Indian Ocean. Global Ecology and Conservation 29: e01713.

Froese, R. and Pauly, D. (eds.), 2019. FishBase. Available at: .http://www.fishbase.org/.

Fry, G., Milton, D.A., Van Der Velde, T., Stobutzki, I., Andamari, R., Badrudin and Sumiono, B., 2009. Reproductive dynamics and nursery habitat preferences of two commercially important Indo-Pacific red snappers Lutjanus erythropterus and L. malabaricus. Fisheries Science. 75. 145-158

Fukunaga A, Kosaki RK, Wagner D, Kane C (2016) Structure of mesophotic reef fish assemblages in the Northwestern Hawaiian Islands. PLOS ONE 11(7): e0157861.

Funk, D., Hannay, D.E., Ireland, D., Rodrigues, R. and Koski, W. (eds.), 2008. Marine mammal monitoring and mitigation during open water seismic exploration by Shell Offshore Inc. in the Chukchi and Beaufort Seas, July–November 2007: 90-day report. LGL Report P969-1. Prepared by LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Research Ltd. for Shell Offshore Inc., National Marine Fisheries Service (U.S.), and U.S. Fish and Wildlife Service. 218 pp.

Gagnon, M.M. and Rawson, C., 2011. Montara well release monitoring study S4A: Assessment of effects on Timor Sea fish. Report prepared by Curtin University for PTTEP Australasia, West Perth, Western Australia.

Galaiduk, R., Huang, Z., Miller, K., Nanson, R., Przeslawski, R., Nichol, S. (2018). An eco-narrative of Joseph Bonaparte Gulf Marine Park: North-west marine region. Report to the National Environmental Science Program, Marine Biodiversity Hub. 21 pp.

Garnett, S.T. and Crowley, G.M., 2000, The action plan for Australian birds 2000, Department of the Environment and Heritage, Canberra, ACT.

Gaughan, D.J. and Santoro, K. (eds), 2018. Status Reports of the Fisheries and Aquatic Resources of Western Australia 2016/17: The State of the Fisheries. Department of Primary Industries and Regional Development, Western Australia.

Gaughan, D.J. and Santoro, K. (eds), 2020. Status Reports of the Fisheries and Aquatic Resources of Western Australia 2018/19: The State of the Fisheries. Department of Primary Industries and Regional Development, Western Australia.

Gaughan, D.J. and Santoro, K. (eds), 2021. Status Reports of the Fisheries and Aquatic Resources of Western Australia 2019/20: The State of the Fisheries. Department of Primary Industries and Regional Development, Western Australia.

Gedamke, J., McCauley, R.D., 2010. Initial quantification of low-frequency masking potential of a seismic survey, SC/60/E12. Paper presented at the International Whaling.

Geoscience Australia, 2021. Ashmore and Cartier Islands. Australian Government, 2021. Available at: https://www.ga.gov.au/scientific-topics/national-location-information/dimensions/remote-offshore-territories/ashmore-and-cartier-islands.

Gibbons MJ and Hutchings L. 1996. Zooplankton diversity and community structure around southern Africa, with special attention to the Benguela upwelling system. South African Journal of Science 92(2): 63–77.

Gilmour, J., Smith, L., Cook, K. and Pincock, S., 2013. Discovering Scott Reef: 20 years of Exploration and Research, Australian Institute of Marine Science, Townsville.

Gomez, C., Lawson, J.W., Wright, A.J., Buren, A.D., Tollit, D. and Lesage, V., 2016. A systematic review on the behavioural responses of wild marine mammals to noise: the disparity between science and policy. Canadian Journal of Zoology 94: 801–819.

Götz, T., Hastie, G., Hatch, L.T., Raustein, O., Southall, B., Tasker, M. and Thomsen, F., 2009. Overview of the impacts of anthropogenic underwater sound in the marine environment. OSPAR Biodiversity Series, Vol 441

Grimes, C.B., 1987. Reproductive biology of the Lutjanidae: a review, p. 239-294. In J.J. Polovina and S. Ralston (eds.) Tropical snappers and groupers: biology and fisheries management. Westview press, Boulder, Colorado.

Grubert, M. A., Saunders, T. M., Martin, J. M., Lee, H. S. and Walters, C. J., 2013. Stock Assessments of Selected Northern Territory Fishes. Fishery Report No. 110. Northern Territory Government, Australia.

Guinea, M.L., 1995. Report to Australian Nature Conservation Agency: The Sea Turtles and Seasnakes of Ashmore Reef National Nature Reserve, Northern Territory University, Darwin, Australia.

Guinea, M, (2006). Sea turtles, sea snakes and dugongs of Scott Reef, Seringapatam Reef and Browse Island with notes on West Lacepede Island., Report submitted to the Australian Government Department of the Environment, Water, Heritage and the Arts, Canberra.

Guinea, M., 2013. Monitoring Program for the Montara Well Release Timor Sea Monitoring Study S6 Seasnakes / Turtles. Available at: http://www.environment.gov.au/system/files/pages/bcefac9b-ebc5-4013-9c88-a356280c202c/files/surveys-sea-snakes-turtles.pdf.

Hale, J (2008), Ecological Character Description of the Ord River Floodplain Ramsar Site, Report to the Department of Environment and Conservation, Perth, Western Australia. Available online: https://www.dpaw.wa.gov.au/images/documents/conservation-management/wetlands/ramsar/ord-floodplain-ecd_final-with-disclaimer.pdf [Accessed April 2023].

Hannay, D.E. and Racca, R.G., 2005. Acoustic Model Validation. Document Number 0000-S-90-04-T-7006-00-E, Revision 02. Technical report by JASCO Research Ltd. for Sakhalin Energy Investment Company Ltd. 34 pp.

Harasti, D., Lee, K.A., Gallen, C., Hughes, J.M. and Stewart, J., 2015. Movements, home range and site fidelity of snapper (Chrysophrys auratus) within a temperate marine protected area. PLoS ONE 10(11): e0142454.

Harris, P, Heap, A, Passlow, V, Sbaffi, L, Fellows, M, Porter-Smith, R, Buchanan, C & Daniell, J. 2005. Geomorphic Features of the Continental Margin of Australia., Report to the National Oceans Office on the production of a consistent, high-quality bathymetric data grid and definition and description of geomorphic units for part of Australia's marine jurisdiction. Geoscience Australia, Record 2003/30.

Hart, A., Travaille, K.L., Jones, R., Brand-Gardner, S., Webster, F., Irving, A. and Harry, A.V., 2016. Western Australian Marine Stewardship Council Report Series No. 5: Western Australian Silver-lipped Pearl Oyster (Pinctada maxima) Industry. Department of Fisheries, Western Australia. 316 pp.

Hart, A., Murphy, D. and Steele, A., 2021a. Pearl Oyster Managed Fishery Resource Status Report 2020. In: Status Reports of the Fisheries and Aquatic Resources of Western Australia 2019/20: The State of the Fisheries eds. D.J. Gaughan and K. Santoro. Department of Primary Industries and Regional Development, Western Australia. pp. 165-169.

Hart, A., Bruce, C. and Steele, A., 2021b. Statewide Specimen Shell Resource Status Report 2020. In: Status Reports of the Fisheries and Aquatic Resources of Western Australia 2019/20: The State of the Fisheries eds. D.J. Gaughan and K. Santoro. Department of Primary Industries and Regional Development, Western Australia. pp. 253-255.

Hastings, M.C. and Miksis-Olds, J., 2012. Shipboard assessment of hearing sensitivity of tropical fishes immediately after exposure to seismic air gun emissions at Scott Reef. Advances in Experimental Medicine and Biology 730: 239-243.

Hastings, M.C., 2008. Coming to terms with the effects of ocean noise on marine animals. Acoustics Today 4(2): 22-33.

Hatch, L.T., Clark, C.W., Van Parijs, S.M., Frankel, A.S. and Ponirakis, D.W., 2012. Quantifying loss of acoustic communication space for right whales in and around a U.S. National Marine Sanctuary. Conservation Biology 26(5): 983-994.

Hawkins, A.D. and Popper, A.N., 2016. A sound approach to assessing the impact of underwater noise on marine fishes and invertebrates. ICES Journal of Marine Science 74(3): 635-651.

Hazel, J., Gyuris, E., 2006. Vessel-related mortality of sea turtles in Queensland, Australia. Wildlife Research 33(2):149–154.

Hazel, J., Lawler, I.R. and Hamann, M., 2009. Diving at the shallow end: Green turtle behaviour in near-shore foraging habitat. Journal of Experimental Marine Biology and Ecology, vol. 371, pp. 84-92.

Hazel, J., Lawler, I.R., Marsh, H. and Robson, S., 2007. Vessel speed increases collision risk for the green turtle Chelonia mydas. Endangered Species Research, vol. 3 pp. 105-113.

Heap, A.D. 2009. Marine Sediments (MARS) Database (webpage). Commonwealth of Australia (Geoscience Australia), Creative Commons Attribution 4.0 International Licence. http://www.ga.gov.au/metadatagateway/metadata/record/gcat_69869.

Heatwole, H. and Cogger, H.G., 1993. 'Family Hydrophiidae', in Fauna of Australia Volume 2A: Amphibia and Reptilia, eds CG Glasby, GJB Ross and PL Beesley, AGPS Canberra, pp. 439.

Hedley, S.L., Bannister, J.L. and Dunlop, R.A., 2011. Abundance estimates of Breeding Stock 'D' humpback whales from aerial and land-based surveys off Shark Bay, Western Australia, 2008. J. Cetacean Res. Manage (special issue 3): 209–21

Heyward, A., Colquhoun, J., Cripps, E., McCorry, D., Stowar, M., Radford, B., Miller, K., Miller, I. and Battershill, C., 2018. No evidence of damage to the soft tissue or skeletal integrity of mesophotic corals exposed to a 3D marine seismic survey. Marine Pollution Bulletin 129: 8-13.

Heyward, A., Colquhoun, J., Cripps, E., McCorry, D., M., Radford, B., Miller, K., Miller, I., and Battershill, C., 2018. No evidence of damage to the soft tissue o skeletal integrity of mesophotic corals exposed to a 3D marine seismic survey. Mar Pollut Bull. 129(1):8-13.

Heyward, A., Jones, R., Meeuwig, J., Burns, K., Radford, B., Colquhoun, J., Cappo, M., Case, M., O'Leary, R., Fisher, R., Meekan, M. and Stowar, M., 2011. Montara: 2011 Offshore Banks Assessment Survey. Monitoring Study S5. Final Report prepared by the Australian Institute of Marine Science for PTTEP Australasia (Ashmore Cartier).

Higgins, P.J. and Davies, S.J.JF. (eds.), 1996. Handbook of Australian, New Zealand and Antarctic Birds. Volume Three – Snipe to Pigeons, Melbourne, Victoria, Oxford University Press.

Higgs, D. M., Lu, Z. and Mann, D. A. 2006. Hearing and mechanoreception. pp. 391-429 in Evans, D. H. and Claiborne, J. B. (eds.), The physiology of fishes. Taylor & Francis Group, Florida, USA.

Hildebrand, J.A., 2009. Anthropogenic and natural sources of ambient noise in the ocean. Marine Ecology Progress Series 395: 5-20.

Hodgson, P (1995). Directory of Important Wetlands in Australia – Information sheet (Shoal Bay – Micket Creek NT032). Compiled by Wetlands Unit, Australian Nature Conservation Agency. Minor additions by S. J. Moore of Moore Environmental Consulting and L. N. Lloyd of Lloyd Environmental Consultants in 1999. DEO-NT update 1999.. Available online: https://www.environment.gov.au/cgi-bin/wetlands/report.pl [Accessed April 2023].

Holliday DV, Pieper RE, Clarke ME and Greenlaw CF. 1987. The effects of airgun energy releases on the eggs, larvae and adults of the northern anchovy (Engraulis mordax). API Publication 4453.

Holliday D, Beckley LE, Weller E and Sutton Al. 2011. Natural variability of macro-zooplankton and larval fishes off the Kimberley, north-western Australia: Preliminary findings. Journal of the Royal Society of Western Australia., 94: 181–195.

Report by Tracor Applied Sciences for American Petroleum Institute, Washington D.C, USA.

Houde, E.D. and Zastrow, C.E., 1993. Ecosystem- and taxon-specific dynamic and energetics properties of larval fish assemblages. Bulletin of Marine Science 53 (2): 290-335.

Houser, D.S., Yost, W., Burkard, R., Finneran, J.J., Reichmuth, J.J. and Mulsow, J., 2017. A review of the history, development and application of auditory weighting functions in humans and marine mammals. The Journal of the Acoustical Society of America 141: 1371-1413.

Inligo Networks. 2023. Asia Connect Cable System (ACC-1). Accessed from: https://www.inligonetworks.com/asia-connect-cable-system/

INPEX (2023a). Bonaparte Basin 3D Marine Seismic Survey Environment Plan. Revision 5. Available at: https://docs.nopsema.gov.au/A1029772

INPEX (2023b). Bonaparte Basin Exploration Drilling Environment Plan. Revision 2. Available at: https://docs.nopsema.gov.au/A1034017

International Federation of the Red Cross, 1974. International Convention for the Safety of Life at Sea. https://www.ifrc.org/docs/idrl/I456EN.pdf

Ireland, D.S., Rodrigues, R., Funk, D., Koski, W. and Hannay, D.E., 2009. Marine mammal monitoring and mitigation during open water seismic exploration by Shell Offshore Inc. in the Chukchi and Beaufort Seas, July–October 2008: 90-Day Report. Document Number LGL Report P1049-1. 277 pp.

Islands. PLoS One 11:e015786

Jaensch, RP (1993).Directory of important wetlands in Australia. Compiled for the Wildlife Division, Conservation Commission of the Northern Territory, January-February 1993. Updated by P. Whitehead and R. Chatto November 1995. Database available online: https://www.environment.gov.au/cgi-bin/wetlands/report.pl [Accessed April 2023].

Jarrett, A., Dennis, D.M., Buckworth, R.C., Bustamante, R., Haywood, M.D.E., Fry, G.C., Tonks, M., Venables, W., Barwick, M., NPF Industry Inc. and CSIRO, 2015. Synthesis of Existing Information, Analysis and Prioritisation of Future Monitoring Activities to Confirm Sustainability of the Red-legged Banana Prawn Sub-fishery in the Joseph Bonaparte Gulf. FRDC Project: 2013/047. 68 pp.

Jenkins, G.P., Milward, N.E. and Hartwick, R.F., 1985. Occurrence of larvae of Spanish mackerels, genus Scomberomorus (Teleostei: Scombridae), in shelf waters of the Great Barrier Reef. Australian Journal of Marine and Freshwater Research 36, 635-640

Jenner, K.C.S., Jenner, M.N, and McCabe, K.A., 2001. Geographical and temporal movements of humpback whales in Western Australian waters. APPEA Journal, 2001: 749-765.

Jenner C, Jenner M, Pirzl R. 2008. A study of cetacean distribution and oceanography in the Scott Reef/Browse Basin development areas during the austral winter of 2008. Centre for Whale Research (WA), Perth

Jensen, F.H., Bejder, L., Wahlberg, M., Aguilar Soto, N., Johnson, M., Madsen, P.T., 2009. Vessel noise effects on delphinid communication. Mar Ecol Prog Ser 395:161-175.

Jiménez-Arranz, G., Glanfield, R., Banda, N. and Wyatt R, 2017. Review on Existing Data on Underwater Sounds Produced by the Oil and Gas Industry. Submitted to E&P Sound & Marine Life.

Johnstone, R.E. and Storr, G.M., 1998. Handbook of Western Australian Birds, Non-passerines (Emu to Dollarbird), Vol. 1, Perth, Western Australia: West Australian Museum.

Jones, D.S. and Morgan, G.J., 1994. A field guide to crustaceans of Western Australia. Western Australian Museum.

Kahng, S.E., Garcia-Sais, .JR., Spalding, H.L., Brokovich, E., Wagner, D., Weil, E., Hinderstein, L., Toonen, R.J., 2010. Community ecology of mesophotic coral reef ecosystems. Coral Reefs 29:255–275

Kahng, S.E., Copus, J.M., Wagner, D., 2014.Recent advances in the ecology of mesophotic coral ecosystems (MCEs). Current Opinion in Environment Sustainability. 7. 72-81.

Kathiresan, K. and Bingham, B.L., 2001. Biology of Mangroves and mangrove Ecosystems. Advances in Marine Biology. 40: 81-251.

Kato, H., 2002. Bryde's Whales Balaenoptera edeni and B. brydei. In: Perrin W.F., B. Wrsig and H.G.M. Thewissen, eds. Encyclopedia of Marine Mammals. Pp. 171-177. Academic Press.

Kearney, A, O'Leary, M, Platten, S. 2023. Sea Country: Plurality and knowledge of saltwater territories in Indigenous Australian contexts. The Geographical Journal, Vol 189 Issue 1.

Kennish, M.J., 1997. Practical handbook of Estuarine and Marine Pollution. Boca Raton, FL: CRC Press.

Kent, C.S., McCauley, R.D., Duncan, A., Erbe, C., Gavrilov, A., Lucke, K. and Parnum, I., 2016. Underwater sound and vibration from offshore petroleum activities and their potential effects on marine fauna: An Australian Perspective. Centre for Marine Science and Technology (CMST). Curtin University.

Kimberley Quest, 2024. Kimberley Cruises. Available at: https://kimberleyquest.com.au/kimberley-cruises/ Accessed 07/03/2024

Klimley, A.P. and Myrberg Jr, A.A., 1979. Acoustic stimuli underlying withdrawal from a sound source by adult lemon sharks, Negaprion brevirostris (Poey). Bulletin of Marine Science, 29: 447–458.

Koessler, M.W. and McPherson, C.R., 2021. Petrel Sub-Basin SW 3D Marine Seismic Survey: Acoustic Modelling for Assessing Marine Fauna Sound Exposures. Document 02115, Version 1.0. Technical report by JASCO Applied Sciences for Santos WA Energy Limited.

Kirillin G, Grossart H-P and Tang KW. 2012. Modeling sinking rate of zooplankton carcasses: Effects of stratification and mixing. Limnology and Oceanography 57(3): 881–894.

Kritzer, J.P., 2004. Sex-specific growth and mortality, spawning season, and female maturation of the stripey bass (Lutjanus carponotatus) on the Great Barrier Reef.

Ladich, F., Fay, R.R., 2013. Effects of Noise on Sound Detection and Acoustic Communication in Fishes. In: H Brumm (ed.), Animal Communication and Noise, Animal Signals and Communication 2, Springer-Verlag Berlin, Heidelberg. DOI: 10.1007/978-3-642-41494-7_4.

Laird, A., 2017. Northern Prawn Fishery Data Summary 2016. NPF Industry Pty Ltd, Australia. 66 pp.

Laird, A., 2018. Northern Prawn Fishery Data Summary 2017. NPF Industry Pty Ltd, Australia. Available at: https://www.afma.gov.au/sites/default/files/uploads/2018/04/NPFData-Summary-2017-FINAL.pdf.

Lane, B.A., 1987. Shorebirds in Australia. Sydney, NSW: Reed.

Langstreth, J., Williams, A., Stewart, J., Marton, N., Lewis, P. and Saunders, T., 2018. Spanish Mackerel (2018). Accessed online on 20 March 2019 at <https://www.fish.gov.au/report/253-Spanish-Mackerel-2018>.

Larcombe, J. and Bath, A., 2017. Chapter 5: Northern Prawn Fishery. Fishery status reports 2017. Commonwealth of Australia.

Larcombe, J., Marton, N. and Curtotti, R., 2018. Northern Prawn Fishery, in H Patterson, J Larcombe, S Nicol and R Curtotti (eds), Fishery status reports 2018, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra.

Last P, Lyne V, Yearsley G, Gledhill D, Gomon M, Rees T, White, W. 2005. Validation of national demersal fish datasets for the regionalisation of the Australian continental slope and outer shelf (>40 m depth). Australian Government Department of the Environment and Heritage & CSIRO Marine and Atmospheric Research, Hobart

Last, P.R. and Stevens, J.D., 2009. Sharks and Rays of Australia. Second Edition. CSIRO Publishing, Collingwood.

Leatherwood, S. and Reeves, R.R., 1983. The Sierra Club Handbook of Whales and Dolphins. Sierra Club Books, San Francisco. 302 pp.

Lenhardt, M.L., 1994. Seismic and very low frequency sound induced behaviors in captive loggerhead marine turtles (Caretta caretta). In Proceedings of the fourteenth annual symposium on sea turtle biology and conservation (K.A. Bjorndal, A.B. Bolten, D.A. Johnson & P.J. Eliazar, eds.) NOAA Technical Memorandum, NMFS-SEFC-351, National Technical Information Service, Springfield, Virginia, 238-241.

Lesser, M.P., Slattery, M., Leichter, J.J., 2009. Ecology of mesophotic coral reefs. Journal of Experimental Marine Biology and Ecology. 375:1-8

Lewis, P. and Bray, N., 2020. Statewide Large Pelagic Finfish Resource Status Report 2018. In: Status Reports of the Fisheries and Aquatic Resources of Western Australia 2018/19: The State of the Fisheries (eds). D.J. Gaughan and K. Santoro. Department of Primary Industries and Regional Development, Western Australia. pp. 244-249.

Lewis, P. and Jones, R., 2018. Statewide Large Pelagic Finfish Resource Status Report 2017 In: Status Reports of the Fisheries and Aquatic Resources of Western Australia 2016/17: The State of the Fisheries eds. D.J. Gaughan and K. Santoro. Department of Primary Industries and Regional Development, Western Australia.

Lewis, P., Blay, N. and Watt, M., 2021. Statewide Large Pelagic Finfish Resource Status Report 2020. In: Status Reports of the Fisheries and Aquatic Resources of Western Australia 2019/20: The State of the Fisheries (eds). D.J. Gaughan and K. Santoro. Department of Primary Industries and Regional Development, Western Australia. pp. 241-247.

LGL, 2012. Environmental Assessment of Marine Geophysical Surveys by the R/V Marcus G. Langseth in the Northeastern Pacific Ocean, June–July 2012. LGL Ltd., environmental research associates. 225 pp.

Liberman, M.C., 2015. Noise-induced hearing loss: permanent vs. temporary threshold shifts and the effects of hair-cell versus neuronal degeneration. pp. 1-7 in Popper, A.N. and Hawkins, A.D. (eds.) The effects of noise on aquatic life II. Springer, New York, USA.

Limpus, C.J., 2007. A biological review of Australian Marine Turtles: The flatback turtle Narator depressus (Garman). Queensland Environmental Protection Agency. 20:513-523

Limpus, C.J., 2008. A Biological Review of Australian Marine Turtle Species. 1. Loggerhead turtle, Caretta caretta (Linneaus), The State of Queensland, Environmental Protection Agency, Australia.

Limpus, C.J., 2009. A Biological Review of Australian Marine Turtle Species. The State of Queensland, Environmental Protection Agency, Australia.

Lindfield, S.J. Harvey, E.S., Halford, A.R. and McIlwain, J.L., 2016, Mesophotic depths as refuge areas for fishery-targeted species on coral reefs. Coral Reefs. 35:125-137.

Lindquist, D.C., Shaw, R.F., Hernandez Jr, F.J., 2005. Distribution patterns of larval and juvenile fishes at offshore petroleum platforms in the north-central Gulf of Mexico. Estuarine, Coastal and Shelf Science. 62(4):655-665.

Lombarte, A. and Popper, A.N., 1994. Quantitative analyses of postembryonic hair cell addition in the otolithic endorgans of the inner ear of the European hake, merluccius merluccius (gadiformes, teleostei). Journal of Comparative Eurology. 345(3):419-428.

Lombarte, A., Lleonart, J. 1993. Otolith size changes related with body growth, habitat depth and temperature. Environ Biol Fish 37, 297–306. doi:10.1007/BF00004637.

Loneragan, N., Die, D., Kenyon, R., Taylor, B., Vance, D., Manson, F., Pendrey, B. and Venables, B., 2002. The growth, mortality, movements and nursery habitats of red-legged banana prawns (Penaeus indicus) in the Joseph Bonaparte Gulf. CSIRO Marine Research. Project FRDC 97/105. 142 pp.

MacGillivray, A.O., 2018a. An Airgun Array Source Model Accounting for High-frequency Sound Emissions During Firing and Solutions to the IAMW Source Test Cases. IEEE Journal of Oceanic Engineering. https://ieeexplore.ieee.org/document/8423063/.

MacGillivray, A.O., 2018b. Underwater noise from pile driving of conductor casing at a deep-water oil platform. Journal of the Acoustical Society of America 143(1): 450-459. https://doi.org/10.1121/1.5021554.

Mackie M.C., Lewis P.D., Kennedy J., Saville K., Crowe F., Newman, S.J. and Smith, K.A., 2010. Western Australian Mackerel Fishery. Ecologically Sustainable Development Series No. 7. Western Australian Department of Fisheries, Perth, Western Australia.

Mackintosh, N.A., 1965. The stocks of whales. Fishing News (Books) Ltd, London.

Malme, C.I., Miles, P.R., Clark, C.W., Tyack, P. and Bird, J.E., 1984. Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior. Bolt Beranek and Newman Report No. 5366 submitted to the Minerals Management Service, U.S. Department of the Interior, Washington, DC. NTIS PB86-218377.

Manning, C. & Pollom, R. 2017. Festucalex cinctus. The IUCN Red List of Threatened Species 2017: e.T65367195A67624728. https://dx.doi.org/10.2305/IUCN.UK.2017-3.RLTS.T65367195A67624728.en. Accessed on 08 September 2023.

Marchant, S. and Higgins, P.J. (eds.), 1993. Handbook of Australian, New Zealand and Antarctic Birds. Volume 2 – Raptors to Lapwings. Melbourne, Victoria: Oxford University Press.

Marchant, S. and Higgins, P.J., 1990. Handbook of Australian, New Zealand and Antarctic birds, Vol. 1, Part A: Ratites to Petrelexs. Oxford University Press, Melbourne.

Marchesan, M., Spotto, M., Verginella, L. and Ferrero, E.A., 2006. Behavioural Effects of Artificial Light on Fish Species of Commercial Interest. Fisheries Research, vol. 73, pp. 171-185.

Marine order 94. Marine pollution prevention- packaged harmful substances. 2014.

Marine order 95. Marine pollution prevention – garbage. 2018.

Marine order 96. Marine pollution prevention- sewage. 2018.

Marine Pest Sectoral Committee, 2018. National biofouling management guidelines for the petroleum production and exploration industry. Available at: https://www.marinepests.gov.au/sites/default/files/Documents/petroleum-exploration-biofouling-guidelines.pdf

Marquenie, J. Donners, M. Poot, H. Steckel, W. de Wit, B. and Nam, A., 2008. Adapting the Spectral Composition of Artificial Lighting to Safeguard the Environment, Petroleum and Chemical Industry Conference Europe – Electrical and Instrumentation Applications, 5th PCIC Europe, pp. 1–6.

Marquez, R., 1990. FAO Species Catalogue; Sea Turtles of the World. An annotated and illustrated catalogue of the sea turtle species known to date. FAO Fisheries Synopsis. 125 (11): pp 81. Rome: Food and Agriculture Organisation of United Nations.

Marriot, R., Jackson, G., Lenaton, R., Telfer, C., Stephenson E., Bruce, C., Adams, D. and Noriss, J., 2012. Biology and Stock Status of Inshore Demersal Scalefish Indicator Species in the Gascoyne Coast Bioregion. Fisheries Research Report No. 228. Department of Fisheries.

Marriott R.J., Mapstone, B.D., Begg, G.A., 2007. Age-specific demographic parameters, and their implications for management of the red bass, Lutjanus bohar (Forsskal 1775): A large, long-lived reef fish. Fisheries Research. 83(2-3): 204-214.

Marriott, R.J., O'Neill, M.F., Newman, S.J., Skepper, C.L., 2014. Abundance indices for log-lived tropical snappers: estimating standardized catch rates from spatially and temporally coarse logbook data. ICEA Journal of Marine Science, 71(3):616-627.

Marshall, A., Bennett, M.B., Kodja, G., Hinojosa-Alvarez, S., Galvan-Magana, F., Harding, M., Stevens, G. and Kashiwagi, T., 2018a. Mobula birostris (amended version of 2011 assessment). The IUCN Red List of Threatened Species 2018:

e.T198921A126669349. http://dx.doi.org/10.2305/IUCN.UK.2018-1.RLTS.T198921A126669349.en. Downloaded on 21 June 2019.

Marshall, A., Kashiwagi, T., Bennett, M.B., Deakos, M., Stevens, G., McGregor, F., Clark, T., Ishihara, H. and Sato, K., 2018b. Mobula alfredi (amended version of 2011 assessment). The IUCN Red List of Threatened Species 2018: e.T195459A126665723. http://dx.doi.org/10.2305/IUCN.UK.2011-2.RLTS.T195459A126665723.en. Downloaded on 21 June 2019.

Martin, B., Broker, K., Matthews, M-N.R., MacDonnell, J. and Bailey, L., 2015. Comparison of measured and modeled air-gun array sound levels in Baffin Bay, West Greenland. Ocean Noise 2015, 11-15 May, Barcelona, Spain.

Martin, B., MacDonnell, J.T. and Bröker, K., 2017a. Cumulative sound exposure levels—Insights from seismic survey measurements. Journal of the Acoustical Society of America 141(5): 3603-3603.

Martin, J., Keag, M., Newman, S. and Wakefield, C., 2014. Goldband Snapper Pristipomoides multidens. Accessed online on 27 February 2019 at <https://www.fish.gov.au/2014-Reports/Goldband_Snapper>.

Martin, S.B. and Popper, A.N., 2016. Short- and long-term monitoring of underwater sound levels in the Hudson River (New York, USA). Journal of the Acoustical Society of America 139(4): 1886-1897. http://dx.doi.org/10.1121/1.4944876.

Martin, S.B., Matthews, M-N.R., MacDonnell, J.T. and Bröker, K., 2017b. Characteristics of seismic survey pulses and the ambient soundscape in Baffin Bay and Melville Bay, West Greenland. Journal of the Acoustical Society of America 142(6): 3331-3346. https://doi.org/10.1121/1.5014049.

Matishov, G.G., 1992. The reaction of bottom-fish larvae to airgun pulses in the context of the vulnerable Barent Sea ecosystem. Fisheries and Offshore Petroleum Exploitation, 2nd International Conference. Bergen, Norway, 6-8 April, 1992

Matthews, M-N.R. and MacGillivray, A.O., 2013. Comparing modeled and measured sound levels from a seismic survey in the Canadian Beaufort Sea. Proceedings of Meetings on Acoustics 19(1): 1-8. https://doi.org/10.1121/1.4800553.

Maxwell, A.J., Vincent, L.W, and Woods, E.P., 2004. The Audacious discovery, Timor Sea and the role of pre-stack depth migration seismic processing. In: Ellis GK, Baillie PW and Munsoon TJ (eds.), Timor Sea Petroleum Geoscience, Proceedings of the Timor Sea Symposium, Darwin, Northern Territory, 19–20 June 2003, Northern Territory Geological Survey, Special Publication 1, 53-65.

McCarthy, J., Wiseman, C., Woo, K., Steinberg, D., O'Leary, M., Wesley, D., Brady, L.M., Ulm, S. and Benjamin, J. 2022. Beneath the Top End: a regional assessment of submerged archaeological potential in the Northern Territory, Australia. Australian Archaeology, 88 (1) pp. 65-83.

McCauley, R.D., 1994. Seismic surveys. In: Environmental Implications of Offshore Oil and Gas Development in Australia—The Findings of an Independent Scientific Review, Swan, J.M. Neff, J.M. and Young, P.C. (eds.), Australian Petroleum Exploration Association, Sydney, pp. 19–122.

McCauley, R.D., 1998. Radiated underwater noise measured from the drilling rig Ocean General, rig tenders Pacific Ariki and Pacific Frontier, fishing vessel Reef Venture and natural sources in the Timor Sea, Northern Australia. CMST Report No. 98-20, CMST, Curtin University, Perth, Australia.

McCauley, R.D. 2002. Underwater noise generated by the Cossack Pioneer FPSO and its translation to the proposed Vincent petroleum field. CMST Report No. 2002-13, Curtin University, Perth Australia.

McCauley, R.D., 2009. Sea Noise Logger Deployment Scott Reef, 2006-2008 – Whales, Fish and Seismic Surveys. Report prepared for Woodside Energy, CMST R2009-15. 88.

McCauley, R.D., 2011. Woodside Kimberley Sea Noise Logger Program, Sept 2006 to June-2009: Whales, Fish and Man-made noise. Report produced for Woodside Energy Ltd, pp. 86.

McCauley, R.D., 2014. Joseph Bonaparte Gulf Sea Noise Logger Program, Sep-2010 to Sep-2013, Ambient Noise, Great Whales and Fish. Report prepared for RPS MetOcean, CMST R2013-52, 75.

McCauley, R.D. and Kent, C.S., 2012. A lack of correlation between air gun signal pressure waveforms and fish hearing damage. In: Popper, A.N. and A.D. Hawkins (eds.), The Effects of Noise on Aquatic Life. Advances in Experimental Medicine and Biology, Volume 730. Springer Science+Business Media, New York, pp 245-250.

McCauley, R.D., Day, R.D., Swadling, K.M., Fitzgibbon, Q.P., Watson, R.A. and Semmens, J.M., 2017. Widely used marine seismic survey air gun operations negatively impact zooplankton. Nature Ecology & Evolution 1: 1-8. http://dx.doi.org/10.1038/s41559-017-0195.

McCauley, R.D., Fewtrell, J., Duncan, A.J., Jenner, C., Jenner, M.-N., Penrose, J.D., Prince, R.I.T., Adhitya, A., Murdoch, J., McCabe, K., 2000a. Marine seismic surveys: Analysis and propagation of air-gun signals; and effects of air-gun exposure on humpback whales, sea turtles, fishes and squid. Report Number R99-15. Prepared for Australian Petroleum Production Exploration Association by Centre for Marine Science and Technology, Western Australia. 198 pp.

McCauley, R.D., Fewtrell, J., Duncan, A.J., Jenner, C., Jenner, M.-N., Penrose, J.D., Prince, R.I.T., Adhitya, A., Murdoch, J., McCable, K., 2000b. Marine seismic surveys: A study of environmental implications. Australian Petroleum Production Exploration Association (APPEA) Journal 40(1): 692-708.

McCauley, R.D., Fewtrell, J., Duncan, A.J., Jenner, C., Jenner, M-N., Penrose, J.D., Prince, R.I.T., Adhitya, A., Murdoch, J. and McCabe, K., 2003. Marine seismic surveys: analysis and propagation of air-gun signals; and effects of exposure on

humpback whales, sea turtles, fishes and squid. In: Anon eds.), Environmental implications of offshore oil and gas development in Australia: further research, Australian Petroleum Production Exploration Association, Canberra.

McCauley, R.D., Jenner, M-N., Jenner, C., McCabe, K.A. and Murdoch, J., 1998. The response of humpback whales (Megaptera novaeangliae) to offshore seismic survey noise: preliminary results of observations about a working vessel and experimental exposures. APPEA Journal. Vol. 38(1), pp. 692-707.

McCrodan, A., McPherson, C. and Hannay, D.E., 2011. Sound Source Characterization (SSC) Measurements for Apache's 2011 Cook Inlet 2D Technology Test. Version 3.0. Technical report for Fairweather LLC and Apache Corporation by JASCO Applied Sciences. 51 pp.

McPherson, C., Delarue, J. and Maxner, E. 2017. Investigating the presence of Omura's whale in Northwest Australian waters using passive acoustic data. The Society for Marine Mammalogy Conference, Halifax, Nova Scotia October, 2017.

McPherson, C.R. and S.B. Martin. 2018. Characterisation of Polarcus 2380 in3 Airgun Array. Document 001599, Version 1.0. Technical report by JASCO Applied Sciences for Polarcus Asia Pacific Pte Ltd.

McPherson, C., MacGillivray, A. and Hagar, E., 2018a. Validation of airgun array modelled source signatures. 176th Meeting Acoustical Society of America, 5–9 November 2018. Accepted Abstract, Victoria, BC, Canada.

McPherson, C., Kowarski, K., Delarue, J., Whitt, C., MacDonnell, J. and Martin, B., 2016a. Passive Acoustic Monitoring of Ambient Noise and Marine Mammals—Barossa Field. JASCO Document 00997, Version 1.0. Technical report by JASCO Applied Sciences for Jacobs.

Mcpherson, C., Martin, B., MacDonnel, J. and Whitt, C. 2016b. Examining the value of the acoustic variability index in the charactisation of Australian marine soundscapes. JASCO Applied Sciences.

McPherson, C.R. and Warner, G., 2012. Sound Sources Characterization for the 2012 Simpson Lagoon OBC Seismic Survey 90-Day Report. Document Number 00443, Version 2.0. Technical report by JASCO Applied Sciences for BP Exploration (Alaska) Inc. http://www.nmfs.noaa.gov/pr/pdfs/permits/bp_openwater_90dayreport_appendices.pdf.

McPherson, C.R., Lucke, K., Gaudet, B., Martin, B.S. and Whitt, C.J., 2018b. Pelican 3-D Seismic Survey Sound Source Characterisation. Report Number 001583. Version 1.0. Technical report by JASCO Applied Sciences for RPS Energy Services Pty Ltd.

McPherson, G.R., 1993. Reproductive biology of the narrow barred Spanish Mackerel (Scomberomorus commerson) in Queensland waters. Asian Fish. Sci. 6, 169–182.

Meekan, M.G., Wilson, S.G., Halford , A. and Retzel, A., 2001. A comparison of catches of fishes and invertebrates by two light trap designs, in tropical NW Australia. Marine Biology, 139: 373–381.

Meekan, M.G., Bradshaw, C.J.A., Press, M., McLean, C., Richards, A., Quasnichka, S. and Taylor, J.G., 2006. Population size and structure of whale sharks Rhincodon typus at Ningaloo Reef, Western Australia. Marine Ecology Progress Series. 319:275-85.

Meekan, M.G., Speed, C.W., McCauley, R.D., Fisher, R., Birt, M.J., Currey-Randall, L.M., Semmens, J.M., Newman, S.J., Cure, K., Stowar, M., Vaughan, B. and Parsons, M.J.G., 2021. A large-scale experiment finds no evidence that a seismic survey impacts a demersal fish fauna. Proceedings of the National Academy of Sciences of the United States of America (PNAS), July 27, 2021 118 (30) e2100869118; https://doi.org/10.1073/pnas.2100869118.

Milicich, M J., 1992. Light traps: a novel technique for monitoring larval supply and replenishment of coral reef fish populations. Ph.D. thesis, Griffith University, Brisbane.

Miller, I. and Cripps, E., 2013. Three dimensional marine seismic survey has no measurable effect on species richness or abundance of a coral reef associated fish community. Marine Pollution Bulletin 77(1-2): 63-70.

Miller, K., 2017. Seabed Biodiversity of the Kimberley., 2017 WAMSI Research Conference, 27–29 November 2017, State Library of Western Australia.

Milton, D.A., 2005. Birds of Ashmore Reef National Nature Reserve: an assessment of its importance for seabirds and waders. The Beagle: Records of the Museums and Art Galleries of the Northern Territory. 1:133-141.

Moein, S.E., Musick, J.A., Keinath, J.A., 1995. Evaluation of seismic sources for repelling sea turtles from hopper dredges. In: Hales LZ (ed) Sea turtle research program: summary report. Prepared for US Army Engineer Division, South Atlantic, Atlanta, GA, and US Naval Submarine Base, Kings Bay, GA. Technical Report CERC-95, 90, pp. 75–78.

Mollet, H.F., Cliff, G., Pratt Jr, H.L. and Stevens, J.D., 2000. Reproductive biology of the female shortfin mako, Isurus oxyrinchus Rafinesque, 1810, with comments on the embryonic development of lamnoids. Fishery Bulletin. 98:298-318.

Moran, M., Burton, C. and Jenke, J., 2004. Long-term movement patterns of continental shelf and inner gulf snapper (Pagrus auratus, Sparidae) from tagging in the Shark Bay region of Western Australia. Marine and Freshwater Research 54 (8): 913–922.

Morley, E.L., Jones, G. and Radford, A.N., 2014. The importance of invertebrates when considering the impacts of anthropogenic noise. Proceedings of the Royal Society of London B: Biological Sciences 281(1776). http://rspb.royalsocietypublishing.org/content/royprsb/281/1776/20132683.full.pdf.

Myrberg Jr, A.A., 2001. The acoustical biology of elasmobranchs. Environmental Biology of Fishes, 60: 31-45.

Narazaki, T., Sato, K., Abernathy, K.J., Marshall, G.J., Miyazaki, N. 2013. Loggerhead Turtles (Caretta caretta) Use Vision to Forage on Gelatinous Prey in Mid-Water. PLoS ONE 8(6): e66043. https://doi.org/10.1371/journal.pone.0066043

Navigation Act, 2012. Australian Government. Available at: https://www.legislation.gov.au/Details/C2019C00268

Nedwell, J.R., Edwards, B., Turnpenny, A.W.H., Gordon, J., 2004. Fish and marine mammal audiograms: A summary of available information. Subacoustech Report ref: 534R0214.

Neil, K.M., Hilliard, R.W., Clark, P., Russell, B., Clark, R. and Polglaze, J., 2005. Situation and Gaps Analysis of Introduced Marine Species, Vectors, Nodes and Management Arrangements for the Northern Planning Area, Report published by the National Oceans Office (Marine Division, Department of Environment and Heritage), Canberra

Nelms, S., Piniak, W.E.D., Weir, C.R., and Godley, B.J., 2016. Seismic surveys and marine turtles: an understanding global threat. Biological Conservation 193: 49-65.

NERP MBH National Environmental Research Program Marine Biodiversity Hub, 2014. Exploring the Oceanic Shoals Commonwealth Marine Reserve, NERP MBH, Hobart.

Newman, S.J., Steckis, R.A., Edmonds, J.S. and Lloyd, J., 2000. Stock structure of the goldband snapper Pristipomoides multidens (Pisces: Lutjanidae) from the waters of northern and western Australia by stable isotope ratio analysis of sagittal otolith carbonate. Marine Ecology Progress Series 198: 239-247.

Newman, S.J., Young, G. C., Travers, M. J., Pember, M. B., Skepper, C. L., Williamson, P. C., and Potter, I. C., 2003. Characterisation of the inshore fish assemblages of the Pilbara and Kimberley coasts. Final Report to the Fisheries Research and Development Corporation for Project 2000/132. Fisheries Research and Development Corporation, Canberra, ACT.

Newman S.J., Smith K.A., Skepper C.L. and Stephenson P.C., 2008. Northern Demersal Scalefish Managed Fishery. Department of Fisheries, Western Australia. ESD Report Series No. 6, June 2008.

Newman, S.J., Wakefield, C., Skepper, C., Boddington, D., Jones, R. and Smith, E., 2018. North Coast Demersal Resource Status Report 2017, in Gaughan, D.J. and Santoro, K. (Ed.) Status Reports of the Fisheries and Aquatic Resources of Western Australia 2016/2017: The State of Fisheries. Department of Primary Industries and Regional Development, Western Australia.

Newman, S., Wakefield, C., Skepper, C., Boddington D. and Smith, E., 2019. North Coast Demersal Resource Status Report 2018. In: Status Reports of the Fisheries and Aquatic Resources of Western Australia 2017/18: The State of the Fisheries eds. D.J. Gaughan and K. Santoro. Department of Primary Industries and Regional Development, Western Australia. pp. 125-133.

Newman, S., Wakefield, C., Skepper, C., Boddington, D. and Blay, N., 2020. North Coast Demersal Resource Status Report 2019. In: Status Reports of the Fisheries and Aquatic Resources of Western Australia 2018/19: The State of the Fisheries (eds). D.J. Gaughan and K. Santoro. Department of Primary Industries and Regional Development, Western Australia. pp. 159-168.

Newman, S.J., Wise, B.S., Santoro, K.G. and Gaughan, D.J. (eds). 2021. Status Reports of the Fisheries and Aquatic Resources of Western Australia 2020/21: The State of the Fisheries. Department of Primary Industries and Regional Development, Western Australia

Newman, S., Wakefield, C., Skepper, C., Boddington, D. and Steele, A., 2021a. North Coast Demersal Resource Status Report 2020. In: Status Reports of the Fisheries and Aquatic Resources of Western Australia 2019/20: The State of the Fisheries (eds). D.J. Gaughan and K. Santoro. Department of Primary Industries and Regional Development, Western Australia. pp. 156-165.

Newman, S., Bruce, C. and Wiberg, L., 2021b. Statewide Marine Aquarium Fish and Hermit Crab Resources Status Report 2020. In: Status Reports of the Fisheries and Aquatic Resources of Western Australia 2019/20: The State of the Fisheries (eds). D.J. Gaughan and K. Santoro. Department of Primary Industries and Regional Development, Western Australia. pp. 247-252.

Newman, S, T. Saunders, F. Trinnie, C. Wakefield, and A. Roelofs. 2021c. Red Emperor (2020). In Status of Australian Fish Stocks Report. Fisheries Research and Development Corporation (FRDC). Accessed from: https://www.fish.gov.au/report/354-Red-Emperor-2020

Newman, S.J., Wise, B.S., Santoro, K.G. and Gaughan, D.J. 2023. Status reports of the fisheries and aquatic resources of Western Australia 2021/22: State of the fisheries. Department of Primary Industries and Regional Development, Western Australia

Nichol, S.L., Howard, F.J.F., Kool, J., Stowar, M., Bouchet, P., Radke, L., Siwabessy, J., Przeslawski, R., Picard, K., Alvarez de Glasby, B., Colquhoun, J., Letessier, T. and Heyward, A., 2013. Oceanic Shoals Commonwealth Marine Reserve (Timor Sea) Biodiversity Survey: GA0339/SOL5650 – Post Survey Report. Record 2013/38. Geoscience Australia: Canberra.

Nohaïc, M.L., Ross, C.L., Cornwall, C.E., Comeau, S., Lowe, R., McCulloch, M.T. and Schoepf, V., 2017. Marine heatwave causes unprecedented regional mass bleaching of thermally resistant corals in north western Australia. Scientific Reports. 7, 14999.

Nowacek D.P, Johnson M.P, Tyack P.L. 2004. North Atlantic right whales (Eubalaena glacialis) ignore ships but respond to alerting stimuli Proceedings of the Royal Society B: Biological Sciences, 271, pp. 227-231, 10.1098/rspb.2003.2570.

NT Gov. 2015. Management Framework: Management Arrangements for the Northern Territory's Demersal Fishery. February 2012, revised July 2015. Accessed from: https://nt.gov.au/marine/commercial-fishing/fishery-licenses/demersal-fishery-and-licences

NT Gov. 2019. About the NT Commercial Fishing Industry. Northern Territory Government. Accessed 2023: https://nt.gov.au/marine/commercial-fishing/commercial-fishing-licences-and-logbooks/about-nt-commercial-fishing-industry

NT Government 2016. Casuarina Coastal Reserve Management Plan. Available at https://dtc.nt.gov.au/__data/assets/pdf_file/0020/249041/ccr-management-plan2016.pdf. Accessed on 6 September 2023.

NT Government, 2018. Snapper Crimson. Available at: https://nt.gov.au/marine/recreational-fishing/types-of-fish/fish-species/crimson-snapper

NT Government, 2020a. Barramundi fishery and licences. Available at: https://nt.gov.au/marine/commercial-fishing/fishery-licenses/barramundi-fishery-and-licences. Accessed on 19 May 2020.

NT Government, 2020b. Coastal Line Fishery. Available at: https://nt.gov.au/marine/commercial-fishing/fishery-licenses/coastal-line-fishery-and-licences. Accessed on 19 May 2020.

NT Government 2020c. Bait Net Fishery. Available at: https://nt.gov.au/marine/commercial-fishing/fishery-licenses/bait-net-fishery-and-licences

NT Government, 2020d Grey Mackerel. Available at: https://www.fish.gov.au/report/397-Grey-Mackerel-2020

NT Government 2020e. Tree Point Conservation Area. https://gunnpoint.com.au/wp-content/uploads/Tree-Point-Conservation-Area-2020.pdf. Accessed on 6 September 2023.

NT Government 2023a. Channel Point Coastal Reserve. https://nt.gov.au/__data/assets/pdf_file/0012/200064/channel-point-coastal-reserve.pdf. Accessed on 6 September 2023.

NT Government 2023b. Shoal Bay Coastal Reserve. https://nt.gov.au/parks/find-a-park/shoal-bay-coastal-reserve. Accessed on 6 September 2023.

NT Government 2023c. Djukbinj National Park. https://nt.gov.au/__data/assets/pdf_file/0014/200066/djukbinj-national-park.pdf. Accessed on 6 September 2023.

NT Government 2023d. Keep River National Park. https://nt.gov.au/parks/find-a-park/keep-river-national-park. Accessed on 6 September 2023.

NT Government 2020e. Tree Point Conservation Area. https://gunnpoint.com.au/wp-content/uploads/Tree-Point-Conservation-Area-2020.pdf. Accessed on 6 September 2023.

NTSC. 2012a. Northern Territory Offshore Net & Line Fishery Environmental Management System. Northern Territory Seafood Council. Accessed from: https://www.ntsc.com.au/documents/item/1445

NTSC. 2012b. Northern Territory Aquarium Fishery Environmental Management System. Northern Territory Seafood Council. Accessed from: https://www.ntsc.com.au/documents/item/1440

O'Hara, J. and Wilcox, R., 1990. Avoidance responses of loggerhead turtles, Caretta caretta, to low frequency sound. Copeia, 1990 (2): 564-567.

Odell, D.K. and MacMurray, C., 1986. Behavioural response to oil. In: Vargo S, Lutz PL, Odell DK, Van Vleet T, Bossart G (eds) Final Report. Study of the effect of oil on marine turtles. Minerals Management Service Contract Number 14–12–0001–30063, Florida Inst. of Oceanography, St. Petersburg, FL.

O'Neill, C., Leary, D. and McCrodan, A., 2010. Sound Source Verification. (Chapter 3) In Blees, M.K., K.G. Hartin, D.S. Ireland, and D.E. Hannay (eds.). Marine mammal monitoring and mitigation during open water seismic exploration by Statoil USA E&P Inc. in the Chukchi Sea, August-October 2010: 90-day report. LGL Report P1119. Prepared by LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Applied Sciences Ltd. for Statoil USA E&P Inc., National Marine Fisheries Service (U.S.), and U.S. Fish and Wildlife Service. pp 1-34.

Ovenden, J.R., Salini, J., O'Connor, S. and Street, A.R., 2004. Pronounced genetic population structure in a potentially vagile fish species (Pristipomoides multidens, Teleostei; Perciformes; Lutjanidae) from the East Indies triangle. Molecular Ecology 13: 1991–1999.

Parra, G.J. 2006, 'Resource partitioning in sympatric delphinids: space use and habitat preferences of Australian snubfin and Indo-Pacific humpback dolphins', Journal of Animal Ecology, vol. 75, pp. 862–874.

Parra, G.J. and Corkeron, P.J. 2001, 'Feasibility of using photo-identification techniques to study the Irrawaddy dolphin, Orcaella brevirostris', Aquatic Mammals, vol. 27, pp. 45–49.

Parra, G.J., Corkeron, P.J. and Marsh, H. 2002, The Indo-Pacific humpback dolphin, Sousa chinensis (Osbeck, 1765), in Australian waters: a summary of current knowledge and recommendations for their conservation, unpublished report to the Scientific Committee of the International Whaling Commission, SC/54/SM27.

Parry, G.D. and Gason, A. 2006. The effect of seismic surveys on catch rates of rock lobsters in western Victoria, Australia. Fisheries Research 79(3):272-284.

Parry, G.D., Heislers, S., Werner, G.F., Asplin, M.D., Gason, A., 2002. Assessment of Environmental Effects of Seismic Testing on Scallop Fisheries in Bass Strait. Marine and Freshwater Resources Institute Report No. 50. Marine and Freshwater Resources Institute, Queenscliff, Victoria.

Parsons, D.M., Morrison, M.A., McKenzie, J.R., Hartill, B.W., Bian, R. and Francis, R.C., 2011. A fisheries perspective of behavioural variability: differences in movement behaviour and extraction rate of an exploited sparid, snapper (Pagrus auratus). Canadian Journal of Fisheries and Aquatic Sciences 68(4): 632–42

Patterson, H., Larcombe, J., Woodhams, J. and Curtotti, R., 2020. Fishery status reports 2020, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. CC BY 4.0.

Patterson, H., Bromhead, D., Galeano, D., Larcombe, J., Woodhams, J. and Curtotti, R., 2021. Fishery status reports 2021, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. CC BY 4.0.

Paulay, G., Kirkendale, L., Lambert, G. and Meyer, C. 2002. Anthropogenic Biotic Interchange in a Coral Reef Ecosystem: A Case Study from Guam. Pacific Science. 56. 10.1353/psc.2002.0036.

Payne, J.F., Andrews, C., Fancey, L., White, D. and Christian, J., 2008. Potential Effects of Seismic Energy on Fish and Shellfish: An Update since 2003. Report Number 2008/060. Canadian Science Advisory Secretariat. 22 pp.

Payne, J.F., Andrews, C.A., Fancey, L.L., Cook, A.L., Christian, J.R., 2007. Pilot study on the effects of seismic air gun noise on lobster (Homarus americanus). Citeseer.

Pearson, W.H., Skalski, J.R., Sulkin, S.D., and Malme, C.I., 1994. Effects of seismic releases on the survival of development of zoeal larvae of dungeness crab (Cancer magister). Marine Environmental Research 38: 93-113.

Peel, D., Smith., J.N. and Childerhouse, S., 2016. Historical data on Australian whale vessel strikes. Presented to the IWC Scientific Committee. SC/66b/HIM/05.

Pearce A, Helleren S and Marinelli M. 2000. Review of productivity levels of Western Australian coastal and estuarine waters for mariculture planning purposes. Fisheries Research Report No. 123. Fisheries Western Australia, Perth, Western Australia.

Peña, H., Handegard, N.O., and Ona, E., 2013. Feeding herring schools do not react to seismic air gun surveys. ICES Journal of Marine Science 70: 1174–1180.

Pendoley, K.L., Schofield, G., Whittock, P.A., Lerodiaconou, D. and Hays, G.C., 2014. Protected species use of a coastal marine migratory corridor connecting marine protected areas. Marine Biology. 161:1455-1466.

Peverell, S., Gribble, N. and Larson, H., 2004. 'Sawfish'. In: National Oceans Office, Description of Key Species Groups in the Northern Planning Area. [Online]. Hobart, Tasmania: Commonwealth of Australia. http://www.environment.gov.au/coasts/mbp/publications/north/pubs/n-key-species.pdf.

Pillans, R.D., Stevens, J.D., Peverell, S. and Edgar, S., 2008. Spatial distribution and habitat utilisation of the speartooth shark Glyphis sp. A in relation to fishing in Northern Australia. CSIRO Marine and Atmospheric Research.

Plagányi, É., Hutton, T., Kenyon, R., Moeseneder, C., Deng, R., Miller, M., Pascoe, S. & Upston, J., 2017. Environmental drivers of variability in Joseph Bonaparte Gulf red-legged banana prawn (Penaeus indicus) fishery, preliminary progress report for the Northern Prawn Fishery Resource Assessment Group, March 2017, AFMA Canberra.

Poiner, I.R. and Harris, A.N.M., 1996. The Incidental Capture, Direct Mortality and Delayed Mortality of Sea Turtles in Australia's Northern Prawn Fishery. Mar.Biol.125, 813–825.

Pollom, R. 2017. Hippocampus angustus. The IUCN Red List of Threatened Species 2017: e.T107261486A54907188. https://dx.doi.org/10.2305/IUCN.UK.2017-3.RLTS.T107261486A54907188.en. Accessed on 08 September 2023.

Popper, A. and Hawkins, A., 2019. An overview of fish bioacoustics and the impacts of anthropogenic sounds on fishes. Journal of Fish Biology. Volume 94, Issue 5. May 2019. Pg. 692-713.

Popper, A.N. and Clarke, N.L., 1976. The auditory system of the goldfish (Carassius auratus): effects of intense acoustic stimulation. Comparative Biochemistry Physiology Part A: Physiology 53:11–18.

Popper, A.N. and Fay, R.R., 2011. Rethinking sound detection by fishes. Hearing Research 273, 25-36.

Popper, A.N. and Hawkins, A.D., 2018. The importance of particle motion to fishes and invertebrates. J. Acoust. Soc. Am. 143 (1): 470-488.

Popper, A.N. and Hoxter, B., 1984. Growth of a fish ear: I. Quantitative analysis of sensory hair cell and ganglion cell proliferation. Hear Res 15:133-142.

Popper, A.N., 2018. Potential for Impact of Cumulative Sound Exposure on fishes during a seismic survey. Produced for Santos Ltd. Bethany 3D Seismic Survey Environment Plan Summary.

Popper, A.N., Halvorsen, M.B., Kane, E., Miller, D.L., Smith, M.E., Song, J., Stein, P. and Wysocki, l.E., 2007. The effects of high-intensity, low-frequency active sonar on rainbow trout. Journal of the Acoustical Society of America 122:623–635.

Popper, A.N., Hawkins, A., Fay, R., Mann, D., Bartol, S., Carlson, T., Coombs, S., Ellison, W., Gentry, R., Halvorsen, M., Løkkeborg, S., Rogers, P., Southall, B., Zeddies, D. and Tavolga, W., 2014., ASA S3/SC1.4 TR-2014 Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. Part of the series SpringerBriefs in Oceanography pp 15-16.

Popper, A.N., Hawkins, A.D., Sand, O. and Sisneros, J.A., 2019. Examining the haring abilities of fishes. The Journal of the Acoustical Society of America. 146, 948.

Popper, A.N., Smith, M.E., Cott, P.A., Hanna, B.W., MacGillivray, A.O., Austin, M.E and Mann, D.A., 2005. Effects of exposure to seismic airgun use on hearing of three fish species. Journal of the Acoustical Society of America 117: 3958.

Protection of the sea (Prevention of Pollution from ships) Act 1983 Available at: https://www.legislation.gov.au/Details/C2017C00162

Przeslawski, R., Alvarez, B., Battershill, C. and Smith, T., 2014. Sponge biodiversity and ecology of the Van Diemen Rise and eastern Joseph Bonaparte Gulf, northern Australia. Hydrobiologia. 730:1-16

Przeslawski, R., Bruce, B., Carroll, A., Anderson, J., Bradford, R., Durrant, A., Edmunds, M., Foster, S., Huang, Z., Hurt, L., Lansdell, M., Lee, K., Lees, C., Nichols, P. and Williams, S., 2016b. Marine Seismic Survey Impacts on Fish and Invertebrates: Final Report for the Gippsland Marine Environmental Monitoring Project. Record 2016/35. Geoscience Australia, Canberra. 63 pp.

Przeslawski, R., Daniell, J., Anderson, T., Barrie, J.V., Heap, A., Hughes, M., Li, J., Potter, A., Radke, R., Siwabessy, J., Tran, M., Whiteway, T., Nichol, S., 2011. Seabed Habitats and Hazards of the Joseph Bonaparte Gulf and Timor Sea, Northern Australia. Geoscience Australia, Record 2011/40.

Przeslawski, R., Huang, Z., Anderson, J., Carroll, A., Edmonds, M., Hurt, L., Williams, S., 2018 Multiple field-based methods to assess the potential impacts of seismic surveys on scallops. Mar. Poll. Bull., 129, pp. 750-761.

Przeslawski, R., Hurt, L., Forrest, A., Carrol, A. and Geoscience Australia, 2016a. Potential short-term impacts of marine seismic surveys on scallops in the Gippsland Basin. Canberra. April. CC BY 3.0.

PTTEP, 2013. Montara Environmental Monitoring Program – Report of Research Edition 2. http://www.au.pttep.com/wp-content/uploads/2013/10/2013-Report-of-Research-Book-vii.pdf

Racca, R.G., Austin, M., Rutenko, A. and Bröker, K., 2015. Monitoring the gray whale sound exposure mitigation zone and estimating acoustic transmission during a 4-D seismic survey, Sakhalin Island, Russia. Endangered Species Research 29(2): 131-146. https://doi.org/10.3354/esr00703.

Racca, R.G., Bröker, K. and Gailey, G., 2012b. Model based sound level estimation and in-field adjustment for real-time mitigation of behavioural impacts from a seismic survey and post-event evaluation of sound exposure for individual whales. Acoustics 2012 Fremantle: Acoustics, Development and the Environment, Fremantle, Australia. http://www.acoustics.asn.au/conference_proceedings/AAS2012/papers/p92.pdf.

Racca, R.G., Rutenko, A., Bröker, K. and Austin, M., 2012a. A line in the water – design and enactment of a closed loop, model based sound level boundary estimation strategy for mitigation of behavioural impacts from a seismic survey. 11th European Conference on Underwater Acoustics 2012. Volume 34(3), Edinburgh, United Kingdom.

Reynolds, S.D., Norman, B.M., Beger, M., Franklin, C.E., Dwyer, R.G., 2017. Movement, distribution and marine reserves use by an endangered migratory giant. Biodiversity Research 23: 1268-1279.

Richardson, A.J., Matear, R.J, and Lenton, A., 2017. Potential impacts on zooplankton of seismic surveys. CSIRO, Australia. 34 pp.

Richardson, J., Greene, C., Malme, C. and Thomson, D., 1995. Marine Mammals and Sound. Academic Press, Waltham.

Rigby, C.L., Barreto, R., Carlson, J., Fernando, D., Fordham, S., Francis, M.P., Jabado, R.W., Liu, K.M., Marshall, A., Pacoureau, N., Romanov, E., Sherley, R.B. and Winker, H., 2019. Isurus paucus. The IUCN Red List of Threatened Species 2019: e.T60225A3095898. http://dx.doi.org/10.2305/IUCN.UK.2019-1.RLTS.T60225A3095898.en.

Rio Tinto, 2009. Cape Lambert Port B Development. Proponent Responses to Issues Raised in Submissions to the Public Environmental Review and Draft Public Environment Report.

Roberts, L. and Elliott, M., 2017. Good or bad vibrations? Impacts of anthropogenic vibration on the marine epibenthos. Science of the Total Environment 595: 255-268. https://doi.org/10.1016/j.scitotenv.2017.03.117.

Roberts, L., Cheesman, S., Breithaupt, T. and Elliott, M., 2015. Sensitivity of the mussel Mytilus edulis to substrate-borne vibration in relation to anthropogenically generated noise. Marine Ecology Progress Series 538: 185-195. http://www.int-res.com/abstracts/meps/v538/p185-195/.

Roberts, L., Cheesman, S., Elliott, M. and Breithaupt, T., 2016. Sensitivity of Pagurus bernhardus (L.) to substrate-borne vibration and anthropogenic noise. Journal of Experimental Marine Biology and Ecology 474: 185-194. http://www.sciencedirect.com/science/article/pii/S0022098115300277.

Robins, J.B. 1995. Estimated catch and mortality of sea turtles from the east coast otter trawl fishery of Queensland, Australia. Biological Conservation 74: 157-167.

Roelofs, A., J. Langstreth, P. Lewis, I. Butler, J. Stewart, and M. Grubert. 2021a. Status of Australia Fish Stocks Reports – Species Profile: Spanish Mackerel. Fisheries Research Development Corporation. Accessed from: https://www.fish.gov.au/report/393-Spanish-Mackerel-2020

Roelofs, A., P. Lewis, and M. Usher. 2021b. Status of Australia Fish Stocks Reports – Species Profile: Grey Mackerel. Fisheries Research Development Corporation. Accessed from: https://www.fish.gov.au/report/397-Grey-Mackerel-2020

RPS, 2011. Bonaparte LNG Preliminary Metocean Study. Report prepared for GDF SUEZ Bonaparte LNG, Perth, Western Australia.

RPS, 2019. Ancient coastline KEF fish and pearl oyster habitat survey report. Study commissioned by Santos WA.

RPS, 2021. Polarcus Petrel Sub-Basin SW 3D MSS. Oil Spill Modelling. Technical report by RPS for Santos WA Energy Limited.

RPS. 2010. Marine Mammals Technical Report. Wheatstone Project Technical Appendix O12. Report prepared for Chevron Australia Pty Ltd, May 2010.

Sætre, R. and Ona, E., 1996. Seismiske Undersøkelser og Skader på Fiskeegg og -Larver; en Vurdering av Mulige Effekter på Bestandsnivå. (Seismic Investigations and Injuries in Fish Eggs and Larvae; an Assessment of Potential Effects on Stock Level); Fisken og Havet, No 8-1996.

Salini, J.P., Ovenden, J.R., Street, R., Pendrey, R., Haryanti, Ngurah, 2006. Genetic population structure of red snappers (Lutjanus malabaricus Bloch & Schneider, 1801 and Lutjanus erythropterus Bloch, 1790) in central and eastern Indonesia and northern Australia. Journal of Fish Biology, 68(B): 217-234.

Salmon, M., Wyneken, J., Fritz, E. and Lucas, M., 1992. Seafinding by hatchling sea turtles: role of brightness, silhouette and beach slope as orientation cues. Behaviour. 122 (1) 56-77.

Santos, 2020a. Keraudren Extension 3D Marine Seismic Survey Environment Plan. NOPSEMA. Key Matter Report. Available at: https://docs.nopsema.gov.au/A725504

Santos, 2020b. Yoorn-1 Geophysical Survey Environment Plan (State and Commonwealth Waters). Available at: https://docs.nopsema.gov.au/A730487 Accessed 26/10/2021.

Santos, 2020c. WA-437-P Geotechnical and Geophysical Survey EP. Available at: https://docs.nopsema.gov.au/A724810 Accessed 26/10/2021.

Santos, 2021. Dancer-1 Exploration Drilling Environment Plan. Availabe at: https://docs.nopsema.gov.au/A783465 Accessed 26/10/2021.

Santos, 2022. Petrel Sub-Basin South-West 3D MSS EP Marine Fauna Observer's Report.

Santulli, A., Modica, A., Messina, C., Ceffa, L., Curatolo, A., Rivas, G., Fabi, G. and D'Amelio, V., 1999. Biochemical responses of European Sea Bass (Dicentrarchus labrax L.) to the stress induced by off shore experimental seismic prospecting. Marine Pollution Bulletin 38: 1105–1114.

Saunders, T., Dawson, A., Trinnie, F. and Newman, S., 2018. Status of Australia Fish Stocks Reports – Species Profile: Goldband Snapper. Fisheries Research Development Corporation, Canberra.

Saunders, T., A. Roelofs, F. Trinnie, C. Wakefield, and S. Newman. 2021a. Status of Australia Fish Stocks Reports – Species Profile: Goldband Snapper. Fisheries Research Development Corporation. Accessed from: https://www.fish.gov.au/report/356-Saddletail-Snapper-2020

Saunders, T., A. Roelofs, F. Trinnie, C. Wakefield, and S. Newman. 2021b. Status of Australia Fish Stocks Reports – Species Profile: Crimson Snapper. Fisheries Research Development Corporation. Accessed from: https://www.fish.gov.au/report/355-Crimson-Snapper-2020

Scholik, A.R. and Yan, H.Y. ,2002b. The effects of noise of the auditory sensitivity of the bluegill sunfish, Lepomis macrochirus. Comp. Biochem. Physiol. (A) 133: 43-52.

Scholik, A.R. and Yan, H.Y., 2001. Effects of underwater noise on auditory sensitivity of cyprinid fish. Hearing Research, 152(1), 17-24.

Scholik, A.R. and Yan, H.Y., 2002a. Effects of boat engine noise on the auditory sensitivity of the fathead minnow, Pimephales promelas. Environ. Biol. Fish. 63: 203-209.

Scholz, D., Michel, J., Shigenaka, G. and Hoff, R., 1992. Biological resources. In: Hayes M., Hoff R., Michel J., Scholz D. and Shigenaka G. Introduction to coastal habitats and biological resources for spill response, report HMRAD 92-4. National Oceanic and Atmospheric Administration, Seattle.

Schuck, J.B. and Smith, M.E., 2009. Cell proliferation follows acoustically-induced hair cell bundle loss in the zebrafish saccule. Hear Res. 2009; 253:67–76. doi: 10.1016/j.heares.2009.03.008.

Semeniuk, V., 1993. The Pilbara coast: a riverine coastal plain in a tropical arid setting, north-western Australia. Sedimentary Geology. 83(3-4):235-256.

Shimose, T. and Tachihara, K., 2005. Age, growth and maturation of the blackspot snapper Lutjanus fulviflammus around Okinawa Island, Japan. Fisheries Science. 71:48-55

Silversea, 2024. Australia and New Zealand. Available at: https://www.silversea.com/destinations/australia-new-zealand-cruise.html Accessed 07/03/2024

Simmonds, M., Dolman, S. and Weilgart, L., 2004. Oceans of Noise. A Whale and Dolphin Conservation Society Science Report. The Whale and Dolphin Conservation Society. Chippernam, Wiltshire, United Kingdom.

Skjoldal, Hein Rune, et al. 2009. Arctic Marine Shipping Assessment. Background Research Report on Potential Environmental Impacts from Shipping in the Arctic. Draft Version July.

Sleeman, J.C., Meekan, M.G., Fitzpatrick, B.J., Steinberg, C.R., Ancel, R., Bradshaw, C.J.A., 2010. Oceanographic and atmospheric phenomena influence the abundance of whale sharks at Ningaloo Reef, Western Australia. Journal of Experimental Marine Biology and Ecology. 383:77-81.

Slotte, A., Hansen, K., Dalen, J. and Ona, E., 2004. Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast. Fisheries Research 67: 143-150.

Smith, M.E., 2012. Predicting hearing loss in fishes. pp 571–574 in Popper, A.N. and Hawkins, A.D. (eds.). The effects of noise on aquatic life. Springer Science + Business Media, New York, USA.

Smith, M.E., 2015. The relationship between hair cell loss and hearing in fishes. In Popper, A.N. and Hawkins, A.D. (eds.). The effects of noise on aquatic life II. Springer Science+Business Media, New York, USA.

Smith, M.E., Coffin, A.B., Miller, D.L., Popper, A.N., 2006. Anatomical and functional recovery of the goldfish (Carassius auratus) ear following noise exposure. Journal of Experimental Biology 209:4193–4202.

Smith, M.E., Kane, A.S., Popper, A.N., 2004a. Noise-induced stress response and hearing loss in goldfish (Carassius auratus). Journal of Experimental Biology 207:427–435.

Smith, M.E., Kane, A.S., Popper, A.N., 2004b. Acoustical stress and hearing sensitivity in fishes: does the linear threshold shift hypothesis hold water? Journal of Experimental Biology 207:3591–3602.

Smith, M.E., Schuck, J.B., Gilley, R.R., Rogers, B.D., 2011. Structural and functional effects of acoustic exposure in goldfish: evidence for tonotopy in the teleost saccule. BMC Neuroscience 12:19.

Smyth, D., 2007. Sea Countries of the North-west, Literature Review on Indigenous Connection to and Uses of the Northwest Marine Region, Department of the Environment and Water Resources, Canberra.

Song, J., Mathieu, A., Soper, R.F. and Popper, A.N., 2006. Structure of the inner ear of bluefin tuna Thunnus thynnus. Journal of Fish Biology 68(6):1767–1781.

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene Jr., C.R., Kastak, D., Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A. and Tyack, P.L., 2007. Marine mammal sound exposure criteria: Initial scientific recommendations. Aquatic Mammals, vol. 33, iss. 4, pp. 411-509.

Southall, B.L., Nowacek, D.P., Miller, P.J.O. and Tyack, P.L., 2016. Experimental field studies to measure behavioural responses of cetaceans to sonar. Endangered Species Research. DOI: https://doi.org/10.3354/esr00764

Southall, B.L., J.J. Finneran, C.J. Reichmuth, P.E. Nachtigall, D.R. Ketten, A.E. Bowles, W.T. Ellison, D.P. Nowacek, and P.L. Tyack. 2019. Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. Aquatic Mammals 45(2): 125-232.

Southall, B.L., Nowacek, D.P., Bowles, A.E., Senigaglia, V., Bejder, L. and Tyack, P.L. 2021. Marine Mammal Noise Exposure Criteria: Assessing the Severity of Marine Mammal Behavioral Responses to Human Noise. Aquatic Mammals 2021, 47(5), 421-464, DOI 10.1578/AM.47.5.2021.421.

Stevens, J.D., Pillans, R.D. and Salini, J., 2005. Conservation Assessment of Glyphis sp. A (Speartooth Shark), Glyphis sp. C (Northern River Shark), Pristis microdon (Freshwater Sawfish) and Pristis zijsron (Green Sawfish). Hobart, Tasmania: CSIRO Marine Research.

Sparks, J.S. & Pollom, R. 2017. Hippichthys cyanospilos. The IUCN Red List of Threatened Species 2017: e.T183167A1731021. https://dx.doi.org/10.2305/IUCN.UK.2017-2.RLTS.T183167A1731021.en. Accessed on 08 September 2023.

Sutton AB and Beckley LE. 2017. Euphausiid assemblages of the oceanographically complex north-west marine bioregion of Australia. Marine and Freshwater Research 68(11) 1988-1998.

Swan, G., 2005. Occasional count no. 7, Ashmore Reef, 21 to 30 January 2002. Stilt 47

Tang, K.W., Gladyshev, M.I., Dubovskaya, O.P., Kirillin, G., Grossart H-P., 2014. Zooplankton carcasses and non-predatory mortality in freshwater and inland sea environments. Journal of Plankton Research 36: 597-612.

Tavolga, W.N and Wodinsky, J., 1963. Auditory capacities in fishes. Pure tone thresholds in nine species of marine teleosts. Bull. Amer. Mus. Nat. Hist. 126:177-240.

Thums, M., Waayers, D., Huang, Z., Pattiaratchi, C., Bernus, J. and Meekan, M., 2017. Environmental predictors of foraging and transit behaviour of flatback turtles Natator depressus. Endangered Species Research, 32: 333-349.

Tiwi Land Council, 2013. Vernon Islands. Conservation Management Plans. Available at: https://tiwilandcouncil.com/documents/Uploads/Vernon%20Islands%20Conservation%20Management%20Plan%20May%202013lr.pdf

Tonks, M., Griffiths, S., Heales, D.S., Brewer, D. and Dell, Q., 2008. Species composition and temporal variation of prawn trawl bycatch in the Joseph Bonaparte Gulf, north-western Australia. Fisheries Research. 89. 276-293. 10.1016/j.fishres.2007.09.007.

Trinnie, F., Walton, L., Wakefield, C., Newman, S., 2021. Goldband Snapper. Fisheries Research & Development Corporation. Available at: https://fish.gov.au/report/352-Goldband-Snapper-2020?jurisdictionId=4

True North, 2024. Departure dates. Available at: https://truenorth.com.au/departure-dates/ Accessed 07/03/2024.

United States Department of the Navy, 2008. Northwest training range complex draft environmental impact statement/overseas environmental impact statement. Volume 1. Prepared by United States Department of the Navy, Washington, USA.

URS, 2001. Review of Environmental Impacts of Petroleum Exploration and Appraisal Activities in Commonwealth Waters, Report prepared for the Department of Science & Resources.

URS 2010a. Ichthys Gas Field Development Project Studies of the Offshore Marine Environment. Prepared for INPEX Browse Ltd, Perth Western Australia, INPEX Document No. C036-AH-REP-0023

Vaidyanathan, T. & Pollom, R. 2017. Hippichthys parvicarinatus. The IUCN Red List of Threatened Species 2017: e.T65368088A67621203. https://dx.doi.org/10.2305/IUCN.UK.2017-3.RLTS.T65368088A67621203.en. Accessed on 08 September 2023.

Van Waerebeek, K., Baker, A.N., Félix, F., Gedamke, J., Iñiguez, M., Sanino, G.P., Secchi, E., Sutaria, D., van Helden, A., Wang, Y., 2007. Vessel collisions with small cetaceans worldwide and with large whales in the Southern Hemisphere, an initial assessment. Latin American Journal of Aquatic Mammals 6(1): 43-69.

Wada, S., Oishi, M., and Yamada, T. K. 2003. A newly discovered species of living baleen whale. Nature 426, 278–281. doi: 10.1038/nature02103

Wales, S. and Heitmeyer, R., 2002. An ensemble source spectra model for merchant ship-radiated noise. The Journal of the Acoustical Society of America 111, 1211.

Walker D.I. and McComb A.J. 1990. Salinity response of the seagrass Amphibolus Antartica: an experimental validation of field results. Aquatic Botany 36: 359–366.

Walker, D.I., Wells, F.E., Hanley, R., 1996. Survey of the marine biota of the eastern Kimberley, Western Australia. University of Western Australia, Western Australian Museum and Art Gallery of the Northern Territory.

Wardle, C.S., Carter, T.J., Urquhart, G.G., Johnstone, A.D.F., Ziolkowski, A.M., Hampson, G. and Mackie, D., 2001. Effects of seismic air guns on marine fish. Continental Shelf Research 21: 1005-1027.

Warner, G., C. Erbe, and D.E. Hannay. 2010. Underwater Sound Measurements. (Chapter 3) In Reiser, C.M., D.W. Funk, R. Rodrigues, and D. Hannay (eds.). Marine Mammal Monitoring and Mitigation during Open Water Shallow Hazards and Site Clearance Surveys by Shell Offshore Inc. in the Alaskan Chukchi Sea, July-October 2009: 90-Day Report. LGL Report P1112-1. Report by LGL Alaska Research Associates Inc. and JASCO Applied Sciences for Shell Offshore Inc., National Marine Fisheries Service (U.S.), and U.S. Fish and Wildlife Service. pp 1-54.

Warner, G.A., M. Austin, and A.O. MacGillivray. 2017. Hydroacoustic measurements and modeling of pile driving operations in Ketchikan, Alaska. Journal of the Acoustical Society of America 141(5): 3992. https://doi.org/10.1121/1.4989141.

Wartzok, D; Ketten, D. 1999. Marine mammal sensory systems. In: Reynolds, JE; Rommel, SA (eds.) The Biology of Marine Mammals. Smithsonian Institution Press, Washington, DC.

Webb, G.J.W., Whitehead, P.J. and Manolis, S.C., 1987. Crocodile management in the Northern Territory of Australia. In: Webb, G. J. W., S. C. Manolis & P. J. Whitehead, eds. Wildlife Management: Crocodiles and Alligators. Page(s) 107-124. Sydney, Surrey Beatty & Sons.

Webster, F.J., Wise, B.S., Fletcher, W.J. and Kemps, H., 2018. Risk Assessment of the potential impacts of seismic air gun surveys on marine finfish and invertebrates in Western Australia. Fisheries Research Report No. 288 Department of Primary Industries and Regional Development, Western Australia. 42 pp.

Welch, D.J., Buckworth, R.C., Ovenden, J.R., Newman, S.J., Broderick, D., Lester, R.J.G., Ballagh, A.C., Stapley, J., Charters, R.A., and Gribble, N.A., 2009 Determination of management units for grey mackerel fisheries in northern Australia. Report. James Cook University, Townsville, Queensland, Australia.

Wells, F. E., McDonald, J. I. and Huisman, J. M., 2009. Introduced Marine Species in Western Australia. Fisheries Occasional Publications No. 57. Department of Fisheries, Perth, Western Australia. 102 pp.

Western Australian Fish Resources Management Act 1994. Western Australian Legislation. Available at: https://www.legislation.wa.gov.au/legislation/statutes.nsf/main_mrtitle_345_homepage.html

Whiteway, TG. 2009. Australian bathymetry and topography grid (electronic resource). Geoscience Australia. Department of Industry, Tourism and Resources, Canberra

Whiting, S, Long, JL & Coyne, M. 2007. Migratory routes and foraging behaviour of olive ridley turtles Lepidochelys olivacea in northern Australia. Endangered Species Research, 3: 1-9

Whiting, A.U., Chaloupka, M., Limpus, C.J., 2008. Sampling Error for Hatchling Turtle Measurements: Probing a Rule-of-Thumb. Copeia 2008(4):889-896

Whittock, P.A., Pendoley, K.L. and Hamann, M., 2016a. Using habitat suitability models in an industrial setting: the case for interesting flatback turtles. Ecosphere 7(11): e01551.

Whittock, P.A., Pendoley, K.L. and Hamann, M., 2016b. Flexible foraging: post-nesting flatback turtles on the Australian continental shelf. Journal of Experimental Marine Biology and Ecology 477(2016): 112-119.

Whittock, P.A., Pendoley, K.L., Hamann, M., 2014. Inter-nesting distribution of flatback turtles Natator depressus and industrial development in Western Australia. Endangered Species Research 26(1):25-38

Wiersma, P., 1996. Charadriidae (Plovers) species accounts. In: del Hoyo, J., A. Elliott & J. Sargatal, eds. Handbook of the Birds of the World. Volume 3. Hoatzin to Auks. Page(s) 411-442. Barcelona: Lynx Edicions.

Wilson, S.G., Polovina, J.J., Stewart, B.S. and Meekan, M.G., 2006. Movements of Whale Sharks (Rhincodon typus) tagged at Ningaloo Reef, Western Australia. Marine Biology. 148:1157-1166.

Woinarski, J., Brennan, K., Hempel, C., Armstrong, M., Milne, D. and Chatto, R., 2003. Biodiversity conservation on the Tiwi Islands, Northern Territory: Part 2. Fauna. Northern Territory Government, Darwin.

Woodside, 2004. Blacktip Project: Section 7 – Existing Marine Environment. Available at https://ntepa.nt.gov.au/__data/assets/pdf_file/0010/286471/Section207.pdf.

Woodside, 2008. Torosa South-1 Pilot Appraisal Well Environment Plan. Woodside Energy, Perth

Woodside, 2011a. Impacts of seismic airgun noise on fish behaviour: a coral reef case study. Maxima 3D MSS Monitoring Program Information Sheet 1. Woodside Energy Ltd., Perth, Western Australia.

Woodside. 2011b. Impacts of Seismic Airgun Noise on Fish Diversity and Abundance: A Coral Reef Case Study. Maxima 3D MSS Monitoring Program Information Sheet 3. 12 pp.

Woodside. 2011c. Impacts of Seismic Airgun Noise on Benthic Communities: A Coral Reef Case Study. Maxima 3D MSS Monitoring Program Information Sheet 4. 12 pp.

Wyatt, R., 2008. Joint Industry Programme on sound and marine life: Review of existing data on underwater sounds produced by the oil and gas industry. Issue 1. Seiche Measurements Limited.

Zudaire, I., Murua, H., Grande, M. and Bodin, N. 2013. Reproductive potential of Yellowfin Tuna (*Thunnus albacares*) in the western Indian Ocean. Fishery Bulletin 111(3).

Zykov, M.M. and MacDonnell, J.T., 2013. Sound Source Characterizations for the Collaborative Baseline Survey Offshore Massachusetts Final Report: Side Scan Sonar, Sub-Bottom Profiler, and the R/V Small Research Vessel experimental. Document Number 00413, Version 2.0. Technical report by JASCO Applied Sciences for Fugro GeoServices, Inc. and the (US) Bureau of Ocean Energy Management.

Appendix A Santos Environment Health and Safety Standard

Santos

Environment, Health and Safety

Policy

Our Commitment

Santos is committed to being the safest gas company wherever we have a presence and preventing harm to people and the environment

Our Actions

We will:

1. Integrate environment, health and safety management requirements into the way we work
2. Comply with all relevant environmental, health and safety laws and continuously improve our management systems
3. Include environmental, health and safety considerations in business planning, decision making and asset management processes
4. Identify, control and monitor risks that have the potential for harm to people and the environment, so far as is reasonably practicable
5. Report, investigate and learn from our incidents
6. Consult and communicate with, and promote the participation of all workers to maintain a strong environment, health and safety culture
7. Empower our people, regardless of position, to "Stop the Job" when they feel it necessary to prevent harm to themselves, others or the environment
8. Work proactively and collaboratively with our stakeholders and the communities in which we operate
9. Set, measure, review and monitor objectives and targets to demonstrate proactive processes are in place to reduce the risk of harm to people and the environment
10. Report publicly on our environmental, health and safety performance

Governance

The Environment Health Safety and Sustainability Committee is responsible for reviewing the effectiveness of this policy.

This policy will be reviewed at appropriate intervals and revised when necessary to keep it current.

Kevin Gallagher

Managing Director and CEO

Document Owner:	David Banks, Chief Operating Officer		
Approved by:	The Board		
Date Approved:	15 August 2022	Version:	3

Appendix B Legislation

Commonwealth Legislation

Commonwealth legislation	Summary	Relevant to activity?	Administering authority	Relevant aspects of the activity	EP Section
Aboriginal and Torres Strait Islander Heritage Protection Act 1984	This Act provides for the preservation and protection from injury or desecration areas and objects that are of significance to Aboriginal people, under which the Minister may make a declaration to protect such areas and objects. The Act also requires the discovery of Aboriginal remains to be reported to the Minister.	No	Commonwealth – Department of Climate Change, Energy, the Environment and Water (DCCEEW)	No activity being undertaken on land or near shore. No known sites of Aboriginal Heritage Significance within the operational area or EMBA.	N/A
Australian Ballast Water Management Requirements, Version 8	Australian Ballast Water Management Requirements outline the mandatory ballast water management requirements to reduce the risk of introducing harmful aquatic organisms into Australia's marine environment through ballast water from international vessels. These requirements are enforceable under the *Biosecurity Act 2015*.	Yes	Commonwealth – Department of Agriculture, Fisheries and Forestry (DAFF)	Potential internationally sourced vessel operating in Australian Waters which could have the potential for introduction of IMS and potential ballast water exchange.	Section 7.7 – Introduction of invasive marine species
Australian Heritage Council Act 2003	This Act identifies areas of heritage value listed on the Register of the National Estate and sets up the Australian Heritage Council and its functions.	No	Australian Heritage Council	There are no heritage places found on the National Heritage List, within the EMBA that could potentially be impacted by unplanned events.	N/A
Australian Maritime Safety Authority Act 1990 (AMSA Act)	This Act specifies that the Australian Maritime Safety Authority's (AMSA) role includes protection of the marine environment from pollution from ships and other environmental damage caused by shipping. AMSA is responsible for administering the Marine Order in Commonwealth waters. This Act facilitates international cooperation and mutual assistance in preparing and responding to a major oil spill incident and encourages countries to develop and maintain an adequate capability to deal with oil pollution emergencies. Requirements are given effect through AMSA. AMSA is the lead agency for responding to oil spills in the marine environment and is responsible for the Australian National Plan for Maritime Environmental Emergencies.	Yes	AMSA	This Act applies to the use of any vessel associated with operations and is relevant to the activity in regard to the unplanned pollution from ships.	Section 7.1 – Marine Diesel Oil (MDO) Section 7.2– Minor hydrocarbon release

Commonwealth legislation	Summary	Relevant to activity?	Administering authority	Relevant aspects of the activity	EP Section
Aquatic Resources Management Act 2016	This Act will be the primary legislation used to manage fishing, aquaculture, pearling and aquatic resources in WA. The Act was scheduled for commencement on 1 January 2019; however, this has been deferred while an amendment to the Act is progressed.	Yes	Department of Primary Industries and Regional Development (DPIRD)	Vessel movements have the potential to introduce IMS (IMS). This Act was considered during development of the Santos IMS Management Zone (IMSMZ) and *IMS Management Plan* (EA-00-RI-10172).	Section 7.7 – Introduction of invasive marine species
Marine Orders	Marine Orders (MO) are subordinate rules made pursuant to the *Navigation Act 2012* and *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* affecting the maritime industry. They are a means of implementing Australia's international maritime obligations by giving effect to international conventions in Australian law.	Yes	AMSA	Vessel movements, safety, discharges and emissions.	Sections 6 and 7 – planned and unplanned events
Maritime Powers Act 2013	Protects the heritage values of shipwrecks and relics for shipwrecks over 75 years. It is an offence to interfere with a shipwreck covered by this Act. Available historic shipwreck locations covered by international conventions enacted by this legislation have been identified and assessed (as applicable) within this EP.	No	The Department of Immigration and Border Protection	No planned interaction or interference. Potential impact could be due to a hydrocarbon spill, but the credible spill is to surface, and therefore shipwrecks are highly unlikely to be impacted.	N/A
Biosecurity Act 2015 Biosecurity Regulations 2016	This Act provides the Commonwealth with powers to take measures of quarantine, and implement related programs as are necessary, to prevent the introduction of any plant, animal, organism or matter that could contain anything that could threaten Australia's native flora and fauna or natural environment. The Commonwealth's powers include powers of entry, seizure, detention and disposal. This Act includes mandatory controls on the use of seawater as ballast in ships and the declaration of sea vessels voyaging out of and into Commonwealth waters. The Regulations stipulate that all information regarding the voyage of the vessel and the ballast water is declared correctly to the quarantine officers.	Yes	Commonwealth – Department of Agriculture, Fisheries and Forestry (DAFF)	This Act applies to all internationally sourced vessels operating in Australian Waters which could have the potential for the introduction of IMS and potential ballast water exchange.	Section 7.7 – Introduction of invasive marine species
Corporations Act 2001	This Act is the principal legislation regulating matters of Australian companies, such as the formation and operation of companies, duties of officers, takeovers and fundraising.	Yes	Commonwealth – Australian Securities and Investments Commission	The titleholder has provided ACN details within the meaning of the Act	Section 1.3
Environment Protection and	The National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA)	Yes	Commonwealth – Department of	This Act applies to all aspects of the activity that have the potential to impact	Section 6.3 – Noise emissions

Commonwealth legislation	Summary	Relevant to activity?	Administering authority	Relevant aspects of the activity	EP Section
Biodiversity Conservation Act 1999 Environment Protection and Biodiversity Conservation Amendment Regulations 2006	is the sole assessor for offshore petroleum activities in Commonwealth water (as of 28 February 2014). Under the new arrangements, environmental protection will be met through NOPSEMA's decision-making processes. This Act is the Australian Government's key piece of environmental legislation and aims to: Protect MNES Provide for Commonwealth environmental assessment and approval processes Provide an integrated system for biodiversity conservation and management of protected areas		Climate Change, Energy, the Environment and Water (DCCEEW)	MNES. Appropriate environmental approvals will be sought from NOPSEMA for all operations (this EP) which outlines compliance with the relevant regulations and plans under the Act. Where activities have existing approvals under the Act, these will continue to apply.	Section 6.5 – Light emissions Section 6.6 – Planned Operational Discharges Section 7.1 – Hydrocarbon Spill (MDO) Section 7.6 – Marine Fauna Interactions
Underwater Cultural Heritage Act 2018 *Underwater Cultural Heritage (Consequential and Transitional Provisions) Act 2018*	This Act replaces the *Historic Shipwrecks Act 1976* and extends protection to other wrecks such as submerged aircraft and human remains. It also increases penalties applicable to damaged sites. The Act came into effect on 1 July 2019.	Yes	Commonwealth – Department of Climate Change, Energy, the Environment and Water (DCCEEW)	This Act applies to the shipwrecks (more than 75 years old) within the EMBA. There is no planned interaction or interference with shipwrecks, and any unplanned impacts is only expected to affect the surface waters.	Section 3– Existing Environment Sections 7.1 and 7.2 and – unplanned hydrocarbon spills
Draft Guidelines to protect underwater cultural heritage	Aims to provide direction on addressing legislative requirements and promoting best practice for identifying, assessing, and protecting underwater cultural heritage in Australian waters.	Yes	Commonwealth – Department of Climate Change, Energy, the Environment and Water (DCCEEW)	There is no planned interaction with cultural, historical or archaeological sites as defined in the draft guidelines. Any unplanned impact is only expected to affect surface waters.	Section 3– Existing Environment
Environment Protection (Sea Dumping) Act 1981	Regulates the loading and dumping of waste at sea and fulfils Australia's international obligations under the London protocol to prevent marine pollution by controlling dumping of wastes and other matter. The Sea Dumping Act applies to all vessels, aircraft and platforms in Australian waters and to all Australian vessels and aircrafts in any part of the sea. This Act does not apply in relation to the disposal or storage of controlled material (other than a vessel, aircraft or platform) directly arising from, or related to, the exploration, exploitation and associated offshore processing, of seabed mineral resources.	No	Commonwealth – Department of Climate Change, Energy, the Environment and Water (DCCEEW)	The Act regulates the loading and dumping of waste at sea. Since the abandonment took place before the *Environment Protection (Sea Dumping) Act 1981* came into force, a permit is not required.	NA

Commonwealth legislation	Summary	Relevant to activity?	Administering authority	Relevant aspects of the activity	EP Section
National Biofouling Management Guidance for the Petroleum Production and Exploration Industry 2009	The guidance document provides recommendations for the management of biofouling hazards by the petroleum industry.	Yes	Commonwealth – Department of Agriculture, Fisheries and Forestry (DAFF)	Applying the recommendations within this document and implementing effective biofouling controls can reduce the risk of the introduction of an introduced marine species.	Section 7.7 – Introduction of invasive marine species
National Greenhouse and Energy Reporting Act 2007	Introduces a single national reporting framework for the reporting and dissemination of information about greenhouse gas emissions, greenhouse gas projects and energy use and production of corporations.	Yes	Commonwealth – Department of Climate Change, Energy, the Environment and Water (DCCEEW) Climate Change Authority	This Act applies to the atmospheric emissions through combustion engine use to operate the vessels associated with the activity. Implementation of the Act will reduce the impact of GHG emissions associated with vessel use for the installation and commissioning activity, through compliance with MARPOL Annex VI (Marine Order Part 97: Marine Pollution Prevention – Air Pollution) and require the use of low sulphur fuel.	Section 6.7 – Atmospheric emissions
Maritime Legislation Amendment (Prevention of Air Pollution from Ships) Act 2007	This Act implements the requirements of MARPOL 73/78 Annex VI for shipping in Commonwealth waters.	Yes	Commonwealth, Department of Infrastructure and Regional Development.	Implementation of this Act reduces the impact of GHG emissions associated with vessel use for the installation and commissioning activity, through compliance with MARPOL Annex VI (Marine Order Part 97: Marine Pollution Prevention – Air Pollution) and require the use of low sulphur fuel.	Section 6.7 – Atmospheric emissions
Navigation Act 2012	An act regulating navigation and shipping including Safety of Life at Sea (SOLAS). A number of Marine Orders enacted under this Act apply directly to offshore petroleum exploration and production activities: • Marine Order 21: Safety and Emergency Arrangements • Marine Order 27: Safety of Navigation and Radio Equipment • Marine Order 30: Prevention of collisions • Marine Order 58: Safe Management of Vessels • Marine Order 70 – Seafarer Certification	Yes	AMSA (operational) Department of Infrastructure and Regional Development Minister for Infrastructure and Regional Development	All vessel movements associated with the activity will be governed by marine safety regulations and Marine Orders under the Act.	Section 6.2 – Interaction with other marine users Section 7.1 – Hydrocarbon release MDO

Commonwealth legislation	Summary	Relevant to activity?	Administering authority	Relevant aspects of the activity	EP Section
Offshore Petroleum and Greenhouse Gas Storage Act 2006 Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023	Petroleum exploration and development activities in Australia's offshore areas are subject to the environmental requirements specified in the OPGGS Act and associated Regulations. The OPGGS Act contains a broad requirement for titleholders to operate in accordance with 'good oil-field practice'. Specific environmental provisions relating to work practices essentially require operators to control and prevent the escape of wastes and petroleum. The Act also requires that activities are carried out in a manner that does not unduly interfere with other rights or interests, including the conservation of the resources of the sea and sea-bed, such as fishing or shipping. In some cases, where there are particular environmental sensitivities or multiple use issues it may be necessary to apply special conditions to an exploration permit area. The holder of a petroleum title must maintain adequate insurance against expenses or liabilities arising from activities in the title, including expenses relating to clean-up or other remedying of the effects of the escape of petroleum. The OPGGS Environment Regulations provide an objective based regime for the management of environmental performance for Australian offshore petroleum exploration and production activities in areas of Commonwealth jurisdiction. Key objectives of the Environment Regulations include: • to ensure operations are carried out in a manner consistent with the principles of ecologically sustainable development • to ensure operations are carried out in a manner by which the environmental impacts and risks of the activity will be reduced to as low as reasonably practicable • to ensure operations are carried out in a manner by which the environmental impacts and risks of the activity will be of an acceptable level.	Yes	NOPSEMA	Environmental impacts and environmental risks of the activity due to: • Interaction with commercial fishers • Interaction with other marine users • Noise emissions • Cumulative and additive seismic impacts • Light emissions • Planned operational discharges • Atmospheric emissions • Marine diesel oil (MDO) release from vessel collision (surface) • Minor hydrocarbon release • Spill response operations • Hazardous and non-hazardous unplanned discharges – liquid • Hazardous and non-hazardous unplanned discharges – solid • Marine fauna collisions • Introduction of invasive marine species	Section 6– Risk Assessments for Planned Events Section 7 – Risk Assessments for Unplanned Events
Ozone Protection and Synthetic Greenhouse Gas Management Act 1989 (and	Regulates the manufacture, importation and use of ozone depleting substances (ODS) (typically used in fire-fighting equipment and refrigerants). Applicable to the handling of any ODS.	Yes	Commonwealth – Department of Climate Change, Energy, the	The activity does not include import, export or manufacture activities of ODS. This Act applies where ODS is found on vessel refrigeration systems, however, this is a rare occurrence.	Section 6.7– Atmospheric emissions

Commonwealth legislation	Summary	Relevant to activity?	Administering authority	Relevant aspects of the activity	EP Section
associated regulations)			Environment and Water (DCCEEW)		
Protection of the Sea (Powers of Intervention) Act 1981 Protection of the Sea (Powers of Intervention) Regulations 1983	The Act authorises the Commonwealth to take measures for the purpose of protecting the sea from pollution by oil and other noxious substances discharged from ships and provides legal immunity for persons acting under an AMSA direction.	Yes	Commonwealth – Department of Infrastructure and Regional Development.	Potential impacts to commonwealth waters in the event of an unplanned hydrocarbon spill.	Section 7.1 – unplanned hydrocarbon spill (MDO)
Protection of the Sea (Prevention of Pollution from Ships) Act 1983 Protection of the Sea (Prevention of Pollution from Ships) (Orders) Regulations 1994	This Act relates to the protection of the sea from pollution by oil and other harmful substances discharged from ships. This Act disallows any harmful discharge of sewage, oil and noxious substances into the sea and sets the requirements for a shipboard waste management plan. The following Marine Orders relating to marine pollution prevention have been put in place to give effect to relevant regulations of Annexes I, II, III, IV, V and VI of MARPOL 73/78: • Marine Order 91: Marine Pollution Prevention – Oil • Marine Order 93: Marine Pollution Prevention – Noxious Liquid Substances • Marine Order 94: Marine Pollution Prevention – Packaged Harmful Substances • Marine Order 95: Marine Pollution Prevention – Garbage • Marine Order 96: Marine Pollution Prevention – Sewage • Marine Order 97: Marine Pollution Prevention – Air Pollution	Yes	Commonwealth – Department of Infrastructure and Regional Development	This Act applies to vessel discharges and movements associated with the activity. The Act is relevant to the extent that Santos WA will comply with MARPOL through the following relevant Marine Orders relating to marine pollution prevention have been put in place to give effect to relevant regulations of Annexes I, II, III, IV, V and VI of MARPOL 73/78: • Marine Order 91: Marine Pollution Prevention – Oil • Marine Order 93: Marine Pollution Prevention – Noxious Liquid Substances • Marine Order 94: Marine Pollution Prevention – Packaged Harmful Substances • Marine Order 95: Marine Pollution Prevention – Garbage • Marine Order 96: Marine Pollution Prevention – Sewage	Section 6.6 – Operational discharges Section 7 – unplanned events
Protection of the Sea (Civil Liability of Bunker Oil Pollution Damage) Act 2008	This Act implements the requirements for the International Convention on Civil Liability for Bunker Oil Pollution Damage.	No	AMSA	This Act applies to diesel refuelling which will not be required during this activity.	NA
Sea Installations Act 1987	This Act regulates the placement, use and maintenance of seabed installations in Australian	No		Yes – the London Protocol is implemented through Section 5 of the	NA

Commonwealth legislation	Summary	Relevant to activity?	Administering authority	Relevant aspects of the activity	EP Section
	waters. A sea installation refers to any manmade structure that is in contact with the seabed and used for an environment-related activity, for example: • Tourism or recreation • Carrying on of a business • Exploring, exploiting or using the living resources of the sea, seabed or sub-soil of the seabed whether by way of fishing, pearling, oyster farming, fish farming or otherwise • Marine archaeology • Other activities including scientific activity or transport activity.			Sea Dumping Act; Article 1.4.1.4 of the London Protocol covers the abandonment of manmade structures. Santos has reviewed the Sea Dumping Act 1981 and determined a permit is not required in this instance as the Act came into operation on 6 March 1984 and the Tern-2 wellhead predates the Act as it was temporarily plugged and abandoned in 1982.	
Protection of the Sea (Harmful Antifouling Systems) Act 2006	This Act relates to the protection of the sea from the effects of harmful anti-fouling systems. It prohibits the use of harmful organotins in anti-fouling paints used on ships.	Yes	Commonwealth, Department of Infrastructure and Regional Development and AMSA	This Act applies to vessel movements in Australian Waters associated with the activity. Vessels are required to have biofouling systems in place to prevent introduction of IMS / harmful impact on Australian biodiversity.	Section 7.7 – Introduction of IMS

International Agreements and Conventions

International agreements and conventions	Summary	Relevant to activity?	Relevant aspects	EP Section
London Convention and Protocol (2006)	The objective of the London Convention and Protocol is to promote the effective control of all sources of marine pollution. Contracting Parties shall take effective measures to prevent pollution of the marine environment cause by dumping at sea. The Protocol is more restrictive than the convention as application of a 'precautionary approach' is included as a general obligation; a 'reverse list' approach is adopted, which implies that all dumping is prohibited unless explicitly permitted.	No	See *Sea Installations Act 1981*	NA
1996 Protocol to The Convention on The Prevention Of Marine Pollution By Dumping Of Wastes And Other Matter, 1972.	Implemented in WA *Marine (Sea Dumping) Act* and *Environmental Protection (Sea Dumping) Act 1981*.	Yes	Planned operational discharges occur as part of the activity and include: • Sewage, grey water, and putrescible wastes generated from the MODU and support vessels • Deck drainage/deck wash-down, cooling, brine, ballast and bilge water from support vessels • Hydraulic fluid released by valve operation on subsea infrastructure • Various discharges from planned maintenance activities.	Section 6.6 – Operational discharges
Agreement Between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and Their Environment 1974 (commonly referred to as the Japan Australia Migratory Bird Agreement or JAMBA)	This agreement recognises the special international concern for the protection of migratory birds and birds in danger of extinction that migrate between Australia and Japan. Implemented in EPBC Act 1999.	Yes	Only relevant in so far as the credible spill scenario may result in impact to migratory seabirds foraging or nesting in area.	Sections 7.1 to 7.3 – unplanned hydrocarbon spills
Agreement Between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and Their Environment 1986 (commonly referred to as the China Australia	This agreement recognises the special international concern for the protection of migratory birds and birds in danger of extinction that migrate between Australia and China. Implemented in EPBC Act 1999.	Yes	Only relevant in so far as the credible spill scenario may result in impact to migratory seabirds foraging or nesting in area.	Sections 7.1 to 7.3 – unplanned hydrocarbon spills

International agreements and conventions	Summary	Relevant to activity?	Relevant aspects	EP Section
Migratory Bird Agreement or CAMBA)				
Convention for the Control of Transboundary Movements of Hazardous Wastes and Their Disposal 1989 (Basel Convention)	This convention deals with the transboundary movement of hazardous wastes, particularly by sea. Implemented in *Hazardous Waste (Regulation of Exports and Imports) Act 1989*.	No	Activity does not involve transboundary movement of hazardous wastes.	N/A
United Nations Convention on Biological Diversity – 1992	An international treaty to sustain life on earth.	Yes	Relevant only insofar as the activity may interact with MNES (threatened and migratory species) protected under the EPBC Act.	Section 6.3– Noise emissions Section 6.5 – Light emissions Section 7.6 – Marine Fauna Interaction Sections 7.1 to 7.3 – for unplanned releases
Convention on Oil Pollution Preparedness, Response and Co-operation 1990 (OPRC 90)	This convention comprises national arrangements for responding to oil pollution incidents from ships, offshore oil facilities, sea ports and oil handling. The convention recognises that in the event of pollution incident, prompt and effective action is essential.	Yes	In the event that worse-case credible spill scenarios may enact a national arrangement for response.	Sections 7.1 to 7.3 – for unplanned releases Section 7.3 – Spill response operations
Convention on the Conservation of Migratory Species of Wild Animals 1979 (Bonn Convention)	The Bonn Convention aims to improve the status of all threatened migratory species through national action and international agreements between range states of particular groups of species.	Yes	Only relevant in so far as the credible spill scenario may result in impact to MNES protected migratory species.	Sections 7.1 to 7.3 – for unplanned releases Section 7.3 – Spill response operations
International Convention for the Establishment of an International Fund for Compensation for Oil Pollution Damage (Fund 92)	This convention ensures compensation is provided for damage caused by oil pollution.	No	Relevant to oil tankers, not supply or support vessels.	N/A

International agreements and conventions	Summary	Relevant to activity?	Relevant aspects	EP Section
International Convention for the Prevention of Pollution from Ships 1973/1978 (MARPOL 73/78)	This Convention and Protocol (together known as MARPOL 73/78) build on earlier conventions in the same area. MARPOL is concerned with operational discharges of pollutants from ships. It contains six Annexes, dealing respectively with oil, noxious liquid substances, harmful packaged substances, sewage, garbage and air pollution. Detailed rules are laid out as to the extent to which (if at all) such substances can be released in different sea areas. The legislation giving effect to MARPOL in Australia is the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*, the *Navigation Act 2012* and several Parts of Marine Orders made under this legislation.	Yes	Already dealt with through the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* – refer to legislation table above	N/A
International Convention for the Safety of Life at Sea 1974	This convention is generally regarded as the most important of all international treaties concerning the safety of merchant ships Implemented in the *Air Navigation Act 1920*.	Yes	Only relevant in so far as SOLAS relates to safety aspects of the activity, such as navigation aids which reduce potential for vessel collision and hydrocarbon release to the environment.	Section 6.2 – Interaction with other marine users
International Convention on Civil Liability for oil pollution damage (1969)	This convention provides a mechanism for ensuring the payment of compensation for oil pollution damage.	No	Relevant to oil tankers	N/A
International Convention for the Control and Management of Ships' Ballast Water and Sediments (Ballast Water Convention) 2004	The IMO has been addressing the problem of invasive marine species in ship's ballast water since the 1980s. Ballast water and sediments guidelines were adopted in 1991 and the ballast water convention was adopted in 2004. Recent accession by Finland has triggered the final entry into force of these international requirements. As a result, the International Convention for the Control and Management of Ships Ballast Water and Sediment will enter into force on 8th September 2017 (IMO Briefing 22 2016). It aims to prevent the spread of harmful aquatic organisms from one region to another, by establishing standards and procedures for the management and control of ships' ballast water and sediments. Ballast Water Management systems must be approved by the Administration in accordance with this IMO Guidelines.	Yes	Potential internationally sourced vessel operating in Australian Waters which could have the potential for introduction of Invasive Marine Species and potential ballast water exchange.	Section 7.7 – Introduction of invasive marine species
United Nations Convention on the Law of the Sea (UNCLOS) (1982)	Part XII of the convention sets up a general legal framework for marine environment protection. The convention imposes obligations on State Parties to prevent, reduce and control marine pollution from the various major pollution sources, including pollution from land, from the atmosphere, from vessels and from dumping (Articles 207 to 212). Subsequent articles provide a regime for the enforcement of national marine pollution laws in the many different situations that can arise. Australia signed the agreement relating to the implementation of Part XI of the Convention in 1982, and UNCLOS in 1994.	Yes	Only relevant to the extent that Santos WA will comply with MARPOL through the following relevant Marine Orders relating to marine pollution prevention have been put in place to give effect to relevant regulations of Annexes I, II, III, IV, V and VI of MARPOL 73/78: • Marine Order 91: Marine Pollution Prevention – Oil	Section 6.6 – Operational discharges Section 7.1 to 7.3 – for unplanned releases Section 7.7 – Introduction of invasive marine species

International agreements and conventions	Summary	Relevant to activity?	Relevant aspects	EP Section
			• Marine Order 93: Marine Pollution Prevention – Noxious Liquid Substances • Marine Order 94: Marine Pollution Prevention – Packaged Harmful Substances • Marine Order 95: Marine Pollution Prevention – Garbage • Marine Order 96: Marine Pollution Prevention – Sewage • Marine Order 97: Marine Pollution Prevention – Air Pollution	
United Nations Framework Convention on Climate Change (1992)	The objective of the convention is to stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous interference with the climate system. Australia ratified the convention in December 1992 and it came into force on 21 December 1993.	Yes	Only relevant to the extent that to reduce impact of GHG emissions associated with vessel use, Santos WA will comply with MARPOL Annex VI (Marine Orders Part 97: Marine Pollution Prevention – Air Pollution) and require the use of low sulphur fuel. The MODU and support vessels will use diesel, which is a low sulphur fuel.	Section 6.7 – Atmospheric emissions

Appendix C EPBC Act Protected Matters Search reports

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 02-Apr-2025

Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat
Acknowledgements

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	21
Listed Migratory Species:	37

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	65
Whales and Other Cetaceans:	13
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	2
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	24
Key Ecological Features (Marine):	2
Biologically Important Areas:	4
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name
Commonwealth Marine Areas (EPBC Act)

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Phaethon rubricauda westralis Red-tailed Tropicbird (Indian Ocean), Indian Ocean Red-tailed Tropicbird [91824]	Endangered	Species or species habitat likely to occur within area
MAMMAL		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
[Balaenoptera musculus](#) Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
[Balaenoptera physalus](#) Fin Whale [37]	Vulnerable	Species or species habitat may occur within area
REPTILE		
[Caretta caretta](#) Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
[Chelonia mydas](#) Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
[Dermochelys coriacea](#) Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
[Eretmochelys imbricata](#) Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
[Lepidochelys olivacea](#) Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat known to occur within area
[Natator depressus](#) Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area
SHARK		
[Carcharodon carcharias](#) White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
[Glyphis garricki](#) Northern River Shark, New Guinea River Shark [82454]	Endangered	Species or species habitat may occur within area
[Pristis clavata](#) Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Pristis pristis		
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area
Pristis zijsron		
Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sphyrna lewini		
Scalloped Hammerhead [85267]	Conservation Dependent	Species or species habitat likely to occur within area

Listed Migratory Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Anous stolidus		
Common Noddy [825]		Species or species habitat may occur within area
Calonectris leucomelas		
Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Fregata ariel		
Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Fregata minor		
Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
Phaethon lepturus		
White-tailed Tropicbird [1014]		Species or species habitat may occur within area
Migratory Marine Species		
Anoxypristis cuspidata		
Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat may occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat may occur within area
Carcharias taurus Grey Nurse Shark [64469]		Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat likely to occur within area
Mobula alfredi as Manta alfredi Reef Manta Ray, Coastal Manta Ray [90033]		Species or species habitat likely to occur within area
Mobula birostris as Manta birostris Giant Manta Ray [90034]		Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Pristis zijsron		
Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Tursiops aduncus (Arafura/Timor Sea populations)		
Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat likely to occur within area
Migratory Wetlands Species		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata		
Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area
Calidris canutus		
Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos		
Pectoral Sandpiper [858]		Species or species habitat may occur within area
Numenius madagascariensis		
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Bird		

Scientific Name	Threatened Category	Presence Text
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Fish		
Bhanotia fasciolata Corrugated Pipefish, Barbed Pipefish [66188]		Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish [66202]		Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus dunckeri Red-hair Pipefish, Duncker's Pipefish [66220]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Reptile		
Aipysurus duboisii Dubois' Sea Snake, Dubois' Seasnake, Reef Shallows Sea Snake [1116]		Species or species habitat may occur within area
Aipysurus laevis Olive Sea Snake, Olive-brown Sea Snake [1120]		Species or species habitat may occur within area
Aipysurus mosaicus as Aipysurus eydouxii Mosaic Sea Snake [87261]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
Hydrelaps darwiniensis Port Darwin Sea Snake, Black-ringed Mangrove Sea Snake [1100]		Species or species habitat may occur within area
Hydrophis atriceps Black-headed Sea Snake, Banded Sea Snake [1101]		Species or species habitat may occur within area
Hydrophis coggeri Cogger's Sea Snake, Black-headed Sea Snake [25925]		Species or species habitat may occur within area
Hydrophis elegans Elegant Sea Snake, Bar-bellied Sea Snake [1104]		Species or species habitat may occur within area
Hydrophis hardwickii as Lapemis hardwickii Spine-bellied Sea Snake [93516]		Species or species habitat may occur within area
Hydrophis inornatus Plain Sea Snake [1107]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Hydrophis kingii as Disteira kingii Spectacled Sea Snake [93511]		Species or species habitat may occur within area
Hydrophis macdowelli as Hydrophis mcdowelli MacDowell's Sea Snake, Small-headed Sea Snake, [75601]		Species or species habitat may occur within area
Hydrophis major as Disteira major Olive-headed Sea Snake [93512]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Sea Snake, Ornate Reef Sea Snake [1111]		Species or species habitat may occur within area
Hydrophis peronii as Acalyptophis peronii Horned Sea Snake [93509]		Species or species habitat may occur within area
Hydrophis platura as Pelamis platurus Yellow-bellied Sea Snake [93746]		Species or species habitat may occur within area
Hydrophis stokesii as Astrotia stokesii Stokes' Sea Snake [93510]		Species or species habitat may occur within area
Hydrophis zweifeli as Enhydrina schistosa Australian Beaked Sea Snake [93514]		Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area

Whales and Other Cetaceans		[Resource Information]
Current Scientific Name	Status	Type of Presence
Mammal		

Current Scientific Name	Status	Type of Presence
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat may occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Tursiops aduncus (Arafura/Timor Sea populations)		
Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat likely to occur within area
Tursiops truncatus s. str.		
Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Australian Marine Parks	[Resource Information]
Park Name	Zone & IUCN Categories
Oceanic Shoals	Multiple Use Zone (IUCN VI)
Joseph Bonaparte Gulf	Special Purpose Zone (IUCN VI)

Extra Information

EPBC Act Referrals			[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status
Boskalis Cambridge Gulf Marine Sand Sourcing Project	2025/10106		Referral Decision
Controlled action			
Bonaparte Liquified Natural Gas Project	2011/6141	Controlled Action	Post-Approval
Ichthys Gas Field, Offshore and onshore processing facilities and subsea pipeline	2008/4208	Controlled Action	Post-Approval
Not controlled action			
2D Seismic Survey in Permit Areas WA-318-P & WA-319-P, near Cape Londonderry	2004/1687	Not Controlled Action	Completed
Nexus Drilling Program NT-P66	2007/3745	Not Controlled Action	Completed
Not controlled action (particular manner)			
2D and 3D Seismic Survey	2011/6197	Not Controlled Action (Particular Manner)	Post-Approval
2D and 3D Seismic Survey WA-405-P	2009/5104	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
2D and 3D Seismic Survey WA-405-P	2008/4133	Not Controlled Action (Particular Manner)	Post-Approval
2D Marine Seismic Survey	2009/4728	Not Controlled Action (Particular Manner)	Post-Approval
2D marine seismic survey within permit area WA-318-P	2007/3879	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic survey	2009/5076	Not Controlled Action (Particular Manner)	Post-Approval
Bonaparte 2D & 3D marine seismic survey	2011/5962	Not Controlled Action (Particular Manner)	Post-Approval
Bonaparte Seismic and Bathymetric Survey	2012/6295	Not Controlled Action (Particular Manner)	Post-Approval
Fishburn2D Marine Seismic Survey	2012/6659	Not Controlled Action (Particular Manner)	Post-Approval
Floyd 3D and Chisel 3D Seismic Surveys	2011/6220	Not Controlled Action (Particular Manner)	Post-Approval
Gold 2D Marine Seismic Survey Permit Areas WA375P and WA376P	2009/4698	Not Controlled Action (Particular Manner)	Post-Approval
Kingtree & Ironstone-1 Exploration Wells	2011/5935	Not Controlled Action (Particular Manner)	Post-Approval
Marine Environmental Survey 2012	2012/6310	Not Controlled Action (Particular Manner)	Post-Approval
NT/P80 2010 2D Marine Seismic Survey	2010/5487	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Petrel MC2D Marine Seismic Survey	2010/5368	Not Controlled Action (Particular Manner)	Post-Approval
Santos Petrel-7 Offshore Appraisal Drilling Programme (Bonaparte Basin)	2011/5934	Not Controlled Action (Particular Manner)	Post-Approval
Sonar and Acoustic Trials	2001/345	Not Controlled Action (Particular Manner)	Post-Approval
Westralia SPAN Marine Seismic Survey, WA & NT	2012/6463	Not Controlled Action (Particular Manner)	Post-Approval

Referral decision			
2D Marine Seismic Survey	2008/4623	Referral Decision	Completed

Key Ecological Features [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Carbonate bank and terrace system of the Sahul Shelf	North-west
Pinnacles of the Bonaparte Basin	North-west

Biologically Important Areas [Resource Information]

Scientific Name	Behaviour	Presence
Marine Turtles		
Caretta caretta Loggerhead Turtle [1763]	Foraging	Known to occur
Chelonia mydas Green Turtle [1765]	Foraging	Known to occur
Lepidochelys olivacea Olive Ridley Turtle [1767]	Foraging	Known to occur

Scientific Name	Behaviour	Presence
Natator depressus		
Flatback Turtle [59257]	Foraging	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data is available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on the contents of this report.

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions when time permits.

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded breeding sites; and
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

© Commonwealth of Australia
Department of Climate Change, Energy, the Environment and Water
GPO Box 3090
Canberra ACT 2601 Australia
+61 2 6274 1111

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 04-Apr-2025

Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat
Acknowledgements

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	1
Wetlands of International Importance (Ramsar	3
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	10
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	85
Listed Migratory Species:	81

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	55
Commonwealth Heritage Places:	9
Listed Marine Species:	134
Whales and Other Cetaceans:	27
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	11
Habitat Critical to the Survival of Marine Turtles:	4

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	17
Regional Forest Agreements:	None
Nationally Important Wetlands:	10
EPBC Act Referrals:	176
Key Ecological Features (Marine):	9
Biologically Important Areas:	51
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

National Heritage Places		[Resource Information]
Name	State	Legal Status
Natural		
The West Kimberley	WA	Listed place

Wetlands of International Importance (Ramsar Wetlands)	[Resource Information]
Ramsar Site Name	Proximity
Ashmore reef national nature reserve	Within 10km of Ramsar site
Cobourg peninsula	Within Ramsar site
Ord river floodplain	Within Ramsar site

Commonwealth Marine Area	[Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)

Listed Threatened Species	[Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text

Scientific Name	Threatened Category	Presence Text
BIRD		
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Arenaria interpres Ruddy Turnstone [872]	Vulnerable	Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Vulnerable	Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Chloebia gouldiae listed as Erythrura gouldiae Gouldian Finch [90091]	Endangered	Species or species habitat known to occur within area
Epthianura crocea tunneyi Alligator Rivers Yellow Chat, Yellow Chat (Alligator Rivers) [67089]	Endangered	Species or species habitat may occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Endangered	Species or species habitat known to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Falcunculus frontatus whitei Crested Shrike-tit (northern), Northern Shrike-tit [26013]	Vulnerable	Species or species habitat likely to occur within area
Geophaps smithii blaauwi Partridge Pigeon (western) [66501]	Vulnerable	Species or species habitat likely to occur within area
Geophaps smithii smithii Partridge Pigeon (eastern) [64441]	Vulnerable	Species or species habitat known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica baueri Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380]	Endangered	Species or species habitat known to occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit [86432]	Endangered	Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]	Endangered	Roosting known to occur within area
Melanodryas cucullata melvillensis Tiwi Islands Hooded Robin, Hooded Robin (Tiwi Islands) [67092]	Critically Endangered	Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Phaethon lepturus fulvus		
Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Phaethon rubricauda westralis		
Red-tailed Tropicbird (Indian Ocean), Indian Ocean Red-tailed Tropicbird [91824]	Endangered	Breeding known to occur within area
Pluvialis squatarola		
Grey Plover [865]	Vulnerable	Roosting known to occur within area
Rostratula australis		
Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Sternula albifrons		
Little Tern [82849]	Vulnerable	Breeding known to occur within area
Tringa nebularia		
Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area
Tyto novaehollandiae kimberli		
Masked Owl (northern) [26048]	Vulnerable	Species or species habitat known to occur within area
Tyto novaehollandiae melvillensis		
Tiwi Masked Owl, Tiwi Islands Masked Owl [26049]	Endangered	Species or species habitat known to occur within area
Xenus cinereus		
Terek Sandpiper [59300]	Vulnerable	Roosting known to occur within area
FROG		
Uperoleia daviesae		
Howard River Toadlet, Davies's Toadlet [85375]	Vulnerable	Species or species habitat known to occur within area
MAMMAL		
Antechinus bellus		
Fawn Antechinus [344]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Conilurus penicillatus Brush-tailed Rabbit-rat, Brush-tailed Tree-rat, Pakooma [132]	Vulnerable	Species or species habitat known to occur within area
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat known to occur within area
Isoodon auratus auratus Golden Bandicoot (mainland) [66665]	Vulnerable	Species or species habitat likely to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat known to occur within area
Mesembriomys gouldii gouldii Black-footed Tree-rat (Kimberley and mainland Northern Territory), Djintamoonga, Manbul [87618]	Endangered	Species or species habitat known to occur within area
Mesembriomys gouldii melvillensis Black-footed Tree-rat (Melville Island) [87619]	Vulnerable	Species or species habitat known to occur within area
Orcaella heinsohni Australian Snubfin Dolphin [81322]	Vulnerable	Breeding known to occur within area
Petrogale concinna canescens Nabarlek (Top End) [87606]	Endangered	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Petrogale concinna concinna		
Nabarlek (Victoria River District) [87605]	Critically Endangered	Species or species habitat likely to occur within area
Petrogale concinna monastria		
Nabarlek (Kimberley) [87607]	Endangered	Species or species habitat known to occur within area
Phascogale pirata		
Northern Brush-tailed Phascogale [82954]	Vulnerable	Species or species habitat known to occur within area
Phascogale tapoatafa kimberleyensis		
Kimberley brush-tailed phascogale, Brush-tailed Phascogale (Kimberley) [88453]	Vulnerable	Species or species habitat likely to occur within area
Saccolaimus saccolaimus nudicluniatus		
Bare-rumped Sheath-tailed Bat, Bare-rumped Sheathtail Bat [66889]	Vulnerable	Species or species habitat likely to occur within area
Sminthopsis butleri		
Butler's Dunnart [302]	Vulnerable	Species or species habitat known to occur within area
Sousa sahulensis		
Australian Humpback Dolphin [87942]	Vulnerable	Breeding known to occur within area
Trichosurus vulpecula arnhemensis		
Northern Brushtail Possum [83091]	Vulnerable	Species or species habitat known to occur within area
Xeromys myoides		
Water Mouse, False Water Rat, Yirrkoo [66]	Vulnerable	Species or species habitat known to occur within area
PLANT		
Burmannia championii listed as Burmannia sp. Bathurst Island (R.Fensham 1021)		
[93461]	Endangered (listed as Burmannia sp. Bathurst Island	Species or species habitat likely to occur within area
Elaeocarpus miegei		
[65147]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Hoya australis subsp. oramicola a vine [55436]	Vulnerable	Species or species habitat known to occur within area
Mitrella tiwiensis a vine [82029]	Vulnerable	Species or species habitat likely to occur within area
Stylidium ensatum a triggerplant [86366]	Endangered	Species or species habitat known to occur within area
Tarennoidea wallichii [65173]	Endangered	Species or species habitat known to occur within area
Typhonium jonesii a herb [62412]	Endangered	Species or species habitat likely to occur within area
Typhonium mirabile a herb [79227]	Endangered	Species or species habitat likely to occur within area
Xylopia monosperma a shrub [82030]	Endangered	Species or species habitat known to occur within area
REPTILE		
Acanthophis hawkei Plains Death Adder [83821]	Vulnerable	Species or species habitat known to occur within area
Aipysurus apraefrontalis Short-nosed Sea Snake, Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area
Aipysurus foliosquama Leaf-scaled Sea Snake, Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat may occur within area
Aipysurus fuscus Dusky Sea Snake [1119]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Carettochelys insculpta Pig-nosed Turtle, Pitted Shell Turtle [1762]	Vulnerable	Species or species habitat may occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Tiliqua scincoides intermedia Northern Blue-tongued Skink [89838]	Critically Endangered	Species or species habitat known to occur within area
Varanus mertensi Mertens' Water Monitor, Mertens's Water Monitor [1568]	Endangered	Species or species habitat known to occur within area
Varanus mitchelli Mitchell's Water Monitor [1569]	Critically Endangered	Species or species habitat known to occur within area
SHARK		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Glyphis garricki Northern River Shark, New Guinea River Shark [82454]	Endangered	Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Glyphis glyphis Speartooth Shark [82453]	Critically Endangered	Species or species habitat known to occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Breeding known to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sphyrna lewini Scalloped Hammerhead [85267]	Conservation Dependent	Species or species habitat known to occur within area

Listed Migratory Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Foraging, feeding or related behaviour known to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat known to occur within area
Onychoprion anaethetus Bridled Tern [82845]		Breeding known to occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Species or species habitat known to occur within area
Sterna dougallii Roseate Tern [817]		Breeding likely to occur within area
Sternula albifrons Little Tern [82849]	Vulnerable	Breeding known to occur within area
Sula leucogaster Brown Booby [1022]		Breeding known to occur within area
Sula sula Red-footed Booby [1023]		Breeding known to occur within area
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat known to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat may occur within area
Carcharias taurus Grey Nurse Shark [64469]		Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Dugong dugon Dugong [28]		Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Megaptera novaeangliae Humpback Whale [38]		Breeding known to occur within area
Mobula alfredi as Manta alfredi Reef Manta Ray, Coastal Manta Ray [90033]		Species or species habitat known to occur within area
Mobula birostris as Manta birostris Giant Manta Ray [90034]		Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Orcaella heinsohni Australian Snubfin Dolphin [81322]	Vulnerable	Breeding known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Breeding known to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sousa sahulensis as Sousa chinensis Australian Humpback Dolphin [87942]	Vulnerable	Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
[Tursiops aduncus (Arafura/Timor Sea populations)](#)		
Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Migratory Terrestrial Species		
[Cecropis daurica](#)		
Red-rumped Swallow [80610]		Species or species habitat known to occur within area
[Cuculus optatus](#)		
Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat known to occur within area
[Hirundo rustica](#)		
Barn Swallow [662]		Species or species habitat known to occur within area
[Motacilla cinerea](#)		
Grey Wagtail [642]		Species or species habitat known to occur within area
[Motacilla flava](#)		
Yellow Wagtail [644]		Species or species habitat known to occur within area
Migratory Wetlands Species		
[Acrocephalus orientalis](#)		
Oriental Reed-Warbler [59570]		Species or species habitat known to occur within area
[Actitis hypoleucos](#)		
Common Sandpiper [59309]		Species or species habitat known to occur within area
[Arenaria interpres](#)		
Ruddy Turnstone [872]	Vulnerable	Roosting known to occur within area
[Calidris acuminata](#)		
Sharp-tailed Sandpiper [874]	Vulnerable	Roosting known to occur within area
[Calidris alba](#)		
Sanderling [875]		Roosting known to occur within area

Scientific Name	Threatened Category	Presence Text
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris subminuta Long-toed Stint [861]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Vulnerable	Roosting known to occur within area
Charadrius dubius Little Ringed Plover [896]		Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Roosting known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting known to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Glareola maldivarum Oriental Pratincole [840]		Roosting known to occur within area

Scientific Name	Threatened Category	Presence Text
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]	Endangered	Roosting known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting known to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]	Vulnerable	Roosting known to occur within area
Thalasseus bergii Greater Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area

Scientific Name	Threatened Category	Presence Text
Tringa incana		
Wandering Tattler [831]		Roosting known to occur within area
Tringa nebularia		
Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area
Tringa stagnatilis		
Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Xenus cinereus		
Terek Sandpiper [59300]	Vulnerable	Roosting known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Lands [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Commonwealth Land Name	State
Attorney-General - Australian Customs Service	
Commonwealth Land - Australian Customs Service [70998]	NT
Attorney-General - Australian Government Solicitor	
Commonwealth Land - Australian Government Solicitor [70092]	NT
Commonwealth Land - Australian Government Solicitor [71135]	NT
Commonwealth Land - Australian Government Solicitor [70996]	NT
Commonwealth Land - Australian Government Solicitor [70332]	NT
Commonwealth Land - Australian Government Solicitor [70208]	NT
Commonwealth Land - Australian Government Solicitor [70450]	NT
Commonwealth Land - Australian Government Solicitor [70089]	NT
Commonwealth Land - Deputy Crown Solicitor [70333]	NT
Commonwealth Land - Deputy Crown Solicitor [70994]	NT
Commonwealth Land - Deputy Crown Solicitor [70334]	NT
Defence	
Defence - AUSTRALIAN ARMY BAND - DARWIN [70042]	NT

Commonwealth Land Name	State
Defence - BRADSHAW FIELD TRAINING AREA [70043]	NT
Defence - DARWIN - AP10 RADAR SITE - LEE POINT [70021]	NT
Defence - DARWIN - AP3 RECEIVING STATION - LEE POINT [70044]	NT
Defence - DARWIN RELOCATIONS CENTRE [70045]	NT
Defence - DEFENCE FORCE CAREERS REFERENCE CENTRE [70046]	NT
Defence - Esanda Builidng [70048]	NT
Defence - LARRAKEYAH BARRACKS [70061]	NT
Defence - LEANYER BOMBING RANGE [70023]	NT
Defence - LEANYER BOMBING RANGE [70024]	NT
Defence - LEANYER BOMBING RANGE [70022]	NT
Defence - MT GOODWIN RADAR SITE [70063]	NT
Defence - Patrol Boat Base (DARWIN NAVAL BASE) [70041]	NT
Defence - QUAIL ISLAND BOMBING RANGE [70003]	NT
Defence - RAAF BASE DARWIN [70073]	NT
Defence - SHOAL BAY RECEIVING STATION [70037]	NT
Defence - STOKES HILL OIL FUEL INSTALLATION [70035]	NT
Defence - WINNELLIE TWO [70077]	NT
Defence - Defence Housing Authority	
Commonwealth Land - Director of Property Services Defence Estate [70855]	NT
Commonwealth Land - Director of Property Services Defence Estate [70856]	NT
Family and Community Services - Department of Community Services & Health	
Commonwealth Land - Department of Community Services & Health [70720]	NT
Finance and Administration	
Commonwealth Land - Department of Administrative Services [70091]	NT
Commonwealth Land - Department of Administrative Services [70590]	NT
Commonwealth Land - Department of Administrative Services [70210]	NT

Commonwealth Land Name	State
Immigration and Multicultural and Indigenous Affairs - Department of Immigration Local Government and Ethnic Affairs	
Commonwealth Land - Department of Immigration Local Government & Ethnic Affairs [70336]	NT
Transport and Regional Services	
Commonwealth Land - Department of Transport & Regional Development [70207]	NT
Unknown	
Commonwealth Land - [70327]	NT
Commonwealth Land - [70090]	NT
Commonwealth Land - [70580]	NT
Commonwealth Land - [70206]	NT
Commonwealth Land - [70203]	NT
Commonwealth Land - [70591]	NT
Commonwealth Land - [70593]	NT
Commonwealth Land - [70204]	NT
Commonwealth Land - [70205]	NT
Commonwealth Land - [70447]	NT
Commonwealth Land - [70993]	NT
Commonwealth Land - [70995]	NT
Commonwealth Land - [70594]	NT
Commonwealth Land - [70337]	NT
Commonwealth Land - [70595]	NT
Commonwealth Land - [70999]	NT
Commonwealth Land - [70338]	NT
Commonwealth Land - [70335]	NT

Commonwealth Heritage Places		[Resource Information]
Name	State	Status
Historic		
Larrakeyah Barracks Headquarters Building	NT	Listed place
Larrakeyah Barracks Precinct	NT	Listed place

Name	State	Status
Larrakeyah Barracks Sergeants Mess	NT	Listed place
RAAF Base Commanding Officers Residence	NT	Listed place
RAAF Base Precinct	NT	Listed place
RAAF Base Tropical Housing Type 2	NT	Listed place
RAAF Base Tropical Housing Type 3	NT	Listed place
Natural		
Bradshaw Defence Area	NT	Listed place
Scott Reef and Surrounds - Commonwealth Area	EXT	Listed place

Listed Marine Species [Resource Information]

Scientific Name	Threatened Category	Presence Text
Bird		
Acrocephalus orientalis Oriental Reed-Warbler [59570]		Species or species habitat known to occur within area overfly marine area
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus Common Noddy [825]		Foraging, feeding or related behaviour known to occur within area
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area overfly marine area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Arenaria interpres Ruddy Turnstone [872]	Vulnerable	Roosting known to occur within area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area overfly marine area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area overfly marine area
Calidris subminuta Long-toed Stint [861]		Roosting known to occur within area overfly marine area
Calidris tenuirostris Great Knot [862]	Vulnerable	Roosting known to occur within area overfly marine area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Cecropis daurica as Hirundo daurica		
Red-rumped Swallow [80610]		Species or species habitat known to occur within area overfly marine area
Chalcites osculans as Chrysococcyx osculans		
Black-eared Cuckoo [83425]		Species or species habitat known to occur within area overfly marine area
Charadrius dubius		
Little Ringed Plover [896]		Roosting known to occur within area overfly marine area
Charadrius leschenaultii		
Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus		
Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius ruficapillus		
Red-capped Plover [881]		Roosting known to occur within area overfly marine area
Charadrius veredus		
Oriental Plover, Oriental Dotterel [882]		Roosting known to occur within area overfly marine area
Chroicocephalus novaehollandiae as Larus novaehollandiae		
Silver Gull [82326]		Breeding known to occur within area
Fregata ariel		
Lesser Frigatebird, Least Frigatebird [1012]		Breeding known to occur within area
Fregata minor		
Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat known to occur within area
Gallinago megala		
Swinhoe's Snipe [864]		Roosting known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area overfly marine area
Glareola maldivarum Oriental Pratincole [840]		Roosting known to occur within area overfly marine area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Roosting known to occur within area overfly marine area
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area overfly marine area
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area overfly marine area
Limnodromus semipalmatus Asian Dowitcher [843]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]	Endangered	Roosting known to occur within area overfly marine area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Motacilla cinerea Grey Wagtail [642]		Species or species habitat known to occur within area overfly marine area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area overfly marine area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting known to occur within area overfly marine area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Onychoprion anaethetus as Sterna anaethetus Bridled Tern [82845]		Breeding known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Species or species habitat known to occur within area
Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area

Scientific Name	Threatened Category	Presence Text
Pluvialis squatarola Grey Plover [865]	Vulnerable	Roosting known to occur within area overfly marine area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area overfly marine area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area overfly marine area
Sterna dougallii Roseate Tern [817]		Breeding likely to occur within area
Sternula albifrons as Sterna albifrons Little Tern [82849]	Vulnerable	Breeding known to occur within area
Stiltia isabella Australian Pratincole [818]		Roosting known to occur within area overfly marine area
Sula leucogaster Brown Booby [1022]		Breeding known to occur within area
Sula sula Red-footed Booby [1023]		Breeding known to occur within area
Thalasseus bengalensis as Sterna bengalensis Lesser Crested Tern [66546]		Breeding known to occur within area
Thalasseus bergii as Sterna bergii Greater Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes as Heteroscelus brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
[Tringa incana as Heteroscelus incanus](#) Wandering Tattler [831]		Roosting known to occur within area
[Tringa nebularia](#) Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area overfly marine area
[Tringa stagnatilis](#) Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area overfly marine area
[Xenus cinereus](#) Terek Sandpiper [59300]	Vulnerable	Roosting known to occur within area overfly marine area
Fish		
[Bhanotia fasciolata](#) Corrugated Pipefish, Barbed Pipefish [66188]		Species or species habitat may occur within area
[Campichthys tricarinatus](#) Three-keel Pipefish [66192]		Species or species habitat may occur within area
[Choeroichthys brachysoma](#) Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
[Choeroichthys suillus](#) Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
[Corythoichthys amplexus](#) Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area
[Corythoichthys flavofasciatus](#) Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
[Corythoichthys haematopterus](#) Reef-top Pipefish [66201]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish [66202]		Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Festucalex cinctus Girdled Pipefish [66214]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus dunckeri Red-hair Pipefish, Duncker's Pipefish [66220]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys cyanospilos Blue-speckled Pipefish, Blue-spotted Pipefish [66228]		Species or species habitat may occur within area
Hippichthys parvicarinatus Short-keel Pipefish, Short-keeled Pipefish [66230]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
[Solegnathus hardwickii](#) Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
[Solegnathus lettiensis](#) Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
[Solenostomus cyanopterus](#) Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
[Syngnathoides biaculeatus](#) Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
[Trachyrhamphus bicoarctatus](#) Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
[Trachyrhamphus longirostris](#) Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammal		
[Dugong dugon](#) Dugong [28]		Species or species habitat known to occur within area
Reptile		
[Aipysurus apraefrontalis](#) Short-nosed Sea Snake, Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area
[Aipysurus duboisii](#) Dubois' Sea Snake, Dubois' Seasnake, Reef Shallows Sea Snake [1116]		Species or species habitat may occur within area
[Aipysurus foliosquama](#) Leaf-scaled Sea Snake, Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat may occur within area
[Aipysurus fuscus](#) Dusky Sea Snake [1119]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Aipysurus laevis Olive Sea Snake, Olive-brown Sea Snake [1120]		Species or species habitat may occur within area
Aipysurus mosaicus as Aipysurus eydouxii Mosaic Sea Snake [87261]		Species or species habitat may occur within area
Aipysurus tenuis Brown-lined Sea Snake, Mjoberg's Sea Snake [1121]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Crocodylus johnstoni Freshwater Crocodile, Johnston's Crocodile, Johnstone's Crocodile [1773]		Species or species habitat may occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Emydocephalus annulatus Eastern Turtle-headed Sea Snake [1125]		Species or species habitat may occur within area
Ephalophis greyae as Ephalophis greyi Mangrove Sea Snake [93738]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Hydrelaps darwiniensis Port Darwin Sea Snake, Black-ringed Mangrove Sea Snake [1100]		Species or species habitat may occur within area
Hydrophis atriceps Black-headed Sea Snake, Banded Sea Snake [1101]		Species or species habitat may occur within area
Hydrophis coggeri Cogger's Sea Snake, Black-headed Sea Snake [25925]		Species or species habitat may occur within area
Hydrophis elegans Elegant Sea Snake, Bar-bellied Sea Snake [1104]		Species or species habitat may occur within area
Hydrophis hardwickii as Lapemis hardwickii Spine-bellied Sea Snake [93516]		Species or species habitat may occur within area
Hydrophis inornatus Plain Sea Snake [1107]		Species or species habitat may occur within area
Hydrophis kingii as Disteira kingii Spectacled Sea Snake [93511]		Species or species habitat may occur within area
Hydrophis macdowelli as Hydrophis mcdowelli MacDowell's Sea Snake, Small-headed Sea Snake, [75601]		Species or species habitat may occur within area
Hydrophis major as Disteira major Olive-headed Sea Snake [93512]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Sea Snake, Ornate Reef Sea Snake [1111]		Species or species habitat may occur within area
Hydrophis pacificus Pacific Sea Snake, Large-headed Sea Snake [1112]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Hydrophis peronii as Acalyptophis peronii Horned Sea Snake [93509]		Species or species habitat may occur within area
Hydrophis platura as Pelamis platurus Yellow-bellied Sea Snake [93746]		Species or species habitat may occur within area
Hydrophis stokesii as Astrotia stokesii Stokes' Sea Snake [93510]		Species or species habitat may occur within area
Hydrophis zweifeli as Enhydrina schistosa Australian Beaked Sea Snake [93514]		Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Parahydrophis mertoni Arafura Smooth Sea Snake, Northern Mangrove Sea Snake [1090]		Species or species habitat may occur within area

Whales and Other Cetaceans		[Resource Information]
Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area

Current Scientific Name	Status	Type of Presence
[Balaenoptera physalus](#) Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
[Delphinus delphis](#) Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
[Feresa attenuata](#) Pygmy Killer Whale [61]		Species or species habitat may occur within area
[Globicephala macrorhynchus](#) Short-finned Pilot Whale [62]		Species or species habitat may occur within area
[Grampus griseus](#) Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
[Kogia breviceps](#) Pygmy Sperm Whale [57]		Species or species habitat may occur within area
[Kogia sima](#) Dwarf Sperm Whale [85043]		Species or species habitat may occur within area
[Lagenodelphis hosei](#) Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area
[Megaptera novaeangliae](#) Humpback Whale [38]		Breeding known to occur within area
[Mesoplodon densirostris](#) Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
[Orcaella heinsohni](#) Australian Snubfin Dolphin [81322]	Vulnerable	Breeding known to occur within area

Current Scientific Name	Status	Type of Presence
[Orcinus orca](#) Killer Whale, Orca [46]		Species or species habitat may occur within area
[Peponocephala electra](#) Melon-headed Whale [47]		Species or species habitat may occur within area
[Physeter macrocephalus](#) Sperm Whale [59]		Species or species habitat may occur within area
[Pseudorca crassidens](#) False Killer Whale [48]		Species or species habitat likely to occur within area
[Sousa sahulensis](#) Australian Humpback Dolphin [87942]	Vulnerable	Breeding known to occur within area
[Stenella attenuata](#) Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
[Stenella coeruleoalba](#) Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
[Stenella longirostris](#) Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
[Steno bredanensis](#) Rough-toothed Dolphin [30]		Species or species habitat may occur within area
[Tursiops aduncus](#) Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
[Tursiops aduncus (Arafura/Timor Sea populations)](#) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area

Current Scientific Name	Status	Type of Presence
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks	[Resource Information]
Park Name	Zone & IUCN Categories
Kimberley	Habitat Protection Zone (IUCN IV)
Oceanic Shoals	Habitat Protection Zone (IUCN IV)
Joseph Bonaparte Gulf	Multiple Use Zone (IUCN VI)
Kimberley	Multiple Use Zone (IUCN VI)
Oceanic Shoals	Multiple Use Zone (IUCN VI)
Oceanic Shoals	Multiple Use Zone (IUCN VI)
Kimberley	National Park Zone (IUCN II)
Oceanic Shoals	National Park Zone (IUCN II)
Cartier Island	Sanctuary Zone (IUCN Ia)
Joseph Bonaparte Gulf	Special Purpose Zone (IUCN VI)
Oceanic Shoals	Special Purpose Zone (Trawl) (IUCN VI)

Habitat Critical to the Survival of Marine Turtles		[Resource Information]
Scientific Name	Behaviour	Presence
All year (Jun - Aug)		
Natator depressus Flatback Turtle [59257]	Nesting	Known to occur
Dec - Jan		
Dermochelys coriacea Leatherback Turtle [1768]	Nesting	Known to occur
May - Jul		

Scientific Name	Behaviour	Presence
Lepidochelys olivacea		
Olive Ridley Turtle [1767]	Nesting	Known to occur

Oct - Mar		
Chelonia mydas		
Green Turtle [1765]	Nesting	Known to occur

Extra Information

State and Territory Reserves		[Resource Information]
Protected Area Name	Reserve Type	State
Browse Island	Nature Reserve	WA
Casuarina	Coastal Reserve	NT
Charles Darwin	National Park	NT
Djukbinj	National Park	NT
Garig Gunak Barlu	National Park	NT
Garig Gunak Barlu	Marine Park	NT
Holmes Jungle	Nature Park	NT
Lalang-gaddam	Marine Park	WA
Lesueur Island	Nature Reserve	WA
Low Rocks	Nature Reserve	WA
Niiwalarra Islands	National Park	WA
North Kimberley	Marine Park	WA
Ord River	Nature Reserve	WA
Pelican Island	Nature Reserve	WA
Scott Reef	Nature Reserve	WA
Unnamed WA41775	5(1)(h) Reserve	WA
Unnamed WA44677	5(1)(h) Reserve	WA

Nationally Important Wetlands	[Resource Information]
Wetland Name	State
Adelaide River Floodplain System	NT

Wetland Name	State
Cobourg Peninsula System	NT
Daly-Reynolds Floodplain-Estuary System	NT
Finniss Floodplain and Fog Bay Systems	NT
Legune Wetlands	NT
Moyle Floodplain and Hyland Bay System	NT
Ord Estuary System	WA
Parry Floodplain	WA
Port Darwin	NT
Shoal Bay - Micket Creek	NT

EPBC Act Referrals			[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status
2 geotechnical surveys - preliminary and final	2006/2886		Completed
Bayview, The Boulevarde, Darwin, NT	2015/7466		Completed
Boskalis Cambridge Gulf Marine Sand Sourcing Project	2025/10106		Referral Decision
Browse Carbon Capture and Storage Project	2024/10028		Referral Decision
Browse to North West Shelf Development, Indian Ocean, WA	2018/8319		Approval
Clarence Strait Offshore Tidal Energy Project	2008/4660		Assessment
Darwin Pipeline Duplication (DPD) Project	2022/09372		Post-Approval
Darwin Pipeline Duplication DPD Project	2022/9166		Completed
Deep Water Northwest Shelf 2D Seismic Survey	2007/3260		Completed
Marine Route Survey for Subsea Fibre Optic Data Cable System - Australia West	2024/09826		Completed
Project Crux Cable Lay and Operation	2022/09441		Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Project Fitzroy Expansion Offshore Cable Lay	2023/09674		Referral Decision
Puffin Oil wells 7, 8 & 9 development	2005/2336		Completed
Replacement of the East Point Outfall	2011/6099		Completed
Tiwi H2 Project	2022/09347		Assessment
Controlled action			
275 km gas pipeline from Wadeye to existing Darwin gas pipeline	2006/2930	Controlled Action	Post-Approval
2-D seismic survey Scott Reef	2000/125	Controlled Action	Post-Approval
Augmentation of the East Point Effluent Rising Main and Extension of East Point Outfall	2009/5113	Controlled Action	Post-Approval
Barramundi Nursery Farm	2005/2378	Controlled Action	Completed
Blacktip Project - Wharf Construction	2007/3293	Controlled Action	Completed
Bonaparte Liquified Natural Gas Project	2011/6141	Controlled Action	Post-Approval
Browse FLNG Development, Commonwealth Waters	2013/7079	Controlled Action	Post-Approval
Conduct an exploration drilling campaign	2010/5718	Controlled Action	Completed
Darwin to Moomba Gas Pipeline	2001/213	Controlled Action	Completed
Develop Ichthys gas-condensate field permit area W	2006/2767	Controlled Action	Completed
Development of Blacktip Gas Field	2003/1180	Controlled Action	Post-Approval
Development of Browse Basin Gas Fields (Upstream)	2008/4111	Controlled Action	Completed
Glyde Point and Middle Arm Peninsula Infrastructure Support	2001/334	Controlled Action	Completed
Glyde Point Industrial Estate	2001/336	Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Glyde Point Industrial Estate and Associated Infrastructure	2004/1506	Controlled Action	Completed
Hardwood Plantation	2001/229	Controlled Action	Post-Approval
Ichthys Gas Field, Offshore and onshore processing facilities and subsea pipeline	2008/4208	Controlled Action	Post-Approval
Kilimiraka Mineral Sands and Associated Infrastructure (Bathurst Island), NT	2012/6587	Controlled Action	Assessment Approach
Lee Point Master-planned urban development, Darwin, NT	2015/7591	Controlled Action	Post-Approval
Montara 4, 5, and 6 Oil Production Wells, and Montara 3 Gas Re-Injection Well	2002/755	Controlled Action	Post-Approval
Muirhead Subdivision	2010/5525	Controlled Action	Post-Approval
Operation of 17 Tiger Helicopters at Robertson Barracks	2004/1459	Controlled Action	Post-Approval
Port Patterson Barramundi Sea Cage Farm	2005/2149	Controlled Action	Completed
Prelude Floating Liquefied Natural Gas Facility and Gas Field Development	2008/4146	Controlled Action	Post-Approval
Project Sea Dragon stage 1 prawn aquaculture project, NT	2015/7527	Controlled Action	Post-Approval
PTTEP AA Floating LNG Facility	2011/6025	Controlled Action	Completed
Residential subdivision of Lot 9793 (formerly Lots 9774 and 9779) Lee Point Road	2005/2108	Controlled Action	Post-Approval
Shipping Channel Enhancement	2010/5431	Controlled Action	Completed
Talisman Saber 2005 Military Exercise	2004/1819	Controlled Action	Post-Approval
Tassie Shoal Gas Reforming and Methanol Production Plants - NT/P48	2000/108	Controlled Action	Post-Approval
Tassie Shoal LNG Project	2003/1067	Controlled Action	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Torosa South Initial Appraisal Drilling	2007/3500	Controlled Action	Completed
Trans-territory Gas Pipeline	2003/1186	Controlled Action	Completed
Tropical Tidal Testing Centre, Clarence Strait, 50km NE Darwin	2014/7299	Controlled Action	Guidelines Issued
Wuudagu Bauxite Project	2019/8606	Controlled Action	Assessment Approach
Not controlled action			
2D seismic survey, exploration permit NT/P67	2004/1587	Not Controlled Action	Completed
2D Seismic Survey in Permit Areas WA-318-P & WA-319-P, near Cape Londonderry	2004/1687	Not Controlled Action	Completed
3D marine seismic survey in WA 314P and WA 315P	2004/1927	Not Controlled Action	Completed
Adele Trend TQ3D Seismic Survey	2001/252	Not Controlled Action	Completed
AEC International Hydrocarbon Well Puffin 6	2000/36	Not Controlled Action	Completed
Aquaculture farm	2002/737	Not Controlled Action	Completed
Backpacker-1 Offshore Hydrocarbon Exploration Well	2001/300	Not Controlled Action	Completed
Barossa-1 (NT/P69), Caldita-2 (NT/P61) exploration wells	2006/2793	Not Controlled Action	Completed
Caldita-1 Hydrocarbon Exploration Well, NT/P61	2004/1854	Not Controlled Action	Completed
Construction and operation of Radar Infrastructure	2004/1406	Not Controlled Action	Completed
Coot-1 hydrocarbon exploration well, Permit Area AC/L2 or AC/L3	2001/296	Not Controlled Action	Completed
Core Breeding and Broodstock Maturation Centre development, Point Ceylon, NT	2016/7713	Not Controlled Action	Completed
Cox Peninsular Remediation Project, NT	2015/7587	Not Controlled Action	Completed
Crux-A and Crux-B appraisal wells, Petroleum Permit Area AC/P23	2006/2748	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Crux gas-liquids development in permit AC/P23	2006/3154	Not Controlled Action	Completed
Darwin Port Maintenance Dredging, Darwin Harbour, NT	2017/8122	Not Controlled Action	Completed
Drilling of 12 Hydrocarbon Exploration Wells, Permit Area WA-371-P	2006/3005	Not Controlled Action	Completed
Drilling of exploration wells, Permit areas WA-301-P to WA-305-P	2002/769	Not Controlled Action	Completed
Drilling of Marina-1 Exploration Well	2007/3586	Not Controlled Action	Completed
Echuca Shoals-2 Exploration of Appraisal Well	2006/3020	Not Controlled Action	Completed
Exploration Well AC/P23	2001/234	Not Controlled Action	Completed
Kaleidoscope exploration well	2001/182	Not Controlled Action	Completed
Marine Seismic Survey in WA-239-P	2000/24	Not Controlled Action	Completed
Marine Survey for the Australia-ASEAN Power Link AAPL	2020/8714	Not Controlled Action	Completed
Montara-3 Offshore Hydrocarbon Exploration Well Permit Area AC/RL3	2001/489	Not Controlled Action	Completed
Nexus Drilling Program NT-P66	2007/3745	Not Controlled Action	Completed
P30 Hydrocarbon Exploration Well	2001/293	Not Controlled Action	Completed
Project Highclere Geophysical Survey	2021/9023	Not Controlled Action	Completed
Project Sea Dragon Stage 1 Hatchery - Gunn Point, NT	2017/8092	Not Controlled Action	Completed
Residential Complex - Lots 6575 and 6576	2001/163	Not Controlled Action	Completed
Saucepan 1 Exploration Well ACP23	2000/2	Not Controlled Action	Completed
Skua and Swift Oilfields	2006/3195	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Strumbo-1 Gas Exploration Well Permit Area WA-288-P	2002/884	Not Controlled Action	Completed
Thresher-1 Well	2000/84	Not Controlled Action	Completed
Waterfront Redevelopment	2003/1256	Not Controlled Action	Completed
Not controlled action (particular manner)			
2 (3D) Marine Seismic Surveys	2009/4994	Not Controlled Action (Particular Manner)	Completed
2D and 3D Seismic Survey	2011/6197	Not Controlled Action (Particular Manner)	Post-Approval
2D and 3D Seismic Survey WA-405-P	2008/4133	Not Controlled Action (Particular Manner)	Post-Approval
2D and 3D Seismic Survey WA-405-P	2009/5104	Not Controlled Action (Particular Manner)	Post-Approval
2D Marine Seismic Survey	2009/4728	Not Controlled Action (Particular Manner)	Post-Approval
2D marine seismic survey of Braveheart,Kurrajong,Sunshine and Crocodile	2006/2917	Not Controlled Action (Particular Manner)	Post-Approval
2D marine seismic survey within permit area WA-318-P	2007/3879	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic Marine Survey	2001/363	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic survey	2009/5076	Not Controlled Action (Particular Manner)	Post-Approval
2D seismic survey in permit areas WA-274P and WA-281P	2004/1521	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
2D Seismic Survey in WA Permit Area TP/22 and Commonwealth Permit Area WA-280-P	2005/2100	Not Controlled Action (Particular Manner)	Post-Approval
3D Marine Seismic Survey	2008/4437	Not Controlled Action (Particular Manner)	Post-Approval
3D Marine Seismic Survey	2009/4681	Not Controlled Action (Particular Manner)	Post-Approval
3D Marine Seismic Survey, Permit AC/P 23	2005/2364	Not Controlled Action (Particular Manner)	Post-Approval
3D marine seismic Survey - Maxima 3D MSS	2006/2945	Not Controlled Action (Particular Manner)	Post-Approval
3D Seismic Survey	2006/2729	Not Controlled Action (Particular Manner)	Post-Approval
3D Seismic Survey, Browse Basin, WA	2009/5048	Not Controlled Action (Particular Manner)	Post-Approval
3D Seismic Survey, near Scott Reef, Browse Basin	2005/2126	Not Controlled Action (Particular Manner)	Post-Approval
3D Seismic Survey (NT/P68)	2006/2980	Not Controlled Action (Particular Manner)	Post-Approval
3D Seismic Survey WA-406-P Bonaparte Basin	2007/3904	Not Controlled Action (Particular Manner)	Post-Approval
AC/P37 3D Seismic Survey Ashmore Cartier	2007/3774	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Aurora MC3D Marine Seismic Survey	2010/5510	Not Controlled Action (Particular Manner)	Post-Approval
Bassett 3D Marine Seismic Survey	2010/5538	Not Controlled Action (Particular Manner)	Post-Approval
Blacktip Gas Project Yelcherr Beach Wharf Construction	2007/3537	Not Controlled Action (Particular Manner)	Post-Approval
Bonaparte 2D & 3D marine seismic survey	2011/5962	Not Controlled Action (Particular Manner)	Post-Approval
Bonaparte 3D & 2D Seismic Survey, in NT/P82, Timor Sea	2012/6398	Not Controlled Action (Particular Manner)	Post-Approval
Bonaparte Basin Barossa Appraisal Drilling Campaign, NT	2012/6481	Not Controlled Action (Particular Manner)	Post-Approval
Bonaparte Basin Seabed Mapping Survey	2009/4951	Not Controlled Action (Particular Manner)	Post-Approval
Bonaparte Seismic and Bathymetric Survey	2012/6295	Not Controlled Action (Particular Manner)	Post-Approval
Braveheart 2D Infill Marine Seismic Survey 100km offshore	2008/4442	Not Controlled Action (Particular Manner)	Post-Approval
Braveheart 2D Marine Seismic Survey	2005/2322	Not Controlled Action (Particular Manner)	Post-Approval
Caldita 3D Marine Seismic Survey - NT/P61, NT/P69, and acreage release area NT06-5	2006/3142	Not Controlled Action (Particular Manner)	Post-Approval
Canis 3D Marine Seismic Survey	2008/4492	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Cartier East and Cartier West 3D Marine Seismic Surveys	2009/5230	Not Controlled Action (Particular Manner)	Post-Approval
Caswell MC3D Marine Seismic Survey	2012/6594	Not Controlled Action (Particular Manner)	Post-Approval
Conduct an exploration drilling campaign	2011/5964	Not Controlled Action (Particular Manner)	Post-Approval
Dredging the outer shipping channels of Darwin Harbour	2013/6988	Not Controlled Action (Particular Manner)	Post-Approval
Drilling of Exploration & Appraisal Wells Braveheart-1 & Cornea-3	2009/5160	Not Controlled Action (Particular Manner)	Post-Approval
Endurance 3D Marine Seismic Data Acquisition Survey	2007/3667	Not Controlled Action (Particular Manner)	Post-Approval
Exploration Drilling Campaign	2011/6047	Not Controlled Action (Particular Manner)	Post-Approval
Exploration Drilling Campaign, Browse Basin, WA-341-P, AC-P36 and WA-343-P	2013/6898	Not Controlled Action (Particular Manner)	Post-Approval
Exploration Drilling in Permit Areas WA-402-P & WA-403-P	2010/5297	Not Controlled Action (Particular Manner)	Post-Approval
Exploration Drilling Program - Permit areas - WA-314-P, WA-315-P, WA-398-P.	2008/4064	Not Controlled Action (Particular Manner)	Post-Approval
Fishburn2D Marine Seismic Survey	2012/6659	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Floyd 3D and Chisel 3D Seismic Surveys	2011/6220	Not Controlled Action (Particular Manner)	Post-Approval
Geoscience Australia - Marine survey in Browse Basin to acquire data to assist assessment of CO2 sto	2013/6747	Not Controlled Action (Particular Manner)	Post-Approval
Gicea 3D Marine Seismic Survey	2008/4389	Not Controlled Action (Particular Manner)	Post-Approval
Gigas 2D Pilot Ocean Bottom Cable Marine Seismic Survey	2007/3839	Not Controlled Action (Particular Manner)	Post-Approval
Gold 2D Marine Seismic Survey Permit Areas WA375P and WA376P	2009/4698	Not Controlled Action (Particular Manner)	Post-Approval
Ichthys 3D Marine Seismic Survey	2010/5550	Not Controlled Action (Particular Manner)	Post-Approval
Joseph Bonaparte Gulf Seabed mapping survey	2010/5517	Not Controlled Action (Particular Manner)	Post-Approval
Kingtree & Ironstone-1 Exploration Wells	2011/5935	Not Controlled Action (Particular Manner)	Post-Approval
Kraken, Lusca & Asperus 3D Marine Seismic Survey	2013/6730	Not Controlled Action (Particular Manner)	Post-Approval
Malita West 3D Seismic Survey WA-402-P and WA-403-P	2007/3936	Not Controlled Action (Particular Manner)	Post-Approval
Marine Environmental Survey 2012	2012/6310	Not Controlled Action (Particular Manner)	Post-Approval
Nova 3D Seismic Survey	2013/6825	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
NT/P77 3D Marine Seismic Survey	2009/4683	Not Controlled Action (Particular Manner)	Post-Approval
NT/P80 2010 2D Marine Seismic Survey	2010/5487	Not Controlled Action (Particular Manner)	Post-Approval
Octantis 3D Marine Seismic Survey, Permit Area AC/P41 off northern Western Australia	2007/3369	Not Controlled Action (Particular Manner)	Post-Approval
Offshore Exploration Drilling Campaign	2011/6222	Not Controlled Action (Particular Manner)	Post-Approval
Offshore Fibre Optic Cable Network Construction & Operation, Port Hedland WA to Darwin NT	2014/7223	Not Controlled Action (Particular Manner)	Post-Approval
Offshore Gas Exploration Drilling Campaign	2012/6384	Not Controlled Action (Particular Manner)	Post-Approval
Panda NT/P76 3D Seismic Acquisition Survey Program	2009/4992	Not Controlled Action (Particular Manner)	Post-Approval
Petrel MC2D Marine Seismic Survey	2010/5368	Not Controlled Action (Particular Manner)	Post-Approval
Pilot Appraisal Well - Torosa South 1	2008/3991	Not Controlled Action (Particular Manner)	Post-Approval
Removal of Potential Unexploded Ordnance within NAXA	2012/6503	Not Controlled Action (Particular Manner)	Post-Approval
Rosebud 3D Marine Seismic Survey in WA-30-R and TR/5	2012/6493	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Santos Petrel-7 Offshore Appraisal Drilling Programme (Bonaparte Basin)	2011/5934	Not Controlled Action (Particular Manner)	Post-Approval
Schild MC3D Marine Seismic Survey	2012/6373	Not Controlled Action (Particular Manner)	Post-Approval
Schild Phase 11 MC3D Marine Seismic Survey, Browse Basin	2013/6894	Not Controlled Action (Particular Manner)	Post-Approval
Scott Reef Seismic Research	2006/2647	Not Controlled Action (Particular Manner)	Post-Approval
Searcher bathymetry & geochemical seismic survey, Brawse Basin,Timor Sea,WA	2013/6980	Not Controlled Action (Particular Manner)	Post-Approval
Sonar and Acoustic Trials	2001/345	Not Controlled Action (Particular Manner)	Post-Approval
Sunshine Infill 2D and Mimosa 2D Marine Seismic Surveys	2009/4699	Not Controlled Action (Particular Manner)	Post-Approval
Tiffany 3D Seismic Survey	2010/5339	Not Controlled Action (Particular Manner)	Post-Approval
Torosa-5 Apraisal Well, WA-30-R	2008/4430	Not Controlled Action (Particular Manner)	Post-Approval
Tow West Atlas wreck from present location to boundary of EEZ	2010/5652	Not Controlled Action (Particular Manner)	Post-Approval
Tridacna 3D Ocean Bottom Cable Marine Seismic Survey	2011/5959	Not Controlled Action (Particular Manner)	Post-Approval
Vampire 2D Non Exclusive Seismic Survey, WA	2010/5543	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Westralia SPAN Marine Seismic Survey, WA & NT	2012/6463	Not Controlled Action (Particular Manner)	Post-Approval
Woodside Southern Browse 3D Seismic Survey, WA	2007/3534	Not Controlled Action (Particular Manner)	Post-Approval
Zeemeermin MC3D seismic survey, Browse Basin, Offshore WA	2009/5023	Not Controlled Action (Particular Manner)	Post-Approval
Zeppelin 3D Seismic Survey	2011/6148	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
2D Marine Seismic Survey	2008/4623	Referral Decision	Completed
Aurora extension MC3D Marine Seismic Survey	2011/5887	Referral Decision	Completed
BRSN08 3D Marine Seismic Survey	2008/4582	Referral Decision	Completed
Experimental Study of Behavioural and Physiological Impact on Fish of Seismic Ex	2006/2625	Referral Decision	Completed
Nova 3D Seismic Survey, WA 442-NT/P81, Joseph Bonaparte Gulf	2013/6820	Referral Decision	Completed
Pilot Appraisal Well - Torosa South-1	2008/3985	Referral Decision	Completed
Puffin South-West Development of Oil Reserves	2007/3834	Referral Decision	Completed
Seismic Data Acquisition, Browse Basin	2010/5475	Referral Decision	Completed

Key Ecological Features [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Ancient coastline at 125 m depth contour	North-west

Name	Region
Ashmore Reef and Cartier Island and surrounding Commonwealth waters	North-west
Carbonate bank and terrace system of the Sahul Shelf	North-west
Carbonate bank and terrace system of the Van Diemen Rise	North
Continental Slope Demersal Fish Communities	North-west
Pinnacles of the Bonaparte Basin	North-west
Pinnacles of the Bonaparte Basin	North
Seringapatam Reef and Commonwealth waters in the Scott Reef Complex	North-west
Shelf break and slope of the Arafura Shelf	North

Biologically Important Areas		[Resource Information]
Scientific Name	Behaviour	Presence
Dolphins		
Orcaella heinsohni Australian Snubfin Dolphin [81322]	Breeding	Known to occur
Orcaella heinsohni Australian Snubfin Dolphin [81322]	Calving	Known to occur
Orcaella heinsohni Australian Snubfin Dolphin [81322]	Foraging	Known to occur
Orcaella heinsohni Australian Snubfin Dolphin [81322]	Foraging (high density prey)	Known to occur
Orcaella heinsohni Australian Snubfin Dolphin [81322]	Resting	Known to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Breeding	Likely to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Breeding	Known to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Calving	Likely to occur

Scientific Name	Behaviour	Presence
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Calving	Known to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Foraging	Known to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Foraging	Likely to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Foraging (high density prey)	Likely to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Foraging (high density prey)	Known to occur
Tursiops aduncus Indo-Pacific/Spotted Bottlenose Dolphin [68418]	Breeding	Known to occur
Marine Turtles		
Caretta caretta Loggerhead Turtle [1763]	Foraging	Known to occur
Chelonia mydas Green Turtle [1765]	Foraging	Likely to occur
Chelonia mydas Green Turtle [1765]	Foraging	Known to occur
Chelonia mydas Green Turtle [1765]	Internesting	Likely to occur
Chelonia mydas Green Turtle [1765]	Internesting buffer	Known to occur
Chelonia mydas Green Turtle [1765]	Internesting buffer	Likely to occur
Chelonia mydas Green Turtle [1765]	Nesting	Known to occur
Chelonia mydas Green Turtle [1765]	Nesting	Likely to occur

Scientific Name	Behaviour	Presence
Eretmochelys imbricata Hawksbill Turtle [1766]	Foraging	Likely to occur
Eretmochelys imbricata Hawksbill Turtle [1766]	Internesting	Likely to occur
Eretmochelys imbricata Hawksbill Turtle [1766]	Internesting buffer	Known to occur
Eretmochelys imbricata Hawksbill Turtle [1766]	Internesting buffer	Likely to occur
Lepidochelys olivacea Olive Ridley Turtle [1767]	Foraging	Likely to occur
Lepidochelys olivacea Olive Ridley Turtle [1767]	Foraging	Known to occur
Lepidochelys olivacea Olive Ridley Turtle [1767]	Internesting	Likely to occur
Natator depressus Flatback Turtle [59257]	Foraging	Known to occur
Natator depressus Flatback Turtle [59257]	Internesting	Likely to occur
Natator depressus Flatback Turtle [59257]	Internesting buffer	Known to occur
Natator depressus Flatback Turtle [59257]	Nesting	Known to occur
Seabirds		
Ardenna tenuirostris Short-tailed Shearwater [84292]	Breeding	Known to occur
Fregata ariel Lesser Frigatebird [1012]	Breeding	Known to occur
Fregata minor Greater Frigatebird [1013]	Breeding	Known to occur
Phaethon lepturus White-tailed Tropicbird [1014]	Breeding	Known to occur

Scientific Name	Behaviour	Presence
Sterna dougallii Roseate Tern [817]	Breeding	Known to occur
Sternula albifrons sinensis Little Tern [82850]	Breeding	Known to occur
Sternula albifrons sinensis Little Tern [82850]	Resting	Known to occur
Sula leucogaster Brown Booby [1022]	Breeding	Known to occur
Sula sula Red-footed Booby [1023]	Breeding	Known to occur
Thalasseus bengalensis Lesser Crested Tern [66546]	Breeding	Known to occur
Thalasseus bergii Crested Tern [83000]	Breeding (high numbers)	Known to occur
Sharks		
Rhincodon typus Whale Shark [66680]	Foraging	Known to occur
Whales		
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging	Known to occur
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Migration	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Calving	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Migration	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Nursing	Known to occur

Scientific Name	Behaviour	Presence
Megaptera novaeangliae		
Humpback Whale [38]	Resting	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data is available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on the contents of this report.

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions when time permits.

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded breeding sites; and
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

© Commonwealth of Australia
Department of Climate Change, Energy, the Environment and Water
GPO Box 3090
Canberra ACT 2601 Australia
+61 2 6274 1111

Appendix D Aboriginal cultural heritage searches

Aboriginal Cultural Heritage Inquiry System

List of Aboriginal Cultural Heritage (ACH) Register

For further important information on using this information please see the WA.gov.au website's Terms of Use at https://www.wa.gov.au/terms-of-use

Search Criteria

57 Aboriginal Cultural Heritage (ACH) Register in Shapefile - MAQ1224J_SMOOTHED_EOS_EMBA. Warning: Search area complex so results may be inaccurate. Contact DPLH for assistance.

Disclaimer

Aboriginal heritage holds significant value to Aboriginal people for their social, spiritual, historical, scientific, or aesthetic importance within Aboriginal traditions, and provides an essential link for Aboriginal people to their past, present and future. In Western Australia Aboriginal heritage is protected under the *Aboriginal Heritage Act 1972*.

All Aboriginal cultural heritage in Western Australia is protected, whether or not the ACH has been reported or exists on the Register.

The information provided is made available in good faith and is predominately based on the information provided to the Department of Planning, Lands and Heritage by third parties. The information is provided solely on the basis that readers will be responsible for making their own assessment as to the accuracy of the information. If you find any errors or omissions in our records, including our maps, it would be appreciated if you provide the details to the Department via https://achknowledge.dplh.wa.gov.au/ach-enquiry-form and we will make every effort to rectify it as soon as possible.

Copyright

Copyright in the information contained herein is and shall remain the property of the State of Western Australia. All rights reserved. This includes, but is not limited to, information from the Register established and maintained under the *Aboriginal Heritage Act 1972*.

Location information data licensed from Western Australian Land Information Authority (WALIA) trading as Landgate. Copyright in the location information data remains with WALIA. WALIA does not warrant the accuracy or completeness of the location information data or its suitability for any particular purpose.

For further important information on using this information please see the WA.gov.au website's Terms of Use at https://www.wa.gov.au/terms-of-use

Terminology

ID: ACH on the Register is assigned a unique ID by the Department of Planning, Lands and Heritage using the format: ACH-00000001. For ACH on the former Register the ID numbers remain unchanged and use the new format. For example the ACH ID of the place Swan River was previously '3536' and is now 'ACH-00003536'.

Access and Restrictions:

- **Boundary Reliable (Yes/No):** Indicates whether to the best knowledge of the Department, the location and extent of the ACH boundary is considered reliable.
- **Boundary Restricted = No:** Represents the actual location of the ACH as understood by the Department..
- **Boundary Restricted = Yes:** To preserve confidentiality the exact location and extent of the place is not displayed on the map. However, the shaded region (generally with an area of at least 4km²) provides a general indication of where the ACH is located. If you are a landowner and wish to find out more about the exact location of the place, please contact the Department of Planning, Lands and Heritage.
- **Culturally Sensitive = No:** Availability of information that the Department of Planning, Lands and Heritage holds in relation to the ACH is not restricted in any way.
- **Culturally Sensitive = Yes:** Some of the information that the Department of Planning, Lands and Heritage holds in relation to the ACH is restricted if it is considered culturally sensitive information. This information will only be made available if the Department of Planning, Lands and Heritage receives written approval from the people who provided the information. To request access please contact via https://achknowledge.dplh.wa.gov.au/ach-enquiry-form.
- **Culturally Sensitive Nature:**
  - **No Gender / Initiation Restrictions:** *Anyone* can view the information.
  - **Men only:** Only *males* can view restricted information.
  - **Women only:** Only *females* can view restricted information.

Status:

- **Register:** Aboriginal cultural heritage places that are assessed as meeting Section 5 of the *Aboriginal Heritage Act 1972*.
- **Lodged:** Information which has been received in relation to an Aboriginal cultural heritage place, but is yet to be assessed under Section 5 of the *Aboriginal Heritage Act 1972.*
- **Historic:** Aboriginal heritage places assessed as not meeting the criteria of Section 5 of the *Aboriginal Heritage Act 1972*. Includes places that no longer exist as a result of land use activities with existing approvals.

Place Type: The type of Aboriginal cultural heritage place. For example an artefact scatter place or engravings place.

Legacy ID: This is the former unique number that the former Department of Aboriginal Sites assigned to the place.

Aboriginal Cultural Heritage Inquiry System

List of Aboriginal Cultural Heritage (ACH) Register

For further important information on using this information please see the WA.gov.au website's Terms of Use at https://www.wa.gov.au/terms-of-use

ID	Name	Boundary Restricted	Boundary Reliable	Culturally Sensitive	Culturally Sensitive Nature	Status	Place Type	Knowledge Holders	Legacy ID
12705	BIGGE ISLAND	Yes	Yes	Yes	No Gender / Initiation Restrictions	Register	Painting	*Registered Knowledge Holder names available from DPLH	K02541
12720	DULI CAVE.	No	No	No	No Gender / Initiation Restrictions	Register	Camp; Ritual / Ceremonial; Creation / Dreaming Narrative; Rock Shelter	*Registered Knowledge Holder names available from DPLH	K02503
12722	DIDJI POINT.	No	No	No	No Gender / Initiation Restrictions	Register	Creation / Dreaming Narrative; Traditional Structure	*Registered Knowledge Holder names available from DPLH	K02505
12725	DIDJI WELLS.	No	No	No	No Gender / Initiation Restrictions	Register	Creation / Dreaming Narrative; Water Source	*Registered Knowledge Holder names available from DPLH	K02508
12726	CASSINI STONE LINE	No	Yes	No	No Gender / Initiation Restrictions	Register	Creation / Dreaming Narrative; Traditional Structure	*Registered Knowledge Holder names available from DPLH	K02509
12727	CASSINI STONE CIRCLES	No	No	No	No Gender / Initiation Restrictions	Register	Creation / Dreaming Narrative; Traditional Structure	*Registered Knowledge Holder names available from DPLH	K02510
12737	BURRUNUNGU.	Yes	Yes	Yes	No Gender / Initiation Restrictions	Register	Burial; Camp; Ritual / Ceremonial; Creation / Dreaming Narrative; Engraving; Grinding areas / Grooves; Midden; Painting; Repository / Storage Place	*Registered Knowledge Holder names available from DPLH	K02466
12738	GANGGARRYU	Yes	Yes	Yes	No Gender / Initiation Restrictions	Register	Ritual / Ceremonial; Creation / Dreaming Narrative; Other	*Registered Knowledge Holder names available from DPLH	K02467
12785	NGARRMU/NGARRMIYU .	Yes	Yes	Yes	No Gender / Initiation Restrictions	Register	Artefacts / Scatter; Ritual / Ceremonial; Creation / Dreaming Narrative; Hunting Place; Midden; Other; Repository / Storage Place	*Registered Knowledge Holder names available from DPLH	K02461
12787	WUNDARRI.	Yes	Yes	Yes	No Gender / Initiation Restrictions	Register	Artefacts / Scatter; Camp; Ritual / Ceremonial; Creation / Dreaming Narrative; Hunting Place; Midden; Other; Quarry; Water Source	*Registered Knowledge Holder names available from DPLH	K02463
12789	BALU-GUNANJARR COMPLEX.	Yes	Yes	Yes	No Gender / Initiation Restrictions	Register	Burial; Ritual / Ceremonial; Creation / Dreaming Narrative; Engraving; Grinding areas / Grooves; Hunting Place; Midden; Painting; Repository / Storage Place	*Registered Knowledge Holder names available from DPLH	K02465
12883	REVELEY ISLAND MIDDEN	No	No	No	No Gender / Initiation Restrictions	Register	Midden	*Registered Knowledge Holder names available from DPLH	K02342
13006	BERKELEY RIVER DUNES	Yes	No	Yes	No Gender / Initiation Restrictions	Register	Creation / Dreaming Narrative	*Registered Knowledge Holder names available from DPLH	K02198

Aboriginal Cultural Heritage Inquiry System

List of Aboriginal Cultural Heritage (ACH) Register

For further important information on using this information please see the WA.gov.au website's Terms of Use at https://www.wa.gov.au/terms-of-use

ID	Name	Boundary Restricted	Boundary Reliable	Culturally Sensitive	Culturally Sensitive Nature	Status	Place Type	Knowledge Holders	Legacy ID
13007	REVELEY ISLAND MIDDEN	No	No	No	No Gender / Initiation Restrictions	Register	Midden	*Registered Knowledge Holder names available from DPLH	K02199
13596	DAVIDSONS POINT	No	Yes	No	No Gender / Initiation Restrictions	Register	Traditional Structure	*Registered Knowledge Holder names available from DPLH	K01555
13845	PELICAN ISLET 1	No	Yes	No	No Gender / Initiation Restrictions	Register	Engraving	*Registered Knowledge Holder names available from DPLH	K01277
14454	CORNEILLE ISLAND 13	No	Yes	No	No Gender / Initiation Restrictions	Register	Traditional Structure	*Registered Knowledge Holder names available from DPLH	K00619
14455	CORNEILLE ISLAND 14	No	Yes	No	No Gender / Initiation Restrictions	Register	Traditional Structure; Other	*Registered Knowledge Holder names available from DPLH	K00620
14505	CORNEILLE ISLAND 1	No	No	No	No Gender / Initiation Restrictions	Register	Traditional Structure; Other	*Registered Knowledge Holder names available from DPLH	K00551
14506	CORNEILLE ISLAND 2	No	No	No	No Gender / Initiation Restrictions	Register	Traditional Structure; Other	*Registered Knowledge Holder names available from DPLH	K00552
14507	CORNEILLE ISLAND 3	No	No	No	No Gender / Initiation Restrictions	Register	Traditional Structure; Other	*Registered Knowledge Holder names available from DPLH	K00553
14508	CORNEILLE ISLAND 4	No	No	No	No Gender / Initiation Restrictions	Register	Traditional Structure; Midden; Modified Tree; Other	*Registered Knowledge Holder names available from DPLH	K00554
14509	CORNEILLE ISLAND 5	No	No	No	No Gender / Initiation Restrictions	Register	Traditional Structure; Midden; Modified Tree; Other	*Registered Knowledge Holder names available from DPLH	K00555
14510	CORNEILLE ISLAND 6	No	No	No	No Gender / Initiation Restrictions	Register	Engraving; Traditional Structure; Modified Tree; Other	*Registered Knowledge Holder names available from DPLH	K00556
14511	CORNEILLE ISLAND 7	No	No	No	No Gender / Initiation Restrictions	Register	Traditional Structure; Other	*Registered Knowledge Holder names available from DPLH	K00557
14512	CORNEILLE ISLAND 8	No	No	No	No Gender / Initiation Restrictions	Register	Traditional Structure; Other	*Registered Knowledge Holder names available from DPLH	K00558
14513	CORNEILLE ISLAND 9	No	No	No	No Gender / Initiation Restrictions	Register	Traditional Structure; Midden; Other	*Registered Knowledge Holder names available from DPLH	K00559
14514	CORNEILLE ISLAND 10	No	No	No	No Gender / Initiation Restrictions	Register	Engraving	*Registered Knowledge Holder names available from DPLH	K00560
14515	CORNEILLE ISLAND 11/KUMBURR	No	No	No	No Gender / Initiation Restrictions	Register	Creation / Dreaming Narrative	*Registered Knowledge Holder names available from DPLH	K00561
14516	CORNEILLE ISLAND 12	No	No	No	No Gender / Initiation Restrictions	Register	Engraving; Traditional Structure	*Registered Knowledge Holder names available from DPLH	K00562

Aboriginal Cultural Heritage Inquiry System

List of Aboriginal Cultural Heritage (ACH) Register

For further important information on using this information please see the WA.gov.au website's Terms of Use at https://www.wa.gov.au/terms-of-use

ID	Name	Boundary Restricted	Boundary Reliable	Culturally Sensitive	Culturally Sensitive Nature	Status	Place Type	Knowledge Holders	Legacy ID
14552	PARRY ISLAND CROCODILE.	Yes	Yes	Yes	No Gender / Initiation Restrictions	Register	Sub surface cultural material; Creation / Dreaming Narrative; Painting	*Registered Knowledge Holder names available from DPLH	K00545
14556	NGAMILI, CONDILLAC ISLAND	Yes	No	Yes	No Gender / Initiation Restrictions	Register	Creation / Dreaming Narrative	*Registered Knowledge Holder names available from DPLH	K00549
14791	WOGU WOGU ISLAND 1.	No	Yes	No	No Gender / Initiation Restrictions	Register	Camp; Traditional Structure	*Registered Knowledge Holder names available from DPLH	K00260
14793	VANSITTART BAY 1-3	Yes	No	Yes	No Gender / Initiation Restrictions	Register	Creation / Dreaming Narrative; Painting	*Registered Knowledge Holder names available from DPLH	K00262
14794	CHALANGDAL, VANSITTART BAY	Yes	No	Yes	No Gender / Initiation Restrictions	Register	Creation / Dreaming Narrative; Painting	*Registered Knowledge Holder names available from DPLH	K00263
14796	ECLIPSE ISLANDS	No	No	No	No Gender / Initiation Restrictions	Register	Quarry	*Registered Knowledge Holder names available from DPLH	K00265
14797	SIR GRAHAM MOORE ISLANDS	Yes	Yes	Yes	No Gender / Initiation Restrictions	Register	Ritual / Ceremonial; Creation / Dreaming Narrative; Traditional Structure	*Registered Knowledge Holder names available from DPLH	K00266
14798	SIR GRAHAM MOORE ISLANDS	Yes	Yes	Yes	No Gender / Initiation Restrictions	Register	Burial; Traditional Structure	*Registered Knowledge Holder names available from DPLH	K00267
14799	ANJO PENNINSULA	Yes	Yes	Yes	No Gender / Initiation Restrictions	Register	Burial	*Registered Knowledge Holder names available from DPLH	K00268
14800	GALNGAURU	Yes	No	Yes	No Gender / Initiation Restrictions	Register	Burial; Creation / Dreaming Narrative; Painting	*Registered Knowledge Holder names available from DPLH	K00269
14802	KAREN, ADMIRALTY GULF	Yes	No	Yes	No Gender / Initiation Restrictions	Register	Creation / Dreaming Narrative; Painting	*Registered Knowledge Holder names available from DPLH	K00271
14808	UNGGALU IS., PARRY HARBOUR	No	Yes	No	No Gender / Initiation Restrictions	Register	Creation / Dreaming Narrative	*Registered Knowledge Holder names available from DPLH	K00277
14817	PARRY HARBOUR	No	No	No	No Gender / Initiation Restrictions	Register	Engraving	*Registered Knowledge Holder names available from DPLH	K00233
14818	PARRY ISLAND,ADMIRLTY GULF.	No	No	No	No Gender / Initiation Restrictions	Register	Artefacts / Scatter; Camp; Painting	*Registered Knowledge Holder names available from DPLH	K00234
14823	NGALUMAL GUDANGARI.	Yes	Yes	Yes	No Gender / Initiation Restrictions	Register	Camp; Ritual / Ceremonial; Creation / Dreaming Narrative	*Registered Knowledge Holder names available from DPLH	K00239
14830	WADAI/ RED ISLAND.	Yes	Yes	Yes	No Gender / Initiation Restrictions	Register	Camp; Creation / Dreaming Narrative	*Registered Knowledge Holder names available from DPLH	K00246

Aboriginal Cultural Heritage Inquiry System

List of Aboriginal Cultural Heritage (ACH) Register

For further important information on using this information please see the WA.gov.au website's Terms of Use at https://www.wa.gov.au/terms-of-use

ID	Name	Boundary Restricted	Boundary Reliable	Culturally Sensitive	Culturally Sensitive Nature	Status	Place Type	Knowledge Holders	Legacy ID
14840	WOGU WOGU ISLAND 2	No	Yes	No	No Gender / Initiation Restrictions	Register	Traditional Structure	*Registered Knowledge Holder names available from DPLH	K00256
14929	ALBERT ISLAND	No	No	No	No Gender / Initiation Restrictions	Register	Engraving	*Registered Knowledge Holder names available from DPLH	K00131
14930	SOUTH MARET ISLAND	No	Yes	No	No Gender / Initiation Restrictions	Register	Traditional Structure	*Registered Knowledge Holder names available from DPLH	K00132
14934	WEST MONTALIVET ISLAND	Yes	No	Yes	No Gender / Initiation Restrictions	Register	Creation / Dreaming Narrative; Traditional Structure; Painting	*Registered Knowledge Holder names available from DPLH	K00136
14935	PRUDHOE ISLAND.	Yes	No	Yes	No Gender / Initiation Restrictions	Register	Ritual / Ceremonial; Creation / Dreaming Narrative; Engraving; Hunting Place	*Registered Knowledge Holder names available from DPLH	K00137
14936	EAST MONTALIVET ISLAND	No	No	No	No Gender / Initiation Restrictions	Register	Traditional Structure	*Registered Knowledge Holder names available from DPLH	K00138
14937	EAST MONTALIVET ISLAND	No	No	No	No Gender / Initiation Restrictions	Register	Traditional Structure	*Registered Knowledge Holder names available from DPLH	K00139
14940	CAPE VOLTAIRE	Yes	No	Yes	No Gender / Initiation Restrictions	Register	Creation / Dreaming Narrative; Painting	*Registered Knowledge Holder names available from DPLH	K00142
14971	BADANBIRI CLIFFS	Yes	No	Yes	No Gender / Initiation Restrictions	Register	Creation / Dreaming Narrative	*Registered Knowledge Holder names available from DPLH	K00173
14973	DIDJINA	Yes	Yes	Yes	No Gender / Initiation Restrictions	Register	Ritual / Ceremonial; Creation / Dreaming Narrative; Engraving; Traditional Structure	*Registered Knowledge Holder names available from DPLH	K00175
14975	GUBARO REEF	Yes	Yes	Yes	No Gender / Initiation Restrictions	Register	Ritual / Ceremonial; Creation / Dreaming Narrative	*Registered Knowledge Holder names available from DPLH	K00177

Aboriginal Cultural Heritage Inquiry System

List of Aboriginal Cultural Heritage (ACH) Lodged

For further important information on using this information please see the WA.gov.au website's Terms of Use at https://www.wa.gov.au/terms-of-use

Search Criteria

49 Aboriginal Cultural Heritage (ACH) Lodged in Shapefile - MAQ1224J_SMOOTHED_EOS_EMBA. Warning: Search area complex so results may be inaccurate. Contact DPLH for assistance.

Disclaimer

Aboriginal heritage holds significant value to Aboriginal people for their social, spiritual, historical, scientific, or aesthetic importance within Aboriginal traditions, and provides an essential link for Aboriginal people to their past, present and future. In Western Australia Aboriginal heritage is protected under the Aboriginal Heritage Act 1972.

All Aboriginal cultural heritage in Western Australia is protected, whether or not the ACH has been reported or exists on the Register.

The information provided is made available in good faith and is predominately based on the information provided to the Department of Planning, Lands and Heritage by third parties. The information is provided solely on the basis that readers will be responsible for making their own assessment as to the accuracy of the information. If you find any errors or omissions in our records, including our maps, it would be appreciated if you provide the details to the Department via https://achknowledge.dplh.wa.gov.au/ach-enquiry-form and we will make every effort to rectify it as soon as possible.

Copyright

Copyright in the information contained herein is and shall remain the property of the State of Western Australia. All rights reserved. This includes, but is not limited to, information from the Register established and maintained under the Aboriginal Heritage Act 1972.

Location information data licensed from Western Australian Land Information Authority (WALIA) trading as Landgate. Copyright in the location information data remains with WALIA. WALIA does not warrant the accuracy or completeness of the location information data or its suitability for any particular purpose.

For further important information on using this information please see the WA.gov.au website's Terms of Use at https://www.wa.gov.au/terms-of-use

Terminology

ID: ACH on the Register is assigned a unique ID by the Department of Planning, Lands and Heritage using the format: ACH-00000001. For ACH on the former Register the ID numbers remain unchanged and use the new format. For example the ACH ID of the place Swan River was previously '3536' and is now 'ACH-00003536'.

Access and Restrictions:

- Boundary Reliable (Yes/No): Indicates whether to the best knowledge of the Department, the location and extent of the ACH boundary is considered reliable.
- Boundary Restricted = No: Represents the actual location of the ACH as understood by the Department..
- Boundary Restricted = Yes: To preserve confidentiality the exact location and extent of the place is not displayed on the map. However, the shaded region (generally with an area of at least 4km²) provides a general indication of where the ACH is located. If you are a landowner and wish to find out more about the exact location of the place, please contact the Department of Planning, Lands and Heritage.
- Culturally Sensitive = No: Availability of information that the Department of Planning, Lands and Heritage holds in relation to the ACH is not restricted in any way.
- Culturally Sensitive = Yes: Some of the information that the Department of Planning, Lands and Heritage holds in relation to the ACH is restricted if it is considered culturally sensitive information. This information will only be made available if the Department of Planning, Lands and Heritage receives written approval from the people who provided the information. To request access please contact via https://achknowledge.dplh.wa.gov.au/ach-enquiry-form.
- Culturally Sensitive Nature:
  - No Gender / Initiation Restrictions: Anyone can view the information.
  - Men only: Only males can view restricted information.
  - Women only: Only females can view restricted information.

Status:

- Register: Aboriginal cultural heritage places that are assessed as meeting Section 5 of the Aboriginal Heritage Act 1972.
- Lodged: Information which has been received in relation to an Aboriginal cultural heritage place, but is yet to be assessed under Section 5 of the Aboriginal Heritage Act 1972.
- Historic: Aboriginal heritage places assessed as not meeting the criteria of Section 5 of the Aboriginal Heritage Act 1972. Includes places that no longer exist as a result of land use activities with existing approvals.

Place Type: The type of Aboriginal cultural heritage place. For example an artefact scatter place or engravings place.

Legacy ID: This is the former unique number that the former Department of Aboriginal Sites assigned to the place.

Aboriginal Cultural Heritage Inquiry System

List of Aboriginal Cultural Heritage (ACH) Lodged

For further important information on using this information please see the WA.gov.au website's Terms of Use at https://www.wa.gov.au/terms-of-use

ID	Name	Boundary Restricted	Boundary Reliable	Culturally Sensitive	Culturally Sensitive Nature	Status	Place Type	Knowledge Holders	Legacy ID
12657	GALE ISLAND SOUTH WEST	No	No	No	No Gender / Initiation Restrictions	Lodged	Traditional Structure	*Registered Knowledge Holder names available from DPLH	
12659	BERNOUILLI ISLAND NORTH	No	No	No	No Gender / Initiation Restrictions	Lodged	Traditional Structure	*Registered Knowledge Holder names available from DPLH	
12660	BERNOUILLI ISLAND NORTHEAST	No	No	No	No Gender / Initiation Restrictions	Lodged	Traditional Structure	*Registered Knowledge Holder names available from DPLH	
12673	DESAIX ISLANDS NORTH	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Traditional Structure	*Registered Knowledge Holder names available from DPLH	
12702	BUFFON ISLAND	No	No	No	No Gender / Initiation Restrictions	Lodged	Traditional Structure	*Registered Knowledge Holder names available from DPLH	
12703	DESFONTAINES ISLAND NORTH	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Traditional Structure	*Registered Knowledge Holder names available from DPLH	
12704	FONTANES ISLAND	No	No	No	No Gender / Initiation Restrictions	Lodged	Traditional Structure	*Registered Knowledge Holder names available from DPLH	
12706	BIGGE ISLAND	No	No	No	No Gender / Initiation Restrictions	Lodged	Traditional Structure	*Registered Knowledge Holder names available from DPLH	
12707	EAST MONTALIVET ISLAND	No	No	No	No Gender / Initiation Restrictions	Lodged	Traditional Structure	*Registered Knowledge Holder names available from DPLH	
12708	KERAUDREN ISLAND	No	No	No	No Gender / Initiation Restrictions	Lodged	Traditional Structure	*Registered Knowledge Holder names available from DPLH	
12709	MALBY ISLAND	No	No	No	No Gender / Initiation Restrictions	Lodged	Traditional Structure	*Registered Knowledge Holder names available from DPLH	
12719	DULI COVE CAVES.	No	No	No	No Gender / Initiation Restrictions	Lodged	Sub surface cultural material; Artefacts / Scatter; Other	*Registered Knowledge Holder names available from DPLH	
12884	WHITE DUNES	Yes	No	Yes	No Gender / Initiation Restrictions	Lodged	Creation / Dreaming Narrative	*Registered Knowledge Holder names available from DPLH	
13462	DESAIX ISLANDS SOUTH	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Traditional Structure	*Registered Knowledge Holder names available from DPLH	
13595	GALE ISLAND EAST	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Traditional Structure	*Registered Knowledge Holder names available from DPLH	
13637	BERKELEY RIVER 11	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Midden	*Registered Knowledge Holder names available from DPLH	
13846	PELICAN ISLET 2	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Midden	*Registered Knowledge Holder names available from DPLH	

Aboriginal Cultural Heritage Inquiry System

List of Aboriginal Cultural Heritage (ACH) Lodged

For further important information on using this information please see the WA.gov.au website's Terms of Use at https://www.wa.gov.au/terms-of-use

ID	Name	Boundary Restricted	Boundary Reliable	Culturally Sensitive	Culturally Sensitive Nature	Status	Place Type	Knowledge Holders	Legacy ID
14504	CONDILLAC MIDDEN.	No	No	No	No Gender / Initiation Restrictions	Lodged	Camp; Midden	*Registered Knowledge Holder names available from DPLH	
14554	CHRISTMAS HARBOUR	No	No	No	No Gender / Initiation Restrictions	Lodged	Midden	*Registered Knowledge Holder names available from DPLH	
14555	KURRUNGU.	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Sub surface cultural material; Camp; Midden	*Registered Knowledge Holder names available from DPLH	
14790	WOGARAGAL.	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Camp	*Registered Knowledge Holder names available from DPLH	
14792	AWADA.	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Camp	*Registered Knowledge Holder names available from DPLH	
14810	BADAMAI.	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Camp	*Registered Knowledge Holder names available from DPLH	
14816	GURARINGAI.	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Camp	*Registered Knowledge Holder names available from DPLH	
14820	KANAMBAI, PARRY HARBOUR.	No	No	No	No Gender / Initiation Restrictions	Lodged	Camp	*Registered Knowledge Holder names available from DPLH	
14821	DANDUL.	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Camp	*Registered Knowledge Holder names available from DPLH	
14822	WUNARAI, PARRY HARBOUR.	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Camp	*Registered Knowledge Holder names available from DPLH	
14824	YUMANGGU, PARRY HARBOUR.	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Camp	*Registered Knowledge Holder names available from DPLH	
14826	BIMALAL.	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Camp	*Registered Knowledge Holder names available from DPLH	
14827	YALALARA.	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Camp	*Registered Knowledge Holder names available from DPLH	
14828	MENGERINGAI.	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Camp	*Registered Knowledge Holder names available from DPLH	
14829	KUALA BAY 2.	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Artefacts / Scatter; Camp; Midden	*Registered Knowledge Holder names available from DPLH	
14831	RED ISLAND.	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Camp	*Registered Knowledge Holder names available from DPLH	
14832	MANDUREI.	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Camp	*Registered Knowledge Holder names available from DPLH	

Aboriginal Cultural Heritage Inquiry System

List of Aboriginal Cultural Heritage (ACH) Lodged

For further important information on using this information please see the WA.gov.au website's Terms of Use at https://www.wa.gov.au/terms-of-use

ID	Name	Boundary Restricted	Boundary Reliable	Culturally Sensitive	Culturally Sensitive Nature	Status	Place Type	Knowledge Holders	Legacy ID
14833	KAN MANDJI.	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Camp	*Registered Knowledge Holder names available from DPLH	
14834	LAININGAI 2	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Artefacts / Scatter; Midden	*Registered Knowledge Holder names available from DPLH	
14835	LANGU MANGEI.	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Camp; Traditional Structure	*Registered Knowledge Holder names available from DPLH	
14836	LAININGAI 1.	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Camp; Midden	*Registered Knowledge Holder names available from DPLH	
14838	MANGU LIMBI.	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Camp	*Registered Knowledge Holder names available from DPLH	
14839	TROUGHTON ISLAND.	No	No	No	No Gender / Initiation Restrictions	Lodged	Camp	*Registered Knowledge Holder names available from DPLH	
14841	WARAMALANI.	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Camp	*Registered Knowledge Holder names available from DPLH	
14842	WALI PUANINGAI.	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Water Source	*Registered Knowledge Holder names available from DPLH	
14867	MALAPURU, PARRY HARBOUR.	No	No	No	No Gender / Initiation Restrictions	Lodged	Camp	*Registered Knowledge Holder names available from DPLH	
14869	DAIBI, PARRY HARBOUR.	No	No	No	No Gender / Initiation Restrictions	Lodged	Camp	*Registered Knowledge Holder names available from DPLH	
14952	CASSINI ISLAND	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Traditional Structure	*Registered Knowledge Holder names available from DPLH	
14974	KULU ISLAND/ HECLA ISLAND.	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Camp	*Registered Knowledge Holder names available from DPLH	
24152	Saltwater Country - reef sites and fish traps (Maret Island)	Yes	Yes	Yes	No Gender / Initiation Restrictions	Lodged	Sub surface cultural material; Camp; Ritual / Ceremonial; Creation / Dreaming Narrative; Fish Trap; Historical; Hunting Place; Meeting Place; Landscape / Seascape Feature; Ochre; Plant Resource; Rock Shelter; Shell; Water Source	*Registered Knowledge Holder names available from DPLH	
24153	Jaradanyingga - Jaajaal	Yes	Yes	Yes	No Gender / Initiation Restrictions	Lodged	Sub surface cultural material; Camp; Ritual / Ceremonial; Historical; Hunting Place; Meeting Place; Landscape / Seascape Feature; Ochre; Plant Resource; Quarry; Rock Shelter; Shell; Water Source	*Registered Knowledge Holder names available from DPLH	

Aboriginal Cultural Heritage Inquiry System

List of Aboriginal Cultural Heritage (ACH) Lodged

For further important information on using this information please see the WA.gov.au website's Terms of Use at https://www.wa.gov.au/terms-of-use

ID	Name	Boundary Restricted	Boundary Reliable	Culturally Sensitive	Culturally Sensitive Nature	Status	Place Type	Knowledge Holders	Legacy ID
34562	Wary Bay Bigge Island	No	Yes	No	No Gender / Initiation Restrictions	Lodged	Painting	*Registered Knowledge Holder names available from DPLH	

Appendix E Stakeholder consultation

Consultation efforts 2023 (multiple activities)

(Relevant persons consultation cover pages are now included)

Advertising

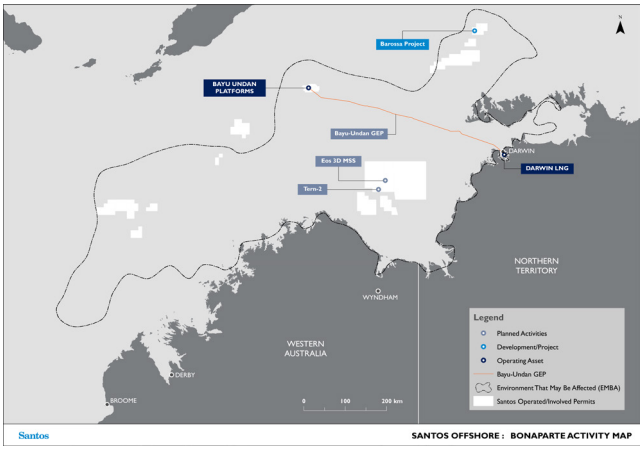
Santos

BONAPARTE BASIN ENVIRONMENT PLANS

Santos is now consulting with relevant persons whose functions, interests or activities may be affected by our proposed activities off Australia's northern coast.

Our proposed activities include:

- **Bayu-Undan to Darwin Gas Export Pipeline (GEP):** The Bayu-Undan GEP currently transports gas from the Bayu-Undan gas and condensate field in Timor-Leste waters to the Darwin liquefied natural gas plant. The Bayu-Undan field is approximately 500 km northwest of Darwin and is approaching the end of its commercially productive life. Santos will need to put the pipeline into a preserved state ahead of planned future use of the pipeline for carbon capture and storage (CCS) with preservation currently estimated from Q3 2024.
- **Eos 3D Marine Seismic Survey:** The Eos 3D marine seismic survey is required to identify subsea geological formations for the potential storage of greenhouse gases (Carbon Capture Storage - CCS). Potential storage at this location is not linked to the proposed Bayu-Undan CCS opportunity. The survey area is approximately 230 km west-south-west of Darwin. The survey is planned to take place from Q3 2024.
- **Tern-2 decommissioning:** Santos is planning to permanently plug and abandon the Tern-2 appraisal well and remove the wellhead. A contingency option to leave the wellhead in-situ could be actioned under ALARP principles, should operational challenges not permit the removal from taking place. Decommissioning activities will be vessel-based. The Tern-2 operational area is approximately 300 km from Darwin. The activity is planned for mid-2024.



The environment that may be affected (EMBA) by proposed activities

Santos is assessing the environmental impacts and risks of these activities, including to ecosystems (including people and communities), protected,significant, threatened and migratory fauna, natural and physical resources, the qualities and characteristics of locations, places and areas and the heritage value of places. This will include assessment of the social, economic and cultural features of the environment that may be affected (EMBA).

The map identifies activity locations and a consolidated EMBA for all proposed activities. The 'EMBA' represents the greatest spatial extent that could be affected by unplanned 'worst case' oil spill scenarios, noting that in the unlikely event of an oil spill, not all environmental, social, economic and cultural aspects would be affected.

Santos is proposing to implement measures to reduce the impacts and risks of the activity. It is a requirement under relevant environmental legislation that these impacts and risks are reduced to as low as reasonably practicable (ALARP) and to an acceptable level.

Consultation

Under environmental legislation, when Santos is preparing its environment plans for these activities, Santos is required to consult with people and organisations who have functions, interests or activities that may be affected. Such functions, interests or activities may include those arising in relation to spiritual or cultural connections to land and sea country in accordance with Indigenous tradition; tourism; recreational and commercial fishing; other commercial or recreational activities and local communities that might be affected by our proposed activities (these are examples and not an exhaustive list).

We welcome your feedback

If you think your functions, interests or activities may be affected by any of these activities, you may be a relevant person with whom Santos must consult.

We will use feedback from relevant persons to help us manage impacts and risks associated with these activities, ahead of submitting environment plans for each activity to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for assessment. NOPSEMA's acceptance of these plans is required before any of these activities can begin.

Factsheets are available for each activity, which includes information about planned activities, identified environmental, social, economic and cultural aspects within each EMBA and how we propose to manage impacts and risks.

Contact us

If you consider you may be a relevant person, please contact us as soon as possible to allow us to initiate consultation with you in relation to the proposed activity and so you can tell us how you would like to be consulted. Consultation closes on **Monday 27 November 2023.**

Santos is committed to undertaking genuine and meaningful consultation. We want to provide information for people to make informed assessments of the possible consequences of the proposed activity on them.

Your feedback is important to us, and input will be considered in the development of our environment plan.

Visit **santos.com/offshoreconsultation/bonaparte/**

Phone **1800 267 600**

Email **offshore.consultation@santos.com**

for more information, to self-identify as relevant person or to provide feedback.

Hostage roll call sparks rally tears

There were emotional scenes in Northbridge on Sunday as the names of Israeli kidnap victims were read out at a rally outside the Perth Cultural Centre.

The pro-Israel protest included guest speakers Liberal Senator Dean Smith and former State health minister Keith Wilson.

Member for Mt Lawley Simon Millman also addressed the crowd before delivering statements on behalf of Premier Roger Cook and Minister Tony Buti.

"Western Australians right across the State grieve alongside you as we grapple with the outrageous acts of terrorism and brutality submitted against Israel," Mr Millman said on behalf of the Premier.

Demonstrators read the names and ages of people held hostage by Hamas —bringing many in attendance to tears.

A proud member of Perth's Jewish community, Lisa Dare said she was in attendance to pay "tribute and respect".

"Both of my children were supposed to be going to Israel in the next month or two to learn and visit sacred sites, Ms Dare said.

"Unfortunately under the circumstances, they're not able to go and so they have grief because they are watching their brothers and sisters and many innocent people suffer. Our hearts are very heavy and we are hurting."

Israel enters 'second stage' of war & Netanyahu vows

'CLEAR GOAL ... DESTROY HAMAS'

NICK CRAVEN IN TEL AVIV

Israeli Prime Minister Benjamin Netanyahu says his forces have unleashed the second phase of the Gaza war as they press ground operations against Hamas militants, vowing to "destroy the enemy above ground and below ground".

Gaza's besieged people had barely any communication with the outside world as Israeli jets dropped more bombs on the Hamas-ruled Palestinian enclave and military chiefs said a long-threatened ground offensive was gearing up.

Speaking at a press conference in Tel Aviv, Mr Netanyahu warned the war would be "long and hard," reiterating Israel's appeal to Palestinian civilians to evacuate the northern Gaza Strip, where Israel was focusing its attack.

He vowed every effort would be made to rescue the more than 200 hostages held by Hamas.

"This is the second stage of the war whose goals are clear — to destroy Hamas' governing and military capabilities and to bring the hostages home," Mr Netanyahu said. "We are only at the start. We will destroy the enemy above ground and below ground."

BONAPARTE BASIN ENVIRONMENT PLANS

Santos

Santos is now consulting with relevant persons whose functions, interests or activities may be affected by our proposed activities off Australia's northern coast.

Our proposed activities include:

- **Bayu-Undan to Darwin Gas Export Pipeline (GEP):** The Bayu-Undan GEP currently transports gas from the Bayu-Undan gas and condensate field in Timor-Leste waters to the Darwin liquefied natural gas plant. The Bayu-Undan field is approximately 500 km northwest of Darwin and is approaching the end of its commercially productive life. Santos will need to put the pipeline into a preserved state ahead of planned future use of the pipeline for carbon capture and storage (CCS) with preservation currently estimated from Q3 2024.
- **Eos 3D Marine Seismic Survey:** The Eos 3D marine seismic survey is required to identify subsea geological formations for the potential storage of greenhouse gases (Carbon Capture Storage - CCS). Potential storage at this location is not linked to the proposed Bayu-Undan CCS opportunity. The survey area is approximately 230 km west-south-west of Darwin. The survey is planned to take place from Q3 2024.
- **Tern-2 decommissioning:** Santos is planning to permanently plug and abandon the Tern-2 appraisal well and remove the wellhead. A contingency option to leave the wellhead in-situ could be actioned under ALARP principles, should operational challenges not permit the removal from taking place. Decommissioning activities will be vessel-based. The Tern-2 operational area is approximately 300 km from Darwin. The activity is planned for mid-2024.

The environment that may be affected (EMBA) by proposed activities

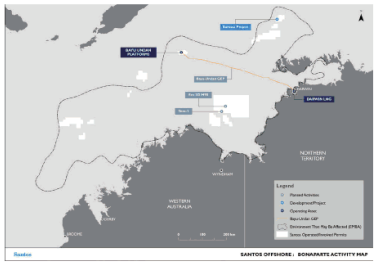
Santos is assessing the environmental impacts and risks of these activities, including to ecosystems (including people and communities), protected,significant, threatened and migratory fauna, natural and physical resources, the qualities and characteristics of locations, places and areas and the heritage value of places. This will include assessment of the social, economic and cultural features of the environment that may be affected (EMBA).

The map identifies activity locations and a consolidated EMBA for all proposed activities. The 'EMBA' represents the greatest spatial extent that could be affected by unplanned 'worst case' oil spill scenarios, noting that in the unlikely event of an oil spill, not all environmental, social, economic and cultural aspects would be affected.

Santos is proposing to implement measures to reduce the impacts and risks of the activity. It is a requirement under relevant environmental legislation that these impacts and risks are reduced to as low as reasonably practicable (ALARP) and to an acceptable level.

Consultation

Under environmental legislation, when Santos is preparing its environment plans for these activities, Santos is required to consult with people and organisations who have functions, interests or activities that may be affected. Such functions, interests or activities may include those arising in relation to spiritual or cultural connections to land and sea country in accordance with Indigenous tradition; tourism; recreational and commercial fishing; other commercial or recreational activities and local communities that might be affected by our proposed activities (these are examples and not an exhaustive list).



SANTOS OFFSHORE | BONAPARTE ACTIVITY MAP

We welcome your feedback

If you think your functions, interests or activities may be affected by any of these activities, you may be a relevant person with whom Santos must consult.

We will use feedback from relevant persons to help us manage impacts and risks associated with these activities, ahead of submitting environment plans for each activity to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for assessment. NOPSEMA's acceptance of these plans is required before any of these activities can begin.

Factsheets are available for each activity, which includes information about planned activities, identified environmental, social, economic and cultural aspects within each EMBA and how we propose to manage impacts and risks.

Contact us

If you consider you may be a relevant person, please contact us as soon as possible to allow us to initiate consultation with you in relation to the proposed activity and so you can tell us how you would like to be consulted. Consultation closes on **Monday 27 November 2023.**

Santos is committed to undertaking genuine and meaningful consultation. We want to provide information for people to make informed assessments of the possible consequences of the proposed activity on them.

Your feedback is important to us, and input will be considered in the development of our environment plan.

Visit **santos.com/offshoreconsultation/bonaparte/**
Phone **1800 267 600**
Email **offshore.consultation@santos.com**
for more information, to self-identify as relevant person or to provide feedback.

Knife key to car thefts

Fence cut and fuel siphoned

Staff at Sharma Auto Sales at Berrimah show the cyclone fence that was cut to allow thieves to drive away three vehicles.

Camden Smith

A black-handled knife could be a key clue as police investigate a break-in at a Darwin car trader and repair shop on Saturday.

At least three vehicles were driven out of Sharma Auto Sales in Moo St, Berrimah, on Saturday evening after intruders gained access and an exit by cutting a cyclone fence.

The three vehicles were a 2012 Toyota Prado, 2010 Ford XR6 and a 2008 Nissan Patrol believed to have had a total value of about $100,000.

An auto scanning tool was also removed.

Intruders spent about three hours at the premises using hoses to siphon fuel from other vehicles into the three cars they intended to steal.

It is the second time in a month the dealership and repair yard has been broken into, with intruders in September breaking in and taking selected auto parts, including an airbag module and entire car door.

Sharma Auto Sales co-owner Deepak Sharma said his team was still identifying what had been taken from the large auto-site but believed used cars, not customer cars, had been driven from the premises.

Mr Sharma said it was not clear what, if anything, the knife had been used for but he was certain the weapon was not in the caryard before Saturday's break-in.

He was checking on Sunday whether his insurance policy covered the latest thefts.

He said it appeared the intruders had cut lengths of hose obtained in the caryard to then siphon fuel from other cars into the vehicles they had chosen to steal from.

Like other business operators, he has grown disturbed at increasing crime making difficult economic conditions even more challenging.

"The Territory economy hasn't really been strong since Covid and these break-ins are another thing to deal with," Mr Sharma said.

He understood police had not attended his site hours after they were notified on Sunday because of chronic overwork. "They've got to prioritise," he said.

The Territory's latest police crime statistics showed a 12 per cent year-on-year increase in commercial crimes and a 15.23 per cent increase in motor vehicle theft in the year to September.

It is not the first time a business he has operated has been impacted by crime.

In 2021 the Outback Steaks and Curry co-owner told the NT News break-ins and lockdowns would force the premises to close, which it did.

Heatwave warning

The Bureau of Meteorology has issued a heatwave warning for parts of the NT, with maximum temperatures forecast in the high 30s, reaching about 40C away from the coast, and overnight minimums in the mid 20s.

Severe conditions will peak in Tiwi Islands, Daly and Arnhem districts late this week.

Teenagers in custody over theft

Three teens are in police custody while another has been served a warning after allegedly stealing a car in Darwin.

Northern Watch Commander Michael Budge said a Toyota Camry was stolen from Darwin's northern suburbs. An ankle monitor attached to one of the youths led police to find the group in Karama about 4am Sunday.

"We located four youths in a car and they were taken into custody," he said.

"Three of them remain in custody and will be charged with offences and the fourth was given a caution."

Mr Budge said the kids were aged between 13 and 16.

The youth that was given a warning had not been involved with any other offences before, Mr Budge said, while the other three were known to police.

BONAPARTE BASIN ENVIRONMENT PLANS

Santos

Santos is now consulting with relevant persons whose functions, interests or activities may be affected by our proposed activities off Australia's northern coast.

Our proposed activities include:

- **Bayu-Undan to Darwin Gas Export Pipeline (GEP):** The Bayu-Undan GEP currently transports gas from the Bayu-Undan gas and condensate field in Timor-Leste waters to the Darwin liquefied natural gas plant. The Bayu-Undan field is approximately 500 km northwest of Darwin and is approaching the end of its commercially productive life. Santos will need to put the pipeline into a preserved state ahead of planned future use of the pipeline for carbon capture and storage (CCS) with preservation currently estimated from Q3 2024.
- **Eos 3D Marine Seismic Survey:** The Eos 3D marine seismic survey is required to identify subsea geological formations for the potential storage of greenhouse gases (Carbon Capture Storage - CCS). Potential storage at this location is not linked to the proposed Bayu-Undan CCS opportunity. The survey area is approximately 230 km west-south-west of Darwin. The survey is planned to take place from Q3 2024.
- **Tern-2 decommissioning:** Santos is planning to permanently plug and abandon the Tern-2 appraisal well and remove the wellhead. A contingency option to leave the wellhead in-situ could be actioned under ALARP principles, should operational challenges not permit the removal from taking place. Decommissioning activities will be vessel-based. The Tern-2 operational area is approximately 300 km from Darwin. The activity is planned for mid-2024.

The environment that may be affected (EMBA) by proposed activities

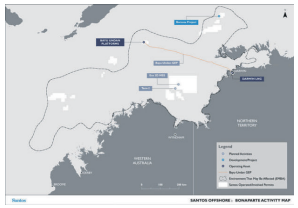
Santos is assessing the environmental impacts and risks of these activities, including to ecosystems (including people and communities), protected,significant, threatened and migratory fauna, natural and physical resources, the qualities and characteristics of locations, places and areas and the heritage value of places. This will include assessment of the social, economic and cultural features of the environment that may be affected (EMBA).

The map identifies activity locations and a consolidated EMBA for all proposed activities. The 'EMBA' represents the greatest spatial extent that could be affected by unplanned 'worst case' oil spill scenarios, noting that in the unlikely event of an oil spill, not all environmental, social, economic and cultural aspects would be affected.

Santos is proposing to implement measures to reduce the impacts and risks of the activity. It is a requirement under relevant environmental legislation that these impacts and risks are reduced to as low as reasonably practicable (ALARP) and to an acceptable level.

Consultation

Under environmental legislation, when Santos is preparing its environment plans for these activities, Santos is required to consult with people and organisations who have functions, interests or activities that may be affected. Such functions, interests or activities may include those arising in relation to spiritual or cultural connections to land and sea country in accordance with Indigenous tradition; tourism; recreational and commercial fishing; other commercial or recreational activities and local communities that might be affected by our proposed activities (these are examples and not an exhaustive list).



SANTOS OFFSHORE – BONAPARTE ACTIVITY MAP

We welcome your feedback

If you think your functions, interests or activities may be affected by any of these activities, you may be a relevant person with whom Santos must consult.

We will use feedback from relevant persons to help us manage impacts and risks associated with these activities, ahead of submitting environment plans for each activity to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for assessment. NOPSEMA's acceptance of these plans is required before any of these activities can begin.

Factsheets are available for each activity, which includes information about planned activities, identified environmental, social, economic and cultural aspects within each EMBA and how we propose to manage impacts and risks.

Contact us

If you consider you may be a relevant person, please contact us as soon as possible to allow us to initiate consultation with you in relation to the proposed activity and so you can tell us how you would like to be consulted. Consultation closes on **Monday 27 November 2023.**

Santos is committed to undertaking genuine and meaningful consultation. We want to provide information for people to make informed assessments of the possible consequences of the proposed activity on them.

Your feedback is important to us, and input will be considered in the development of our environment plan.

Visit **santos.com/offshoreconsultation/bonaparte/**
Phone **1800 267 600**
Email **offshore.consultation@santos.com**
for more information, to self-identify as relevant person or to provide feedback.

NTNE01Z01MA - V1

Coffee with your parcel?

Adella Beaini

Fancy a coffee with your parcel pick-up?

Baristas could soon become a permanent feature of post offices across the country, as the one-time thriving service looks for ways to stay profitable beyond the humble letter.

Australia Post is trialling a "concept store" in Orange, NSW, from Monday, which will look and feel more like a shopping mall than a package collection centre. Aside from brewing espressos, the store will sell a range of goods — from coats and jewellery to electronics, including the iPhone 15 — and offer change rooms for people to try on their online purchases.

It will also trial "digital queuing", where customers scan a QR code, select their service and receive a text message when it's their turn.

Dedicated lines for parcel delivery and for small business and separate lines of banking will be offered.

Australia Post's chief executive Paul Graham said the revamp was essential as the business grappled with the uneven conundrum of booming parcel deliveries and a decline in letters.

The company posted a $200m loss in the 2022-23 financial year, only the second loss since 1989.

"This has been a year in the making, and we've been looking at the overall format for our large network, both in terms of what we sell in those post offices, as well as the look and feel of them," he said.

"The community hub post is the ability for customers within regional towns to come in and have a one-stop shop to do the banking, pay their bills and also get access to a range of local products and general merchandising in their store."

Australia Post plans to open more community hub posts at Williamstown in Victoria, Burnie in Tasmania and Noosa Heads in Queensland in 2024.

Across Australia, there are 4271 post offices. Some metro stores will close in years to come once they are assessed as unsustainable.

Mr Graham told Senate estimates "it makes no sense for Australia Post to keep the same number of post offices".

NT economy trailing

But Defence investment provides boost for Territory

Camden Smith

Bill Yan.

The Northern Territory's economy remains the country's weakest with home prices falling, dwelling starts plummeting, housing finance tanking and vehicle registration the nation's lowest.

Construction work was 48.3 per cent down on the 10-year Territory average, housing finance down 10.4 per cent, dwelling starts down 51.4 per cent and home prices dropped 1.6 per cent in the September quarter.

CommSec's quarterly state-of-the-states report has again identified the NT as Australia's economic laggard and said the economy was heading backwards with a 2.4 per cent decline in economic growth.

The study found the Territory's economy came in eighth out of eight as Victoria, South Australia and NSW took the podium. But in a sign business is benefiting from the billions being injected into the Territory by Defence, equipment investment in the Territory was the nation's highest with a 26 per cent annual increase.

In a concession to the NT government, which has rejected the economic assessments because it said the 10-year-measure used figures from the Inpex boom which was a unique economic opportunity, CommSec has also introduced annual comparisons.

Despite this, the NT government dismissed the review.

"This has always been a deeply flawed report that does not accurately show how the Territory is performing compared to the rest of the nation - with comparing the Territory to the peak of the Inpex construction boom," it said.

Either way, the data showed the NT economy was struggling to compete for major projects and workers.

CommSec chief economist Craig James said a positive from the report was the rise in population growth from 0.34 per cent last year to 0.85.

Mr James also said the 3.9 per cent unemployment figure was in line with other jurisdictions..

"What every economy needs is a driver of growth whether it's a new project, more tourists coming through or more migrants settling," he said. The report identified relative population growth as a strength, with retail spending a major weakness with only a 0.3 per cent increase in the June quarter.

Shadow Treasurer Bill Yan said a CLP government would grow the economy.

"With stagnant population growth, lack of investment in the housing market and poor consumer confidence, the Territory could be facing even stronger economic headwinds," Mr Yan said.

Vien Lu, Grace Murphy and Sonny Tran the winning team Chow, taking out the grand prize in the Darwin International Laksa Festival. The 11 finalists' final dishes in 2023 Darwin Laksa Festival's golden bowl competition. Picture: Glenn Campbell

City favourite wins at Laksa Festival

Annabel Bowles

A Waterfront favourite has again been crowned the highly anticipated Golden Bowl winner in this year's Darwin International Laksa Festival.

Chow! took out the top gong at the festival finale's awards ceremony on Sunday evening, beating 10 other finalists, while the regional best laksa went to Thai De Cuisine in Alice Springs.

It comes after a record-breaking number of dishes and venues took part in the month-long festival, with more than 120 laksa and laksa-inspired dishes from 90 different venues.

People's Choice awards went to KOPI Stop and 168 Food Bar in the regional category – a second win with the Katherine eatery – while a "lucky laksa pizza" from Gorge Bush Retreat and Darwin Sailing Club's laksa-inspired mango crepe with housemade ice cream came out on top in the creative inspired-by category.

Almost 1800 players took part in the inaugural Laksa League game, tasting and rating dishes to earn points.

A participant by the username of jleight tasted more than 100 dishes from 99 different venues.

Chief Minister Natasha Fyles said the annual festival continued to be a hit.

Northern Territory Senior Sergeant Sandi Mellon (left) with Neil Mellon. Picture: Supplied

Cop 'too disturbed to be responsible for assault'

Zizi Averill

A top Territory cop has one last chance to prove she was too mentally disturbed to be legally responsible for assaulting and threatening to kill another person, the day after her husband was arrested.

NT Water Police Officer in Charge Senior Sergeant Sandilee Mellon faces five charges in relation to an incident in a Darwin home on August 26, 2022.

The Senior Sergeant allegedly trespassed and unlawfully entered a home before assaulting and making threats to kill another person.

The 46-year-old was also charged with disorderly behaviour and it will be alleged the obscene language was loud enough to be heard from the street.

This was the day after her husband and fellow officer Neil Mellon was arrested for unrelated conspiracy charges over the chopper crash which killed Outback Wrangler Chris 'Willow' Wilson.

Ms Mellon's charges do not relate to her husband's case.

On Thursday her barrister Luke Officer told Darwin Local Court that he was still attempting to change a mental health report which found she was responsible for her alleged actions.

"In his view the mental illness didn't materially contribute to the conduct," Mr Officer told the court.

Mr Officer said he was still waiting for a response from the Chief Psychiatrist, and prosecutor Caitlin Searle said it was "prudent for one last" mention.

Judge Ben O'Loughlin said he had written "in capitals 'last mention'" on her file, as after December 7 he would force the parties to go into a contested hearing.

V1 - NTNE01Z01MA

Fast chargers to electrify region

SARAH CRAWFORD

The day when road trippers will be cruising through Kununurra in Teslas instead of LandCruisers is getting closer with the opening of an electric vehicle fast-charging station.

The station at the Horizon Power depot on Messmate Way is the northernmost one on the WA EV Network.

Once completed, the WA EV Network will be the longest in Australia, stretching 7000km from Kununurra to Esperance and east to Kalgoorlie-Boulder and Eucla.

The stations have a 150kW fast charger that allows drivers to top up in just 20 minutes.

Currently the Kununurra station is still well out of range of the next fast-charging stop, 1099km away in Broome.

However, eight more high-powered charging stations are expected to be installed in Kimberley towns on Great Northern Highway by next dry season.

Until then, intrepid tourists can still top up using the smaller EV chargers at caravan parks and roadhouses along the way at Warmun, Halls Creek, Fitzroy Crossing and Derby, where charging will take hours.

The EV fast charging station in Exmouth. Picture: The Shire of Exmouth

Twenty minutes at the Kununurra fast charger will allow an EV to travel another 200km, and at a cost of 60¢ per kilowatt hour, it will be about $20.

Energy Minister Bill Johnston said WA's transition to a cleaner, greener, electric vehicle future was well under way.

"We are delighted Karratha, Exmouth and Kununurra have joined the WA EV Network, with many more fast-chargers opening soon," Mr Johnston said.

The WA EV Network is a $43.5 million project being delivered by Horizon Power and Synergy.

Once completed it will comprise 98 charging stations in 49 locations.

More than 3200 cars have charged up on the network since it went live in Geraldton in April.

In Kununurra, the Cambridge Hotel had an 11kW three-phase unit installed a year ago.

Cambridge Hotel CEO Mat Dear said Kununurra was the ideal place to charge up an EV as the town's primary source of power was hydro-electricity from Lake Argyle.

Cambridge Gulf Limited chief operating officer Mat Dear with one of their new 11kW, three-phase EV chargers.

Santos

BONAPARTE BASIN ENVIRONMENT PLANS

Santos is now consulting with relevant persons whose functions, interests or activities may be affected by our proposed activities off Australia's northern coast.

Our proposed activities include:

- **Bayu-Undan to Darwin Gas Export Pipeline (GEP):** The Bayu-Undan GEP currently transports gas from the Bayu-Undan gas and condensate field in Timor-Leste waters to the Darwin liquefied natural gas plant. The Bayu-Undan field is approximately 500 km northwest of Darwin and is approaching the end of its commercially productive life. Santos will need to put the pipeline into a preserved state ahead of planned future use of the pipeline for carbon capture and storage (CCS) with preservation currently estimated from Q3 2024.
- **Eos 3D Marine Seismic Survey:** The Eos 3D marine seismic survey is required to identify subsea geological formations for the potential storage of greenhouse gases (Carbon Capture Storage - CCS). Potential storage at this location is not linked to the proposed Bayu-Undan CCS opportunity. The survey area is approximately 230 km west-south-west of Darwin. The survey is planned to take place from Q3 2024.
- **Tern-2 decommissioning:** Santos is planning to permanently plug and abandon the Tern-2 appraisal well and remove the wellhead. A contingency option to leave the wellhead in-situ could be actioned under ALARP principles, should operational challenges not permit the removal from taking place. Decommissioning activities will be vessel-based. The Tern-2 operational area is approximately 300 km from Darwin. The activity is planned for mid-2024.

The environment that may be affected (EMBA) by proposed activities

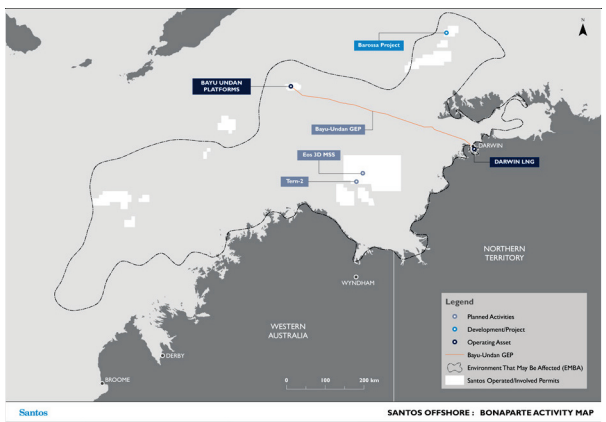
Santos is assessing the environmental impacts and risks of these activities, including to ecosystems (including people and communities), protected,significant, threatened and migratory fauna, natural and physical resources, the qualities and characteristics of locations, places and areas and the heritage value of places. This will include assessment of the social, economic and cultural features of the environment that may be affected (EMBA).

The map identifies activity locations and a consolidated EMBA for all proposed activities. The 'EMBA' represents the greatest spatial extent that could be affected by unplanned 'worst case' oil spill scenarios, noting that in the unlikely event of an oil spill, not all environmental, social, economic and cultural aspects would be affected.

Santos is proposing to implement measures to reduce the impacts and risks of the activity. It is a requirement under relevant environmental legislation that these impacts and risks are reduced to as low as reasonably practicable (ALARP) and to an acceptable level.

Consultation

Under environmental legislation, when Santos is preparing its environment plans for these activities, Santos is required to consult with people and organisations who have functions, interests or activities that may be affected. Such functions, interests or activities may include those arising in relation to spiritual or cultural connections to land and sea country in accordance with Indigenous tradition; tourism; recreational and commercial fishing; other commercial or recreational activities and local communities that might be affected by our proposed activities (these are examples and not an exhaustive list).



We welcome your feedback

If you think your functions, interests or activities may be affected by any of these activities, you may be a relevant person with whom Santos must consult.

We will use feedback from relevant persons to help us manage impacts and risks associated with these activities, ahead of submitting environment plans for each activity to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for assessment. NOPSEMA's acceptance of these plans is required before any of these activities can begin.

Factsheets are available for each activity, which includes information about planned activities, identified environmental, social, economic and cultural aspects within each EMBA and how we propose to manage impacts and risks.

Contact us

If you consider you may be a relevant person, please contact us as soon as possible to allow us to initiate consultation with you in relation to the proposed activity and so you can tell us how you would like to be consulted. Consultation closes on **Monday 27 November 2023.**

Santos is committed to undertaking genuine and meaningful consultation. We want to provide information for people to make informed assessments of the possible consequences of the proposed activity on them.

Your feedback is important to us, and input will be considered in the development of our environment plan.

Visit **santos.com/offshoreconsultation/bonaparte/**

Phone **1800 267 600**

Email **offshore.consultation@santos.com**

for more information, to self-identify as relevant person or to provide feedback.

Linton Sampi.
Picture: Facebook

Sampi pleads not guilty to killing partner

SARAH STEGER

A Broome man accused of killing his partner by running her over with a car while allegedly driving under the influence of alcohol has denied his guilt.

Linton Patrick Sampi, the cousin of former West Coast Eagle Ashley Sampi, pleaded not guilty to one count of manslaughter in Stirling Gardens Magistrates Court in Perth on Wednesday.

The 43-year-old allegedly was behind the wheel of his Holden Epica when the vehicle struck his partner Candice Shea at his D'Antoine Street home about 12.30am on March 17, 2022.

Ms Shea, who was in her 30s, died at the scene.

St John Ambulance confirmed paramedics were called to the scene but that the woman could not be saved.

At a previous hearing, the court was told Ms Shea had been lying in the driveway at the time of the incident and that her children and other family members were present. It was further alleged Mr Sampi had a blood alcohol reading of .204.

Mr Sampi was charged with one count of unlawfully killing another under such circumstances as not to constitute murder in April.

He was connected to the courtroom by video link from the Broome Courthouse.

Mr Sampi did not speak other than to enter his plea of not guilty. He is due back in court on December 4.

Bill double could affect frack plans

CAIN ANDREWS

Two Bills recently introduced in the Federal Parliament to close a legal loophole that enables gas corporations to drill without consideration for local water resources may affect projects in the Kimberley.

Not one but two Bills were introduced in Federal Parliament on October 16 to apply the water trigger to shale and tight gas fracking in WA and the Northern Territory.

The water trigger, which requires the Environment Minister to consider a project's impact on local water sources, currently only extends to coal seam gas projects.

Although most of the the commentary revolved around the Beetaloo Basin in the Northern Territory the Bills could also affect gas projects in the Kimberley's Canning Basin where fracking is a looming issue.

Independent MP Sophie Scamps introduced a Bill in the Lower House and Greens Senator Sarah Hanson-Young introduced another in the Upper House.

"There is a water trigger in the current laws, but it is very narrow and doesn't take into consideration unconventional gas and fracking," Senator Hanson-Young said at a press conference at Parliament House.

"We're worried this loophole is going to mean the big gas corporations who want to frack in the Northern Territory can get environmental approval without any consideration of the impacts those gas projects are going to have on the water they take and the land that they are on."

In the lead-up to the last election Federal Labor said they would extend the water trigger to shale gas by the end of 2023.

But with the end of the year rapidly approaching Environment Minister Tanya Plibersek said the passage of the Bill would have to wait until next year.

"We would welcome support, across party lines, to expedite our strong new laws through the Parliament next year," she said.

It comes as several exploration fracking proposals for the region have been submitted to the EPA in the years since the moratorium on fracking in the Kimberley was lifted in 2019.

BONAPARTE BASIN ENVIRONMENT PLANS

Santos

Santos is now consulting with relevant persons whose functions, interests or activities may be affected by our proposed activities off Australia's northern coast.

Our proposed activities include:

- **Bayu-Undan to Darwin Gas Export Pipeline (GEP):** The Bayu-Undan GEP currently transports gas from the Bayu-Undan gas and condensate field in Timor-Leste waters to the Darwin liquefied natural gas plant. The Bayu-Undan field is approximately 500 km northwest of Darwin and is approaching the end of its commercially productive life. Santos will need to put the pipeline into a preserved state ahead of planned future use of the pipeline for carbon capture and storage (CCS) with preservation currently estimated from Q3 2024.
- **Eos 3D Marine Seismic Survey:** The Eos 3D marine seismic survey is required to identify subsea geological formations for the potential storage of greenhouse gases (Carbon Capture Storage - CCS). Potential storage at this location is not linked to the proposed Bayu-Undan CCS opportunity. The survey area is approximately 230 km west-south-west of Darwin. The survey is planned to take place from Q3 2024.
- **Tern-2 decommissioning:** Santos is planning to permanently plug and abandon the Tern-2 appraisal well and remove the wellhead. A contingency option to leave the wellhead in-situ could be actioned under ALARP principles, should operational challenges not permit the removal from taking place. Decommissioning activities will be vessel-based. The Tern-2 operational area is approximately 300 km from Darwin. The activity is planned for mid-2024.

The environment that may be affected (EMBA) by proposed activities

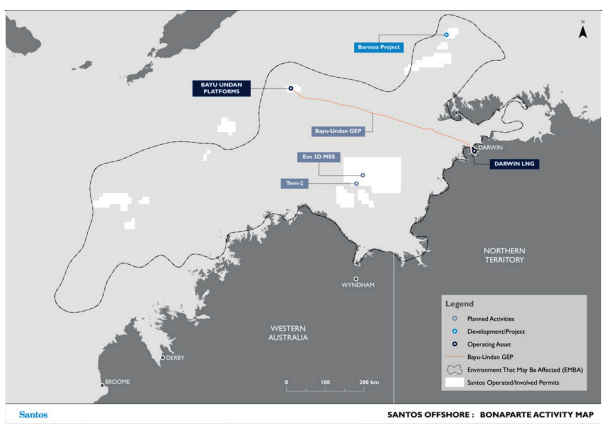
Santos is assessing the environmental impacts and risks of these activities, including to ecosystems (including people and communities), protected,significant, threatened and migratory fauna, natural and physical resources, the qualities and characteristics of locations, places and areas and the heritage value of places. This will include assessment of the social, economic and cultural features of the environment that may be affected (EMBA).

The map identifies activity locations and a consolidated EMBA for all proposed activities. The 'EMBA' represents the greatest spatial extent that could be affected by unplanned 'worst case' oil spill scenarios, noting that in the unlikely event of an oil spill, not all environmental, social, economic and cultural aspects would be affected.

Santos is proposing to implement measures to reduce the impacts and risks of the activity. It is a requirement under relevant environmental legislation that these impacts and risks are reduced to as low as reasonably practicable (ALARP) and to an acceptable level.

Consultation

Under environmental legislation, when Santos is preparing its environment plans for these activities, Santos is required to consult with people and organisations who have functions, interests or activities that may be affected. Such functions, interests or activities may include those arising in relation to spiritual or cultural connections to land and sea country in accordance with Indigenous tradition; tourism; recreational and commercial fishing; other commercial or recreational activities and local communities that might be affected by our proposed activities (these are examples and not an exhaustive list).



We welcome your feedback

If you think your functions, interests or activities may be affected by any of these activities, you may be a relevant person with whom Santos must consult.

We will use feedback from relevant persons to help us manage impacts and risks associated with these activities, ahead of submitting environment plans for each activity to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for assessment. NOPSEMA's acceptance of these plans is required before any of these activities can begin.

Factsheets are available for each activity, which includes information about planned activities, identified environmental, social, economic and cultural aspects within each EMBA and how we propose to manage impacts and risks.

Contact us

If you consider you may be a relevant person, please contact us as soon as possible to allow us to initiate consultation with you in relation to the proposed activity and so you can tell us how you would like to be consulted. Consultation closes on **Monday 27 November 2023.**

Santos is committed to undertaking genuine and meaningful consultation. We want to provide information for people to make informed assessments of the possible consequences of the proposed activity on them.

Your feedback is important to us, and input will be considered in the development of our environment plan.

Visit **santos.com/offshoreconsultation/bonaparte/**

Phone **1800 267 600**

Email **offshore.consultation@santos.com**

for more information, to self-identify as relevant person or to provide feedback.

SEEKING RELEVANT PERSONS

OPERATIONS, MARINE SEISMIC AND DECOMMISSIONING ENVIRONMENT PLANS

Santos

Santos is seeking to identify and consult with relevant persons whose functions, interests or activities may be affected by our proposed activities off Australia's northern coast.

Santos is planning a number of activities at our northern Australian interests:

- **Bayu-Undan to Darwin Gas Export Pipeline (GEP):** The Bayu-Undan GEP currently transports gas from the Bayu-Undan gas and condensate field in offshore Timor-Leste territorial waters to the Darwin liquefied natural gas (LNG) Plant, Northern Territory. The Bayu-Undan field is approximately 500 km northwest of Darwin and is approaching the end of its commercially productive life. Santos will need to put the pipeline into a preserved state ahead of planned future use of the pipeline for carbon capture and storage (CCS) purposes. Activity timing is from Q1 2024.
- **Eos 3D Marine Seismic Survey:** The Eos marine seismic survey is required to identify subsea geological formations for the potential storage of greenhouse gases (CCS). The survey area is approximately 300 km southwest of Darwin. The survey is planned to take place from Q1 2024.
- **Tern-2 decommissioning:** Santos is planning to permanently plug the Tern-2 exploration well and remove the wellhead. Decommissioning activities will be vessel-based. The Tern-2 exploration well is approximately 300 km southwest of Darwin. The activity is planned for mid-2024.

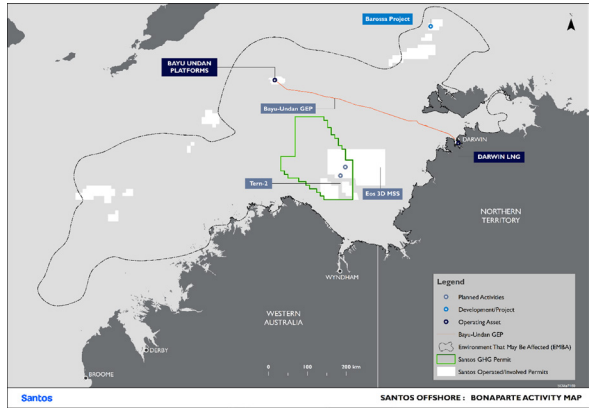
The environment that may be affected (EMBA) by proposed activities

Santos is assessing impacts and risks to the environment that may be affected (EMBA) by each of these activities, including on ecosystems (including people and communities), natural and physical resources, the qualities and characteristics of locations, places and areas and the heritage value of places. This will include assessment of the social, economic and cultural features of the environment. The map depicts activity locations and a consolidated EMBA for all proposed activities. The 'EMBA' represents the greatest spatial extent that could be affected by unplanned 'worst case' oil spill scenarios, noting that in the unlikely event of an oil spill not all environmental, social, economic and cultural aspects would be affected.

Santos is proposing to implement measures to reduce the impacts and risks of the activities. It is a requirement under relevant environmental legislation that these impacts and risks are reduced to as low as reasonably practicable and to an acceptable level.

Consultation

Under environmental legislation, when Santos is preparing its environment plans for these activities, Santos is required to consult with people and organisations who have functions, interests or activities that may be affected. Such functions, interests or activities may include those arising in relation to spiritual or cultural connections to land and sea country in accordance with Indigenous tradition; tourism; recreational and commercial fishing; other commercial or recreational activities and local communities that might be affected by our proposed activities (these are examples and not an exhaustive list).



We welcome your feedback

If you think your functions, interests or activities may be affected by any of these activities, you may be a relevant person with whom Santos must consult.

We will use feedback from relevant persons to help us manage impacts and risks associated with these activities, ahead of submitting environment plans for each activity to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for assessment. NOPSEMA acceptance of these plans is required before any of these activities can begin.

We have prepared consultation information sheets for each activity, which includes information about planned activities, identified environmental, social, economic and cultural aspects within each EMBA and how we propose to manage impacts and risks.

Contact us

If you consider you may be a relevant person, please contact us by **19 October 2023** to allow Santos to initiate consultation with you in relation to the proposed activity and so you can tell us how you would like to be consulted throughout this process.

Santos is committed to undertaking genuine and meaningful consultation. We want to provide information for people to make informed assessments of the possible consequences of the proposed activity on them.

Your feedback is important to us, and input will be considered in the development of our environment plan.

Visit **santos.com/location**

Phone **1800 267 600**

Email **offshore.consultation@santos.com**

for more information, to self-identify as relevant person or to provide feedback.

Teachers do the gardening and cleaning to keep schools running

Exhausted, burnt out & overworked

EXCLUSIVE
CAITLYN RINTOUL

WA teachers are picking up gardening and cleaning shifts in a desperate attempt to keep their schools open as the union warns the education system is stretched so badly the situation has now become "untenable".

The warning from the State's shadow education minister comes after the family of a Perth teacher told The West Australian the stress of her job had contributed to her decision to take her own life.

Nicole Naeslund, 36, pictured left, had resigned from teaching at Middle Swan Primary School when she killed herself earlier this month. Her family have since blamed the Education Department for a lack of support for her mental health decline.

Shadow education minister Peter Rundle said he'd heard of teachers taking on odd jobs to keep their schools open.

"I am hearing in some remote and regional schools where principals and teachers already overstretched . . . are trying to keep things running," he said.

"(They're) picking up internal relief as well as filling cleaning/gardening rosters to maintain their schools, adding to their untenable load.

"Internal relief is another untenable solution.

"Staff new to a group of students are on the back foot (and) we know every day counts for young people attending school."

The union said Statewide staff shortages had led to a consistent rotation of relief teachers with vacancies often filled internally — by teachers picking up extra jobs in their own schools.

State School Teachers Union president Matt Jarman said despite being paid to pick up the class periods of sick teachers, the internal relief model only stretched staff further.

"One of the big issues that we have in our schools is the management of internal relief where teachers are asked and paid to cover other people's classes," Mr Jarman said.

"We have teachers and school leaders who are exhausted.

"They're already worn out and they can't take on more."

Mr Rundle said it was "no wonder" graduate teachers were leaving the industry.

"Teachers who have spoken to me say they are burnt out. Demands on teachers are immense, catering for increasing diverse and complex individual student needs," Mr Rundle said.

"Add increased violence in schools, parental overreach, lack of support from the department — and the load multiplies.

"It is no wonder graduates are leaving the profession within five years.

"Experienced teachers are exhausted and when schools are not providing the support for those teachers, they are electing to retire or move to another job."

Education Minister Tony Buti defended the Cook Government's efforts to combat the staff issue, saying it was "committed to (having) a qualified teacher in every classroom and relief teachers have long played a crucial role in schools".

Lifeline 13 11 14

SEEKING RELEVANT PERSONS

Santos

OPERATIONS, MARINE SEISMIC AND DECOMMISSIONING ENVIRONMENT PLANS

Santos is seeking to identify and consult with relevant persons whose functions, interests or activities may be affected by our proposed activities off Australia's northern coast.

Santos is planning a number of activities at our northern Australian interests:

- **Bayu-Undan to Darwin Gas Export Pipeline (GEP):** The Bayu-Undan GEP currently transports gas from the Bayu-Undan gas and condensate field in offshore Timor-Leste territorial waters to the Darwin liquefied natural gas (LNG) Plant, Northern Territory. The Bayu-Undan field is approximately 500 km northwest of Darwin and is approaching the end of its commercially productive life. Santos will need to put the pipeline into a preserved state ahead of planned future use of the pipeline for carbon capture and storage (CCS) purposes. Activity timing is from Q1 2024.
- **Eos 3D Marine Seismic Survey:** The Eos marine seismic survey is required to identify subsea geological formations for the potential storage of greenhouse gases (CCS). The survey area is approximately 300 km southwest of Darwin. The survey is planned to take place from Q1 2024.
- **Tern-2 decommissioning:** Santos is planning to permanently plug the Tern-2 exploration well and remove the wellhead. Decommissioning activities will be vessel-based. The Tern-2 exploration well is approximately 300 km southwest of Darwin. The activity is planned for mid-2024.

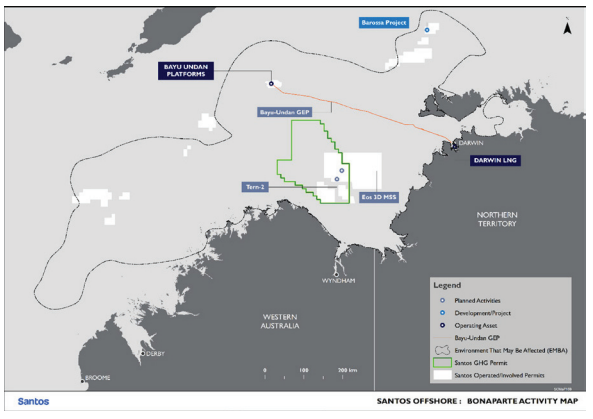
The environment that may be affected (EMBA) by proposed activities

Santos is assessing impacts and risks to the environment that may be affected (EMBA) by each of these activities, including on ecosystems (including people and communities), natural and physical resources, the qualities and characteristics of locations, places and areas and the heritage value of places. This will include assessment of the social, economic and cultural features of the environment. The map depicts activity locations and a consolidated EMBA for all proposed activities. The 'EMBA' represents the greatest spatial extent that could be affected by unplanned 'worst case' oil spill scenarios, noting that in the unlikely event of an oil spill not all environmental, social, economic and cultural aspects would be affected.

Santos is proposing to implement measures to reduce the impacts and risks of the activities. It is a requirement under relevant environmental legislation that these impacts and risks are reduced to as low as reasonably practicable and to an acceptable level.

Consultation

Under environmental legislation, when Santos is preparing its environment plans for these activities, Santos is required to consult with people and organisations who have functions, interests or activities that may be affected. Such functions, interests or activities may include those arising in relation to spiritual or cultural connections to land and sea country in accordance with Indigenous tradition; tourism; recreational and commercial fishing; other commercial or recreational activities and local communities that might be affected by our proposed activities (these are examples and not an exhaustive list).



We welcome your feedback

If you think your functions, interests or activities may be affected by any of these activities, you may be a relevant person with whom Santos must consult.

We will use feedback from relevant persons to help us manage impacts and risks associated with these activities, ahead of submitting environment plans for each activity to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for assessment. NOPSEMA acceptance of these plans is required before any of these activities can begin.

We have prepared consultation information sheets for each activity, which includes information about planned activities, identified environmental, social, economic and cultural aspects within each EMBA and how we propose to manage impacts and risks.

Contact us

If you consider you may be a relevant person, please contact us by **19 October 2023** to allow Santos to initiate consultation with you in relation to the proposed activity and so you can tell us how you would like to be consulted throughout this process.

Santos is committed to undertaking genuine and meaningful consultation. We want to provide information for people to make informed assessments of the possible consequences of the proposed activity on them.

Your feedback is important to us, and input will be considered in the development of our environment plan.

Visit **santos.com/location**
Phone **1800 267 600**
Email **offshore.consultation@santos.com**
for more information, to self-identify as relevant person or to provide feedback.

Spirited Childs of our time

Singer in Red Centre

She is known for her powerful voice and inspiring spirit, and Red Centre residents will be able to experience both when Toni Childs tours the region.

The Emmy-winning and multi Grammy-nominated artist will perform at the Araluen Arts Centre in Alice Springs on Saturday, September 30.

The special two-hour performance is part of Childs' tour across Australia, which also includes shows in Byron Bay, Taree, Kyneton, Ballarat, Tamworth, Horsham and Albury.

Celebrating her life's music works, Childs will perform hits and fan favourites from her older works for the first hour of the show, before introducing audiences to her new music from albums It's All a Beautiful Noise and Citizens of the Planet.

Childs is entering a new era in her illustrious career, having already opened for the likes of Bob Dylan and performed duets with soul artist Al Green and rocker Peter Gabriel.

Music from her two new albums, which will be released widely in the next two years, is being released as part of two unique 3D mapping animated shows jam-packed with high tech audience engagement.

Fans will also have the chance to meet Childs in Alice Springs, with exclusive VIP meet and greet packages that include concert tickets within the first row, a digital copy of Toni Childs' Greatest Hits two CD set, plus a drink backstage before the concert with the star, available for $175.

There is an allocation of only 15 VIP tickets per show.

Toni Childs is headed to the Red Centre at the end of the month. Picture: Cherrie Hughes

Hunt for Alice gun thieves

Police are appealing for information after burglars reportedly stole three guns and up to 200 rounds of ammunition from a home in Alice Springs at the weekend.

An NT Police spokesman said officers responded to reports of a break-in at a residence on Kunoth St about 5.30pm on Sunday.

He said the thieves broke into a gun safe and made off with two .22 calibre rifles and an air rifle along with about 200 rounds of ammunition.

A crime scene was established with CCTV capturing the alleged culprits, whose identities remain unknown, inside the property about 11.30pm on Saturday.

Strike Force Viper is investigating the incident and appealing for anyone with any information to call police on 131 444 or Crime Stoppers on 1800 333 000, quoting reference number 10459674.

SCAN HERE
NT News
FOR THE LATEST NEWS

SEEKING RELEVANT PERSONS

Santos

OPERATIONS, MARINE SEISMIC AND DECOMMISSIONING ENVIRONMENT PLANS

Santos is seeking to identify and consult with relevant persons whose functions, interests or activities may be affected by our proposed activities off Australia's northern coast.

Santos is planning a number of activities at our northern Australian interests:

- **Bayu-Undan to Darwin Gas Export Pipeline (GEP):** The Bayu-Undan GEP currently transports gas from the Bayu-Undan gas and condensate field in offshore Timor-Leste territorial waters to the Darwin liquefied natural gas (LNG) Plant, Northern Territory. The Bayu-Undan field is approximately 500 km northwest of Darwin and is approaching the end of its commercially productive life. Santos will need to put the pipeline into a preserved state ahead of planned future use of the pipeline for carbon capture and storage (CCS) purposes. Activity timing is from Q1 2024.
- **Eos 3D Marine Seismic Survey:** The Eos marine seismic survey is required to identify subsea geological formations for the potential storage of greenhouse gases (CCS). The survey area is approximately 300 km southwest of Darwin. The survey is planned to take place from Q1 2024.
- **Tern-2 decommissioning:** Santos is planning to permanently plug the Tern-2 exploration well and remove the wellhead. Decommissioning activities will be vessel-based. The Tern-2 exploration well is approximately 300 km southwest of Darwin. The activity is planned for mid-2024.

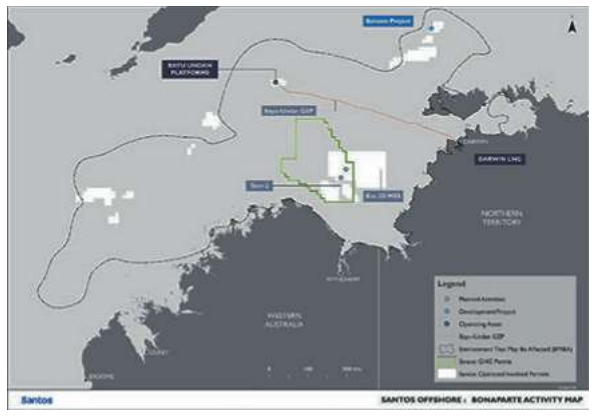
The environment that may be affected (EMBA) by proposed activities

Santos is assessing impacts and risks to the environment that may be affected (EMBA) by each of these activities, including on ecosystems (including people and communities), natural and physical resources, the qualities and characteristics of locations, places and areas and the heritage value of places. This will include assessment of the social, economic and cultural features of the environment. The map depicts activity locations and a consolidated EMBA for all proposed activities. The 'EMBA' represents the greatest spatial extent that could be affected by unplanned 'worst case' oil spill scenarios, noting that in the unlikely event of an oil spill not all environmental, social, economic and cultural aspects would be affected.

Santos is proposing to implement measures to reduce the impacts and risks of the activities. It is a requirement under relevant environmental legislation that these impacts and risks are reduced to as low as reasonably practicable and to an acceptable level.

Consultation

Under environmental legislation, when Santos is preparing its environment plans for these activities, Santos is required to consult with people and organisations who have functions, interests or activities that may be affected. Such functions, interests or activities may include those arising in relation to spiritual or cultural connections to land and sea country in accordance with Indigenous tradition; tourism; recreational and commercial fishing; other commercial or recreational activities and local communities that might be affected by our proposed activities (these are examples and not an exhaustive list).



We welcome your feedback

If you think your functions, interests or activities may be affected by any of these activities, you may be a relevant person with whom Santos must consult.

We will use feedback from relevant persons to help us manage impacts and risks associated with these activities, ahead of submitting environment plans for each activity to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for assessment. NOPSEMA acceptance of these plans is required before any of these activities can begin.

We have prepared consultation information sheets for each activity, which includes information about planned activities, identified environmental, social, economic and cultural aspects within each EMBA and how we propose to manage impacts and risks.

Contact us

If you consider you may be a relevant person, please contact us by **19 October 2023** to allow Santos to initiate consultation with you in relation to the proposed activity and so you can tell us how you would like to be consulted throughout this process.

Santos is committed to undertaking genuine and meaningful consultation. We want to provide information for people to make informed assessments of the possible consequences of the proposed activity on them.

Your feedback is important to us, and input will be considered in the development of our environment plan.

Visit **santos.com/location**
Phone **1800 267 600**
Email **offshore.consultation@santos.com**
for more information, to self-identify as relevant person or to provide feedback.

NTNE01Z01MA - V1

09.18.2023 17:43 NewsCorp Australia – Tearsheet

Fight for life after alleged DV attack

SHANNON HAMPTON

A 26-year-old woman continues to fight for her life almost a week after an alleged domestic violence attack in Kununurra.

The woman's 27-year-old partner, David Junior Tax, faced Kununurra Magistrates Court on Wednesday charged over the assault on Monday last week, which left her with a life-threatening head injury.

Police said local officers were on patrol in the Kimberley town about 9.40pm when they came across the woman, who had allegedly run away from her partner and onto the road, where she collapsed and became unconscious.

"This occurred immediately before the arrival of police, almost in the path of the police vehicle," Insp. Geoff DeSanges said in the wake of the alleged attack. "They immediately were able to render assistance to the victim."

The woman was taken to the local hospital by St John WA before being transferred by the Royal Flying Doctor Service to Royal Darwin Hospital, where she had emergency surgery for a serious head injury.

She remained in a critical condition in the hospital on Sunday — six days later.

Mr Tax has been charged with aggravated grievous bodily harm and breaching a violence restraining order, with police confirming the order was in relation to the injured woman.

He was remanded in custody to reappear in Kununurra Magistrates Court on October 13.

The first segment of the new bridge deck. Picture: Facebook

BRIDGE STARTS TO TAKE SHAPE

CAIN ANDREWS

The new $200m Fitzroy Crossing Bridge is starting to take shape with the first segment of the bridge being launched into position and the project set to be completed by mid-2024.

The old Fitzroy Crossing Bridge collapsed when the once in a century Kimberley floods inundated the region earlier this year, causing a supply chain breakdown.

Now the vital piece of infrastructure between the East and West Kimberley is starting to take form with the first deck segment launched on September 7.

Praising the progress on the project Federal Emergency Management Minister Murray Watt said the infrastructure would also provide ongoing local jobs.

"Critically for the community, the bridge construction project is also providing employment opportunities for the local Fitzroy Valley community, which is an ongoing, important part of recovery," he said.

Federal Infrastructure Minister Catherine King said the new bridge would reconnect the remote part of the country with national supply chains.

"This will be vital during the upcoming wet seasons the area is all too used to," she said.

To ensure construction won't be affected by adverse weather in the upcoming wet season the 36m bridge segments will be launched from the western side of the river with one segment being put in place every eight days until it is completed.

Repair works will also be carried out on damaged sections of the Great Northern Highway which were washed away in the unprecedented flooding.

The new bridge is funded by the Australian and WA Governments.

SEEKING RELEVANT PERSONS

Santos

OPERATIONS, MARINE SEISMIC AND DECOMMISSIONING ENVIRONMENT PLANS

Santos is seeking to identify and consult with relevant persons whose functions, interests or activities may be affected by our proposed activities off Australia's northern coast.

Santos is planning a number of activities at our northern Australian interests:

- **Bayu-Undan to Darwin Gas Export Pipeline (GEP):** The Bayu-Undan GEP currently transports gas from the Bayu-Undan gas and condensate field in offshore Timor-Leste territorial waters to the Darwin liquefied natural gas (LNG) Plant, Northern Territory. The Bayu-Undan field is approximately 500 km northwest of Darwin and is approaching the end of its commercially productive life. Santos will need to put the pipeline into a preserved state ahead of planned future use of the pipeline for carbon capture and storage (CCS) purposes. Activity timing is from Q1 2024.
- **Eos 3D Marine Seismic Survey:** The Eos marine seismic survey is required to identify subsea geological formations for the potential storage of greenhouse gases (CCS). The survey area is approximately 300 km southwest of Darwin. The survey is planned to take place from Q1 2024.
- **Tern-2 decommissioning:** Santos is planning to permanently plug the Tern-2 exploration well and remove the wellhead. Decommissioning activities will be vessel-based. The Tern-2 exploration well is approximately 300 km southwest of Darwin. The activity is planned for mid-2024.

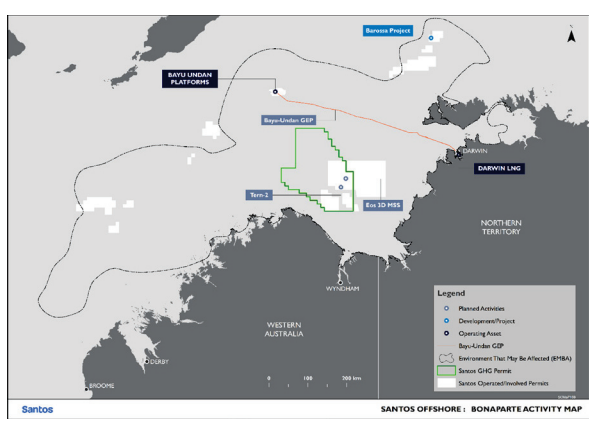
The environment that may be affected (EMBA) by proposed activities

Santos is assessing impacts and risks to the environment that may be affected (EMBA) by each of these activities, including on ecosystems (including people and communities), natural and physical resources, the qualities and characteristics of locations, places and areas and the heritage value of places. This will include assessment of the social, economic and cultural features of the environment. The map depicts activity locations and a consolidated EMBA for all proposed activities. The 'EMBA' represents the greatest spatial extent that could be affected by unplanned 'worst case' oil spill scenarios, noting that in the unlikely event of an oil spill not all environmental, social, economic and cultural aspects would be affected.

Santos is proposing to implement measures to reduce the impacts and risks of the activities. It is a requirement under relevant environmental legislation that these impacts and risks are reduced to as low as reasonably practicable and to an acceptable level.

Consultation

Under environmental legislation, when Santos is preparing its environment plans for these activities, Santos is required to consult with people and organisations who have functions, interests or activities that may be affected. Such functions, interests or activities may include those arising in relation to spiritual or cultural connections to land and sea country in accordance with Indigenous tradition; tourism; recreational and commercial fishing; other commercial or recreational activities and local communities that might be affected by our proposed activities (these are examples and not an exhaustive list).



We welcome your feedback

If you think your functions, interests or activities may be affected by any of these activities, you may be a relevant person with whom Santos must consult.

We will use feedback from relevant persons to help us manage impacts and risks associated with these activities, ahead of submitting environment plans for each activity to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for assessment. NOPSEMA acceptance of these plans is required before any of these activities can begin.

We have prepared consultation information sheets for each activity, which includes information about planned activities, identified environmental, social, economic and cultural aspects within each EMBA and how we propose to manage impacts and risks.

Contact us

If you consider you may be a relevant person, please contact us by **19 October 2023** to allow Santos to initiate consultation with you in relation to the proposed activity and so you can tell us how you would like to be consulted throughout this process.

Santos is committed to undertaking genuine and meaningful consultation. We want to provide information for people to make informed assessments of the possible consequences of the proposed activity on them.

Your feedback is important to us, and input will be considered in the development of our environment plan.

Visit **santos.com/location**
Phone **1800 267 600**
Email **offshore.consultation@santos.com**
for more information, to self-identify as relevant person or to provide feedback.

Connor Barrett

Sophia Marshall

Harrison Carthew

Emily Houston

you kids'," Emily said. Emily's mum, Andrea, said: "As a parent you never aspire to your child to be a Telethon Star because of what it means. But to have been on this journey and have this opportunity, it is just amazing to be able to help and give back because we have benefited from so many organisations funded through Telethon."

Sophia Marshall

Sophia's parents knew something was wrong when the seven-year-old wasn't her usual bubbly self.

The Attadale Primary School Year 2 student was diagnosed with type 1 diabetes four years ago after she lost weight, was always thirsty and needed to urinate frequently.

Her family were sent straight into the care of the Perth Children's Hospital diabetes team to learn how to deal with the life-long disease. Sophia's dad, Ben, said the program helped settle their nerves. "We were looked after for a week and went through a whole program of how to care for a child with diabetes," he said. "It's pretty scary when it first happened, but throughout that process you get to a point where you're still very much starting the journey, but you feel like you can go out back into the world." Sophia also has coeliac disease, but has a new lease on life since being diagnosed and receiving a wearable glucose monitor.

She said she wanted to give back to Perth Children's Hospital as a Little Telethon Star.

"We'll probably speak in the microphone and meet other Telethon people, answering the phones, and doing lots of other stuff," she said.

Telethon chairman Richard Goyder knows all too well the struggles that come with having a child with an invisible disease.

His son Will was diagnosed with diabetes as a child, with the now 25-year-old FaceTiming Sophia to talk about their shared difficulties in keeping on top of the disease.

"I think people sort of see outwardly a healthy person, but they don't understand what's required to keep blood sugar levels in a reasonable band and it can be dangerous," he said. Telethon Kids Institute has recently been named a global centre of excellence for diabetes — the only one outside North America — through the help of funding into diabetes research from Telethon and Rio Tinto. The announcement of the new Little Telethon Stars starts the countdown to Telethon from October 21-22. This year, Telethon helped 107 beneficiaries with the $71.3m raised in 2022.

SEEKING RELEVANT PERSONS

OPERATIONS, MARINE SEISMIC AND DECOMMISSIONING ENVIRONMENT PLANS

Santos

Santos is seeking to identify and consult with relevant persons whose functions, interests or activities may be affected by our proposed activities off Australia's northern coast.

Santos is planning a number of activities at our northern Australian interests:

- **Bayu-Undan to Darwin Gas Export Pipeline (GEP):** The Bayu-Undan GEP currently transports gas from the Bayu-Undan gas and condensate field in offshore Timor-Leste territorial waters to the Darwin liquefied natural gas (LNG) Plant, Northern Territory. The Bayu-Undan field is approximately 500 km northwest of Darwin and is approaching the end of its commercially productive life. Santos will need to put the pipeline into a preserved state ahead of planned future use of the pipeline for carbon capture and storage (CCS) purposes. Activity timing is from Q1 2024.
- **Eos 3D Marine Seismic Survey:** The Eos marine seismic survey is required to identify subsea geological formations for the potential storage of greenhouse gases (CCS). The survey area is approximately 300 km southwest of Darwin. The survey is planned to take place from Q1 2024.
- **Tern-2 decommissioning:** Santos is planning to permanently plug the Tern-2 exploration well and remove the wellhead. Decommissioning activities will be vessel-based. The Tern-2 exploration well is approximately 300 km southwest of Darwin. The activity is planned for mid-2024.

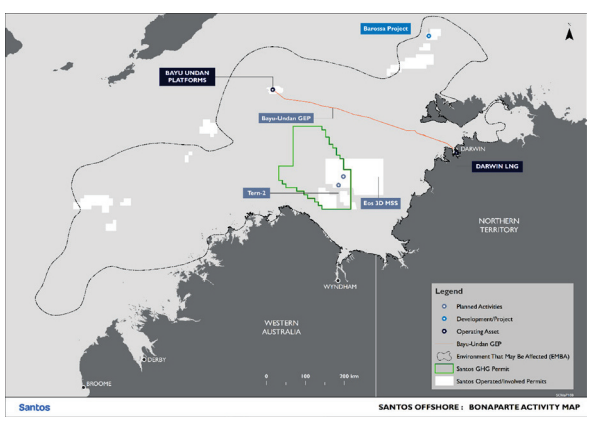
The environment that may be affected (EMBA) by proposed activities

Santos is assessing impacts and risks to the environment that may be affected (EMBA) by each of these activities, including on ecosystems (including people and communities), natural and physical resources, the qualities and characteristics of locations, places and areas and the heritage value of places. This will include assessment of the social, economic and cultural features of the environment. The map depicts activity locations and a consolidated EMBA for all proposed activities. The 'EMBA' represents the greatest spatial extent that could be affected by unplanned 'worst case' oil spill scenarios, noting that in the unlikely event of an oil spill not all environmental, social, economic and cultural aspects would be affected.

Santos is proposing to implement measures to reduce the impacts and risks of the activities. It is a requirement under relevant environmental legislation that these impacts and risks are reduced to as low as reasonably practicable and to an acceptable level.

Consultation

Under environmental legislation, when Santos is preparing its environment plans for these activities, Santos is required to consult with people and organisations who have functions, interests or activities that may be affected. Such functions, interests or activities may include those arising in relation to spiritual or cultural connections to land and sea country in accordance with Indigenous tradition; tourism; recreational and commercial fishing; other commercial or recreational activities and local communities that might be affected by our proposed activities (these are examples and not an exhaustive list).



We welcome your feedback

If you think your functions, interests or activities may be affected by any of these activities, you may be a relevant person with whom Santos must consult.

We will use feedback from relevant persons to help us manage impacts and risks associated with these activities, ahead of submitting environment plans for each activity to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for assessment. NOPSEMA acceptance of these plans is required before any of these activities can begin.

We have prepared consultation information sheets for each activity, which includes information about planned activities, identified environmental, social, economic and cultural aspects within each EMBA and how we propose to manage impacts and risks.

Contact us

If you consider you may be a relevant person, please contact us by **19 October 2023** to allow Santos to initiate consultation with you in relation to the proposed activity and so you can tell us how you would like to be consulted throughout this process.

Santos is committed to undertaking genuine and meaningful consultation. We want to provide information for people to make informed assessments of the possible consequences of the proposed activity on them.

Your feedback is important to us, and input will be considered in the development of our environment plan.

Visit **santos.com/location**
Phone **1800 267 600**
Email **offshore.consultation@santos.com**
for more information, to self-identify as relevant person or to provide feedback.

NOTICE OF CONSULTATION WITH TIWI ISLANDS PEOPLE

BAROSSA GAS PROJECT AND OTHER PROPOSED ACTIVITIES

YOUR VIEWS ARE IMPORTANT TO US.

Santos is preparing Environment Plans (EPs) for several proposed activities, as required by legislation:

Darwin Pipeline Duplication (DPD) Environment Plan – this relates to the 23 km portion of the underwater pipeline and supporting subsea infrastructure in Commonwealth waters, in an area approximately 27 km south-west of the Tiwi Islands.

DPD Construction Environmental Management Plan (CEMP) - this CEMP relates to the 100km portion of the DPD and supporting subsea infrastructure in Northern Territory waters, extending to the existing Darwin Liquefied Natural Gas (DLNG) facility.

Bayu-Undan Gas Export Pipeline Environment Plan – Santos operates the Bayu-Undan Gas Export Pipeline, which connects the Bayu-Undan field to the Darwin LNG facility. The Bayu-Undan field is approaching end of life, at which time production will cease at the Bayu-Undan facility. The existing in force Environment Plan is being revised to allow the pipeline to be put into preservation ahead of a future decision on whether to proceed with plans to re-purpose the Pipeline for Carbon Capture and Storage (CCS) at the depleted Bayu-Undan field.

Eos 3 Marine Seismic Survey (MSS) Environment Plan – this relates to a vessel-based survey in Commonwealth waters of the southern Bonaparte Basin, commencing at the earliest from mid-2024. The Operational Area is approximately 107 km from the nearest coastline, and approximately 119 km from Wadeye in the Northern Territory. The purpose of the survey is to identify image detailed subsea geological formations for potential carbon capture and storage.

Tern-2 Plug and Abandonment Environment Plan – this relates to vessel-based decommissioning activities within the WA-27-R permit in Commonwealth waters within the Bonaparte Basin, commencing mid-2024. The Operational Area for these activities is approximately 106 km from the nearest coastline, and approximately 181 km from Wadeye in the Northern Territory.

We are currently consulting with Tiwi Island peoples whose functions, interests or activities may be affected by project activities proposed under the EPs listed above. Based on input from Tiwi Island peoples, we will continue to consult with you at the sessions detailed below through Clan group meetings with videos and visual aids available.

At the upcoming sessions we will consult with relevant persons about our proposed activities, including:

- providing information and responding to questions about the proposed activities, potential impacts and risks and how we plan to reduce these to as low as reasonably practicable and to an acceptable level.
- inviting you to consider the information given and tell us if you seek further or different information.
- if you are ready, listening to you so we can understand the environmental values and environmental impacts and risks associated with the activity and any measures you would like us to consider to reduce impacts and risks, with further opportunities to provide input, including at our next visit.

TIMING AND VENUES

Tuesday 5 December 2023, Milikapiti

10.30am – Marrikawuyanga & Yimpinari Clans

1.00pm – Wulirankuwu

Wednesday 6 December 2023, Wurrumiyanga

10.30am – Mantiyupwi Clan

1.00pm – Jikilaruwu Clan

Thursday 7 December 2023, Wurrumiyanga

10.30am – Wurankuwu Clan

1.00pm – Malawu Clan

Friday 8 December 2023, Pirlangimpi

10.30am – Munupi Clan

CONTACT US

T: 1800 267 600

E: offshore.consultation@santos.com

For more information please scan QR codes:

Barossa DPD Project

Barossa Relevant Person

Bonaparte Consultation

Santos Ltd ▸ Tiwi Islands Notice Board
26m ·

Details of our upcoming consultation sessions on the Tiwi Islands are available below. We look forward to chatting with you early next month.

For more information, visit:

Barossa Consultation: www.santos.com/barossa

Bonaparte Consultation: www.santos.com/offshoreconsultation/bonaparte

Santos

YOUR VIEWS ARE IMPORTANT TO US.

Santos is preparing Environment Plans (EPs) for several proposed activities, as required by legislation:

Darwin Pipeline Duplication (DPD) Environment Plan – this relates to the 23 km portion of the underwater pipeline and supporting subsea infrastructure in Commonwealth waters, in an area approximately 27 km south-west of the Tiwi Islands.

DPD Construction Environmental Management Plan (CEMP) - this CEMP relates to the 100km portion of the DPD and supporting subsea infrastructure in Northern Territory waters, extending to the existing Darwin Liquefied Natural Gas (DLNG) facility.

Bayu-Undan Gas Export Pipeline Environment Plan – Santos operates the Bayu-Undan Gas Export Pipeline, which connects the Bayu-Undan field to the Darwin LNG facility. The Bayu-Undan field is approaching end of life, at which time production will cease at the Bayu-Undan facility. The existing in force Environment Plan is being revised to allow the pipeline to be put into preservation ahead of a future decision on whether to proceed with plans to re-purpose the Pipeline for Carbon Capture and Storage (CCS) at the depleted Bayu-Undan field.

Eos 3D Marine Seismic Survey Environment Plan – this relates to a vessel-based survey in Commonwealth waters of the southern Bonaparte Basin, commencing at the earliest from mid-2024. The Operational Area is approximately 107 km from the nearest coastline, and approximately 119 km from Wadeye in the Northern Territory. The purpose of the survey is to identify image detailed subsea geological formations for potential carbon capture and storage.

Tern-2 Plug and Abandonment Environment Plan - this relates to vessel-based decommissioning activities within the WA-27-R permit in Commonwealth waters within the Bonaparte Basin, commencing mid-2026. The Operational Area for these activities is approximately 106 km from the nearest coastline, and approximately 161 km from Wadeye in the Northern Territory.

We are currently consulting with Tiwi Island peoples whose functions, interests or activities may be affected by project activities proposed under the EPs listed above. Based on input from Tiwi Island peoples, we will continue to consult with you at the sessions detailed below through Clan group meetings with videos and visual aids available.

At the upcoming sessions we will consult with relevant persons about our proposed activities, including:

- providing information and responding to questions about the proposed activities, potential impacts and risks and how we plan to reduce these to as low as reasonably practicable and to an acceptable level.
- inviting you to consider the information given and tell us if you seek further or different information.
- If you are ready, listening to you so we can understand the environmental values and environmental impacts and risks associated with the activity and any measures you would like us to consider to reduce impacts and risks, with further opportunities to provide input, including at our next visit.

TIMING AND VENUES

Tuesday 5 December 2023, Milikapiti: Sports & Social Club

10.30am – Mantkawuyanga & Yimpinari Clans
1.00pm – Wulirankuwu

Wednesday 6 December 2023, Wurrumiyanga: Ngulu Club

10.30am – Mantiyupwi Clan
1.00pm – Jikilaruwu Clan

Thursday 7 December 2023, Wurrumiyanga: Mantiyupwi Meeting Room

10.30am – Wurankuwu Clan
1.00pm – Malawu Clan

Friday 8 December 2023, Pirlangimpi: Sports & Social Club

10.30am – Munupi Clan

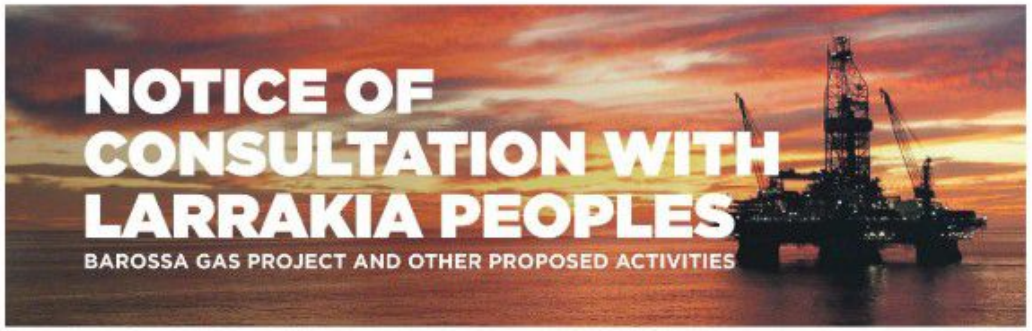
CONTACT US

T: 1800 267 600
E: offshore.consultation@santos.com
For more information please scan QR codes:

Barossa DPD Project | Barossa Relevant Person | Bonaparte Consultation

Edit | Delete

Santos



NOTICE OF CONSULTATION WITH LARRAKIA PEOPLES

BAROSSA GAS PROJECT AND OTHER PROPOSED ACTIVITIES

YOUR VIEWS ARE IMPORTANT TO US.

Santos is preparing Environment Plans (EPs) for several proposed activities, as required by legislation:

Darwin Pipeline Duplication (DPD) Environment Plan – this relates to the 23 km portion of the underwater pipeline and supporting subsea infrastructure in Commonwealth waters, in an area approximately 27 km south-west of the Tiwi Islands.

DPD Construction Environmental Management Plan (CEMP) – this CEMP relates to the 100km portion of the DPD and supporting subsea infrastructure in Northern Territory waters, extending to the existing Darwin Liquefied Natural Gas (DLNG) facility.

Bayu-Undan Gas Export Pipeline Environment Plan – Santos operates the Bayu-Undan Gas Export Pipeline, which connects the Bayu-Undan field to the Darwin LNG facility. The Bayu-Undan field is approaching end of life, at which time production will cease at the Bayu-Undan facility. The existing in force Environment Plan is being revised to allow the pipeline to be put into preservation ahead of a future decision on whether to proceed with plans to re-purpose the Pipeline for Carbon Capture and Storage (CCS) at the depleted Bayu-Undan field.

Eos 3 Marine Seismic Survey (MSS) Environment Plan – this relates to a vessel-based survey in Commonwealth waters of the southern Bonaparte Basin, commencing at the earliest from mid-2024. The Operational Area is approximately 107 km from the nearest coastline, and approximately 119 km from Wadeye in the Northern Territory. The purpose of the survey is to identify image detailed subsea geological formations for potential carbon capture and storage.

Tern-2 Plug and Abandonment Environment Plan – this relates to vessel-based decommissioning activities within the WA-27-R permit in Commonwealth waters within the Bonaparte Basin, commencing mid-2024. The Operational Area for these activities is approximately 106 km from the nearest coastline, and approximately 181 km from Wadeye in the Northern Territory.

We are currently consulting with Larrakia peoples whose functions, interests or activities may be affected by project activities proposed under the EPs listed above.

At the upcoming session we will consult with relevant persons about our proposed activities, including:

- providing information and responding to questions about the proposed activities, potential impacts and risks and how we plan to reduce these to as low as reasonably practicable and to an acceptable level.
- inviting you to consider the information given and tell us if you seek further or different information.
- if you are ready, listening to you so we can understand the environmental values and environmental impacts and risks associated with the activity and any measures you would like us to consider to reduce impacts and risks, with further opportunities to provide input, including at our next visit.

TIMING AND VENUE

Tuesday 19 December 2023, Nightcliff Community Centre, Boab Meeting Room

Session 1: 2.30-4.30pm

Session 2: 5.30-7pm

For more information please scan QR codes:

Barossa DPD Project

Barossa Relevant Person

Bonaparte Consultation

CONTACT US

T: 1800 267 600 | E: offshore.consultation@santos.com

Fact sheets

Information for relevant persons

Santos

Eos 3D Marine Seismic Survey Environment Plan

Activity overview

Santos is seeking to acquire subsurface data via a 3D Marine Seismic Survey (MSS) in Commonwealth waters of the southern Bonaparte Basin, commencing at the earliest from mid 2024 until end of 2026.

The Operational Area for the Eos 3D MSS is approximately 107 km from the nearest coastline, and approximately 119 km from Wadeye in the Northern Territory (NT see **Figure 1**).

The purpose of the survey is to identify, and image detailed subsea geological formations for the potential injection and storage of carbon dioxide (CO_2).

Activity duration is approximately 50 days, subject to weather standby and technical downtime.

Consultation and feedback

All petroleum activities in Commonwealth waters must have an Environment Plan (EP) accepted by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) before any activities can take place.

Under Commonwealth Environmental Regulations, Santos is required to consult with relevant persons about proposed activities when preparing an EP. A relevant person includes authorities, persons or organisations whose functions, interests or activities may be affected by the proposed activity.

Santos meets this requirement by undertaking consultation in two phases:

- **Preliminary consultation** to understand values and sensitivities and confirm consultation expectations of authorities, persons and organisations whose functions, interests or activities who may be affected by proposed activities (relevant persons).
- **Consultation** of relevant persons on specific activities.

Activity specific consultation is planned to commence on **27 October 2023**, with the consultation period closing on **27 November 2023**. More details on consultation and providing feedback can be found on the back page of this fact sheet.

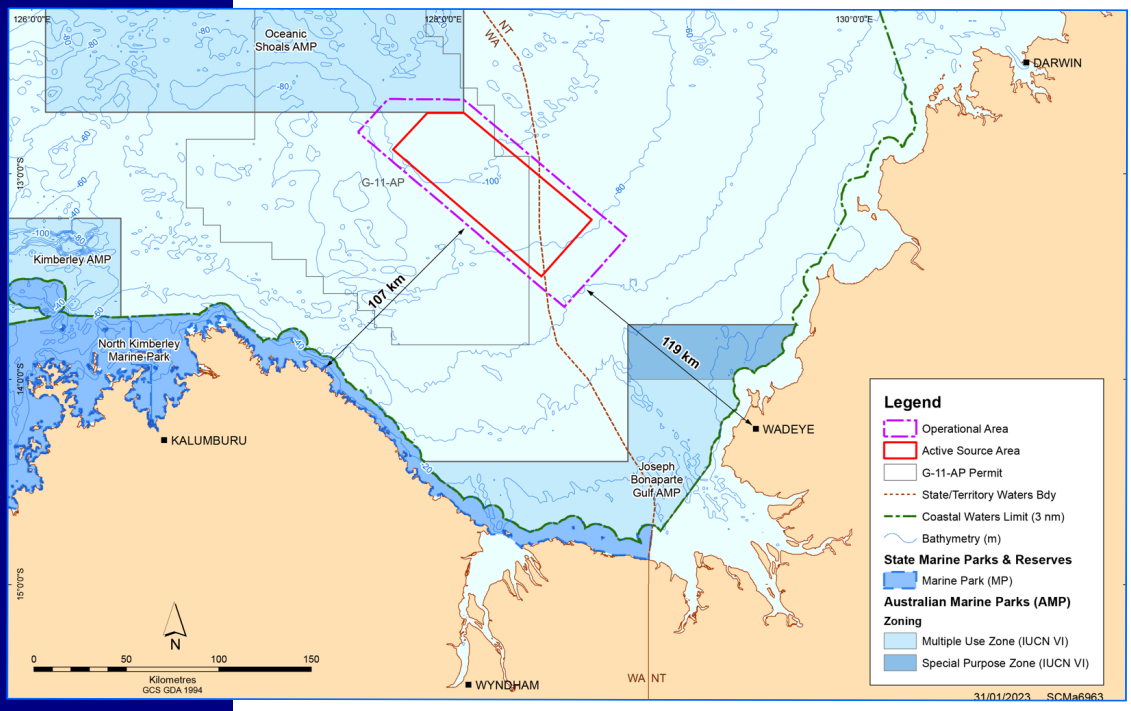


Figure 1. *Eos 3D MSS activity location*

Activity description

Activity details		
Timing	Earliest commencement of the activity is Q3 2024, however, activity may occur anytime from EP acceptance by NOPSEMA to the end of December 2026.	
Duration	• Approximately 50 days to complete the activity. • The expected duration is a forecast and is subject to change based on adverse weather conditions or technical/equipment issues that may arise during the activity.	
Water depth	Operational Area 60 m to 115 m.	Active Source Area 67 m to 111 m.
Vessels	• Seismic survey vessel. • Up to two dedicated support vessels (one being a chase vessel) will accompany the seismic survey vessel to provide logistical, safety and equipment management duties. • Vessel details are unknown at this time.	
Aircraft	• Aircraft maybe used for crew changes, critical equipment supply, surveillance and emergency response uses. Aircraft includes helicopters and drones.	
Volume of seismic source	• Max. 3,050 cubic inches (in^3).	
Operating pressure	• 2,000 psi.	
Description of the natural environment	• The Operational Area is predominately characterised by a relatively flat and largely featureless seabed, predominantly sand with a proportion of silt and clay which gradually slopes from south to north.	
Exclusion zone	• 3 nm (5.6 km) exclusion (safety) zone around the seismic vessel and trailing streamers.	
Greenhouse gas assessment permit	• G-11-AP.	
Activity coordinates		
Operational Area	**Latitude**	**Longitude**
	12° 47′ 45.870″ S	127° 35′ 9.014″ E
	12° 38′ 5.216″ S	127° 44′ 2.253″ E
	12° 38′ 16.443″ S	128° 6′ 3.199″ E
	13° 18′ 22.214″ S	128° 53′ 45.423″ E
	13° 38′ 52.656″ S	128° 35′ 23.154″ E
Active source area	**Latitude**	**Longitude**
	12° 52′ 52.261″ S	127° 45′ 28.575″ E
	12° 42′ 9.215″ S	127° 55′ 28.219″ E
	12° 42′ 8.964″ S	128° 6′ 5.702″ E
	13° 13′ 21.492″ S	128° 43′ 23.459″ E
	13° 29′ 56.111″ S	128° 28′ 44.239″ E

Activity purpose and approvals

The Eos 3D MSS is required to meet Santos' work program obligations for GHG assessment permit G-11-AP.

GHG assessment permits allow titleholders to explore in the permit area for potential GHG storage formations and potential GHG injection sites in Commonwealth offshore areas. The primary purpose of the 3D MSS is to facilitate future CO_2 injection activities by providing detailed structural and amplitude imaging of the reservoir/seal interface for each identified storage target to confirm suitability for injection and storage of CO_2.

An EP is being prepared for the survey, which must demonstrate that the impacts and risks of the activity will be managed to a level as low as reasonably practicable and acceptable over the life of the activity. The EP will be submitted to NOPSEMA for acceptance in accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth)*.

About marine seismic surveys

The process of collecting seismic data is known as 'acquisition'. A marine seismic survey takes place along a series of pre-defined acquisition lines (normally several hundred metres apart) within an overall acquisition area.

Figure 2. Example of a seismic array and marine seismic vessel for 3D or 4D surveys.

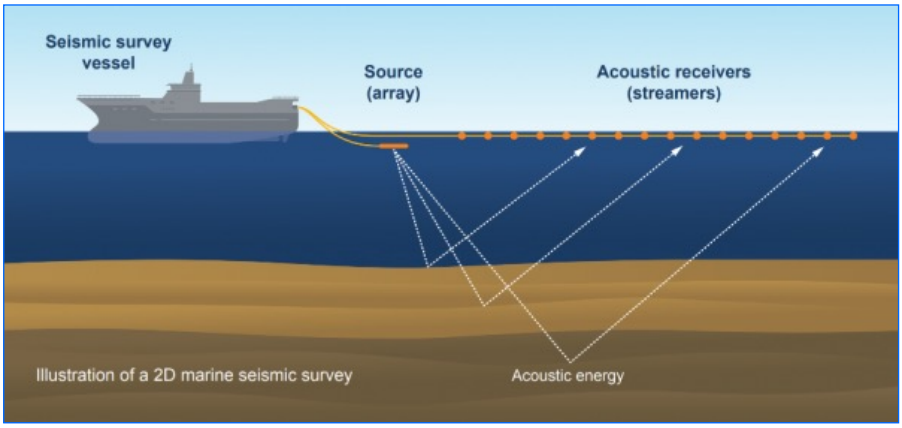


Figure 3. Illustration of a marine seismic survey (Source: NOPSEMA).

Marine seismic surveys are carried out by specialised vessels that tow an array of acoustic sources (airguns) and receivers (hydrophones) across a defined acquisition area. Airguns work by rapidly releasing compressed air to form a bubble, which creates a pulse of sound. This sound energy is directed at the seafloor and penetrates into the various rock layers beneath.

The reflected soundwaves are then captured by hydrophone receivers, which are towed behind the vessel on a series of cables known as 'streamers'.

Marine seismic surveys can be two, three, or four dimensional (2D, 3D, or 4D). 2D surveys tend to have a smaller sound source and a single streamer (see **Figure 3**) while 3D and 4D surveys use a larger sound source and multiple streamers (see **Figure 2**).

More information about marine seismic surveys can be found **here**.

Source: NOPSEMA

Defining the environment area for proposed activities

Santos has undertaken an assessment to define the environmental, social, economic and cultural aspects that may be affected by proposed activities.

To do this we have considered the totality of the area where activity impacts and risks may occur.

These areas are summarised in Table 1. The widest extent of these area is called the Environment that May Be Affected (EMBA), which for this activity is the outer boundary of worst-case marine diesel oil spill resulting from a vessel collision (see **Figure 4**).

Oil spill EMBAs are defined by overlaying a great number (usually hundreds) of individual, computer simulated, hypothetical oil spill events into a single map. Each simulation starts from the same location (release point), but each will be subject to a different set of wind and weather conditions derived from historical data. The use of advanced and sophisticated models enables us to present all the areas that could be affected.

While the EMBA represents the largest possible spatial extent that could be contacted by the worst-case spill events modelled, an actual spill event is more accurately represented by a single simulation run, resulting in a smaller spatial extent. Often one or more simulation runs are selected to be representative of the 'worst-case' based on the nature and scale of the Activity and the local environment.

However, both the EMBA (based on numerous possible spills) and the single representative worst-case oil spill are used for the environmental risk assessment and oil spill preparedness and response planning.

Please see the **NOPSEMA Spill Modelling Video** for more information on oil spill modelling and why it is required for the preparation of Environment Plans.

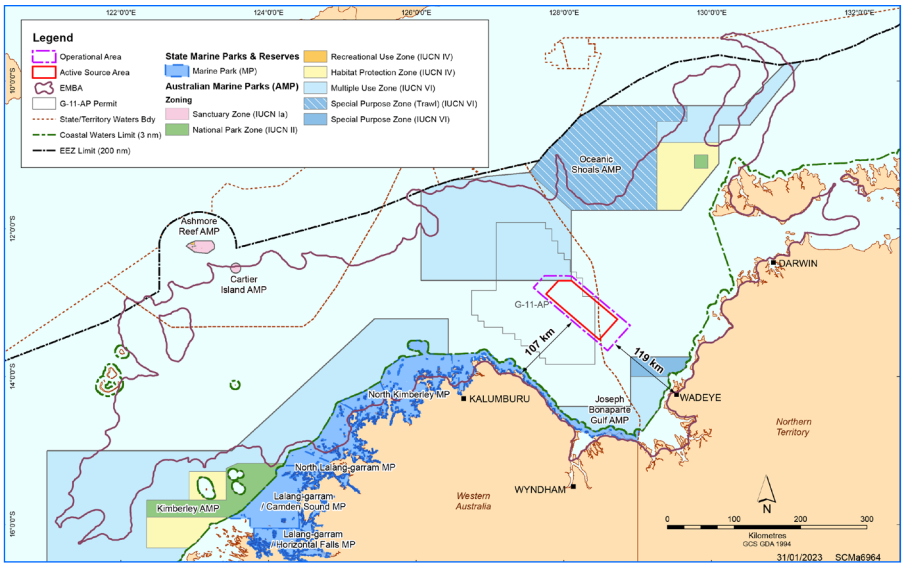


Figure 4. *Eos 3D MSS activity location & EMBA.*

Table 1. Environment area for proposed activities

Operational Area
The area in which the seismic vessel will operate, accounting for line turns with streamers deployed.
Active source area
The area in which the seismic vessel will operate to acquire the seismic data and achieve the geophysical objectives of the survey.
Environment that May Be Affected (EMBA)
The spatial extent of activity impacts (e.g. vessel presence, light, noise) and risk (e.g., hydrocarbon spill).

Santos has undertaken a review of publicly available information to identify environmental, social, economic and cultural features and/or values that may be affected by activity impacts and risks. The outcomes of this review are summarised in **Table 2**.

Table 2. Environmental, social, economic and cultural features

Feature	Description	Within Operational Area	Within EMBA	Public information review
Aboriginal heritage	Registered Aboriginal heritage sites protected under the: • *Aboriginal Torres Strait Islander Heritage Protection Act 1984 (Cwth).* • *Aboriginal Sacred Sites Act 1989.* • *Heritage Act 2011(NT).* • *Aboriginal Land Act 1978 (NT).* • *Aboriginal Cultural Heritage Act 2021 (WA).* • *Aboriginal Heritage Act 1972 (WA).*	No	Yes	Aboriginal Heritage sites are present along the southern eastern boundaries of the EMBA. Sea country interests may exist in the EMBA.
Biologically important areas	Biologically important areas (BIAs) are spatially defined areas where aggregations of individuals of a species are known to display biologically important behaviour such as breeding, foraging, resting or migration.	Yes	Yes	The Operational Area includes BIAs for turtles.
Cultural heritage	*Registered cultural sites under the:* • *Underwater Cultural Heritage Act 2018.*	No	Yes	No known sites of shipwrecks, sunken aircraft or Aboriginal and Torres Strait Islander Underwater Cultural Heritage have been identified within the Operational Area. The nearest shipwreck, the SEDCO Helen, is approximately 10 km northeast of the Operational Area.

Table 2. Environmental, social, economic and cultural features ... continued

Feature	Description	Within Operational Area	Within EMBA	Public information review
Defence	Designated defence activity areas.	Yes	Yes	Defence activities may take place within the Operational Area.
Fishing	Commercial fishing.	Yes	Yes	A number of Commonwealth, State and Territory fisheries overlap the EMBA, some of which are active in the Operational Area.
	Indigenous, subsistence or customary fishing.	No	Yes	Traditional Australian Indigenous fishing activities are generally concentrated within 3 nm of the Northern Territory / Western Australian coastline.
	Recreational fishing.	Yes	Yes	Fishing charter vessels may transit through the Operational Area and EMBA but fishing activities are considered unlikely in the Operational Area due to remoteness.
Key ecological features	Key ecological features (KEFs) are elements of the Commonwealth marine environment that are considered to be of regional importance for either a region's biodiversity or its ecosystem function and integrity.	Yes	Yes	The Operational Area overlaps one KEF for the carbonate bank and terrace system of the Sahul Shelf. KEFs are present in the EMBA.
Oil and gas operations	Petroleum operations.	Yes	Yes	Petroleum exploration and production activities have been undertaken within the EMBA and the Bonaparte Basin is an established hydrocarbon province with a number of commercial operations. Several exploration permits overlap the Operational Area with the closest production licence being the Eni Australia B.V. located 21 km south-east of the Operational Area.

Table 2. Environmental, social, economic and cultural features ... continued

Feature	Description	Within Operational Area	Within EMBA	Public information review
Protected areas (nearest Commonwealth and Territory)	Australian Marine Park (AMP).	Yes	Yes	The Operational Area overlaps the Oceanic Shoals AMP and five AMPs overlap the EMBA.
	Northern Territory Reserves.	No	Yes	The EMBA overlaps the Garig Gunak Barlu Marine Park (Cobourg Peninsula), located approximately 318 km north-east of the Operational Area, and several other Northern Territory Reserves. • Casuarina Coastal Reserve. • Channel Point Coastal Reserve. • Shoal Bay Coastal Reserve. • Tree Point Conservation Area. • Buffalo Creek Management Area. • Djukbinj National Park. • Keep River National Park.
	Western Australia Reserves.	No	Yes	The EMBA overlaps the North Kimberley Marine Park (NKMP), located approximately 105 km west of the Operational Area, and several other Western Australia Reserves including the Ord River Nature Reserve (Ramsar Site), located approximately 133 km south of the Operational Area. • Niiwalarra Islands National Park. • Browse Island Nature Reserve. • Lesueur Island Nature Reserve. • Low Rocks Nature Reserve. • Pelican Island Nature Reserve.

Table 2. Environmental, social, economic and cultural features ... continued

Feature	Description	Within Operational Area	Within EMBA	Public information review
Shipping	Shipping routes.	Yes	Yes	The Operational Area does not overlap any shipping fairways, however there is vessel traffic that passes through the northern end of the Operational Area.
Telecommunications	Subsea telecommunications cables.	No	Yes	The North West Cable System (NWCS) connects offshore oil and gas facilities in the Browse, Bonaparte and Carnarvon Basins to onshore locations and is approximately 125 km north-north- east of the Operational Area.
Tourism	Marine and coastal tourism.	No	Yes	Remoteness of the Operational Area and water depth limits opportunities for tourism. Tourism is likely within the EMBA.
Towns / communities	Darwin.	No	Yes	Darwin is the nearest capital city and is approximately 230 km northeast from the Operational Area.
	Wadeye.	No	Yes	Wadeye is the nearest community and is approximately 119 km southeast from the Operational Area.

We have summarised in Table 3 the potential environmental impacts and risks and associated management measures for the proposed activity. These aspects will be risk-assessed with the Environment Plan on a case-by-case basis.

Table 3. Activity impacts and risk management

Potential impacts – planned activities	
Acoustic disturbance to fauna	

Description of potential impacts
Potential impacts from noise emissions may occur in the operational area from the following sources:
• Seismic source array.
• Vessel operations (e.g. vessel engines, thrusters, propeller cavitation and operation of machinery and equipment).
• Helicopter activities relating to crew change requirements.
	Compliance with the following key management measures
	Marine fauna observations undertaken to minimise the disturbance to fauna caused by the Activity.
	• Implementation of EPBC Act Policy Statement 2.1 (Part A):
	  • Pre start-up visual observation.
	  • Soft start procedures.
	  • Start-up delay procedure.
	  • Operations procedure.
	  • Shut-down procedure.
	  • Night-time and low visibility procedures.
	• Adoption of EPBC Regulations (Part 8) for interacting with cetaceans.
	• Implementation of selected control options of EPBC Act Policy Statement 2.1 (Part B).
	  • Use of 2 Marine Fauna Observers (or 1 x MFO and 1 x SEA) on board the seismic survey vessel (Part B.1).
	  • Adaptive management measures for Omura's whales (Part B.6).
	• No operation of seismic source within the Carbonate Bank and Terrace Systems of the Sahul Shelf or the Pinnacles of the Bonaparte Basin KEFs.
	• No operation of the seismic source within the Active Source Area where impacts to the Australian snubfin dolphin foraging/resting/calving/breeding BIAs may occur.

Table 3. Activity impacts and risk management ... continued

	• Shutdown procedures for turtles in accordance with EPBC Act Policy Statements 2.1 (Part A). • No operation of the seismic source within the internesting BIA for flatback turtles during nesting season. • Night-time and low-visibility procedures for turtles consistent with EPBC Act Policy Statement 2.1 - Procedure A.3.6. • Seismic source validation. • Increased duration of pre-start visual observations conducted by MFO (Omura's whale is primary observation target however, all fauna to be observed).
Atmospheric emissions	
Description of potential impacts Potential impacts from atmospheric emissions may occur in the operational area from the following sources: • Vessel operations (e.g. vessel & aircraft engines, generators, mobile and fixed plant and equipment). • Vessel waste incinerator. • Vessel ozone-depleting substances (ODS) used in closed-system rechargeable refrigeration systems.	**Compliance with the following key management measures** • International Convention for the Prevention of Pollution from Ships (MARPOL) -compliant Marine diesel oil (MDO) will be used during activity. • Waste incineration managed in accordance MARPOL and Marine Orders as appropriate. • All vessel engines to be maintained in accordance with manufacturers specifications. • Air pollution prevention certification. • Ozone-depleting substance handling procedures.

Table 3. Activity impacts and risk management ... continued

Light emissions	
Description of potential impacts	**Compliance with the following key management measures**
Potential impacts from light emissions may occur in the operational area from the following sources: • Vessel operations (e.g. external navigation and safe operations lighting). • Vessel-based spot lighting (e.g. streamer deployment and retrieval procedures).	• Lighting will be used as required for safe work conditions and navigational purpose.
Planned operational discharges	
Description of potential impacts	**Compliance with the following key management measures**
• Planned discharges from the vessel in the operational area may include: • Sewage/greywater. • Food waste. • Brine. • Cooling water. • Deck drainage. • Oily water.	• Sewage treatment system. • Oily water treatment system. • General chemical management procedures. • Hazardous chemical management procedures. • Waste (garbage) management procedure. • Deck cleaning product selection procedure. • Clean up of oil/ lubricant spills to deck in accordance with vessel Shipboard Oil Pollution Emergency Plan (SOPEP).

Table 3. Activity impacts and risk management ... continued

Interaction with commercial fisheries	
Description of potential impacts Interaction with commercial fisheries may occur as a result of: • Vessel operations including the presence of any towed equipment (e.g. streamers).	**Compliance with the following key management measures** • Recreational fishing restrictions. • Navigation equipment and procedures. • Vessels fitted with AIS systems and radars, including AIS (virtual or installed) to mark the location of streamer tail buoys. • Exclusion (safety) zone established to reduce potential for collision or interference with other marine user activities. • Maritime Notices - Notices to Mariners (NTM) and AUSCOAST warnings. • Santos activity notifications (where requested). • Support vessel present and operational during the Activity. • Decision making and communications protocol implemented in the event that the seismic vessel and towed equipment are required to leave the Operational Area during the survey. • Concurrent operations planning with relevant commercial fishers. • Application of Santos Commercial Fishers Payment Claim Protocol. • Constant bridge watch. • Protocols for handling entangled fishing gear to be provided to seismic contractor.

Table 3. Activity impacts and risk management ... continued

Interaction with other marine users	
Description of potential impacts Interaction with commercial fisheries may occur as a result of: • Vessel operations including the presence of any towed equipment (e.g. streamers).	**Compliance with the following key management measures** • Navigation equipment and procedures. • Vessels fitted with AIS systems and radars, including AIS (virtual or installed) to mark the location of streamer tail buoys. • Exclusion (safety) zone established to reduce potential for collision or interference with other marine user activities. • Maritime Notices - Notices to Mariners (NTM) and AUSCOAST warnings. • Notices to Department of Defence (DoD). • Stakeholder consultation. • Support vessel present and operational during the Activity. • Constant bridge watch. • Santos decision making and communications protocol implemented in the event that the seismic vessel and towed equipment are required to leave the Operational Area during the survey. • Recreational fishing restrictions.
Cumulative and additive noise emissions impacts	
Description of potential impacts Potential impacts from successive seismic surveys can be classified as the following: • Cumulative impacts - Considered when the spatial footprint of impacts from previous seismic surveys (or other significant underwater sound producing activities) have occurred over the same area of activity. • Additive impacts - Result from other concurrent seismic surveys (or other significant underwater sound producing activities), where the effects may or may not overlap spatially, but when taken together have an additive or incremental effect on the same receptors.	**Compliance with the following key management measures** • Seismic source separation distance during concurrent surveys: minimum 40 km while operating. • Management of concurrent seismic surveys within commercial fisheries. • Identification and risk assessment of other concurrent petroleum activities within 20 km of the operating seismic source.

Table 3. Activity impacts and risk management ... continued

Potential risks - unplanned activities	
Marine diesel oil (MDO) release from vessel collision (surface)	
Description of potential risks Potential release of MDO may occur in the operational area from the following sources: • Vessel collision and fuel tank rupture.	**Compliance with the following key management measures** • MARPOL-compliant fuel oil (MDO) will be used during the activity. • Vessels fitted with AIS systems and radars (virtual or installed) to mark the location of seismic streamer tail buoys. • Exclusion (safety) zone established to reduce potential for collision or interference with other marine user activities. • Maritime Notices - Notices to Mariners (NTM) and AUSCOAST warnings. • Navigation equipment and procedures. • Support vessel in place during Activity to reduce potential for collision or interference with other marine users. • Constant bridge watch. • Restrictions on how small volumes of unused IFO and HFO must be stored on a vessel, including restricting volumes and limiting storage to tanks that do not have direct exposure to the marine environment. • Implementation of Oil Pollution Emergency Plan (OPEP). • Implementation of Vessel spill response plans (SOPEP/SMPEP). • Maximum volume of fuel stored in a single tank of vessels used for the Activity will not exceed 1,065 m^3.

Table 3. Activity impacts and risk management ... continued

Minor hydrocarbon release	
Description of potential risks Sources of risk from an accidental minor release of hydrocarbons may occur as a result of: • Vessel refuelling (e.g. fuel hose breaks, coupling failure, tank overfilling). • Vessel equipment and machinery failure (e.g. tank pipework failure or rupture, hydraulic hose failure, inadequate bunding and/or storage, insufficient fastening or inadequate handling, vessel thruster/propeller stern tube seal leak and/or mechanical damage).	**Compliance with the following key management measures** • MARPOL-compliant fuel oil (MDO) will be used during the activity. • Deck drainage control measures (such as scupper plugs) in areas where chemicals and hydrocarbons are stored and frequently handled. • General chemical management procedures. • Hazardous chemical management procedures. • Maritime dangerous goods code. • Bulk refuelling transfer procedures. • Implementation of Oil Pollution Emergency Plan (OPEP). • Implementation of Vessel spill response plans (SOPEP/SMPEP). • Bunkering / bunkering drill undertaken prior to the Activity.
Spill response operations	
Description of potential risks In the event of a hydrocarbon spill, response strategies will be implemented where possible to reduce environmental impacts to ALARP but may include: • Light, noise and atmospheric emissions. • Operational discharges and waste. • Physical presence and disturbance. • Disruption to other users of marine and coastal areas and townships. • Shoreline clean-up operations. • Oiled wildlife response operations.	**Compliance with the following key management measures** • In the event of a hydrocarbon spill, the Oil Pollution Emergency Plan (OPEP) requirements are implemented to mitigate environmental impacts.

Table 3. Activity impacts and risk management ... continued

Unplanned hazardous and non-hazardous discharges - liquid	
Description of potential impacts Sources of risk from an accidental release of hazardous and non-hazardous (non-hydrocarbon) liquids may occur as a result of: • Vessel equipment and machinery failure (e.g. tank pipework failure or rupture, hydraulic hose failure, inadequate bunding and/or storage, insufficient fastening or inadequate handling, vessel thruster/propeller stern tube seal leak and/or mechanical damage).	**Compliance with the following key management measures** • Equipment maintenance in accordance with preventative maintenance system (PMS). • Oily water treatment system. • General chemical management procedures. • Hazardous chemical management procedures. • Maritime dangerous goods code. • Dropped object prevention procedure. • Implementation of Vessel spill response plans (SOPEP/SMPEP).
Unplanned hazardous and non-hazardous discharges - solid	
Description of potential risks Sources of risk from an accidental release of hazardous and non-hazardous (non-hydrocarbon) solids may occur as a result of: • Overfull/uncovered bins on deck. • Incorrectly disposed items. • Spills during transfers of waste. • Loss of vessel and survey equipment (e.g. streamers, fenders). • Supply transfer from support vessel to survey vessel. Solid objects, such as those below, can be accidentally released to the marine environment, and potentially impact sensitive receptors: • Non-hazardous solid wastes, such as paper, plastics and packaging. • Hazardous sold wastes, such as batteries, fluorescent tubes, medical wastes, and aerosol cans.	**Compliance with the following key management measures** • Equipment maintenance in accordance with Preventative Maintenance System (PMS). • Streamers are fitted with streamer recovery devices (SRD). • Waste (garbage) management procedure. • Dropped object prevention procedure. • Streamer deployment / retrieval procedure. • Streamers have locating devices fitted. • Streamer tow depth constrained.

Table 3. Activity impacts and risk management ... continued

Marine fauna collisions	
Description of potential risks Marine fauna interactions may occur as a result of: • Vessel collision. • Equipment collision (e.g. streamers, seismic source).	**Compliance with the following key management measures** • Streamer deployment / retrieval procedure. • Use of a 'turtle friendly' tail buoy. • Implementation of *Environmental Protection and Biodiversity Regulations 2000* (Part 8) for interacting with cetaceans. • Implementation of control measures consistent with EPBC Act Policy Statement 2.1 (Part B): • Use of two Marine Fauna Observers (MFOs) (or 1 x MFO and 1 x SEA) on board the seismic survey vessel. At least one MFO will have previous experience on a seismic survey vessel as an MFO. • Constant bridge watch. • Marine fauna observations undertaken to minimise the disturbance to fauna caused by the Activity. • Whale shark interaction guideline for support vessel.
Introduction of invasive marine species (IMS)	
Description of potential risks Introduction of invasive marine species (IMS) may occur due to: • Biofouling on vessels and marine equipment (e.g. streamers, ballast water exchange). • External / internal niches (e.g. sea chests, seawater systems).	**Compliance with the following key management measures** • Anti-foulant system. • Aquatic Biosecurity Solution vessel check tool (applied to vessels), and immersible equipment clean. • Biosecurity risk management Plan. • Ballast water management plan.

Consultation

Consultation provides Santos with an opportunity to receive feedback from authorities, persons and organisations whose functions, interests or activities may be affected by proposed petroleum activities.

This feedback helps us to refine or change the management measures we are planning to address potential activity impacts and risks. Santos' objective for proposed activities is to reduce environmental impacts and risks to a level that is As Low As Reasonably Practicable (ALARP) and acceptable over the life of the activity.

Consultation also helps us to identify values and sensitivities where information is not publicly available, such as spiritual and cultural connection to land and sea country, as well as first-hand feedback on commercial and recreational fishing, tourism and local community activities and interests.

Providing feedback

You might be a relevant person if, for example, you have spiritual or cultural connections to land and sea country in accordance with Indigenous tradition that might be affected by our activity, if you otherwise carry out recreational or commercial fishing, tourism or other activities that might be affected by our proposed activity, or if you are part of a local community that might be affected by our proposed activity.

If you consider you may be a relevant person, please contact us by **26 October 2023** to allow Santos time to initiate consultation with you, so you can tell us how you would like to be consulted throughout this process or if you need additional information.

The merits of relevant person feedback provided through the consultation process will be considered during EP development, with a summary of responses summarised and included in the EP submitted to NOPSEMA for assessment. Please let us know if you would like your personal/organisational details or any part of your feedback to remain private and we will ensure this remains confidential to NOPSEMA.

More information about how community members can participate in environmental approvals for activities proposed in Commonwealth waters has been published in a **brochure** by NOPSEMA.

Contact

E: offshore.consultation@santos.com
T: 1800 267 600
santos.com/offshoreconsultation

Information for relevant persons – commercial fishers

Santos

Eos 3D Marine Seismic Survey Environment Plan

Activity overview

This Information Sheet provides additional information on proposed on-water activities, an overview of fisheries potentially impacted by these activities and details on Santos' approach to the co-existence of marine seismic surveys and commercial fishing. This approach is defined by:

- Minimising the extent of interruption by the seismic survey activities on commercial fishing operators' activities to the lowest practicable level.
- Mitigating the effects of the interruptions.
- Application of an equitable 'commercial fishers payment claim protocol'.

In developing this information Santos acknowledges the **Guidance framework Supporting cooperative coexistence of seismic surveys and commercial fisheries in Australia's Commonwealth marine area**.

Providing feedback and activity notification

Santos recognises the importance of the offshore petroleum and commercial fishing industries to regional and national economies, as well as the rights and responsibilities of individual operators to go about their respective activities.

Commercial fishers are encouraged to contact Santos by close of business on **26 October 2023** to discuss the proposed survey acquisition sequence and ways to minimise interference with fishing operations and vessel movements.

Opportunities are also provided to establish on-water communications, including activity notifications prior to the start, during and upon completion of activities.

Please note that any feedback provided is required to be recorded in the Eos 3D MSS Environment Plan (EP) that will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for assessment. Please let us know if you would like your personal/organisational details or any part of your feedback to remain private and we will ensure this remains confidential to NOPSEMA.

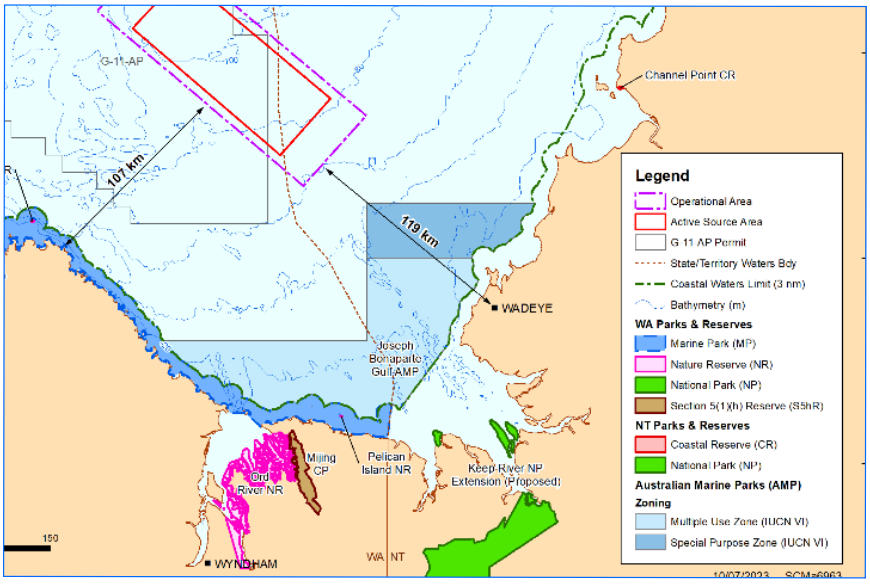


Figure 1. *Eos 3D MSS activity location*

Activity description

Activity details		
Timing	Earliest commencement of the activity is Q3 2024, however, activity may occur anytime from EP acceptance by NOPSEMA to the end of December 2026.	
Duration	• Up to 50 days to complete the activity. • The expected duration is a forecast and is subject to change based on adverse weather conditions or technical/equipment issues that may arise during the activity.	
Water depth	Operational Area 60 m to 115 m.	Active Source Area 67 m to 111 m.
Vessels	• Seismic survey vessel. • Up to two dedicated support vessels (one being a chase vessel) will accompany the seismic survey vessel to provide logistical, safety and equipment management duties. • Vessel details are unknown at this time.	
Vessel speed	Approx 4.5 knots (8.3 km/hr).	
Survey azimuth (line orientation)	North-west / south-east.	
Active source area	Total area: 4,028 km^2.	
Time to traverse a single sail line	Approx. 8 hrs and 30 mins.	
Seismic streamer length	Approx. 8 km.	
Sail line turn time	Approx. 3 – 4 hrs.	
Seismic streamer depth	Between 10 m and 30 m.	
Sail line spacing	Approx. 500 m – 700 m.	
Total seismic streamer spread width	Approx. 1,350 m.	
Volume of seismic source	Max. 3,050 in$^{3.}$	
Operating pressure	2,000 psi.	
Seismic source depth	Approx. 6 – 8 m.	
Seismic source interval	Approx. 8.33 m.	
Exclusion zone	3 nm (5.6 km) exclusion (safety) zone around the seismic vessel and trailing streamers.	
Greenhouse gas assessment permit	G-11-AP.	

Commercial fishery implications

Santos has undertaken an assessment to define the environmental, social, economic and cultural features that may be affected by proposed activities.

As part of this process, we have identified commercial fisheries that have been active in the Operational Area whose functions, interests and activities may be affected by planned activities, acknowledging that seismic surveys can potentially result in:

- Behaviour changes of target species in response to underwater noise emissions and the physical presence of the seismic vessel and trailing equipment.
- Disruption or temporary physical displacement of fishing operations from preferred fishing grounds and/or damage to fishing gear due to interaction with the survey vessel and trailing equipment.

We have also identified those fisheries that are entitled to fish in the broader Environment that May Be Affected (EMBA).

Table 1 provides an overview of those fisheries active in the Operational Area and those licensed to fish in the EMBA. Our fisheries assessment is based on publicly available government managed catch and effort data, our ongoing discussions with commercial fishing representative organisations, and historic engagements for previous petroleum activities.

Fishery	Operational Area	EMBA
Commonwealth fishery		
Northern Prawn Fishery	Yes	Yes
North West Slope Trawl Fishery	No	Yes
Southern Bluefin Tuna Fishery	No	Yes
Western Tuna and Billfish Fishery	No	Yes
Western Skipjack Fishery	No	Yes
WA fishery		
Northern Demersal Scalefish Managed Fishery	Yes	Yes
Mackerel Managed Fishery	Yes	Yes
Kimberley Prawn Managed Fishery	No	Yes
West Australian Sea Cucumber Fishery	No	Yes
Pearl Oyster Managed Fishery	No	Yes
Marine Aquarium Fish Managed Fishery	No	Yes
Specimen Shell Managed Fishery	No	Yes
NT fishery		
Demersal Fishery	Yes	Yes
Spanish Mackerel Fishery	Yes	Yes
Offshore Net and Line Fishery	Yes	Yes
Aquarium Fishery	Yes	Yes
Timor Reef Fishery	No	Yes
Barramundi Fishery	No	Yes
Coastal Line Fishery	No	Yes
Trepang Fishery	No	Yes
Development – Small Pelagic	No	Yes
Coastal Net Fishery	No	Yes

Table 1. Commercial fisheries identified

The EMBA is defined by the spatial extent of activity impacts (e.g., facility presence, light, noise) and risk (e.g., hydrocarbon spill). The EMBA for this activity is the outer boundary of a worst-case marine diesel oil spill resulting from a vessel collision (see **Figure 2**).

While the EMBA represents the largest possible spatial extent that could be contacted by any of the worst-case spill events modelled, an actual spill event is more accurately represented by only one of the simulations from the modelling, resulting in a much smaller spatial footprint in the event of an actual spill. Often one or more simulation runs are selected to be representative of the 'worst-case' based on the nature and scale of the activity and the local environment. However, both the EMBA (based on numerous possible spills) and the single representative worst-case oil spill are used for the environmental risk assessment and oil spill preparedness and response planning.

Please see the **NOPSEMA Spill Modelling Video** for more information on oil spill modelling and why it is required for the preparation of Environment Plans.

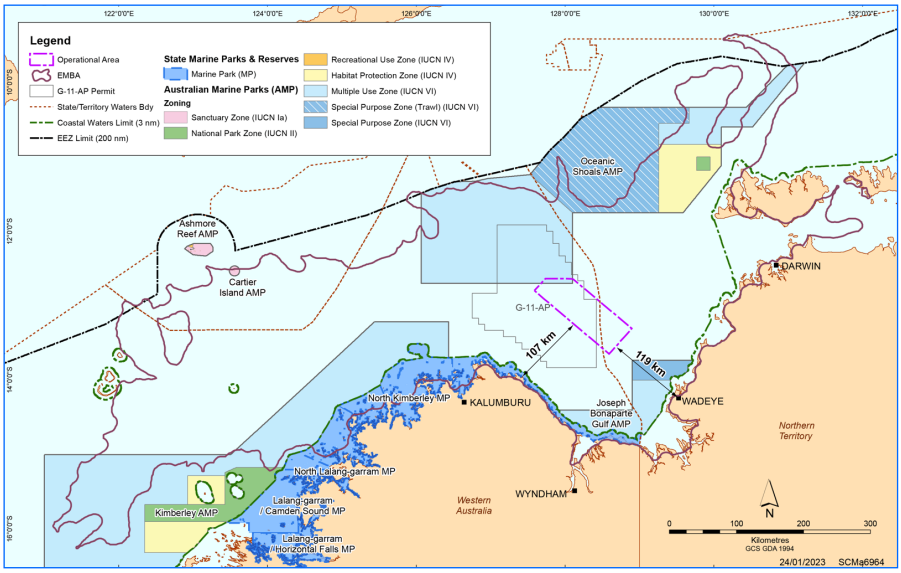


Figure 2. . Eos 3D EMBA location

Operational Area access

Commercial fishers and other marine users can access the Operational Area but are requested to avoid the 3 nm (5.6 km) exclusion (safety) zone around the seismic vessel and trailing streamers during the survey to ensure the safety of the seismic vessel and third-party vessels.

Santos has proposed the below control measures where seismic and commercial fishing activities occur concurrently:

- Santos will not restrict commercial fishing access to the Operational Area where safe to do so and concurrent operational planning will be undertaken with commercial fishers.
- Santos will develop communication protocols including direct radio contact for both parties at sea and provide operational survey plans, commencement and cessation notifications, and daily operational reports if requested.
- At a minimum the daily operational reports will include:
  - Current seismic survey vessel position.
  - Look ahead seismic survey activities and vessel positions.
  - Support vessel activities and positions.
  - Vessel contact details.
  - Santos WA management contact details.

Commercial key indicator fish species spawning

The Eos 3D MSS EP will include an assessment of potential temporal overlap between spawning periods for commercial key indicator fish species and acquisition of the survey. Control measures are presented in the following text. A summary is provided in **Table 2**.

Commercial prawn and indicator fish species spawning	J	F	M	A	M	J	J	A	S	O	N	D	Source
Banana prawn spawning													AFMA 2020
Juvenile banana prawn migration													Longeran et al. 2002
Brown tiger prawn spawning													AFMA 2020
Grooved tiger prawn spawning													AFMA 2020
Blue endeavour prawn spawning													AFMA 2020
Red endeavour prawn spawning													AFMA 2020
Red emperor													DPIRD 2019
Goldband snapper													DPIRD 2019
Spanish mackerel (Kimberley stock)													DPIRD 2019

Key

Sensitivity/activity occurs

Extended peak spawning period

Peak spawning/migration period

Commercial fishers payment claim protocol

The survey will potentially impact commercial fishers whose fishing operations overlap with the seismic survey.

Santos has a process to enable commercial fishers to lodge evidence-based payment claims for temporary loss of fish catch, displacement costs and equipment damage or loss directly caused by the seismic survey. Santos will also assess requests for administrative support to help fishers collate historical fishing data required for an evidence-based payment claim.

The control measures identified within the draft Environment Plan, to outline how the potentially competing demands of commercial fishing operators and Santos' seismic survey may be managed, are consistent with those adopted for other Santos marine seismic surveys.

Consultation

All greenhouse gas activities in Commonwealth waters must have an Environment Plan (EP) accepted by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) before any activities can take place.

Under Commonwealth Environmental Regulations, Santos is required to consult with relevant persons about proposed activities when preparing an EP. A relevant person includes authorities, persons or organisations whose functions, interests or activities may be affected by the proposed activity.

Consultation provides Santos with an opportunity to receive feedback from authorities, persons and organisations whose functions, interests or activities may be affected by proposed activities.

This feedback helps us to refine or change the management measures we are planning to address potential activity impacts and risks. Santos' objective for proposed activities is to reduce environmental impacts and risks to a level that is As Low As Reasonably Practicable (ALARP) and acceptable over the life of the activity.

Consultation also helps us to identify values and sensitivities where information is not publicly available, such as first-hand feedback on commercial fishing activities and interests.

Providing feedback

If you consider that you have commercial fishing functions, interests or activities that may be affected by our proposed activity, you may be a relevant person. Please contact us by **26 October 2023** to allow Santos time to initiate consultation with you, so you can tell us how you would like to be consulted throughout this process or if you need additional information.

The merits of relevant person feedback provided through the consultation process will be considered during EP development, with a summary of responses summarised and included in the EP submitted to NOPSEMA for assessment.

More information about how community members can participate in environmental approvals for activities proposed in Commonwealth waters has been published in a **brochure** by NOPSEMA.

Contact

E: offshore.consultation@santos.com
T: 1800 267 600
santos.com/offshoreconsultation

Campaign Emails

From: Consultation, Santos <Offshore.consultation@santos.com>
Sent: Thursday, September 28, 2023 1:04 PM
To: [redacted]
Bcc: [redacted]
Subject: Bonaparte Basin consultation

Consultation on Bonaparte Basin activities:

- **Bayu-Undan Gas Export Pipeline Environment Plan**
- **Eos 3 Marine Seismic Survey Environment Plan**
- **Tern-2 Plug and Abandonment Environment Plan**

Santos is contacting you as we are proposing to undertake activities in Commonwealth, State and Territory waters offshore northern Western Australia and Northern Territory.

Under government Environmental Regulations, Santos is required to consult with relevant persons whose functions, interest and activities may be affected by our proposed activities.

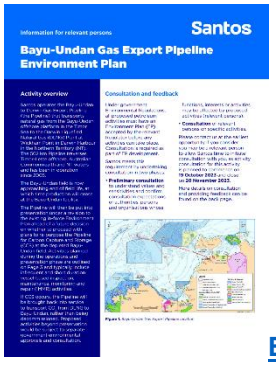
Activity summaries are provided below, with links provided to fact sheets on our Consultation Hub at www.santos.com/offshoreconsultation. These fact sheets include information on proposed activities; potential impacts, risks and management measures; and the presence, based on a review of publicly available information, of environmental, social, economic and cultural features and/or values within the Environment That May Be Affected.

Consultation for these activities will commence on **27 October 2023**, with the consultation period closing on **27 November 2023.**

Please contact us at the earliest opportunity if you consider you may be a relevant person to allow time to initiate consultation with you. Also, please let us know if you know of other authorities, persons or organisations we should consult.

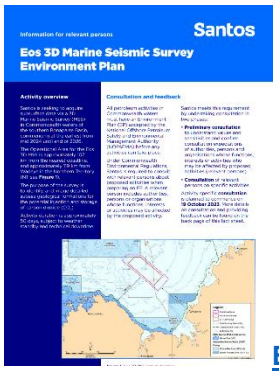
Feedback from consultation will be used for the development of Environment Plans (EPs) for each activity, which will be assessed by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA).

Proposed activities



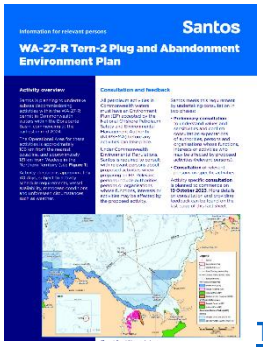
Bayu-Undan Gas Export Pipeline Environment Plan

The Bayu-Undan field is now approaching end of life, at which time production will cease at the Bayu-Undan facility. This pipeline will then be put into preservation under a revision to the existing in-force Environment Plan ahead of a future decision on whether to proceed with plans to re-purpose the Pipeline for Carbon Capture and Storage (CCS) at the depleted Bayu-Undan field. This activity is planned to commence in Q1 2024.



Eos 3 Marine Seismic Survey Environment Plan

Santos is seeking to acquire subsurface data via a 3D Marine Seismic Survey (MSS) in Commonwealth waters of the southern Bonaparte Basin, commencing at the earliest from mid-2024 until end of 2026. The Operational Area is approximately 107km from the nearest coastline, and approximately 119km from Wadeye in the Northern Territory. The purpose is to identify, and image detailed subsea geological formations for the potential injection and storage of carbon dioxide (CO_2).



Tern-2 Plug and Abandonment Environment Plan

Santos is planning to undertake subsea decommissioning activities within the WA-27-R permit in Commonwealth waters within the Bonaparte Basin, commencing mid-2024. The Operational Area for these activities is approximately 106km from the nearest coastline, and approximately 181km from Wadeye in the Northern Territory.

Next steps

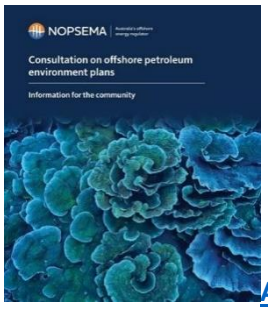
Please contact us if you would like to be consulted for any of the proposed activities. We can then discuss with you consultation methods appropriate to your information needs and interests.

If you would like to provide feedback now, please note that a summary of your feedback will be included in the respective EP, including our assessment of your feedback and response to you.

You can provide feedback via return email or call us toll free on **1800 267 600**.

Please let us know if you would like any sensitive information to remain private. If requested, Santos will ensure your information remains confidential between us and NOPSEMA and will not be published or otherwise made publicly available. Santos will handle your information in accordance with our *Offshore Western Australia and Northern Territory Consultation Privacy Policy*.

Importantly, we recognise that First Nations people and groups may have concerns about sharing culturally sensitive information so we will follow guidance when undertaking consultation activities.



Additional resources

NOPSEMA has published information that sets out titleholders' responsibilities for consultation, as well as opportunities for relevant persons to provide guidance for consultation expectations. Click the image to read in full.

We look forward to hearing from you soon.

Regards
Santos Consultation Team

Santos Ltd A.B.N. 80 007 550 923
Disclaimer: The information contained in this email is intended only for the use of the person(s) to whom it is addressed and may be confidential or contain privileged information. If you are not the intended recipient you are hereby notified that any perusal, use, distribution, copying or disclosure is strictly prohibited. If you have received this email in error please immediately advise us by return email and delete the email without making a copy. Please consider the environment before printing this email

From: Consultation, Santos <Offshore.consultation@santos.com>
Sent: Friday, November 3, 2023 11:09 AM
To: [redacted]
Bcc: [redacted]
Subject: Bonaparte Basin consultation

Consultation on Bonaparte Basin activities:

- **Bayu-Undan Gas Export Pipeline Environment Plan**
- **Eos 3 Marine Seismic Survey Environment Plan**
- **Tern-2 Plug and Abandonment Environment Plan**

Further to our previous correspondence, Santos advises it is now consulting on proposed activities in Commonwealth, State and Territory waters offshore northern Western Australia and Northern Territory.

Activity summaries are provided in the email below, with links provided to fact sheets on our Consultation Hub.

Relevant person consultation

Under government Environmental Regulations, Santos is required to consult with relevant persons whose functions, interest and activities may be affected by our proposed activities.

Feedback from consultation is used for the development of Environment Plans (EPs) for each proposed activity. EPs listed below will be assessed by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA).

Santos is seeking your feedback by **27 November 2023**, which can be provided via return email or call us toll free on **1800 267 600**.

In providing feedback, please note that a summary of your feedback will be included in the respective EP, including our assessment of your feedback and response to you.

Please let us know if you would like any sensitive information to remain private. If requested, Santos will ensure your information remains confidential between us and NOPSEMA and will not be published or otherwise made publicly available. Santos will handle your information in accordance with our *Offshore Western Australia and Northern Territory Consultation Privacy Policy*.
Importantly, we recognise that First Nations people and groups may have concerns about sharing culturally sensitive information so we will follow your guidance when undertaking consultation activities.

Additional resources

NOPSEMA has published information that sets out titleholders' responsibilities for consultation, as well as opportunities for relevant persons to provide guidance for consultation expectations. Click the image to read in full.

We look forward to hearing from you soon.

Regards
Santos Consultation Team

From: Consultation, Santos <Offshore.consultation@santos.com>
Sent: Tuesday, November 21, 2023 4:24 PM
To: [redacted]
Subject: Bonaparte Basin consultation - [redacted]

We recently emailed you about consultation on our Bonaparte Basin activities as per the email below.

It has information about relevant persons consultation and the development of Environment Plans, and links to information about the activities Santos is consulting on.

Santos is seeking your feedback by **27 November 2023**, which can be provided via return email or by calling us toll free on 1800 267 600.

We look forward to hearing from you soon.

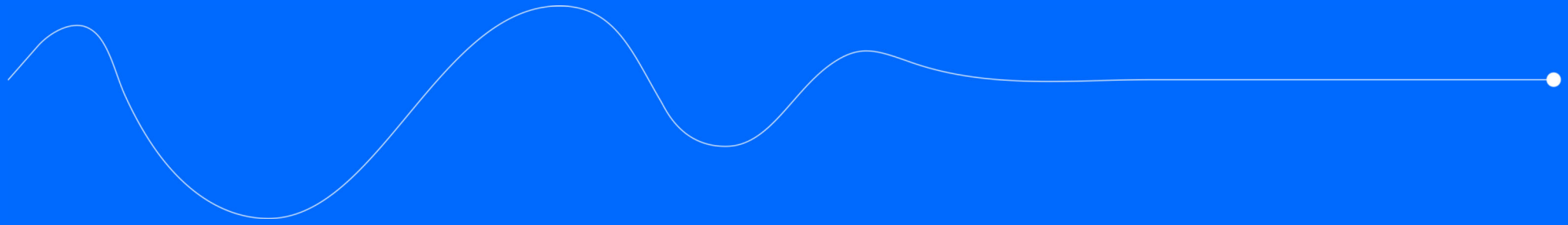
Regards,
Santos Consultation Team

Presentations

NT & WA 11A
Consultation_2023_Four EPs

Santos

NORTHERN TERRITORY & WESTERN AUSTRALIA PROJECT CONSULTATION SESSION



WA & NT Environment Plan Consultation

Presented by **Santos Team**

Santos

Privacy Statement

Santos Ltd and its related bodies corporate (together, we, our, us or Santos) collect personal information about you, such as your name and sensitive information about your indigenous heritage. We use this information to record your attendance at any meeting or other discussion with us, to provide you with information about our projects, to receive and respond to any information that you provide, to answer any questions you might have and for other purposes that we tell you about during your meeting or other discussion with us. Santos will handle any information that you provide in accordance with our Code of Conduct and our Confidentiality, IP and Privacy Procedure. You can ask us for a copy of this Privacy Notice or these other documents.

If you do not provide your personal information, we may not be able to identify you as the person who provided information, or we may be unable to discuss any information you have provided with you further or respond to your questions. We may disclose your information to other companies within the Santos group, to third parties that help us run our business and to relevant government agencies and government departments.

Due to the global nature of our operations and business, your personal information may be accessed by or disclosed to Santos personnel outside Australia. We may also use overseas third parties to collect, transfer, store and handle your personal information. Some of the overseas countries that your personal information may be accessed from, disclosed or transmitted to or stored in include but are not limited to, Papua New Guinea and the United States of America.

You have a right to request a copy of any personal information that we hold about you, as well as a right to request that we correct any information that we hold about you that is inaccurate, out-of-date, incomplete, irrelevant or misleading. You can also make a complaint about how we have handled your personal information. Our Consultation Privacy Policies explain in more detail how you can exercise these rights, including how we will respond to your access or correction request or to any privacy complaint that you make. The Barossa Gas Project Consultation Privacy Policy is available on our website at **www.santos.com/barossa/barossa-gas-project-consultation-privacy-policy**, and the Western Australia and Northern Territory Consultation Privacy Policy is available on our website at **https://www.santos.com/offshore-wa-and-nt-consultation-privacy-policy/.** You can also contact us to request copies be provided to you.

You can contact us by:

- posting a letter addressed to us at 60 Flinders Street, Adelaide, South Australia, 5000;
- telephoning us on +61 8 8116 5000; or
- sending us an email at offshore.consultation@santos.com and compliance@santos.com.

Santos

Acknowledgement of Country

Santos acknowledges the Traditional Owners of the land on which we meet today.

We pay our respects to Elders past, present and emerging.

Santos

Welcome & Introductions

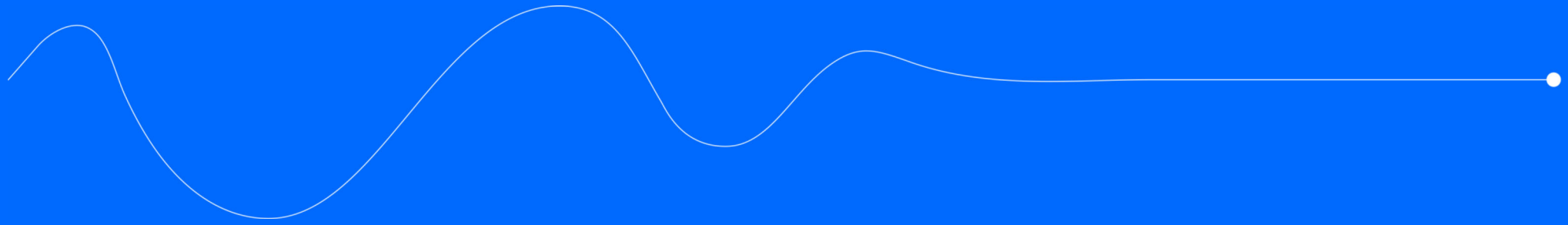
We are here today to share information about our company & operations and to listen to your questions about Santos & upcoming projects.

Peter Kirkpatrick *– General Manager, Darwin*

Emma Haddon *– Senior Environmental Advisor*

Santos

SANTOS OPERATIONS & DARWIN LNG



WA & NT Environment Plan Consultation

Presented by **Barossa Team**

SANTOS - South Australia, Northern Territory Oil Search

Santos is a global energy company committed to increasingly cleaner energy and fuels production, with operations across Australia, Papua New Guinea, Timor-Leste and North America (Alaska).

At Santos, our commitment is to be a global leader in the transition to cleaner energy and clean fuels, by helping the world decarbonise to reach net-zero emissions in an affordable and sustainable way.

For more than 65 years, Santos has been working in partnership with local communities, providing local jobs and business opportunities, safely developing its natural gas resources, and powering industries and households.

Santos is one of Australia's biggest domestic gas suppliers and a leading LNG supplier in the Asia Pacific region.

We are committed to supplying critical fuels such as oil and gas in a more sustainable way through decarbonising projects, including the Moomba CCS Project, while we all transition to cleaner fuels.

Our business focus: Safe, reliable operations & Minimise our social and environmental impacts.

Darwin LNG Facility & Operations

Santos

- Located in Darwin at Wickham Point Darwin LNG (DLNG) is a single train liquefaction and storage facility that started production in 2006.
- The Bayu-Undan facility, which supplies gas to DLNG via 26-inch subsea pipeline, is located approximately 500 kilometers north-west of Darwin in the Timor Sea.
- The facility includes a central production Storage and Offloading vessel for condensate and LPG products and an unmanned wellhead platform.
- Approx 140 local Darwin people work at the LNG Facility.
- 100% Darwin residential Santos employee workforce.
- DLNG established the NT's first LNG Process Operator Traineeships in 2010.
  - ~10% of those who have completed identified as an Aboriginal or Torres Strait Islander.

The Oil & Gas lifecycle

Santos

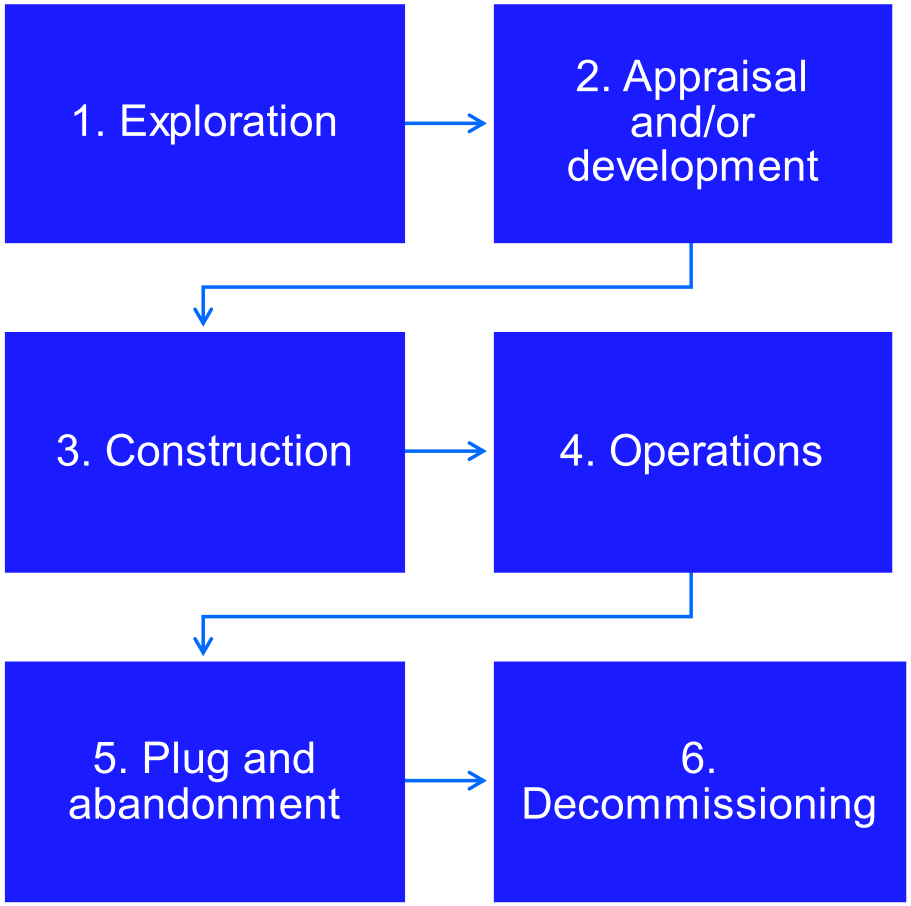
The oil & gas lifecycle involves the exploration, extraction, and use of these resources. Followed by closing the site when complete.

It starts with searching for gas deep underground using seismic surveys and drilling exploration wells, followed by the construction of infrastructure to extract and produce them.

Afterward, the products are transported to end-users.

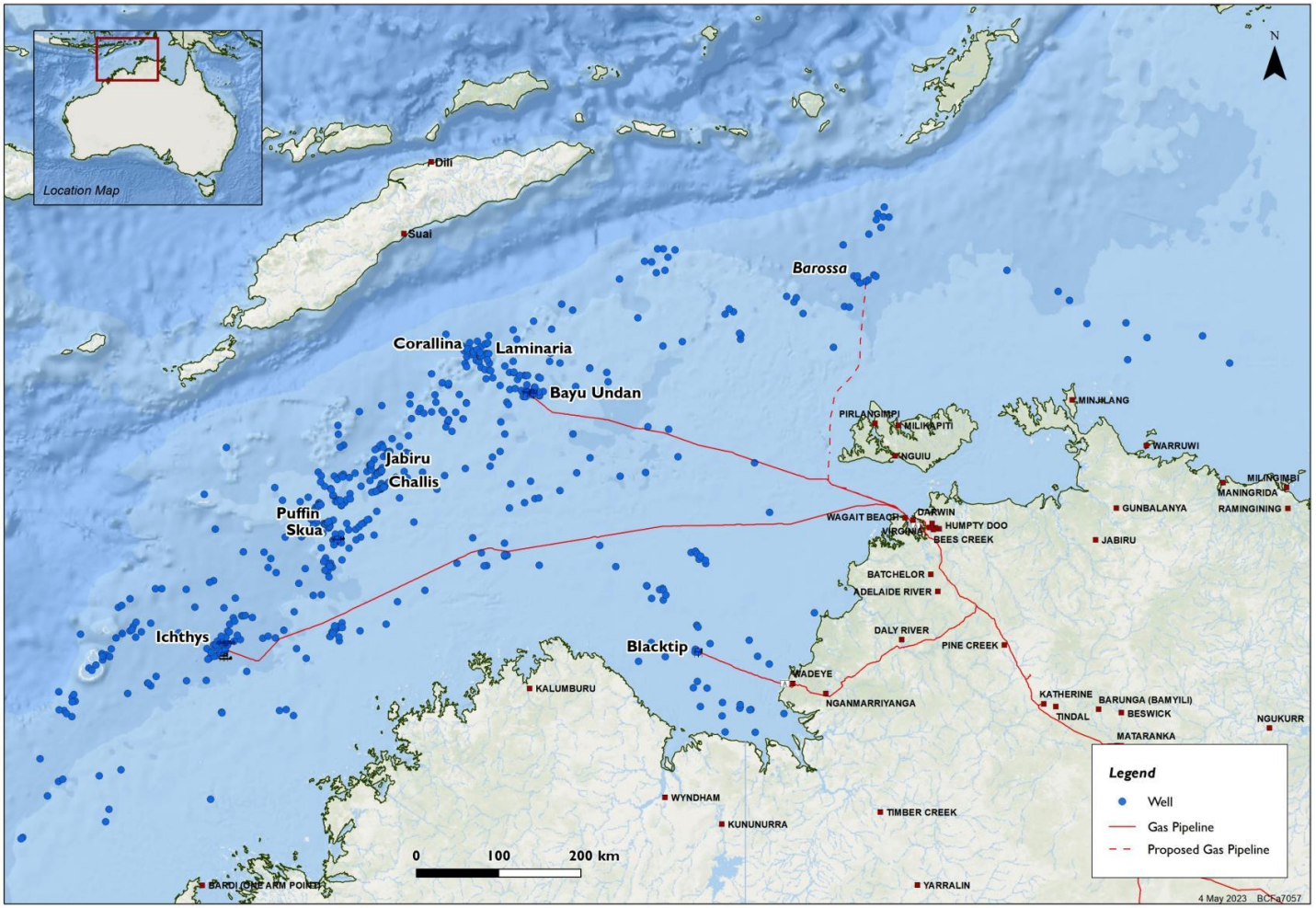
When the resources are depleted, there's a process to close down operations and ensure environmental compliance. This is called decommissioning.

Current Santos projects are at various stages of this lifecycle.



Wells Oil & Gas Drilled by All Industry Since 1969

Santos



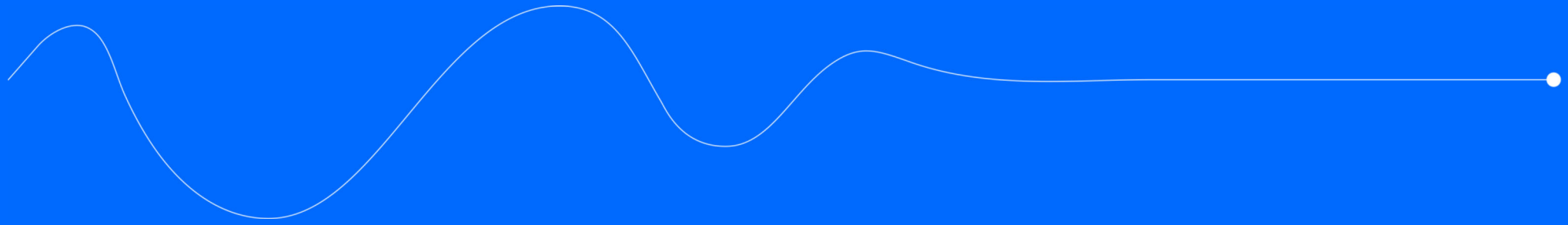
These are not all Santos owned and operated.

This map shows all wells drilled in the NT area.

Not all of these wells are used. Many are capped.

Santos

ENGAGEMENT & CONSULTATION EXPLAINED



Consultation for Environment Plans

Commonwealth waters – National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA)

"In the course of preparing an Environment Plan, a titleholder must consult with relevant persons in accordance with Division 2.2A, Regulation 11A…

"The purpose of consultation under regulation 11A of the Environment Regulations is to ensure that authorities, persons or organisations that are potentially affected by activities are consulted and their input considered in the development of environment plans."

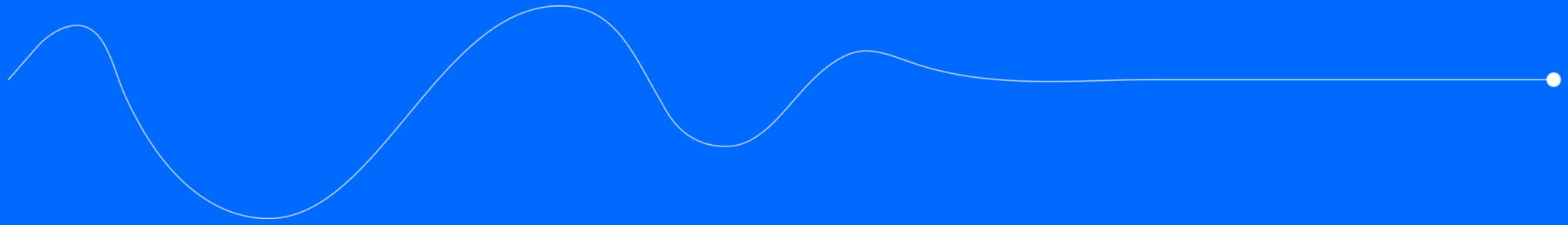
Guideline - Consultation in the course of preparing an environment plan, NOPSEMA

NOPSEMA

Information provided by relevant persons in consultation may also help titleholders **better understand the values and sensitivities of the environment** and inform the evaluation of the **potential impacts and risks** associated with the activity and **how to manage them** appropriately

Santos

BAROSSA GAS PROJECT & DARWIN PIPELINE DUPLICATION ENVIRONMENT PLAN CONSULTATION



WA & NT Environment Plan Consultation

Presented by **Barossa Team**

Santos

Barossa Gas Project - Overview

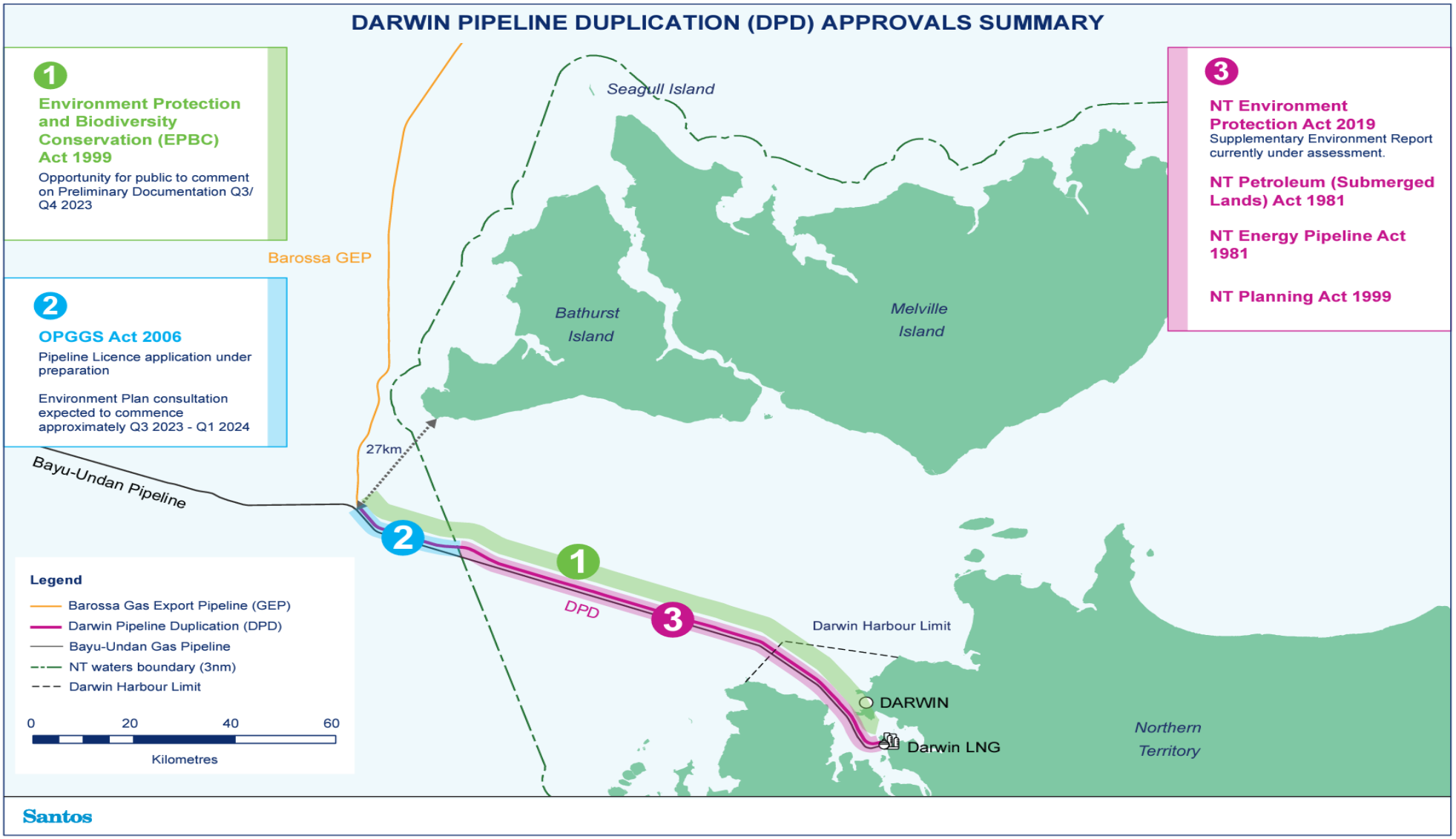
- The Santos-operated Barossa Gas Project is an offshore gas and condensate project that proposes to provide a new source of gas to the existing Darwin liquified natural gas (DLNG) facility in Darwin.
- The Barossa gas field is approximately 285 kilometres offshore north-north west from Darwin.
- Natural gas would be extracted from the Barossa field and transported via a gas pipeline (Gas Export Pipeline (GEP) and Darwin Pipeline Duplication (DPD)) to the existing DLNG facility.
- Project infrastructure would comprise a Floating Production Storage and Offloading (FPSO) facility, a subsea production system, supporting in-field subsea infrastructure, the GEP and the DPD.
- Up to eight subsea wells are planned to be drilled in the Barossa field (six wells from three drill centres, with contingency plans for an additional two wells). Gas and condensate would be gathered from the wells through the subsea production system and then brought to the FPSO facility via a network of subsea infrastructure.
- Initial processing would occur at the FPSO facility, to separate the natural gas, water and condensate extracted from the Barossa field. The dry natural gas would be transported through the gas pipeline for onshore processing at the DLNG facility. Condensate would be transferred from the FPSO to specialised tankers for export.

Santos

Barossa Gas Project Overview Video

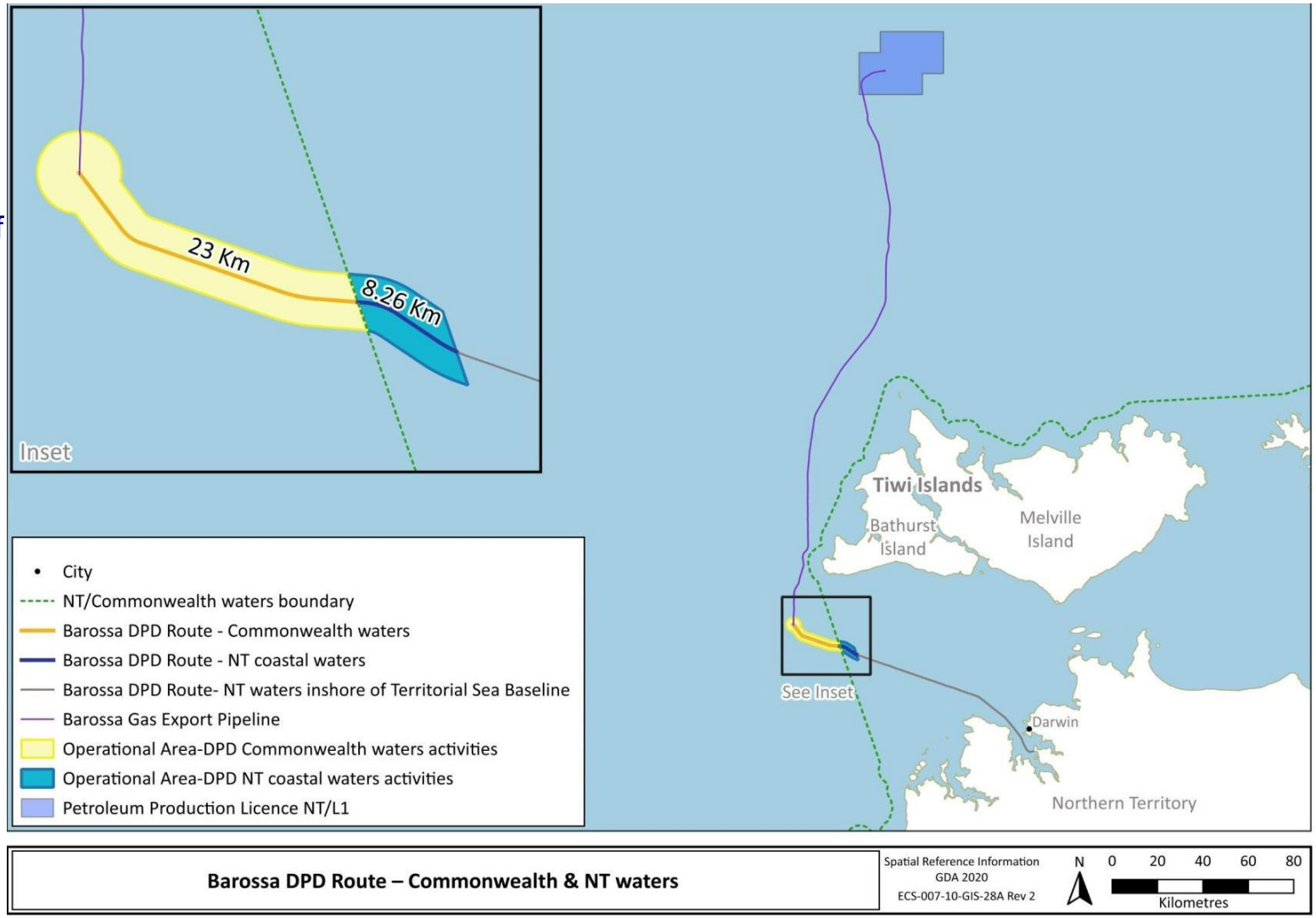
DPD Approvals

Santos



Darwin Pipeline Duplication (DPD) - Overview Santos

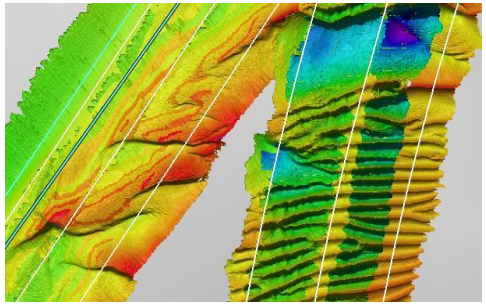
- The DPD will connect to the Barossa gas export pipeline and will send gas to Darwin.
- The pipeline will run from approximately 27km south-west of the Tiwi Islands to the gas plant in Darwin Harbour.
- Activities consist of acoustic positioning, survey, pipeline and structure installation, pipeline testing, refuelling, connecting the DPD to the Barossa gas export pipeline and unplanned maintenance/repairs.
- DPD activities are currently planned to start between Q3 of 2024 and Q2 of 2025, depending on availability of vessels and equipment, and should last 3 months)



Key DPD Installation Steps

Santos

Pre-lay Survey



Pre-lay Span Correction

Concrete mattresses are installed to support the pipeline where the seabed is rough.

Pipelay and Survey

Approximately 31km of pipeline is installed in Commonwealth and coastal waters by a pipelay vessel. Survey and post lay span correction, if required, is performed as pipelay progresses.

Pipeline Testing

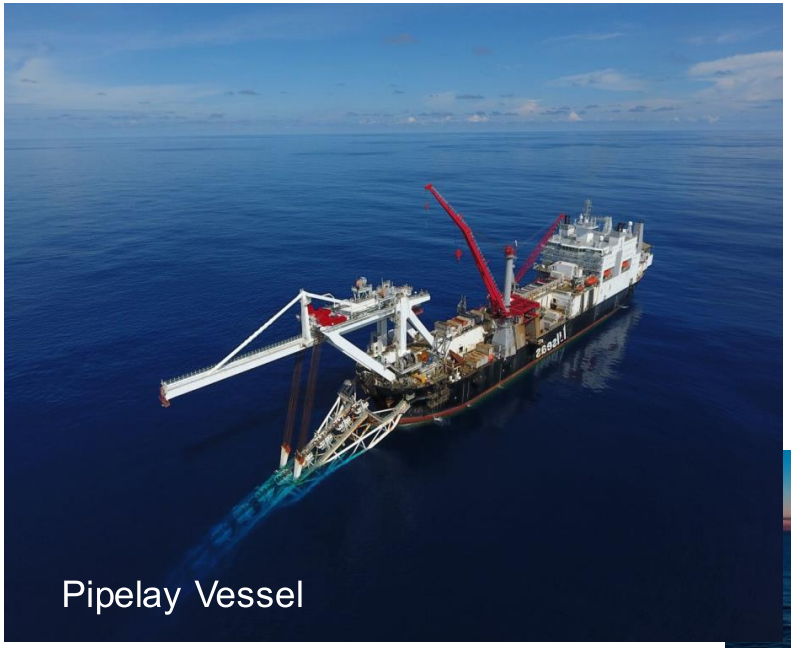
The DPD will be flooded with treated seawater and leak tested before the water is removed and the DPD is prepared for introduction of gas.

Connect DPD to the Gas Export Pipeline and Test

A spool shall be installed connecting the offshore gas export pipeline to the DPD. Once installed the spool will be leak tested.

DPD Installation Activities – Key Vessels

Santos



Pipelay Vessel

Survey and Construction Support Vessel

Supply Vessel

Santos

DPD impacts

Planned events	Expected Impact	How we manage (the rules we follow)
Light disturbance	Behavioural impact to marine life (e.g. attraction)	We only use lights where needed for safe operations and to comply with relevant safety rules. We turn off lights when not required.
Noise disturbance	Behavioural impact to marine life (e.g. avoidance)	We follow procedures and look out for marine life (e.g., whales, dolphins, turtles) and we slow down and move away from them where possible if they are too close. Boats and equipment will be maintained to minimise noise.
Seabed disturbance	Turbidity, smothering of habitat	We are putting equipment on a mainly flat sandy seabed close to an existing pipeline. We record the position of installed equipment so we can collect it at a later date.
Discharges (boat discharges, pipeline testing)	Impact to water quality	We will manage discharges to acceptable levels and follow the standard rules for what boats can discharge. We will select water treatment chemicals that are environmentally acceptable, and we will limit its use.
Air emissions	Impact to air quality, greenhouse gas emissions	We ensure engines and other equipment are looked after and low emission fuel will be used.
Disturbance to other boats	Exclude other users from activity area	We will communicate to other boats where we are and what we are doing. We mark the location of equipment on charts.

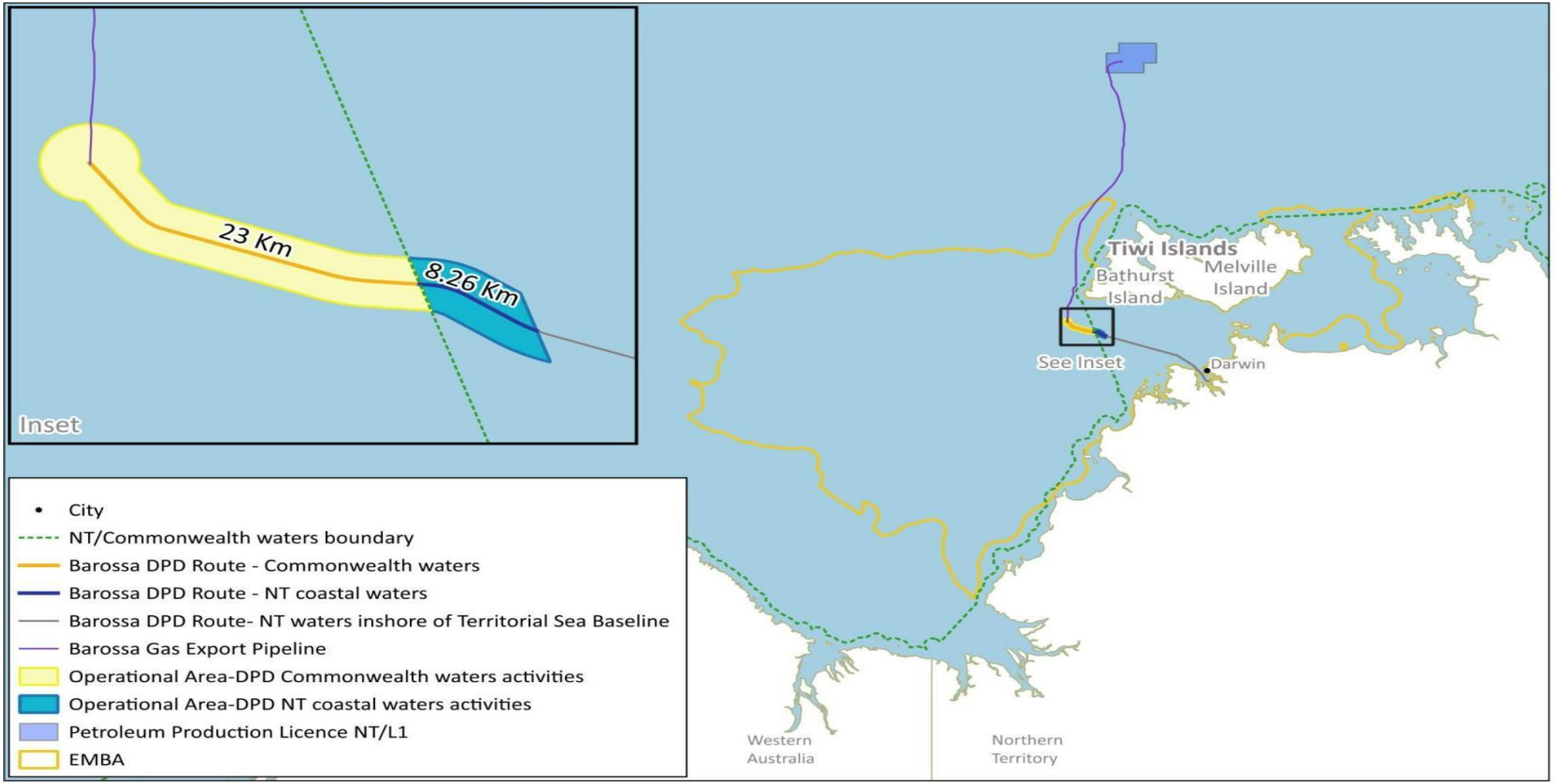
Santos

DPD risks

Unplanned events (Accidents)	Unplanned Impact	How we manage (the rules we follow)
Dropped objects	Impacts to water quality, disturbance to seabed and marine life	We follow strict procedures to stop objects dropping overboard and we pick up objects when it is safe to do so.
Disturbing marine animals	Disturbance (e.g. collisions) with marine life	We look out for marine life (e.g., whales, dolphins, turtles) and we slow down and move away from them where possible if they are too close. We follow rules that outline how we need to interact with
Invasive marine life	Impacts to other marine life and industry	We inspect the boats to ensure no invasive marine life before they arrive. We have plans and equipment in place on boats to prevent invasive marine species. The Federal government has strict rules we need to follow.
Chemical spill	Water quality impacts	We select chemicals that are friendly to the environment where possible and store them carefully. We have procedures for using and cleaning up chemicals.
Gas release (dry gas or nitrogen) - Bayu-Undan pipeline	Marine life impacts, other user impacts	We follow strict rules for lifting to prevent dropped objects. We have procedures in place to minimise loss of gas from Bayu-Undan pipeline.
Diesel spill	Water quality, impacts to habitats and marine life, protected areas, socio-economic and cultural values	We make sure all the boats are following the rules for preventing collisions. We let other boats know where we are and what we are doing. We follow strict procedures for refueling. We have plans and arranegments in place for responding to spills.

DPD Environment That May Be Affected – Diesel spill

Santos



Barossa DPD Route and EMBA in Commonwealth & NT waters

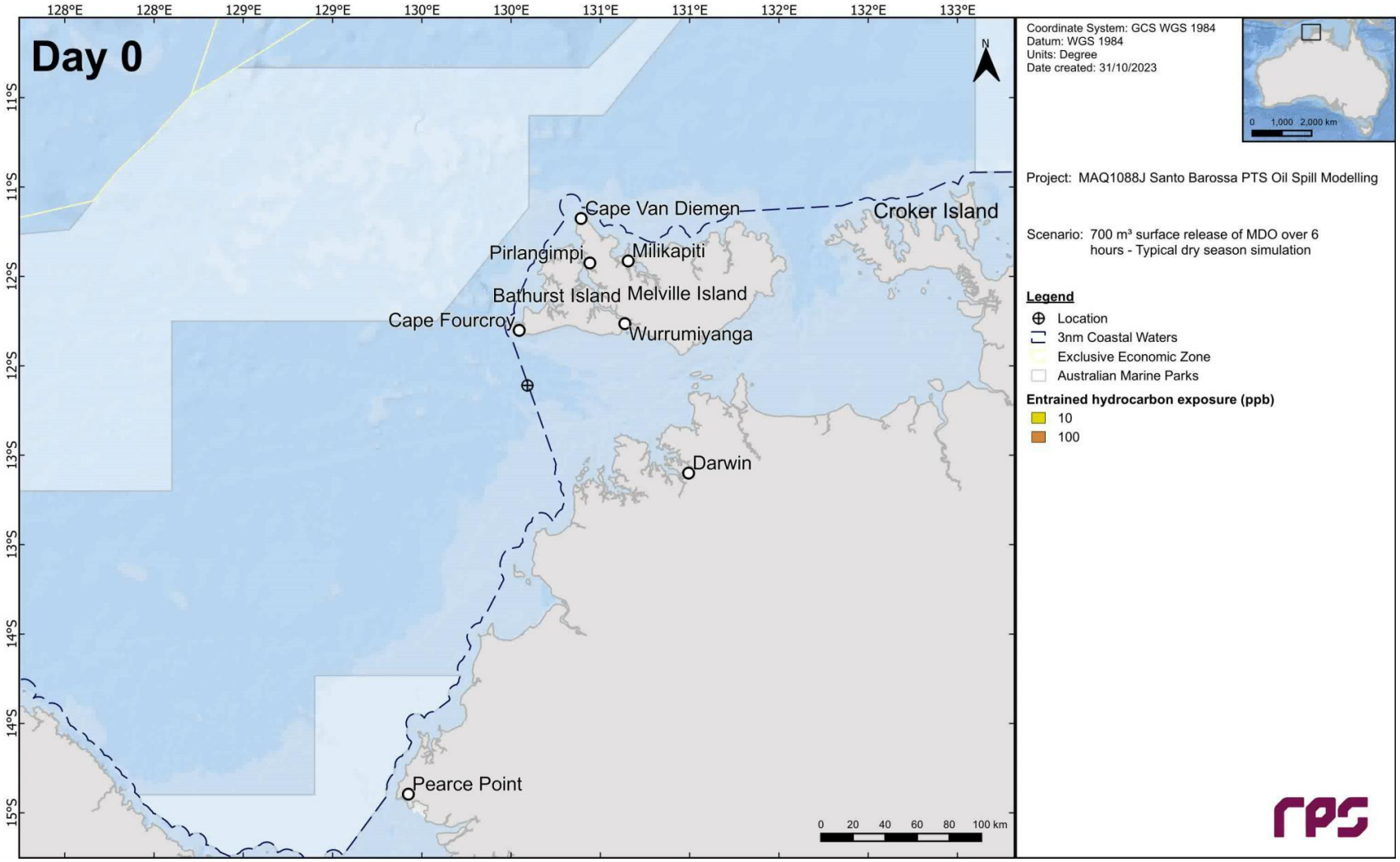
Spatial Reference Information
GDA 2020
ECS-007-10-GIS-28B Rev 2

N

0 40 80 120 160
Kilometres

DPD Diesel Spill Animation – typical dry season simulation

Santos



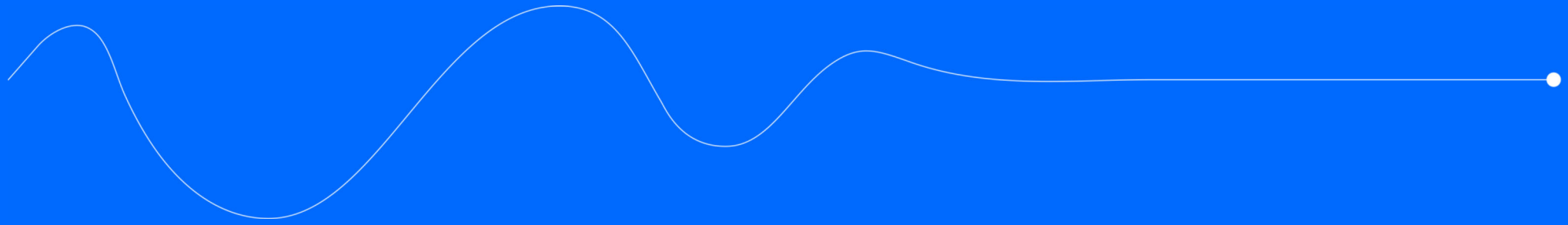
Santos

DPD QUESTIONS?

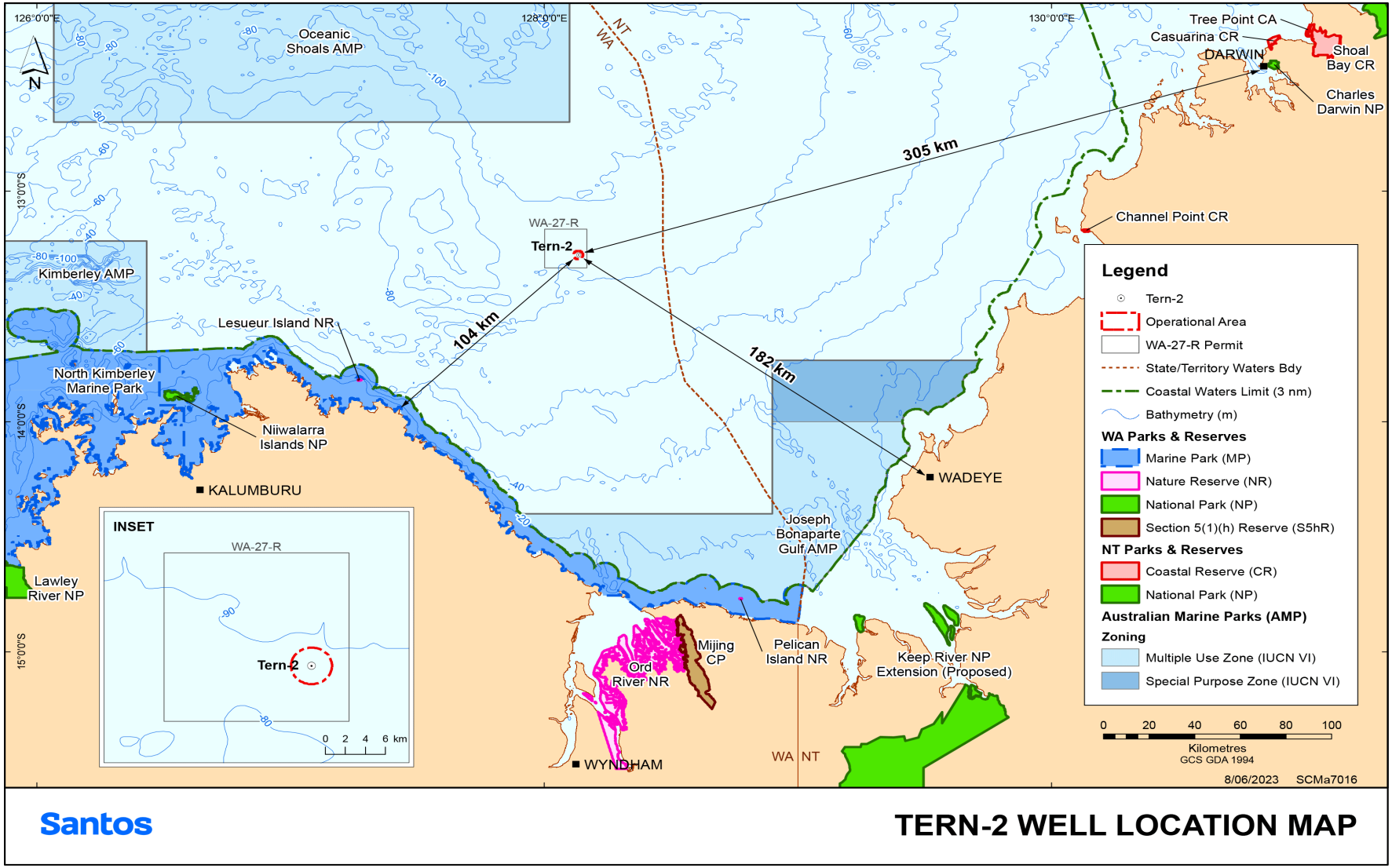
Santos

BONAPARTE BASIN CONSULTATION

TERN-2 PLUG AND ABANDONMENT



Tern-2 P&A - Location



Tern-2 P&A - Overview

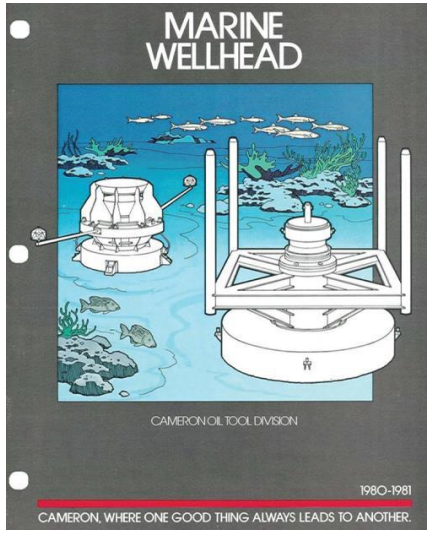
- Tern-2 is an appraisal well located within the Tern field of retention lease licence WA-27-R, approximately 300 km WSW of Darwin. The well was drilled in 1981 and 82. It was temporarily abandoned with cement barriers in January 1982.

- Key objectives of P&A activity:
  - Installing and verifying additional well barriers to supplement the existing system of well barriers.
  - Removing the wellhead and any structural evidence of the well from the seabed as best as practical to eliminate future hazards to the environment or other users of the area.

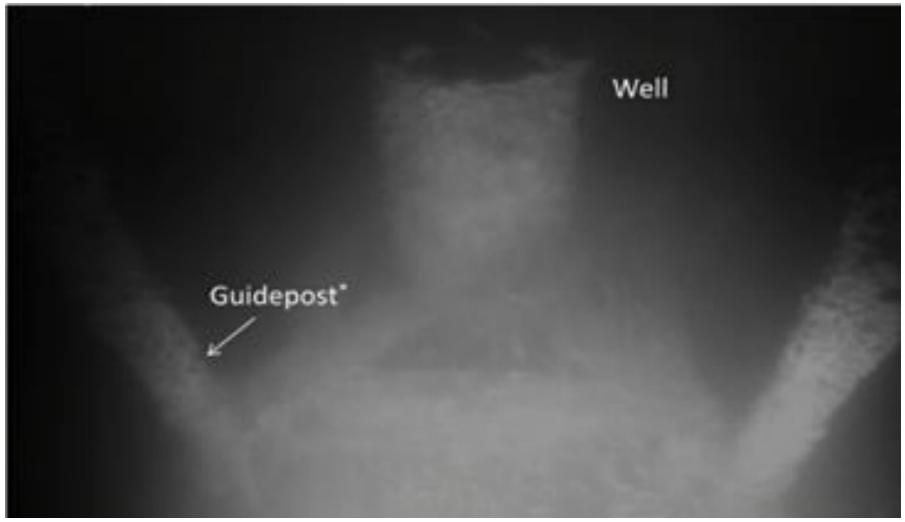
- Estimated activity duration:
  - ~10 days (Continuous operations, 24 hours per day, 7 days per week).
  - Up to 40 days in the event of unforeseen delays and poor metocean conditions.

- The Operational Area:
  - A circular area with a 2 km radius around the Tern-2 wellhead.
  - ~ 106 km from the closest shoreline
  - ~ 62 km southwest of Petrel-1 and ~ 9.8 km southeast of Tern-1 well.
  - Average water depth is ~ 83 m.

- The petroleum activities require the following vessels:
  - Light Well Intervention Vessel (LWIV)
  - Support vessel
  - Remotely Operated Vehicle (ROV)
  - Helicopters



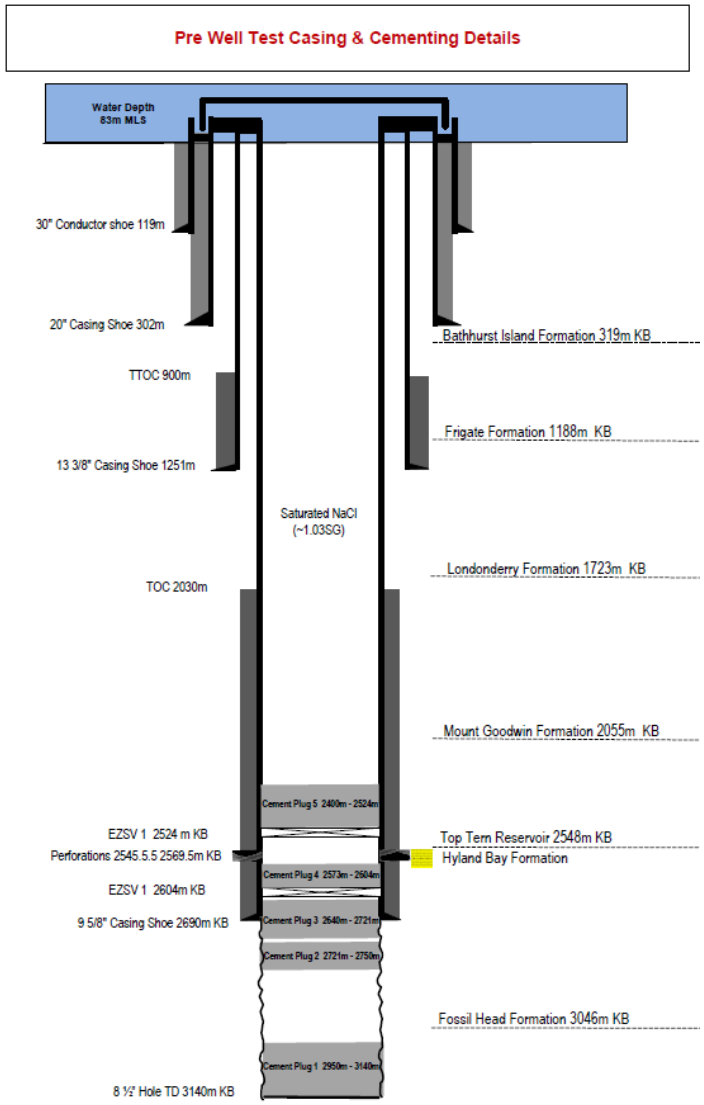
Example of the Tern-2 wellhead.



Example of wellhead at Tern-2 wellhead location.

Tern-2 P&A - Activity

- Utilising a Light Well Intervention Vessel for the following scope:
  - Clean and remove wellhead debris cap
  - Inspect and evaluate condition inside well
  - Using wireline, install additional P&A barriers into the well
  - Cut and remove wellhead
  - Contingency to place wellhead on seabed only if needed
  - Move wellhead to the vessel using ROV
  - If the wellhead is in poor condition and can't be removed it will be left on the seabed



Tern-2 wellhead schematic

Tern-2 P&A – Vessels & Vehicles

Example Light Well Intervention Vessel (LWIV)

Example Support Vessel

Example ROV

Example Helicopter

Tern-2 P&A - Impacts

Santos

Planned events	How we manage (the rules we follow)
Disturbance to other boats	We will communicate to other boats where we are and what we are doing. We mark the location of equipment on charts.
Seabed disturbance	We are putting equipment on a flat sandy seabed. We only put equipment in the approved location.
Light disturbance	We only use lights where needed for safe operations. We turn off lights when not needed.
Noise disturbance	We look out for marine life (e.g., whales, dolphins, turtles). Noise levels are not expected to impact at population level or have a significant impact on foraging behaviours of marine turtles.
Air emissions	We ensure engines and other equipment is looked after and fuel use and waste incineration standards are maintained.
Discharges	We will reduce discharges to only those necessary for operations and we follow the standard rules for what boats can discharge.
Wellhead left on seabed	We will leave the wellhead on the seabed only if it cannot be removed easily due to technical difficulties.
Oil spill response	We have plans and resources to be used if there is an accidental oil spill.

Tern-2 P&A - Risks

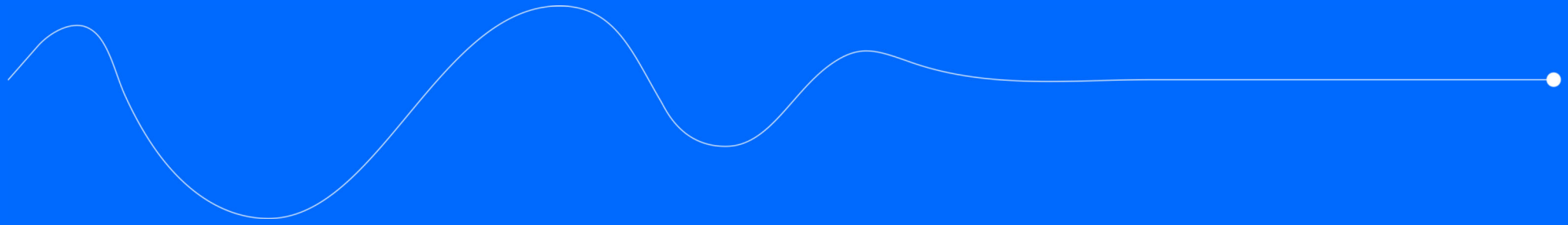
Santos

Unplanned events (Accidents)	How we manage (the rules we follow)
Diesel spill	We make sure all the boats are following the rules for preventing collisions. We let other boats know where we are and what we are doing. We will not refuel within the operational area.
Dropped objects	We follow strict procedures to stop objects dropping overboard and we pick up objects when it is safe to do so.
Disturbing marine animals	We look out for marine life (e.g., whales, dolphins, turtles) when transiting within and to and from the operational area and we slow down and move away from them where possible if they are too close.
Invasive marine life	We will use an anti-foulant system and follow strict procedures to avoid any introduction of invasive marine life.
Chemical spill	We select chemicals that are friendly to the environment where possible and store them carefully. We have procedures for using and cleaning up chemicals.
Disturbance to other boats	We let other boats know where we are and what we are doing. We will let other boats, fishing groups, and the government know if the wellhead cannot be removed and will be left on the seabed.

Santos

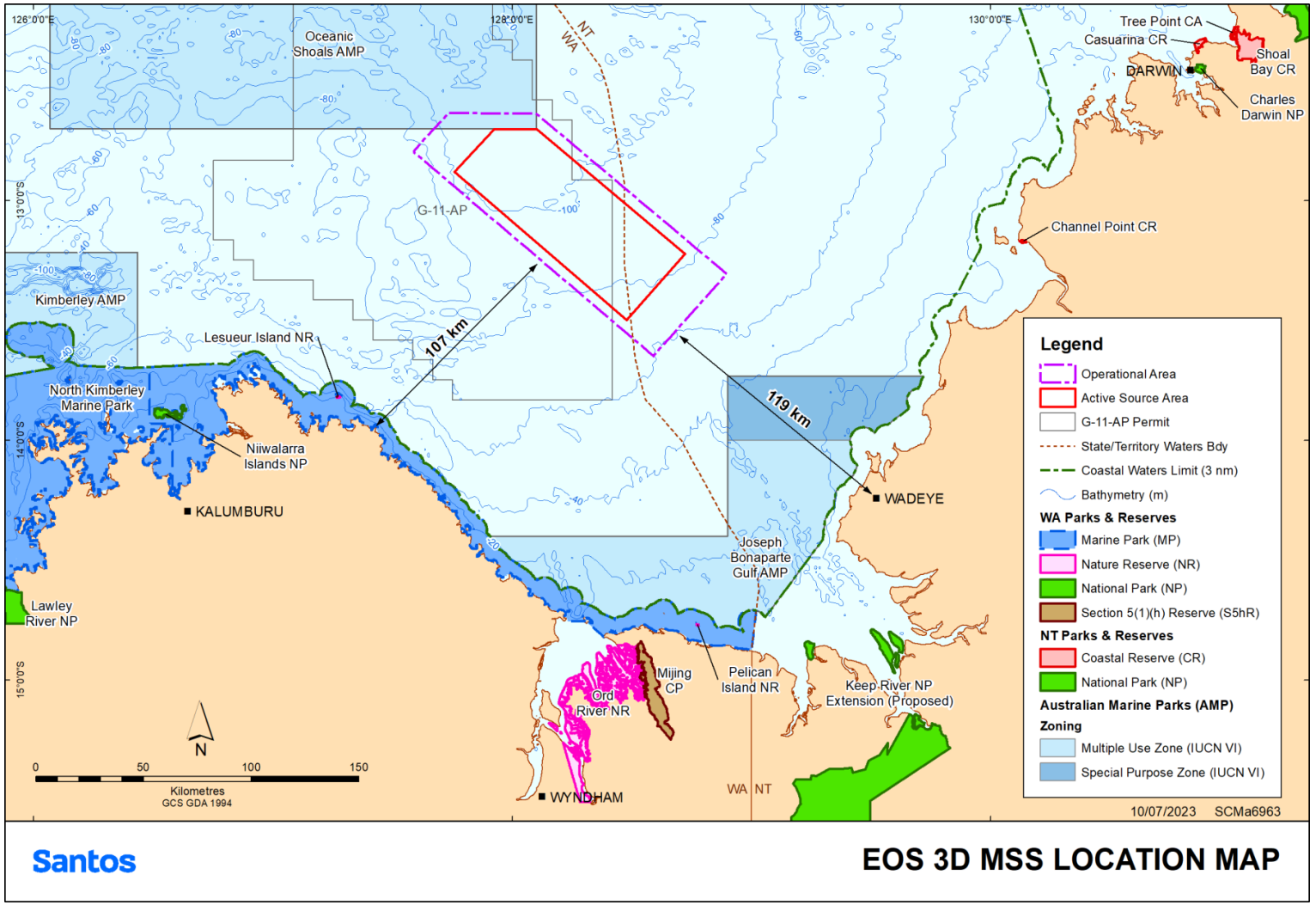
BONAPARTE BASIN CONSULTATION

EOS 3D MARINE SEISMIC SURVEY



WA & NT Environment Plan Consultation

Eos 3D MSS - Location



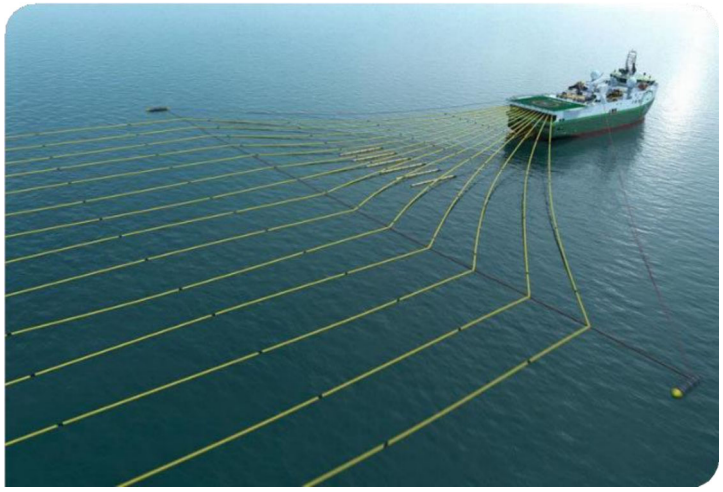
Eos 3D Marine Seismic Survey

What is a marine seismic survey?

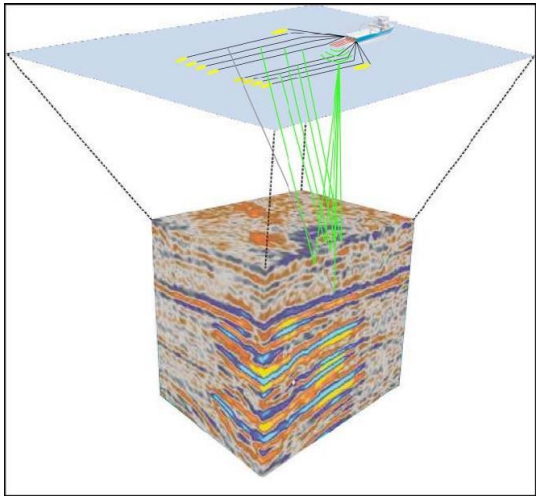
https://www.youtube.com/watch?v=T1yzHW5x1HE

Eos 3D MSS - Overview

- Santos plans to acquire a three-dimensional (3D) marine seismic survey (MSS) in Commonwealth waters in the Bonaparte Basin.
- The proposed activity is required to complete an appraisal of the carbon storage potential of Santos' greenhouse gas assessment (GHG) permit G-11-AP. The survey extends into GHG G-7-AP and overlaps petroleum permits WA-548-P and WA-6-R and surrounding waters in the Petrel Sub-Basin.
- Key objectives:
  - Facilitate future Carbon Dioxide (CO_2) injection activities by providing detailed structural and amplitude imaging of the reservoir/seal interface for each identified storage target to confirm suitability for injection and storage of CO_2.
- Timing:
  - 50 days, (42 days plus 8 days for contingency, e.g. weather, mechanical etc)
  - Continuous operations, 24 hours per day, 7 days per week.
- Operational Area:
  - Area within which the seismic survey vessel will operate during the normal conduct of the activity.
  - Includes the Active Source Area.
  - 60 to 115 m water depth.
- Active Source Area:
  - Area within which the seismic source will be operated to acquire the seismic data and achieve the geophysical objectives of the survey.
  - Area size: 4,028 km^2
  - 67 to 111 m water depth.
- Project vessels:
  - Seismic survey vessel
  - Up to two Support Vessels (one being a chase vessel)
  - Helicopters and drones

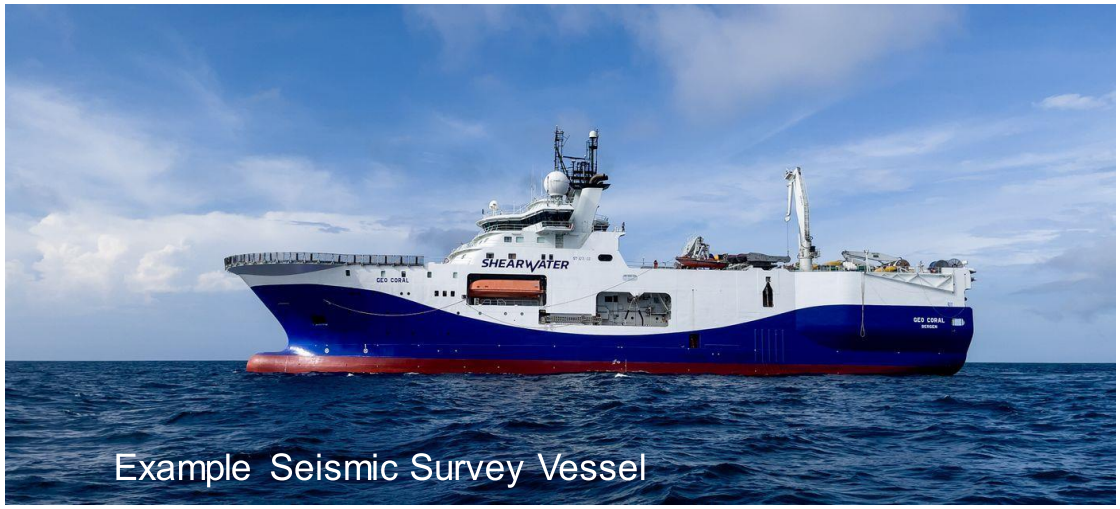


Example of a seismic array and Marine Seismic Vessel for 3D or 4D surveys



3D seismic survey, showing simplified configuration of seismic vessel and subsurface cube of data (Cameselle, 2020)

Eos 3D MSS – Vessels & Vehicles



Example Seismic Survey Vessel

Example Support Vessel

Example Chase Vessel

Example Helicopter

Eos 3D MSS - Impacts

Santos

Planned events	How we manage (the rules we follow)
Disturbance to commercial fishers	We will communicate to fishing boats where we are and what we are doing.
Disturbance to other boats	We will communicate to other boats where we are and what we are doing and provide notifications in advance of the survey starting.
Light disturbance	We only use lights where needed for safe operations. We turn off lights when not needed.
Noise disturbance	We look out for marine life (e.g., whales, dolphins, turtles) before the survey begins Animal spotters stay on the vessel during the survey and monitor. Soft start up- meaning the noise slowly gets louder giving marine animals time to move away from the sound.
Air emissions	We ensure engines and other equipment are looked after. Fuel use and waste incineration standards are maintained.
Discharges	We will follow the standard rules and procedures for what boats can discharge.
Impacts from other seismic surveys	We will communicate with other companies that may also be doing seismic surveys in the area and keep a large distance between other seismic vessels.

Eos 3D MSS - Risks

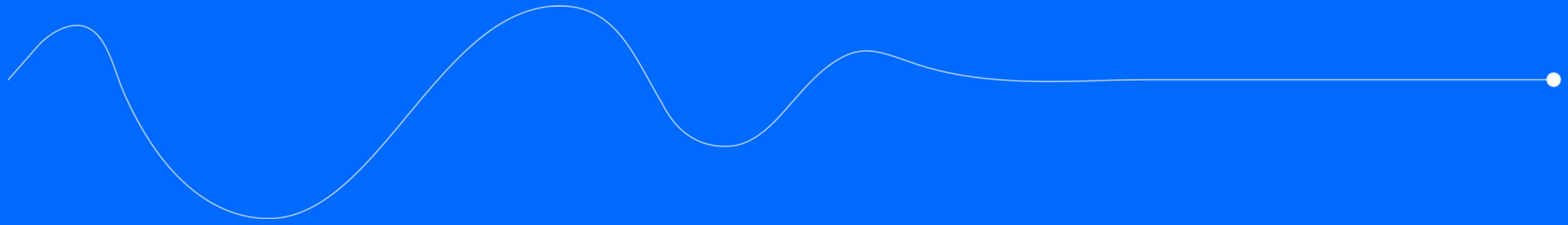
Santos

Unplanned events (Accidents)	How we manage (the rules we follow)
Diesel spill	We make sure all the boats are following the rules for preventing collisions. We let other boats know where we are and what we are doing. We follow strict procedures for refuelling.
Discharges	Where possible and safe to do so, we will recover any waste or equipment that accidentally falls overboard into the ocean.
Disturbing marine animals	We look out for marine life (e.g., whales, dolphins, turtles) and the support vessel will slow down and move away from them where possible if they are too close while the survey is taking place.
Invasive marine life	We will use an anti-foulant system and follow strict procedures to avoid any introduction of invasive marine life.
Chemical spill	We select chemicals that are friendly to the environment where possible and store them carefully. We have procedures for using and cleaning up chemicals.
Oil spill response	We have plans and resources to be used if there is an accidental oil spill.

Santos

BONAPARTE BASIN CONSULTATION

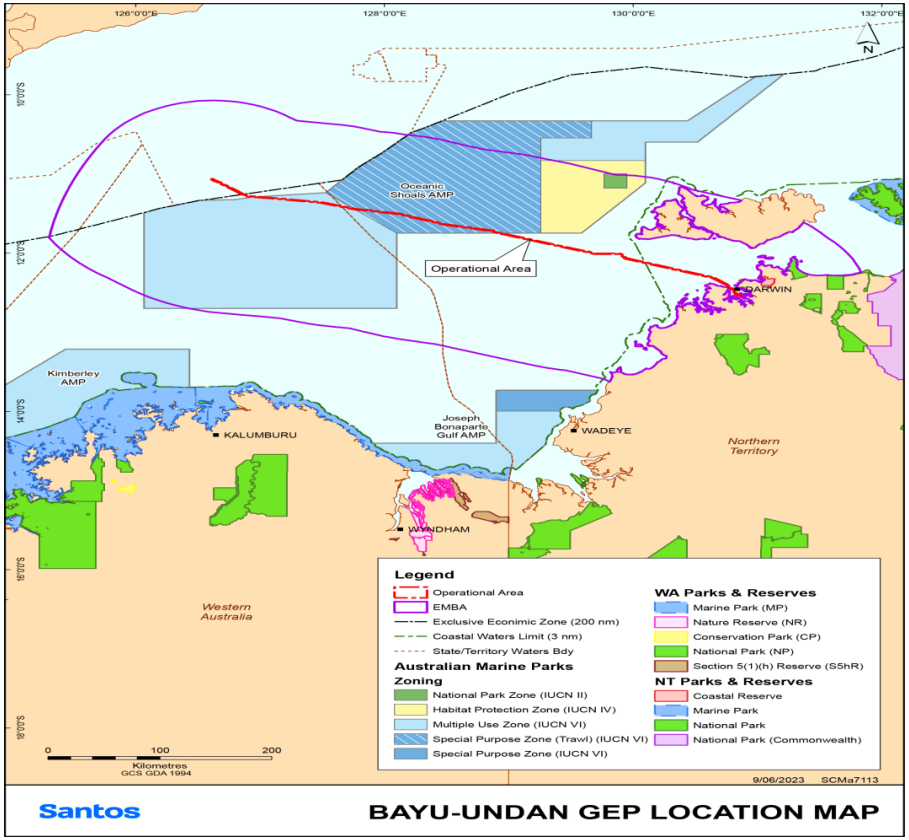
BAYU-UNDAN PIPELINE

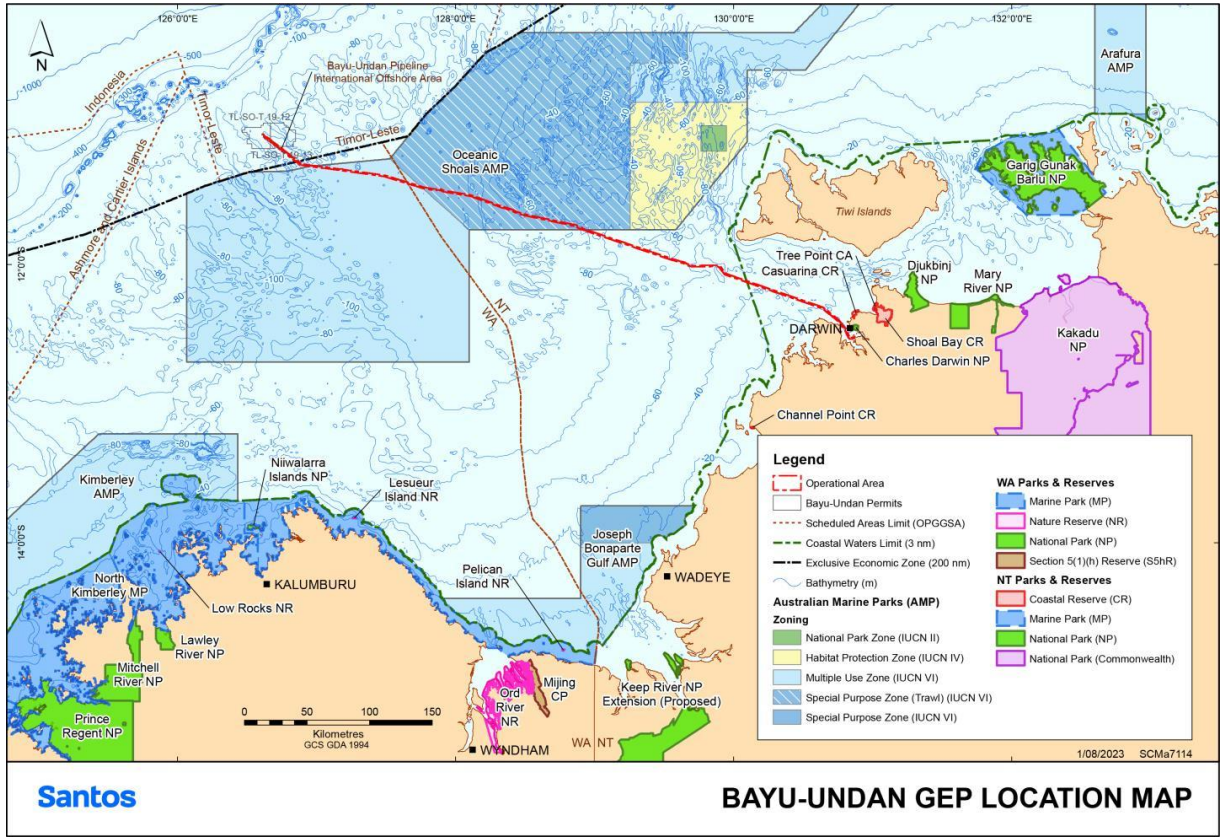


WA & NT Environment Plan Consultation

Bayu-Undan Gas Export Pipeline EP

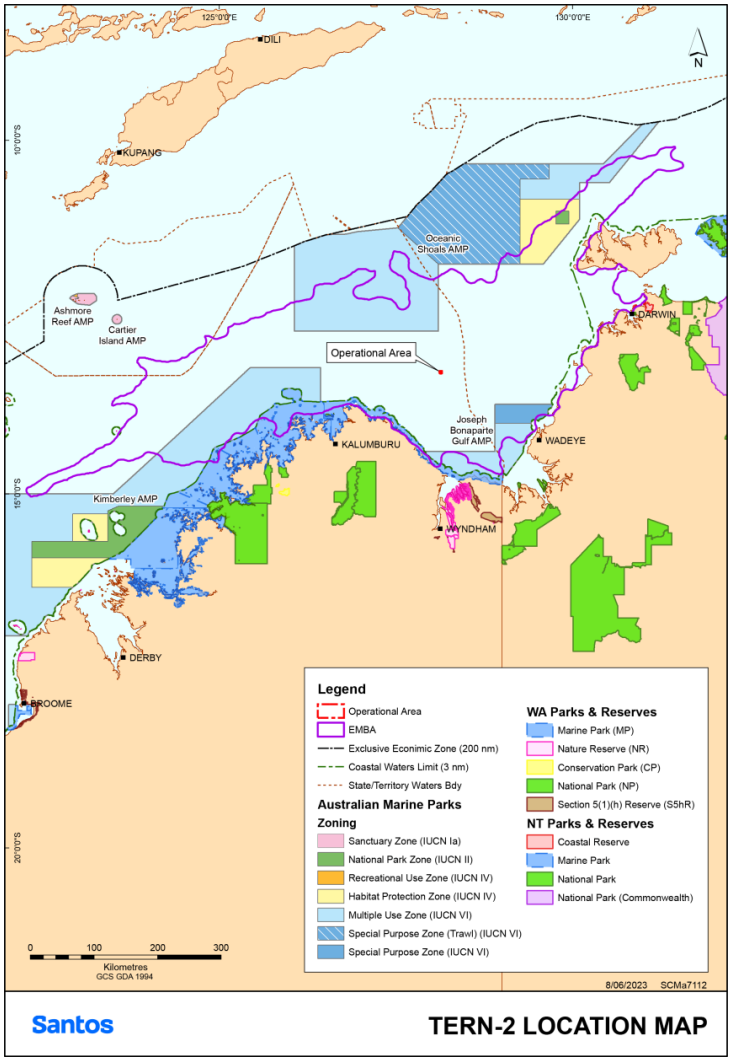
- Santos is the operator of the existing 502km Gas Export Pipeline.
- The pipeline transports dry natural gas from the Bayu-Undan Field (Timor-Leste waters) to the onshore Darwin liquefied natural gas (DLNG) plant.
- The pipeline has been operational since 2005.
- As the Field is approaching the end of life, the pipeline will transition from operations to a preservation state.
- The original EP for operations was accepted by NOPSEMA in 2019.
- The EP has been updated to include the final stages of operations (linepacking and back-feed), plus a preservation phase (gas-filled).





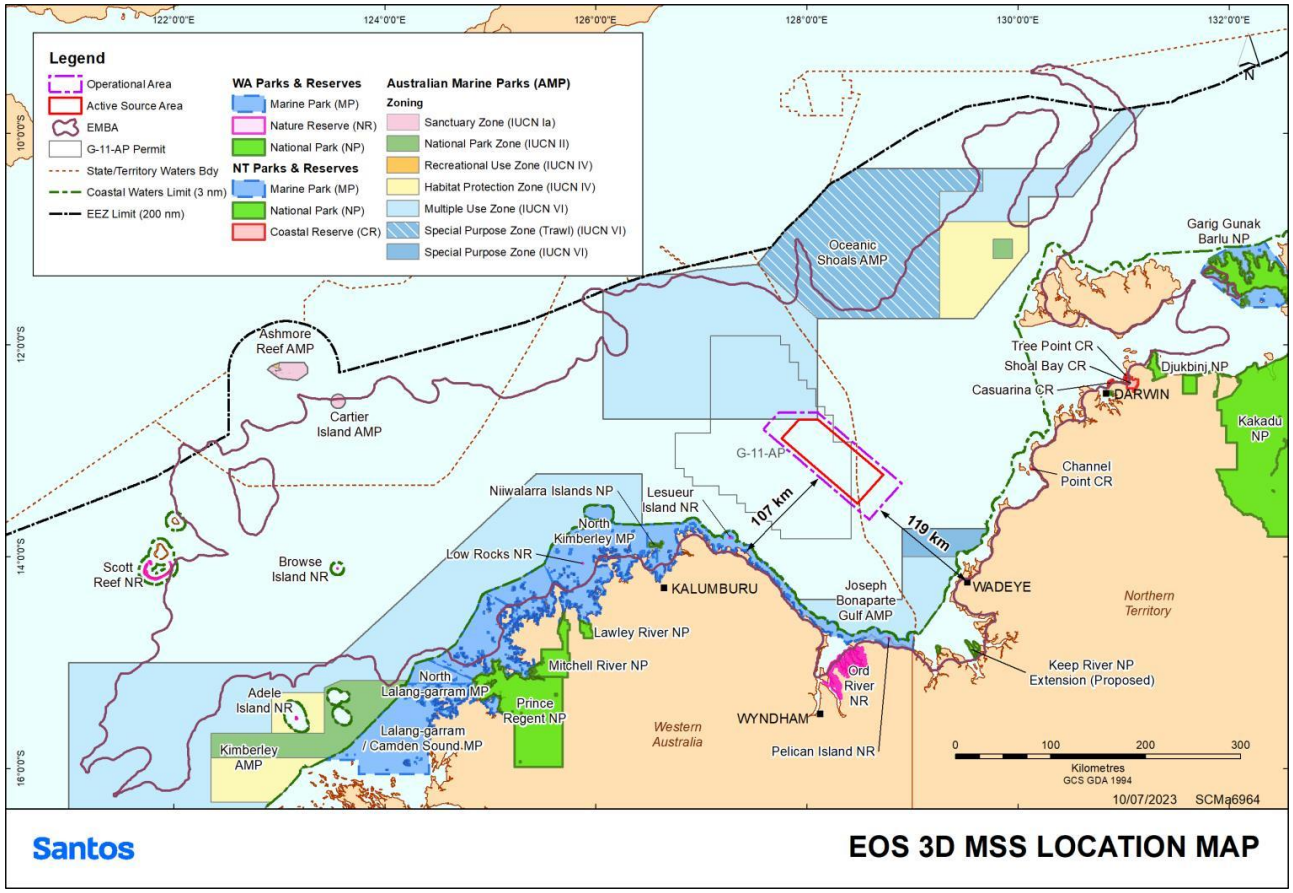
Santos

Spill Risk



Santos

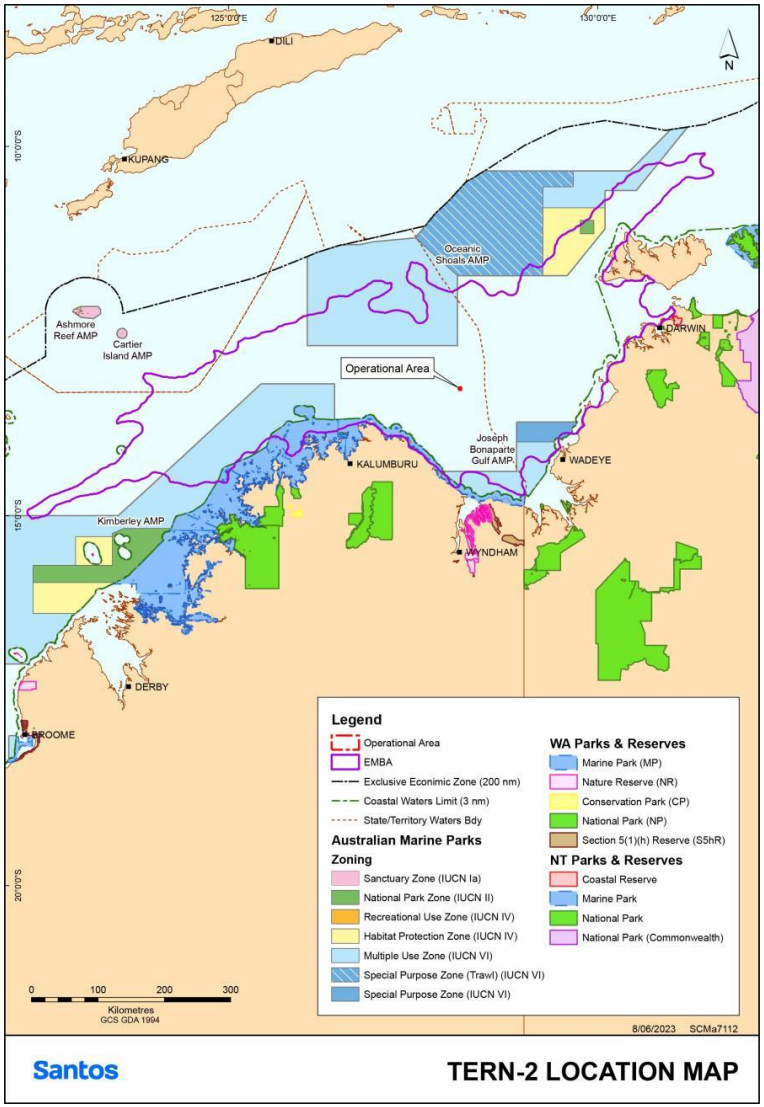
TERN-2 LOCATION MAP



Santos

EOS 3D MSS LOCATION MAP

Tern-2 P&A – Environment That May Be Affected



Feature	Public Information Review
Aboriginal Heritage	Aboriginal Heritage sites are present along the southern and eastern boundaries of the Environment That May Be Affected (EMBA).
Biologically Important Areas (BIAs)	The Operational Area includes BIAs for turtles only, the EMBA includes BIAs for dolphins, seabirds, sharks, whales and turtles.
Cultural Heritage	No known sites of shipwrecks, sunken aircraft or Aboriginal and Torres Strait Islander Underwater Cultural Heritage have been identified within the Operational Area. Within the EMBA the nearest shipwreck, the SEDCO Helen, is approximately 60 km northeast of the Operational Area located in depths of approximately 100 m .
Defence	Operational area overlaps practice and training areas that comprise the North Australian Exercise Area (NAZA) a maritime military zone administered by the Australian Defence Force, as well as restricted airspace.
Energy industry	Several offshore petroleum projects are in operation and there is exploration activity within the EMBA. The nearest platform is the ENI Blacktip Platform approximately 75 km to the southeast of the operational area.
Fishing	A number of Commonwealth, State and Territory fisheries management areas overlap the Operational Area and EMBA however, neither Commonwealth nor WA state-managed fisheries show activity within the Operational Area between 2010-2020.
	Traditional Australian Indigenous fishing activities are generally concentrated within 3 nm of the Northern Territory / Western Australian coastline.
	No interaction with recreational or charter boat fishers is anticipated given the remoteness of the Operational Area (~106 km from nearest coastline).
Key Ecological Features (KEFs)	The EMBA includes KEFs for the carbonate bank and terrace system of the Van Diemen Rise, the carbonate bank and terrace system of the Sahul Shelf, ancient coastline at 125m depth contour, continental slope Demersal Fish communities, the shelf break and slope of the Arafura Shelf, and the Pinnacles of the Bonaparte Basin.
Protected Areas (nearest Commonwealth and Territory)	In Commonwealth Waters the EMBA overlaps with the Oceanic Shoals Marine Park, Joseph Bonaparte Gulf AMP and the Kimberley AMP. The closest being the Oceanic Shoals AMP which is approximately 63 km north of the Operational Area.
	The North Kimberley State Marine Park is approximately 182 km west from the Operational Area and overlaps with the EMBA.
Shipping	The Operational Area does not overlap any shipping fairways, though is adjacent to vessel traffic. Vessel traffic from Wyndham may be present within the EMBA at periods of the year.
Telecommunications	The North West Cable System (NWCS) connects offshore oil and gas facilities in the Browse, Bonaparte and Carnarvon Basins to onshore locations and is approximately 140 km north-north-east of the Operational Area.
Tourism	Remoteness of the Operational Area and water depth limits opportunities for tourism. Tourism is likely within the EMBA.
Towns/Communities	Darwin is the nearest capital city and is approximately 300 km northeast from the Operational Area.

Eos 3D MSS - Activity

- The process of collecting seismic data is known as ‘acquisition’.
- Marine seismic surveys are carried out by specialised vessels that tow an array of acoustic sources (airguns) and receivers (hydrophones) across a defined acquisition area.
- The seismic survey vessel will tow a seismic source array (up to 3,500 in3) and up to 12 streamers, approximately 113 m apart, and will travel back and forth across the survey area in a “race track” pattern, lines separated by approximately 500-700m within an overall acquisition area.
- The streamer array will be approximately 8 km long and positioned 10 – 30 m below the ocean surface.
- Airguns work by rapidly releasing compressed air to form a bubble, which creates a pulse of sound. This sound energy is directed at the seafloor and penetrates into the various rock layers beneath.
- The reflected soundwaves are then captured by hydrophone receivers, which are towed behind the vessel on a series of cables known as 'streamers'.
- Support vessels will be on standby, one support vessel will be present at all times.
- 3 nm exclusion zone requested.
- Auscoast warning and/or Notice to Mariners will be issued prior to the start of the activity.
- The seismic survey vessel will display appropriate day shapes and lights to indicate it is under tow and is therefore restricted in it’s ability to manoeuvre, and the streamers will tow surface tail buoys fitted with radar reflectors.
- A visual and radar watch will be maintained on the bridge at all times.

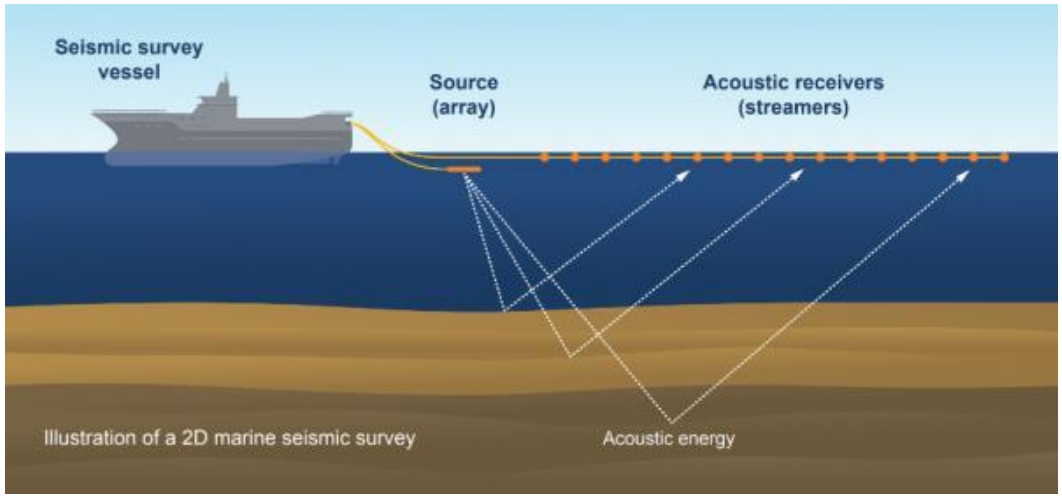
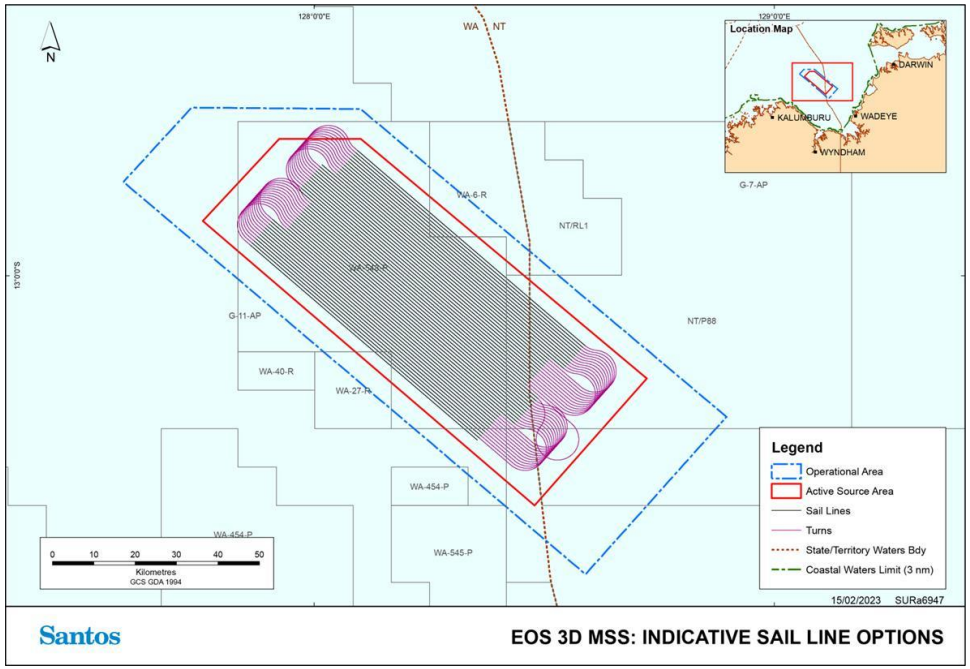


Diagram of a marine seismic survey (Source: NOPSEMA).



Eos 3D MSS – Environment That May Be Affected

Feature	Public Information Review
Aboriginal Heritage	Aboriginal Heritage sites are present along the coastline along the southern boundary of the EMBA.
Biologically Important Areas (BIAs)	The Operational Area includes BIAs for turtles.
Cultural Heritage	No known sites of shipwrecks, sunken aircraft or Aboriginal and Torres Strait Islander Underwater Cultural Heritage have been identified within the Operational Area. The nearest shipwreck, the SEDCO Helen, is approximately 11 km northeast of the Operational Area.
Defence	Operational area overlaps practice and training areas that comprise the North Australian Exercise Area (NAZA) a maritime military zone administered by the Australian Defence Force, as well as restricted airspace.
Energy Industry	Petroleum exploration and production activities have been undertaken within the EMBA and the Bonaparte Basin is an established hydrocarbon province with a number of commercial operations. Several exploration permits overlap the Operational Area with the closest production licence being the Eni Australia B.V. located 21 km south of the Operational Area.
Fishing	Five Commonwealth, thirteen Western Australia and ten Northern Territory fisheries overlap the EMBA, some of which are active in the Operational Area.
	Traditional Australian Indigenous fishing activities are generally concentrated within 3 nm of the Northern Territory / Weste rn Australian coastline.
	Fishing charter vessels may transit through the Operational Area and EMBA. Northern Prawn Fishery (NPF) fishing season (within the NPF licence area) is annually from August to November.
Key Ecological Features (KEFs)	The Operational Area overlaps one KEF for the Carbonate Bank and Terrace System of the Sahul Shelf.
Protected Areas (nearest Commonwealth and Territory)	The Operational Area overlaps the Oceanic Shoals Marine Park and four additional Australian Marine Parks overlap the EMBA. .
	Eighteen state/territory marine parks overlap the EMBA with the closest being the North Kimberley Marine Park located approximately 100 km south-west of the Operational Area.
Shipping	The Operational Area does not overlap any shipping fairways, however there is vessel traffic that passes through the northern end of the Operational Area. High vessel traffic to be expected from largest exporter of cattle out of Wyndham during Q3.
Telecommunications	The North West Cable System (NWCS) connects offshore oil and gas facilities in the Browse, Bonaparte and Carnarvon Basins to onshore locations and is approximately 125 km north-north- east of the Operational Area.
Tourism	Remoteness of the Operational Area and water depth limits opportunities for tourism. Tourism is likely within the EMBA.
Towns/Communities	Darwin is the nearest capital city and is approximately 230 km northeast from the Operational Area.
	Wadeye is the nearest community and is approximately 119 km southeast from the Operational Area.

Eos 3D MSS - Activity

- The process of collecting seismic data is known as ‘acquisition’.
- Marine seismic surveys are carried out by specialised vessels that tow an array of acoustic sources (airguns) and receivers (hydrophones) across a defined acquisition area.
- The seismic survey vessel will tow a seismic source array (up to 3,500 in3) and up to 12 streamers, approximately 113 m apart, and will travel back and forth across the survey area in a “race track” pattern, lines separated by approximately 500-700m within an overall acquisition area.
- The streamer array will be approximately 8 km long and positioned 10 – 30 m below the ocean surface.
- Airguns work by rapidly releasing compressed air to form a bubble, which creates a pulse of sound. This sound energy is directed at the seafloor and penetrates into the various rock layers beneath.
- The reflected soundwaves are then captured by hydrophone receivers, which are towed behind the vessel on a series of cables known as 'streamers'.
- Support vessels will be on standby, one support vessel will be present at all times.
- 3 nm exclusion zone requested.
- Auscoast warning and/or Notice to Mariners will be issued prior to the start of the activity.
- The seismic survey vessel will display appropriate day shapes and lights to indicate it is under tow and is therefore restricted in it’s ability to manoeuvre, and the streamers will tow surface tail buoys fitted with radar reflectors.
- A visual and radar watch will be maintained on the bridge at all times.

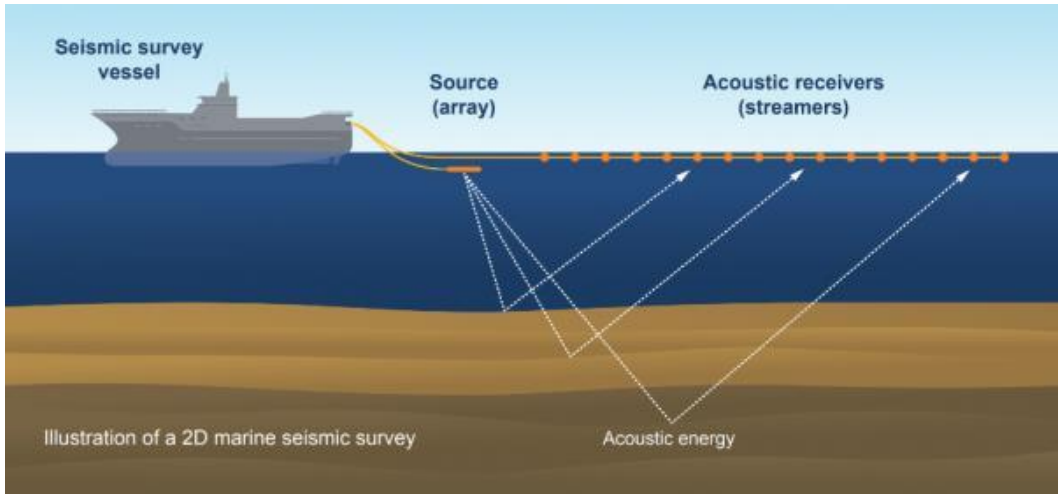
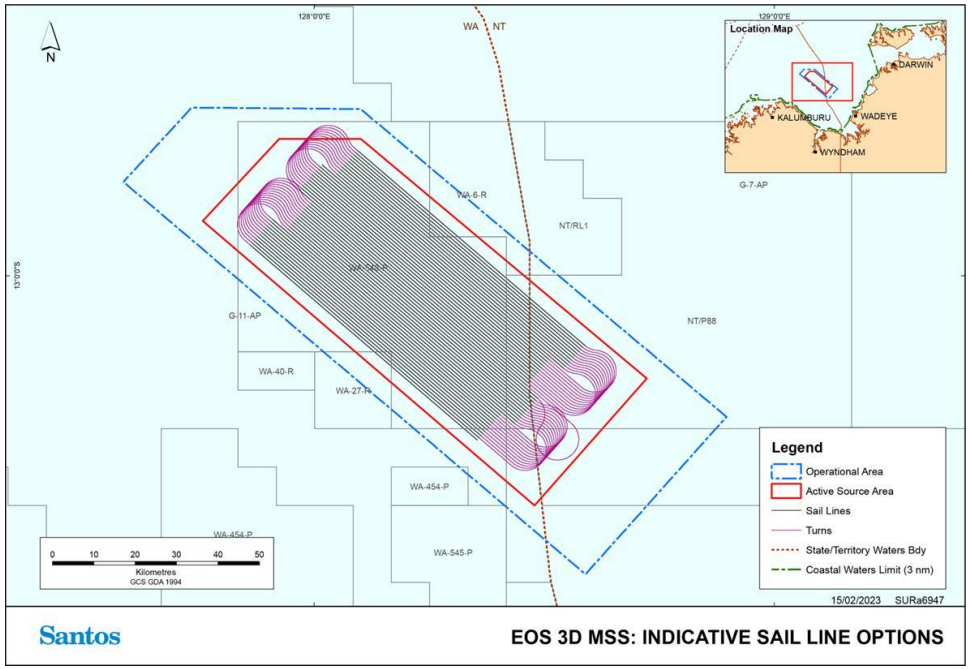


Diagram of a marine seismic survey (Source: NOPSEMA).



Eos 3D MSS – Commercial Fishers

Co-existence approach

- Minimise the extent of interruption by the seismic survey activities on commercial fishing operators' activities to the lowest practicable level.
- Mitigate the effects of the interruptions.
- Apply an equitable 'commercial fishers payment claim protocol'.

Commercial fishers payment claim protocol

- The survey will potentially impact commercial fishers whose fishing operations overlap with the seismic survey.
- Santos has a process to enable commercial fishers to lodge evidence-based payment claims for temporary loss of fish catch, displacement costs and equipment damage or loss directly caused by the seismic survey.
- Santos will also assess requests for administrative support to help fishers collate historical fishing data required for an evidence-based payment claim.
- The control measures identified within the draft Environment Plan, to outline how the potentially competing demands of commercial fishing operators and Santos' seismic survey may be managed, are consistent with those adopted for other Santos marine seismic surveys.

Commercial prawn and indicator fish species spawning	J	F	M	A	M	J	J	A	S	O	N	D	Source
Banana prawn spawning													AFMA 2020
Juvenile banana prawn migration													Longeran et al. 2002
Brown tiger prawn spawning													AFMA 2020
Grooved tiger prawn spawning													AFMA 2020
Blue endeavour prawn spawning													AFMA 2020
Red endeavour prawn spawning													AFMA 2020
Red emperor													DPIRD 2019
Goldband snapper													DPIRD 2019
Spanish mackerel (Kimberley stock)													DPIRD 2019

Key

Sensitivity/activity occurs

Extended peak spawning period

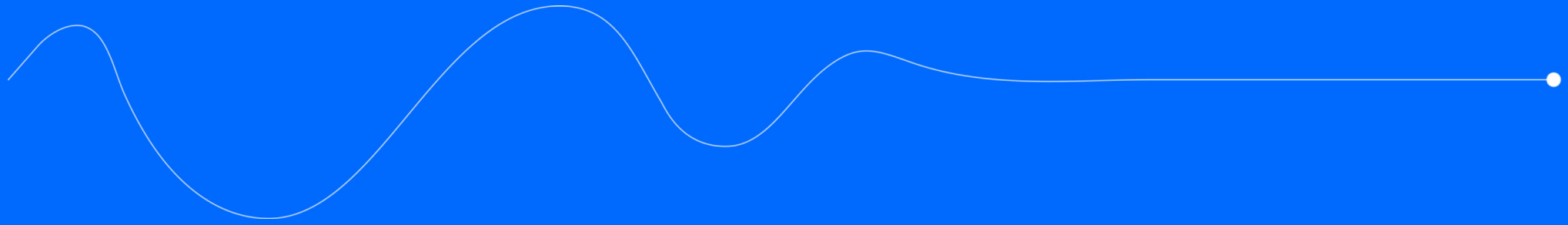
Peak spawning/migration period

*Extended peak spawning period – applies only to Goldband Snapper and Spanish Mackerel

NT & WA 11A Consultation_2023_Tern 2 & EOS

Santos

NORTHERN TERRITORY & WESTERN AUSTRALIA PROJECT CONSULTATION SESSION



WA & NT Environment Plan Consultation

Presented by **Santos Team**

Acknowledgement of Country

Santos acknowledges the Traditional Owners of the land on which we meet today.

We pay our respects to Elders past, present and emerging.

Privacy Statement

Santos Ltd, Santos NA Barossa Pty Ltd and their related bodies corporate (together, we, our, us or Santos) collect personal information about you, such as your name and sensitive information about your indigenous heritage. We use this information to record your attendance at any meeting or other discussion with us, to provide you with information about our projects, to receive and respond to any feedback that you provide, to answer any questions you might have and for other purposes that we tell you about during your meeting or other discussion with us. Santos will handle any information that you provide in accordance with our Code of Conduct and our Confidentiality, IP and Privacy Procedure. You can ask us for a copy of this Privacy Notice or these other documents.

If you do not provide your personal information, we may not be able to identify you as the person who provided particular feedback or we may be unable to discuss any feedback you have provided with you further or respond to your questions. We may disclose your information to other companies within the Santos group, to third parties that help us run our business and to relevant government agencies and government departments.

Due to the global nature of our operations and business, your personal information may be accessed by or disclosed to Santos personnel outside Australia. We may also use overseas third parties to collect, transfer, store and handle your personal information. Some of the overseas countries that your personal information may be accessed from, disclosed or transmitted to or stored in include but are not limited to, Papua New Guinea and the United States of America.

You have a right to request a copy of any personal information that we hold about you, as well as a right to request that we correct any information that we hold about you that is inaccurate, out-of-date, incomplete, irrelevant or misleading. You can also make a complaint about how we have handled your personal information. Our Barossa Gas Project Consultation Privacy Policy explains in more detail how you can exercise these rights, including how we will respond to your access or correction request or to any privacy complaint that you make. This Privacy Policy is available on our website at www.santos.com/barossa/barossa-gas-project-consultation-privacy-policy, or you can contact us to request a copy be provided to you.

You can contact us by:

- posting a letter addressed to us at 60 Flinders Street, Adelaide, South Australia, 5000;
- telephoning us on +61 8 8116 5000; or
- sending us an email at offshore.consultation@santos.com and compliance@santos.com.

Santos

Welcome & Introductions

We are here today to share information about our company & operations and to listen to your questions about Santos & upcoming projects.

Peter Kirkpatrick *– General Manager, Darwin*

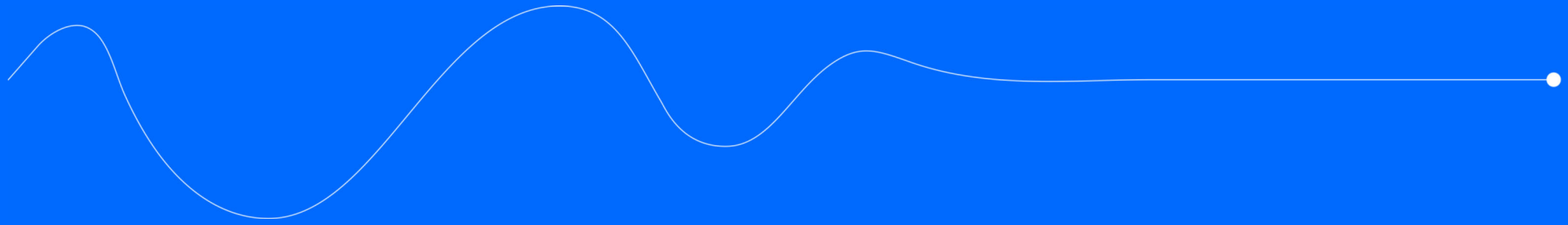
Tony Johnson *- Manager Consultation and Engagement, Offshore*

Lachlan MacArthur *– Senior Environmental Adviser*

Emma Haddon *– Senior Environmental Advisor*

Santos

SANTOS OPERATIONS & DARWIN LNG



WA & NT Environment Plan Consultation

Presented by **Barossa Team**

SANTOS - South Australia, Northern Territory Oil Search

Santos is a global energy company committed to increasingly cleaner energy and fuels production, with operations across Australia, Papua New Guinea, Timor-Leste and North America (Alaska).

At Santos, our commitment is to be a global leader in the transition to cleaner energy and clean fuels, by helping the world decarbonise to reach net-zero emissions in an affordable and sustainable way.

For more than 65 years, Santos has been working in partnership with local communities, providing local jobs and business opportunities, safely developing its natural gas resources, and powering industries and households.

Santos is one of Australia's biggest domestic gas suppliers and a leading LNG supplier in the Asia Pacific region.

We are committed to supplying critical fuels such as oil and gas in a more sustainable way through decarbonising projects, including the Moomba CCS Project, while we all transition to cleaner fuels.

Our business focus: Safe, reliable operations & Minimise our social and environmental impacts.

Darwin LNG Facility & Operations

Santos

- Located in Darwin at Wickham Point Darwin LNG (DLNG) is a single train liquefaction and storage facility that started production in 2006.
- The Bayu-Undan facility, which supplies gas to DLNG via 26-inch subsea pipeline, is located approximately 500 kilometers north-west of Darwin in the Timor Sea.
- The facility includes a central production Storage and Offloading vessel for condensate and LPG products and an unmanned wellhead platform.
- Approx 140 local Darwin people work at the LNG Facility.
- 100% Darwin residential Santos employee workforce.
- DLNG established the NT's first LNG Process Operator Traineeships in 2010.
  - ~10% of those who have completed identified as an Aboriginal or Torres Strait Islander.

The Oil and Gas lifecycle

Santos

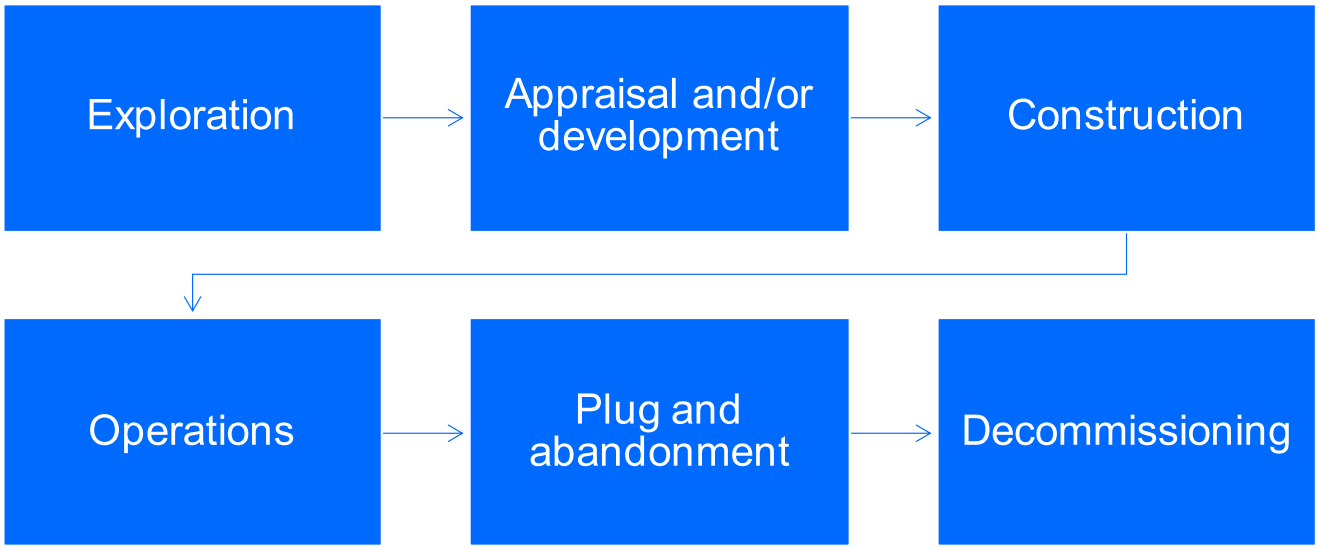
The oil and gas lifecycle involves the exploration, extraction, and use of these valuable resources.

It starts with searching for oil and gas deep underground using seismic surveys and drilling exploration wells, followed by the construction of infrastructure to extract and produce them.

Afterward, the products are transported to end-users.

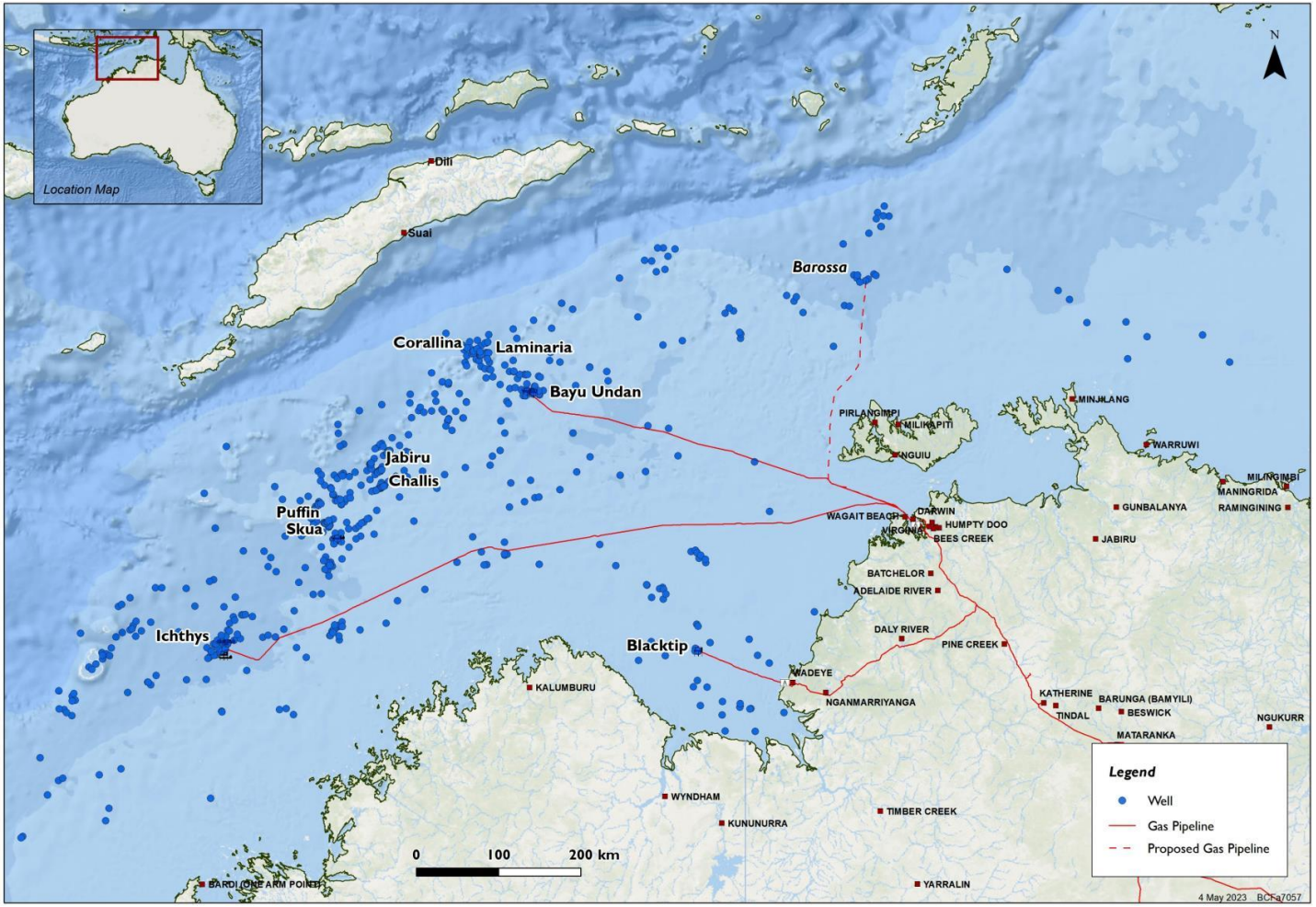
When the resources are depleted, there's a process to close down operations and ensure environmental compliance, called decommissioning.

Current Santos projects are at various stages of this lifecycle.



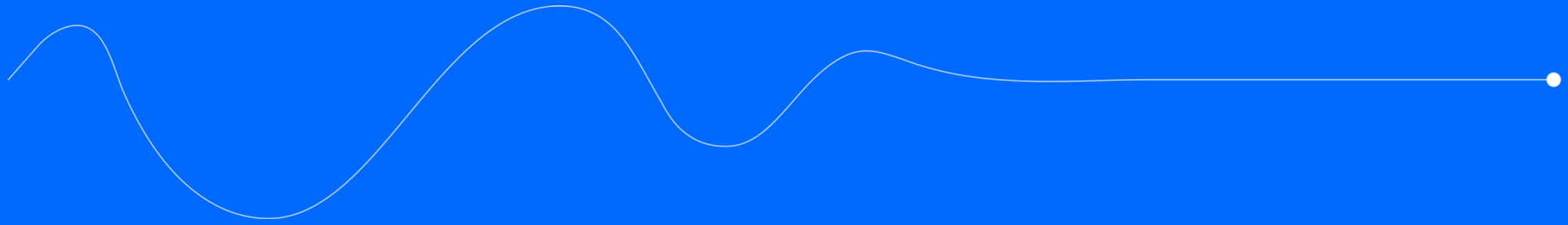
Wells Drilled by All Industry Since 1969

Santos



Santos

ENGAGEMENT & CONSULTATION EXPLAINED



Consultation for Environment Plans

Commonwealth waters – National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA)

"In the course of preparing an Environment Plan, a titleholder must consult with relevant persons in accordance with Division 2.2A, Regulation 11A…

"The purpose of consultation under regulation 11A of the Environment Regulations is to ensure that authorities, persons or organisations that are potentially affected by activities are consulted and their input considered in the development of environment plans."

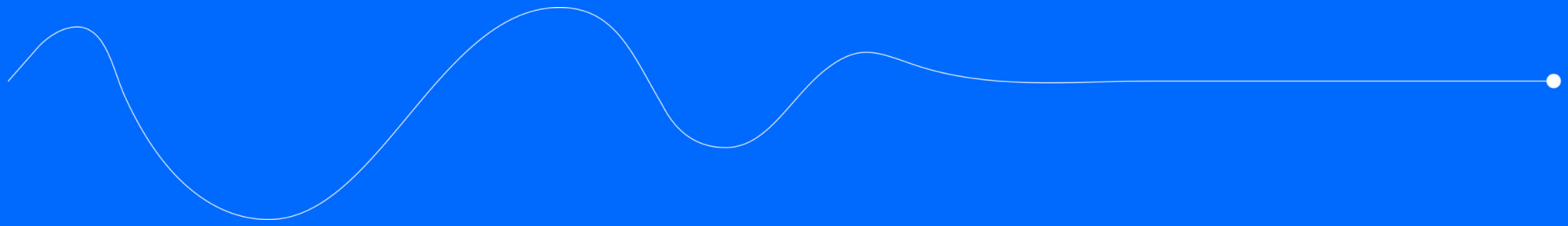
Guideline - Consultation in the course of preparing an environment plan, NOPSEMA

NOPSEMA

Information provided by relevant persons in consultation may also help titleholders **better understand the values and sensitivities of the environment** and inform the evaluation of the **potential impacts and risks** associated with the activity and **how to manage them** appropriately

Santos

BONAPARTE BASIN CONSULTATION

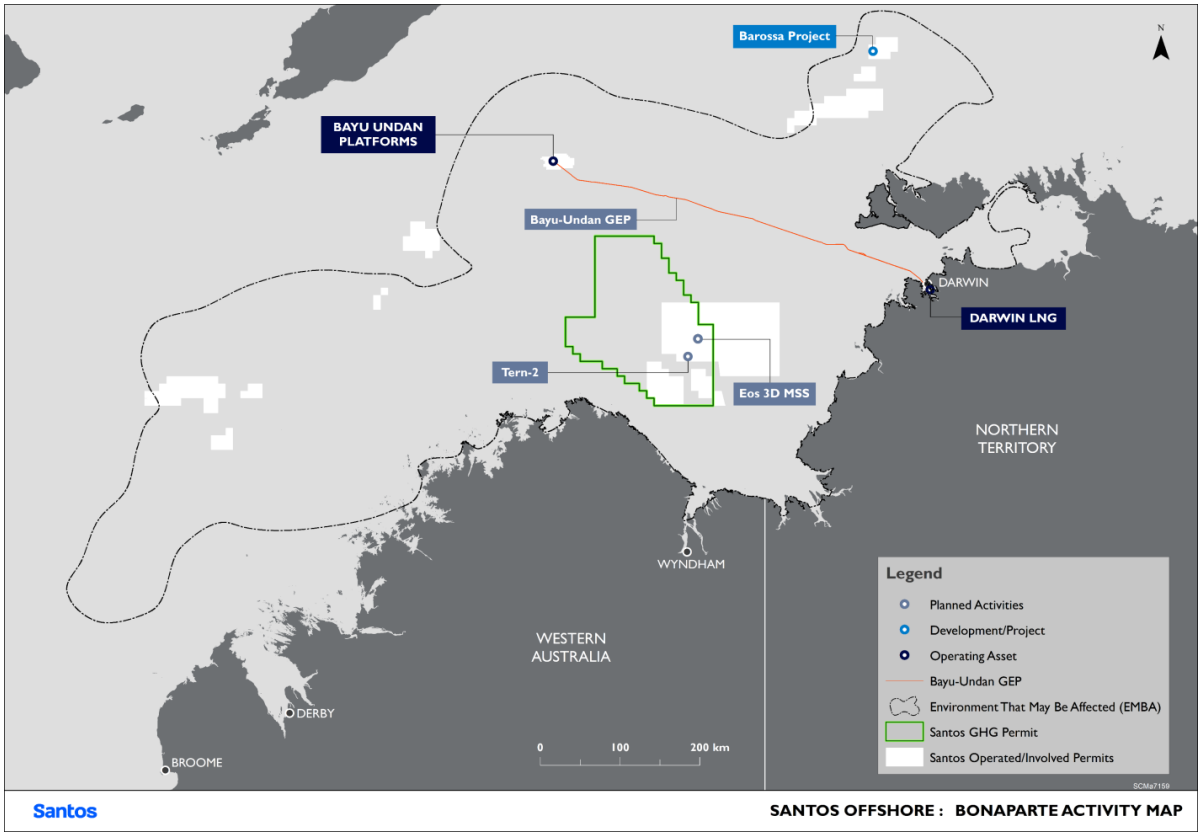


WA & NT Environment Plan Consultation

Bonaparte Basin

- Santos is proposing to undertake Consultation for our Bonaparte Basin activities (outside of Barossa Gas Project activities); starts on **27 October 2023** and closes on **27 November 2023**.
- Proposed activities are:
  - Tern-2 Plug and Abandonment (P&A)
  - Eos 3D Marine Seismic Survey

  Santos is also looking to place the Bayu-Undan Gas Export Pipeline into preservation at end of field life.

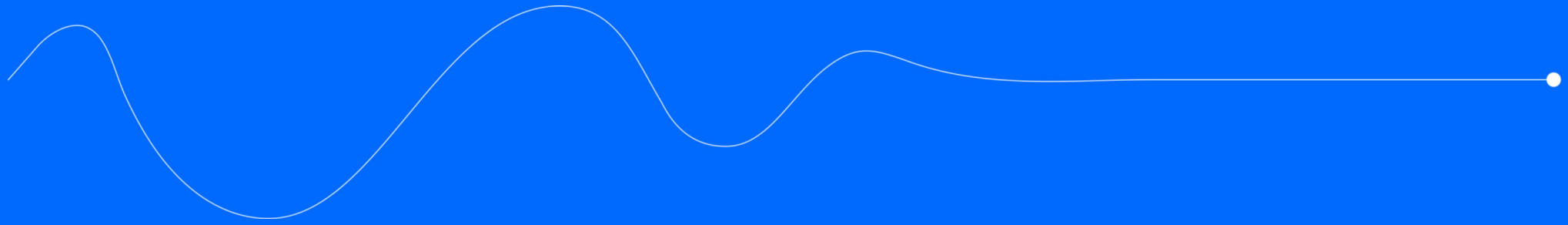


Oil Spill Modelling

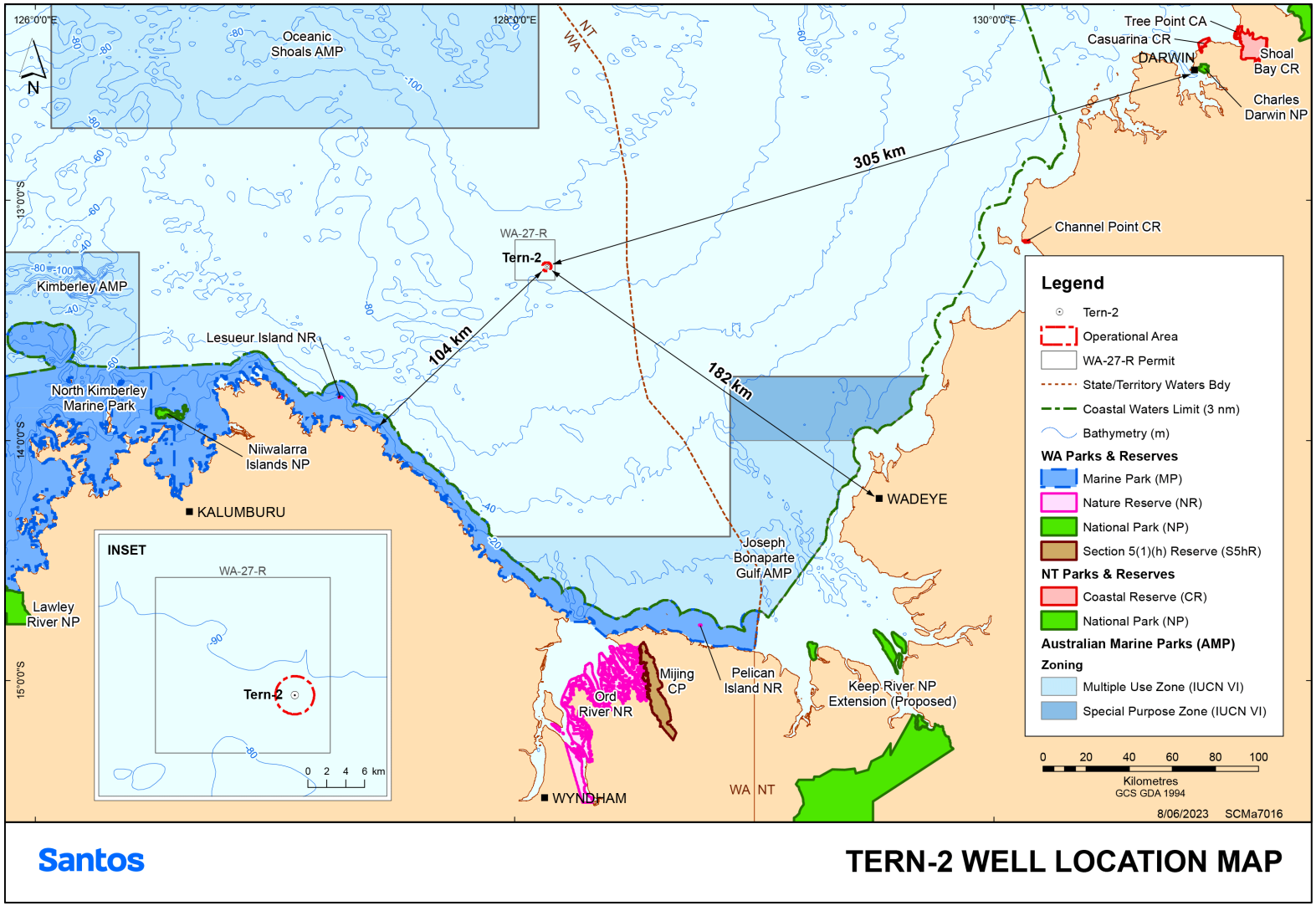
Santos

BONAPARTE BASIN CONSULTATION

TERN-2 PLUG AND ABANDONMENT



Tern-2 P&A - Location



Tern-2 P&A - Overview

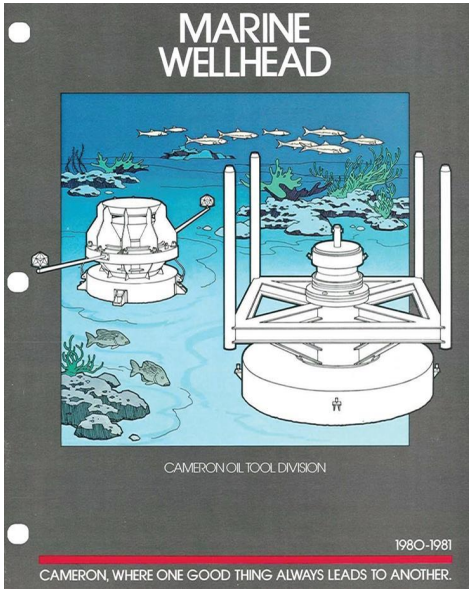
- Tern-2 is an appraisal well located approximately 300 km WSW of Darwin.
- The well was drilled in 1981 and 82.
- It was temporarily abandoned with cement barriers in January 1982.

- Key objectives of P&A activity:
  - Installing and verifying additional well barriers
  - Removing the wellhead and any infrastructure from the seabed as best as practical to eliminate future hazards to the environment or other users of the area.

- Estimated activity duration:
  - ~10 days (Continuous operations, 24 hours per day, 7 days per week).
  - Up to 40 days in the event of unforeseen delays and poor metocean conditions.

  The Operational Area:
  - A circular area with a 2 km radius around the Tern-2 wellhead.
  - ~ 106 km from the closest shoreline
  - Average water depth is ~ 83 m.

- The petroleum activities require the following vessels:
  - Light Well Intervention Vessel (LWIV)
  - Support vessel
  - Remotely Operated Vehicle (ROV)
  - Helicopters

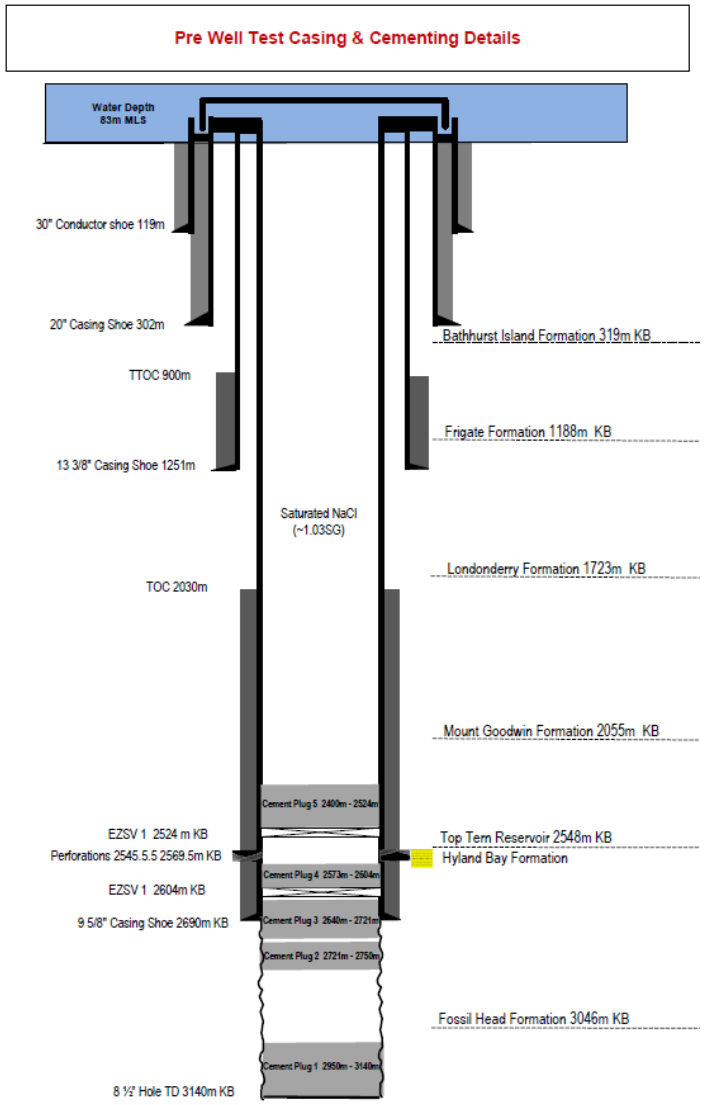


Example of the Tern-2 wellhead.

Example of wellhead at Tern-2 wellhead location.

Tern-2 P&A - Activity

- Utilising a Light Well Intervention Vessel for the following scope:
  - Clean and remove wellhead debris cap
  - Inspect and evaluate condition inside well
  - Using wireline, install additional P&A barriers into the well
  - Cut and remove wellhead
  - Contingency to place wellhead on seabed only if needed
  - Move wellhead to the vessel using ROV
  - If the wellhead is in poor condition and can't be removed it will be left on the seabed



Tern-2 wellhead schematic

Tern-2 P&A – Vessels & Vehicles

Example Light Well Intervention Vessel (LWIV)

Example Support Vessel

Example ROV

Example Helicopter

Tern-2 P&A - Impacts

Santos

Planned events	How we manage (the rules we follow)
Disturbance to other boats	We will communicate to other boats where we are and what we are doing. We mark the location of equipment on charts.
Seabed disturbance	We are putting equipment on a flat sandy seabed. We only put equipment in the approved location.
Light disturbance	We only use lights where needed for safe operations. We turn off lights when not needed.
Noise disturbance	We look out for marine life (e.g., whales, dolphins, turtles). Noise levels are not expected to impact at population level or have a significant impact on foraging behaviours of marine turtles.
Air emissions	We ensure engines and other equipment is looked after and fuel use and waste incineration standards are maintained.
Discharges	We will reduce discharges to only those necessary for operations and we follow the standard rules for what boats can discharge.
Wellhead left on seabed	We will leave the wellhead on the seabed only if it cannot be removed easily due to technical difficulties.
Oil spill response	We have plans and resources to be used if there is an accidental oil spill.

Tern-2 P&A - Risks

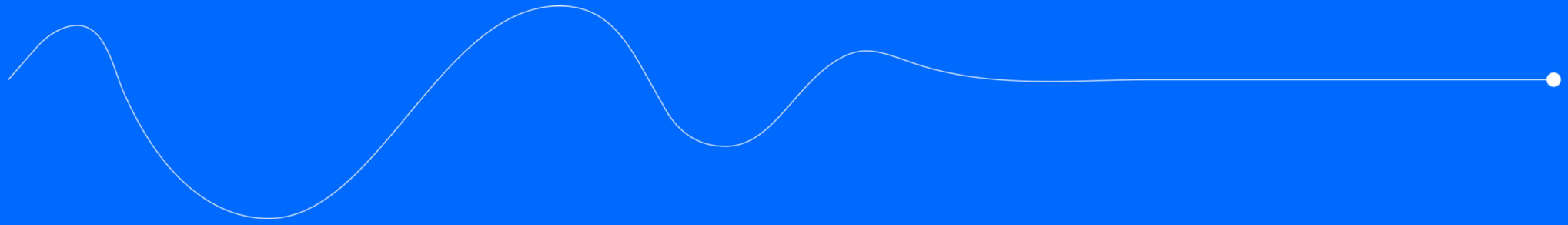
Santos

Unplanned events (Accidents)	How we manage (the rules we follow)
Diesel spill	We make sure all the boats are following the rules for preventing collisions. We let other boats know where we are and what we are doing. We will not refuel within the operational area.
Dropped objects	We follow strict procedures to stop objects dropping overboard and we pick up objects when it is safe to do so.
Disturbing marine animals	We look out for marine life (e.g., whales, dolphins, turtles) when transiting within and to and from the operational area and we slow down and move away from them where possible if they are too close.
Invasive marine life	We will use an anti-foulant system and follow strict procedures to avoid any introduction of invasive marine life.
Chemical spill	We select chemicals that are friendly to the environment where possible and store them carefully. We have procedures for using and cleaning up chemicals.
Disturbance to other boats	We let other boats know where we are and what we are doing. We will let other boats, fishing groups, and the government know if the wellhead cannot be removed and will be left on the seabed.

Santos

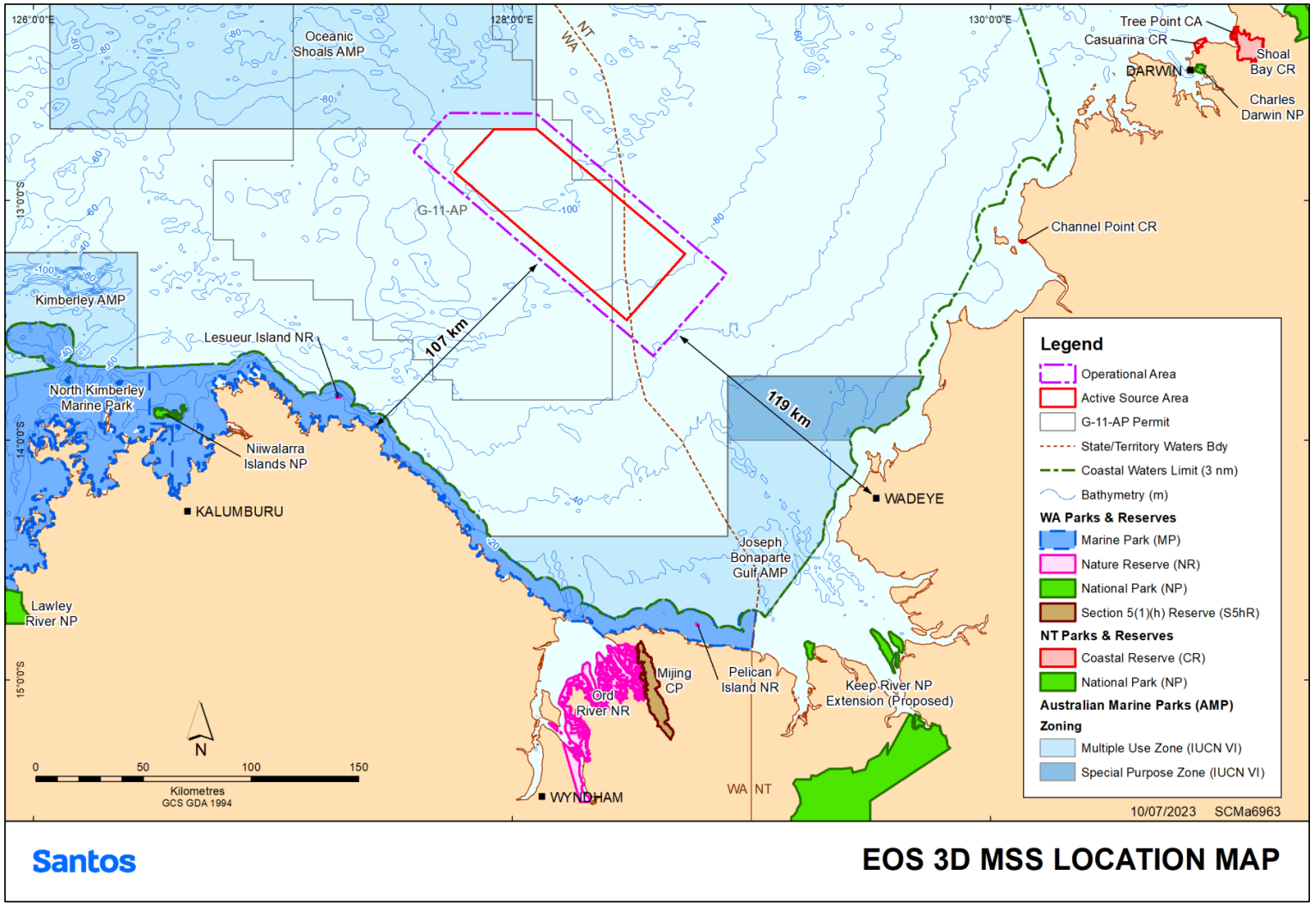
BONAPARTE BASIN CONSULTATION

EOS 3D MARINE SEISMIC SURVEY



WA & NT Environment Plan Consultation

Eos 3D MSS - Location



Eos 3D Marine Seismic Survey

What is a marine seismic survey?

Eos 3D MSS - Overview

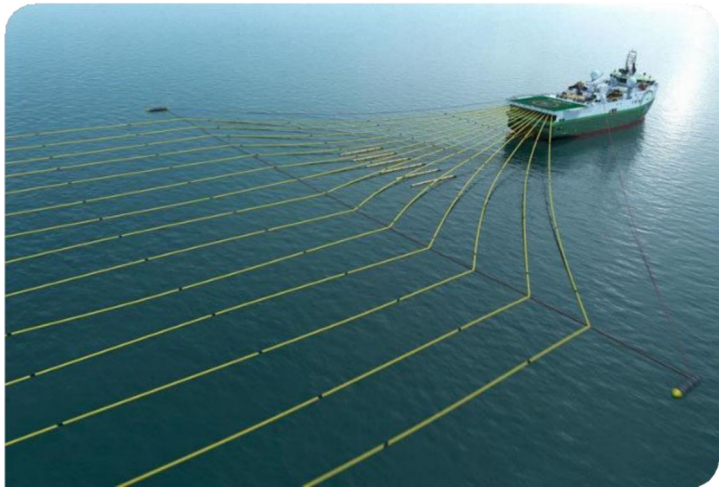
- Santos plans to acquire a three-dimensional (3D) marine seismic survey (MSS) in Commonwealth waters in the Bonaparte Basin.
- The proposed activity is required to complete an appraisal of the carbon storage potential of Santos' greenhouse gas assessment (GHG) permit

- Key objectives:
  - future Carbon Dioxide (CO_2) injection activities by providing details of geology for suitability of injection and storage of CO_2.
- Timing:
  - 50 days, (42 days plus 8 days for contingency, e.g. weather, mechanical etc)
  - Continuous operations, 24 hours per day, 7 days per week.

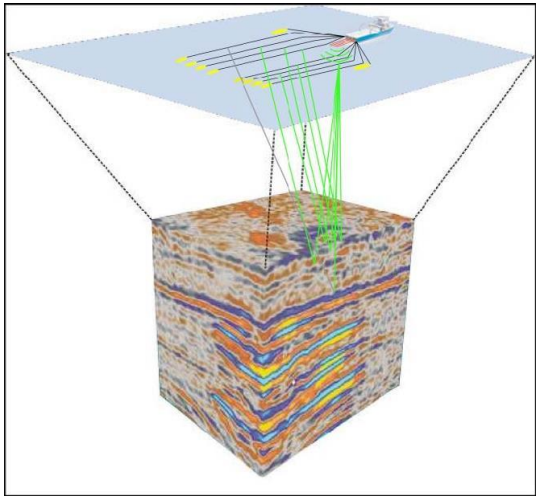
- Operational Area:
  - Area within which the seismic survey vessel will operate during the normal conduct of the activity.
  - 60 to 115 m water depth.

- Active Source Area:
  - Area size: 4,028 km^2
  - 67 to 111 m water depth.

- Project vessels:
  - Seismic survey vessel
  - Up to two Support Vessels (one being a chase vessel)
  - Helicopters and drones

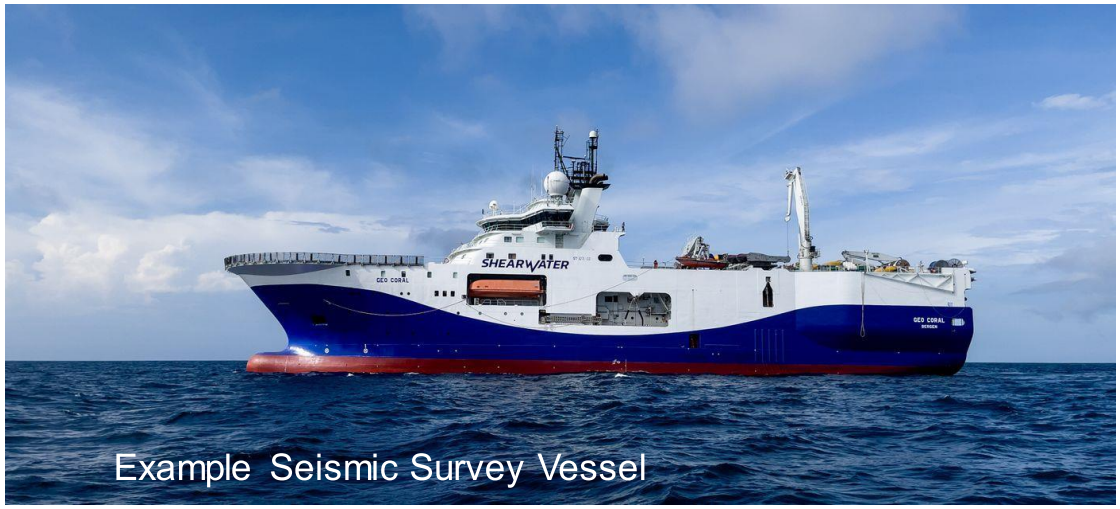


Example of a seismic array and Marine Seismic Vessel for 3D or 4D surveys



3D seismic survey, showing simplified configuration of seismic vessel and subsurface cube of data (Cameselle, 2020)

Eos 3D MSS – Vessels & Vehicles



Example Seismic Survey Vessel

Example Support Vessel

Example Chase Vessel

Example Helicopter

Eos 3D MSS - Impacts

Santos

Planned events	How we manage (the rules we follow)
Disturbance to commercial fishers	We will communicate to fishing boats where we are and what we are doing. We have a process to enable commercial fishers to lodge evidence-based payment claims for temporary loss of fish catch, displacement costs and equipment damage or loss directly caused by the seismic survey.
Disturbance to other boats	We will communicate to other boats where we are and what we are doing and provide notifications in advance of the survey starting.
Light disturbance	We only use lights where needed for safe operations. We turn off lights when not needed.
Noise disturbance	We look out for marine life (e.g., whales, dolphins, turtles) and the support vessel will slow down and move away from them where possible if they are too close while the survey is taking place.
Air emissions	We ensure engines and other equipment is looked after and fuel use and waste incineration standards are maintained.
Discharges	We will follow the standard rules and procedures for what boats can discharge.
Impacts from other seismic surveys	We will communicate with other companies that may also be doing seismic surveys in the area and keep a large distance between other seismic vessels.

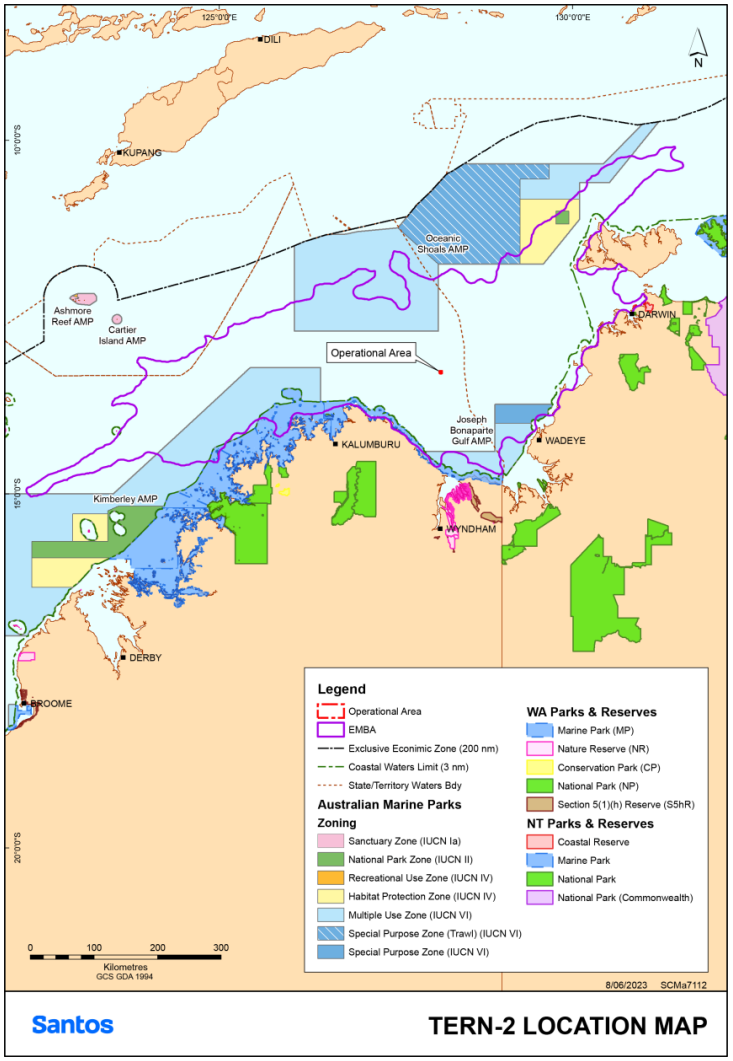
Eos 3D MSS - Risks

Santos

Unplanned events (Accidents)	How we manage (the rules we follow)
Diesel spill	We make sure all the boats are following the rules for preventing collisions. We let other boats know where we are and what we are doing. We follow strict procedures for refuelling.
Discharges	Where possible and safe to do so, we will recover any waste or equipment that accidentally falls overboard into the ocean.
Disturbing marine animals	We look out for marine life (e.g., whales, dolphins, turtles) and the support vessel will slow down and move away from them where possible if they are too close while the survey is taking place.
Invasive marine life	We will use an anti-foulant system and follow strict procedures to avoid any introduction of invasive marine life.
Chemical spill	We select chemicals that are friendly to the environment where possible and store them carefully. We have procedures for using and cleaning up chemicals.
Oil spill response	We have plans and resources to be used if there is an accidental oil spill.

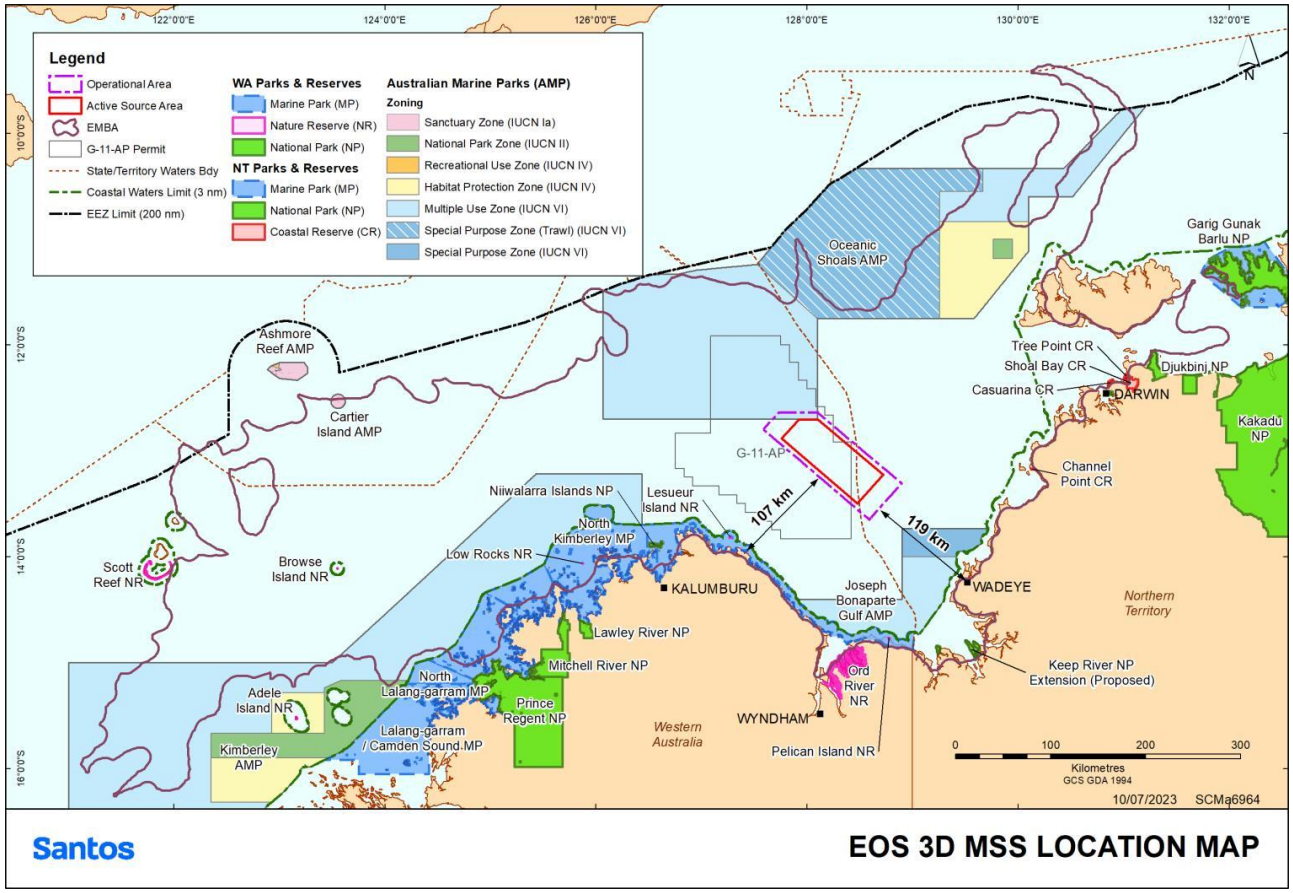
Santos

Spill Risk



Santos

TERN-2 LOCATION MAP

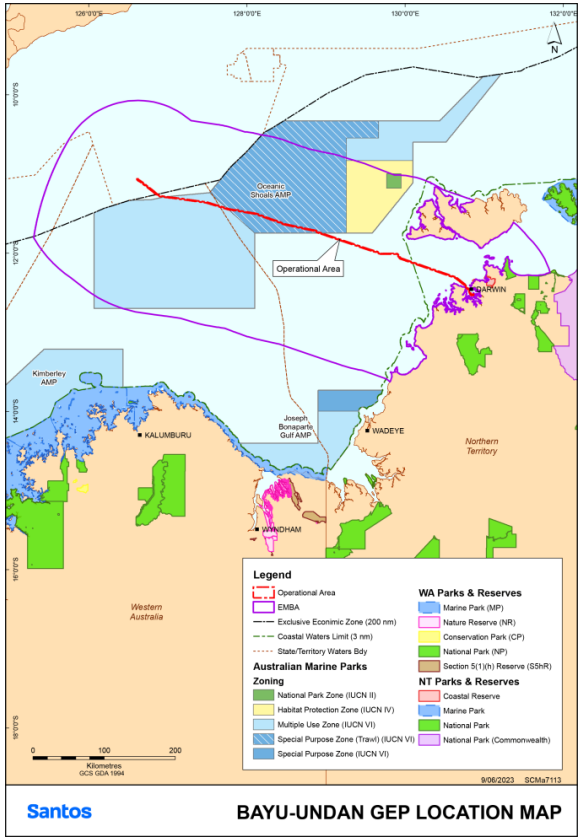


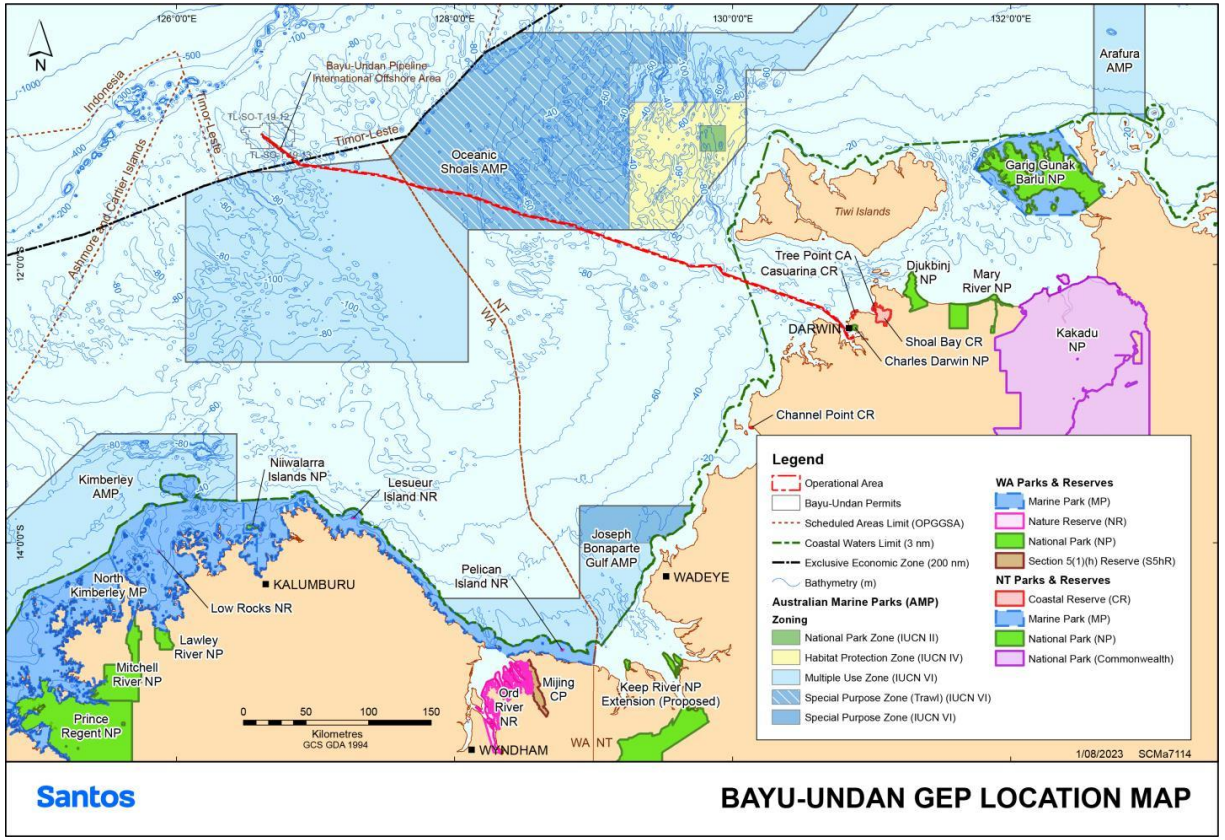
Santos

EOS 3D MSS LOCATION MAP

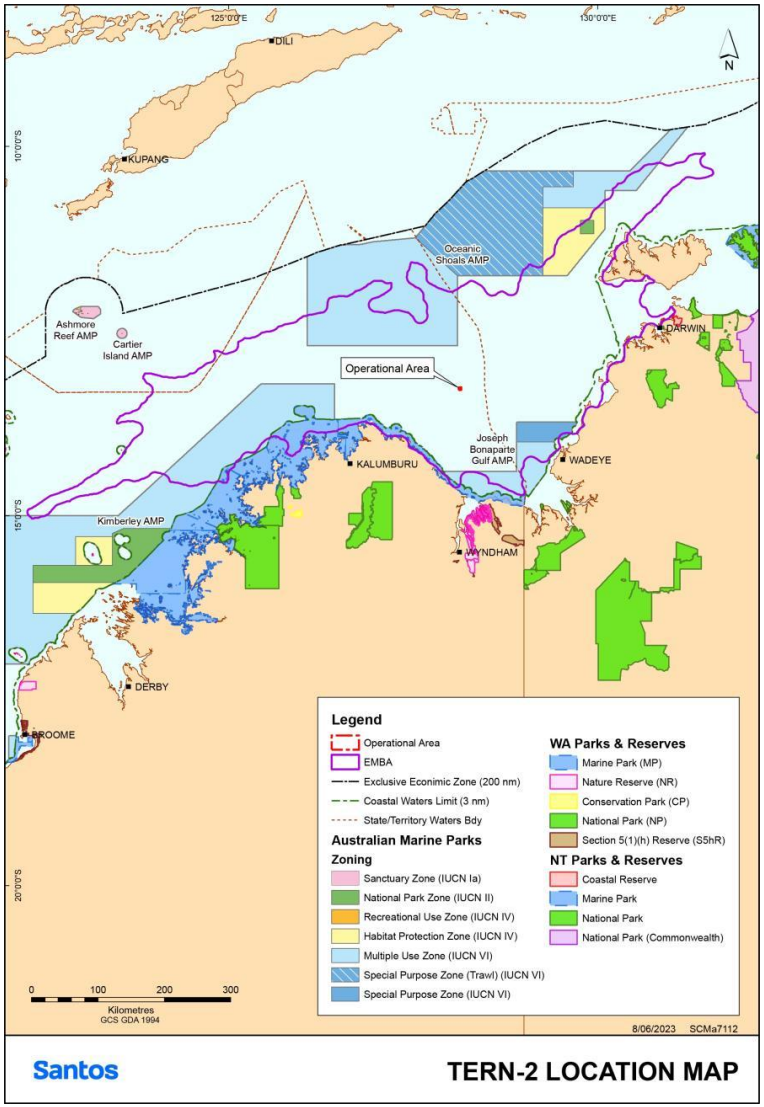
Bayu-Undan Gas Export Pipeline EP

- Santos is the operator of the existing 502km Gas Export Pipeline.
- The pipeline transports dry natural gas from the Bayu-Undan Field (Timor-Leste waters) to the onshore Darwin liquefied natural gas (DLNG) plant.
- The pipeline has been operational since 2005.
- As the Field is approaching the end of life, the pipeline will transition from operations to a preservation state.
- The original EP for operations was accepted by NOPSEMA in 2019.
- The EP has been updated to include the final stages of operations (linepacking and back-feed), plus a preservation phase (gas-filled).





Tern-2 P&A – Environment That May Be Affected



Feature	Public Information Review
Aboriginal Heritage	Aboriginal Heritage sites are present along the southern and eastern boundaries of the Environment That May Be Affected (EMBA).
Biologically Important Areas (BIAs)	The Operational Area includes BIAs for turtles only, the EMBA includes BIAs for dolphins, seabirds, sharks, whales and turtles.
Cultural Heritage	No known sites of shipwrecks, sunken aircraft or Aboriginal and Torres Strait Islander Underwater Cultural Heritage have been identified within the Operational Area. Within the EMBA the nearest shipwreck, the SEDCO Helen, is approximately 60 km northeast of the Operational Area located in depths of approximately 100 m .
Defence	Operational area overlaps practice and training areas that comprise the North Australian Exercise Area (NAZA) a maritime military zone administered by the Australian Defence Force, as well as restricted airspace.
Energy industry	Several offshore petroleum projects are in operation and there is exploration activity within the EMBA. The nearest platform is the ENI Blacktip Platform approximately 75 km to the southeast of the operational area.
Fishing	A number of Commonwealth, State and Territory fisheries management areas overlap the Operational Area and EMBA however, neither Commonwealth nor WA state-managed fisheries show activity within the Operational Area between 2010-2020.
	Traditional Australian Indigenous fishing activities are generally concentrated within 3 nm of the Northern Territory / Western Australian coastline.
	No interaction with recreational or charter boat fishers is anticipated given the remoteness of the Operational Area (~106 km from nearest coastline).
Key Ecological Features (KEFs)	The EMBA includes KEFs for the carbonate bank and terrace system of the Van Diemen Rise, the carbonate bank and terrace system of the Sahul Shelf, ancient coastline at 125m depth contour, continental slope Demersal Fish communities, the shelf break and slope of the Arafura Shelf, and the Pinnacles of the Bonaparte Basin.
Protected Areas (nearest Commonwealth and Territory)	In Commonwealth Waters the EMBA overlaps with the Oceanic Shoals Marine Park, Joseph Bonaparte Gulf AMP and the Kimberley AMP. The closest being the Oceanic Shoals AMP which is approximately 63 km north of the Operational Area.
	The North Kimberley State Marine Park is approximately 182 km west from the Operational Area and overlaps with the EMBA.
Shipping	The Operational Area does not overlap any shipping fairways, though is adjacent to vessel traffic. Vessel traffic from Wyndham may be present within the EMBA at periods of the year.
Telecommunications	The North West Cable System (NWCS) connects offshore oil and gas facilities in the Browse, Bonaparte and Carnarvon Basins to onshore locations and is approximately 140 km north-north-east of the Operational Area.
Tourism	Remoteness of the Operational Area and water depth limits opportunities for tourism. Tourism is likely within the EMBA.
Towns/Communities	Darwin is the nearest capital city and is approximately 300 km northeast from the Operational Area.

Eos 3D MSS - Activity

- The process of collecting seismic data is known as ‘acquisition’.
- Marine seismic surveys are carried out by specialised vessels that tow an array of acoustic sources (airguns) and receivers (hydrophones) across a defined acquisition area.
- The seismic survey vessel will tow a seismic source array (up to 3,500 in3) and up to 12 streamers, approximately 113 m apart, and will travel back and forth across the survey area in a “race track” pattern, lines separated by approximately 500-700m within an overall acquisition area.
- The streamer array will be approximately 8 km long and positioned 10 – 30 m below the ocean surface.
- Airguns work by rapidly releasing compressed air to form a bubble, which creates a pulse of sound. This sound energy is directed at the seafloor and penetrates into the various rock layers beneath.
- The reflected soundwaves are then captured by hydrophone receivers, which are towed behind the vessel on a series of cables known as 'streamers'.
- Support vessels will be on standby, one support vessel will be present at all times.
- 3 nm exclusion zone requested.
- Auscoast warning and/or Notice to Mariners will be issued prior to the start of the activity.
- The seismic survey vessel will display appropriate day shapes and lights to indicate it is under tow and is therefore restricted in it’s ability to manoeuvre, and the streamers will tow surface tail buoys fitted with radar reflectors.
- A visual and radar watch will be maintained on the bridge at all times.

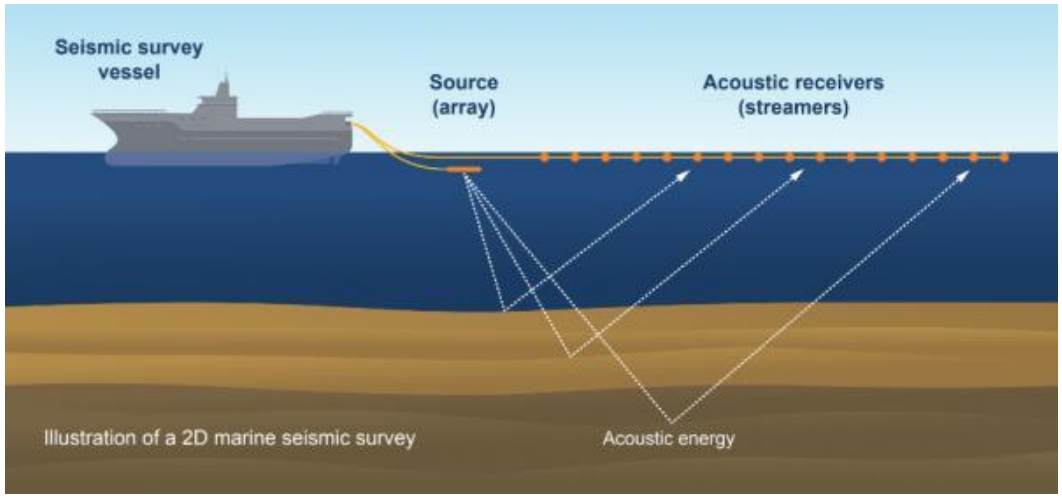
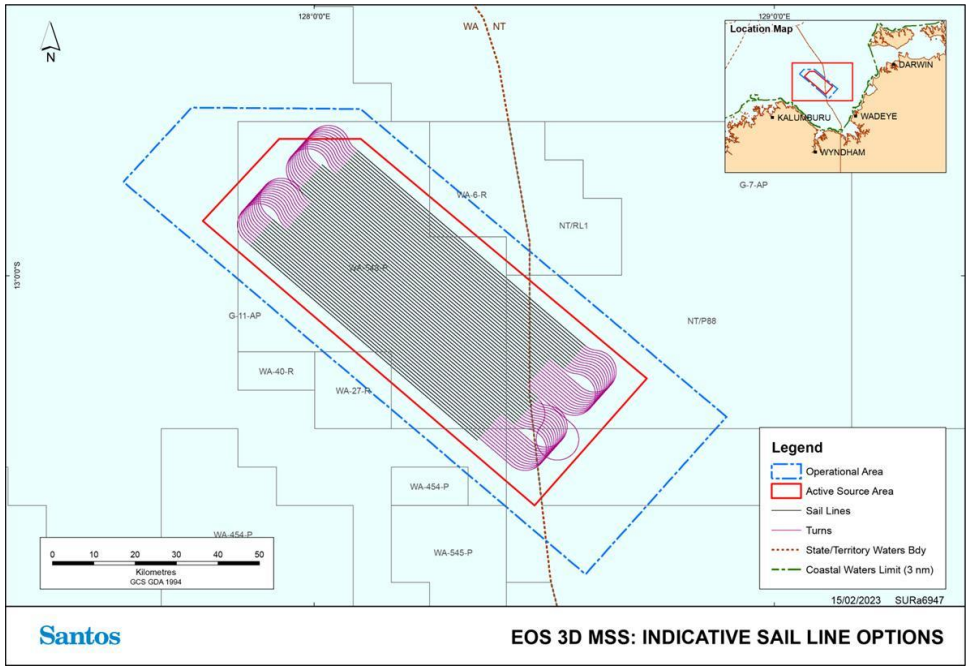


Diagram of a marine seismic survey (Source: NOPSEMA).



Eos 3D MSS – Environment That May Be Affected

Feature	Public Information Review
Aboriginal Heritage	Aboriginal Heritage sites are present along the coastline along the southern boundary of the EMBA.
Biologically Important Areas (BIAs)	The Operational Area includes BIAs for turtles.
Cultural Heritage	No known sites of shipwrecks, sunken aircraft or Aboriginal and Torres Strait Islander Underwater Cultural Heritage have been identified within the Operational Area. The nearest shipwreck, the SEDCO Helen, is approximately 11 km northeast of the Operational Area.
Defence	Operational area overlaps practice and training areas that comprise the North Australian Exercise Area (NAZA) a maritime military zone administered by the Australian Defence Force, as well as restricted airspace.
Energy Industry	Petroleum exploration and production activities have been undertaken within the EMBA and the Bonaparte Basin is an established hydrocarbon province with a number of commercial operations. Several exploration permits overlap the Operational Area with the closest production licence being the Eni Australia B.V. located 21 km south of the Operational Area.
Fishing	Five Commonwealth, thirteen Western Australia and ten Northern Territory fisheries overlap the EMBA, some of which are active in the Operational Area.
	Traditional Australian Indigenous fishing activities are generally concentrated within 3 nm of the Northern Territory / Weste rn Australian coastline.
	Fishing charter vessels may transit through the Operational Area and EMBA. Northern Prawn Fishery (NPF) fishing season (within the NPF licence area) is annually from August to November.
Key Ecological Features (KEFs)	The Operational Area overlaps one KEF for the Carbonate Bank and Terrace System of the Sahul Shelf.
Protected Areas (nearest Commonwealth and Territory)	The Operational Area overlaps the Oceanic Shoals Marine Park and four additional Australian Marine Parks overlap the EMBA. .
	Eighteen state/territory marine parks overlap the EMBA with the closest being the North Kimberley Marine Park located approximately 100 km south-west of the Operational Area.
Shipping	The Operational Area does not overlap any shipping fairways, however there is vessel traffic that passes through the northern end of the Operational Area. High vessel traffic to be expected from largest exporter of cattle out of Wyndham during Q3.
Telecommunications	The North West Cable System (NWCS) connects offshore oil and gas facilities in the Browse, Bonaparte and Carnarvon Basins to onshore locations and is approximately 125 km north-north- east of the Operational Area.
Tourism	Remoteness of the Operational Area and water depth limits opportunities for tourism. Tourism is likely within the EMBA.
Towns/Communities	Darwin is the nearest capital city and is approximately 230 km northeast from the Operational Area.
	Wadeye is the nearest community and is approximately 119 km southeast from the Operational Area.

Eos 3D MSS - Activity

- The process of collecting seismic data is known as ‘acquisition’.
- Marine seismic surveys are carried out by specialised vessels that tow an array of acoustic sources (airguns) and receivers (hydrophones) across a defined acquisition area.
- The seismic survey vessel will tow a seismic source array (up to 3,500 in3) and up to 12 streamers, approximately 113 m apart, and will travel back and forth across the survey area in a “race track” pattern, lines separated by approximately 500-700m within an overall acquisition area.
- The streamer array will be approximately 8 km long and positioned 10 – 30 m below the ocean surface.
- Airguns work by rapidly releasing compressed air to form a bubble, which creates a pulse of sound. This sound energy is directed at the seafloor and penetrates into the various rock layers beneath.
- The reflected soundwaves are then captured by hydrophone receivers, which are towed behind the vessel on a series of cables known as 'streamers'.
- Support vessels will be on standby, one support vessel will be present at all times.
- 3 nm exclusion zone requested.
- Auscoast warning and/or Notice to Mariners will be issued prior to the start of the activity.
- The seismic survey vessel will display appropriate day shapes and lights to indicate it is under tow and is therefore restricted in it’s ability to manoeuvre, and the streamers will tow surface tail buoys fitted with radar reflectors.
- A visual and radar watch will be maintained on the bridge at all times.

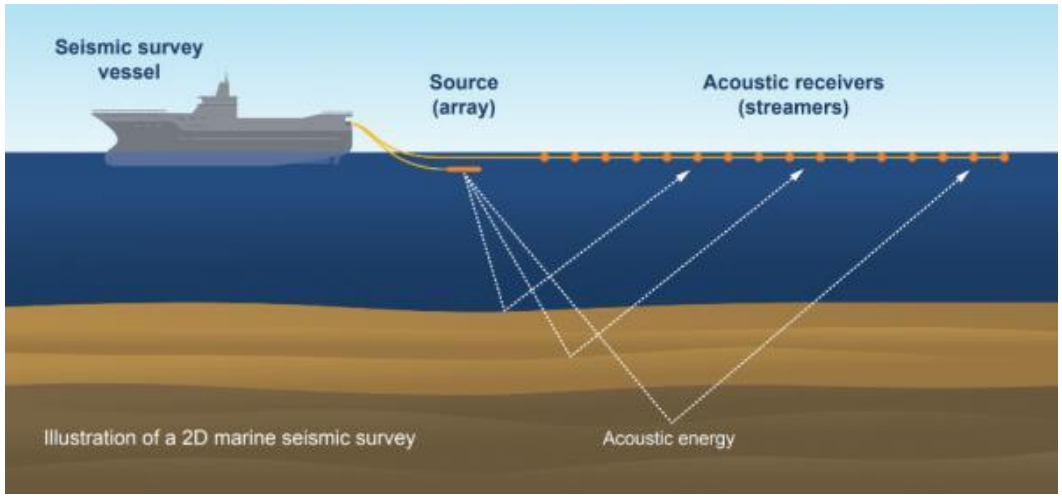
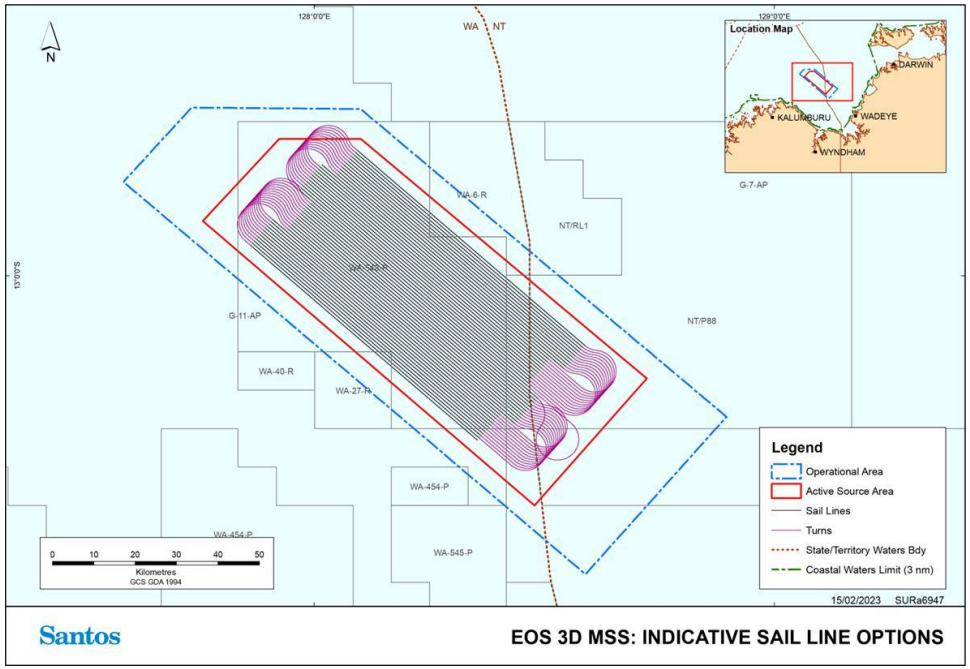


Diagram of a marine seismic survey (Source: NOPSEMA).



Eos 3D MSS – Commercial Fishers

Co-existence approach

- Minimise the extent of interruption by the seismic survey activities on commercial fishing operators' activities to the lowest practicable level.
- Mitigate the effects of the interruptions.
- Apply an equitable 'commercial fishers payment claim protocol'.

Commercial fishers payment claim protocol

- The survey will potentially impact commercial fishers whose fishing operations overlap with the seismic survey.
- Santos has a process to enable commercial fishers to lodge evidence-based payment claims for temporary loss of fish catch, displacement costs and equipment damage or loss directly caused by the seismic survey.
- Santos will also assess requests for administrative support to help fishers collate historical fishing data required for an evidence-based payment claim.
- The control measures identified within the draft Environment Plan, to outline how the potentially competing demands of commercial fishing operators and Santos' seismic survey may be managed, are consistent with those adopted for other Santos marine seismic surveys.

Commercial prawn and indicator fish species spawning	J	F	M	A	M	J	J	A	S	O	N	D	Source
Banana prawn spawning													AFMA 2020
Juvenile banana prawn migration													Longeran et al. 2002
Brown tiger prawn spawning													AFMA 2020
Grooved tiger prawn spawning													AFMA 2020
Blue endeavour prawn spawning													AFMA 2020
Red endeavour prawn spawning													AFMA 2020
Red emperor													DPIRD 2019
Goldband snapper													DPIRD 2019
Spanish mackerel (Kimberley stock)													DPIRD 2019

Key

Sensitivity/activity occurs

Extended peak spawning period

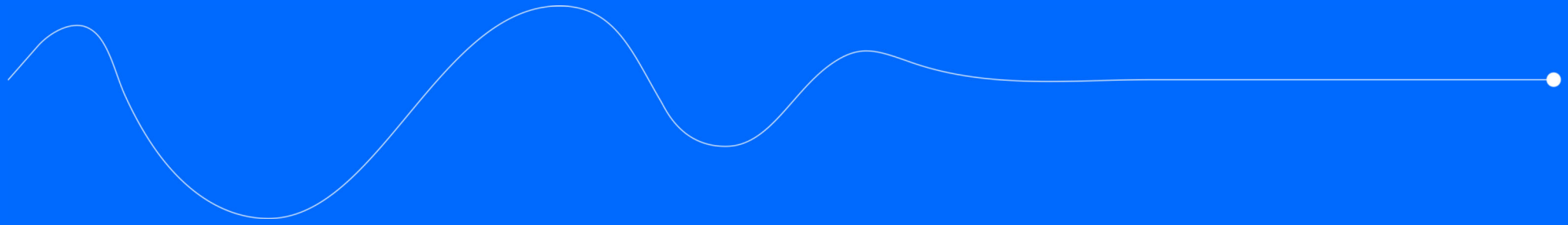
Peak spawning/migration period

*Extended peak spawning period – applies only to Goldband Snapper and Spanish Mackerel

NT & WA 11A Consultation_2023_Four EPs_Jabiru

Santos

NORTHERN TERRITORY & WESTERN AUSTRALIA PROJECT CONSULTATION SESSION



WA & NT Environment Plan Consultation

Presented by **Santos Team**

Santos

Privacy Statement

Santos Ltd and its related bodies corporate (together, we, our, us or Santos) collect personal information about you, such as your name and sensitive information about your indigenous heritage. We use this information to record your attendance at any meeting or other discussion with us, to provide you with information about our projects, to receive and respond to any information that you provide, to answer any questions you might have and for other purposes that we tell you about during your meeting or other discussion with us. Santos will handle any information that you provide in accordance with our Code of Conduct and our Confidentiality, IP and Privacy Procedure. You can ask us for a copy of this Privacy Notice or these other documents.

If you do not provide your personal information, we may not be able to identify you as the person who provided information, or we may be unable to discuss any information you have provided with you further or respond to your questions. We may disclose your information to other companies within the Santos group, to third parties that help us run our business and to relevant government agencies and government departments.

Due to the global nature of our operations and business, your personal information may be accessed by or disclosed to Santos personnel outside Australia. We may also use overseas third parties to collect, transfer, store and handle your personal information. Some of the overseas countries that your personal information may be accessed from, disclosed or transmitted to or stored in include but are not limited to, Papua New Guinea and the United States of America.

You have a right to request a copy of any personal information that we hold about you, as well as a right to request that we correct any information that we hold about you that is inaccurate, out-of-date, incomplete, irrelevant or misleading. You can also make a complaint about how we have handled your personal information. Our Consultation Privacy Policies explain in more detail how you can exercise these rights, including how we will respond to your access or correction request or to any privacy complaint that you make. The Barossa Gas Project Consultation Privacy Policy is available on our website at **www.santos.com/barossa/barossa-gas-project-consultation-privacy-policy**, and the Western Australia and Northern Territory Consultation Privacy Policy is available on our website at **https://www.santos.com/offshore-wa-and-nt-consultation-privacy-policy/.** You can also contact us to request copies be provided to you.

You can contact us by:

- posting a letter addressed to us at 60 Flinders Street, Adelaide, South Australia, 5000;
- telephoning us on +61 8 8116 5000; or
- sending us an email at offshore.consultation@santos.com and compliance@santos.com.

Santos

Acknowledgement of Country

Santos acknowledges the Traditional Owners of the land on which we meet today.

We pay our respects to Elders past, present and emerging.

Santos

Welcome & Introductions

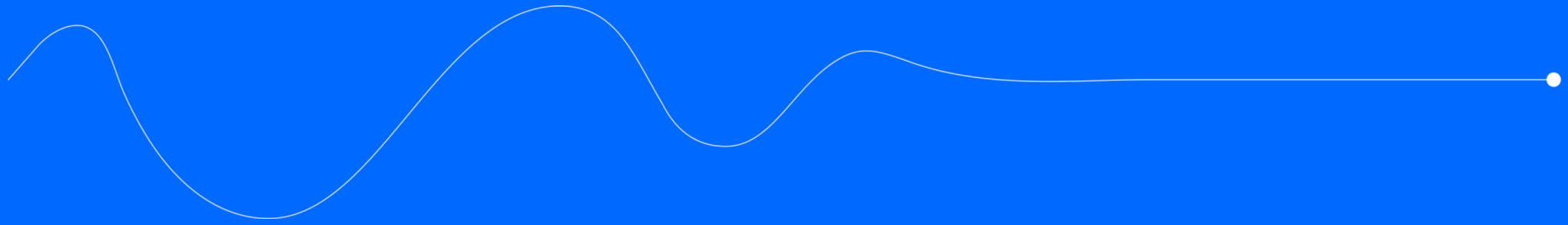
We are here today to share information about our company & operations and to listen to your questions about Santos & upcoming projects.

Peter Kirkpatrick *– General Manager, Darwin*

Emma Haddon *– Senior Environmental Advisor*

Santos

SANTOS OPERATIONS & DARWIN LNG



WA & NT Environment Plan Consultation

Presented by **Barossa Team**

SANTOS - South Australia, Northern Territory Oil Search

Santos is a global energy company committed to increasingly cleaner energy and fuels production, with operations across Australia, Papua New Guinea, Timor-Leste and North America (Alaska).

For more than 65 years, Santos has been working in partnership with local communities, providing local jobs and business opportunities, safely developing its natural gas resources, and powering industries and households.

We are committed to supplying critical fuels such as oil and gas in a more sustainable way through decarbonising projects, including the Moomba CCS Project, while we all transition to cleaner fuels.

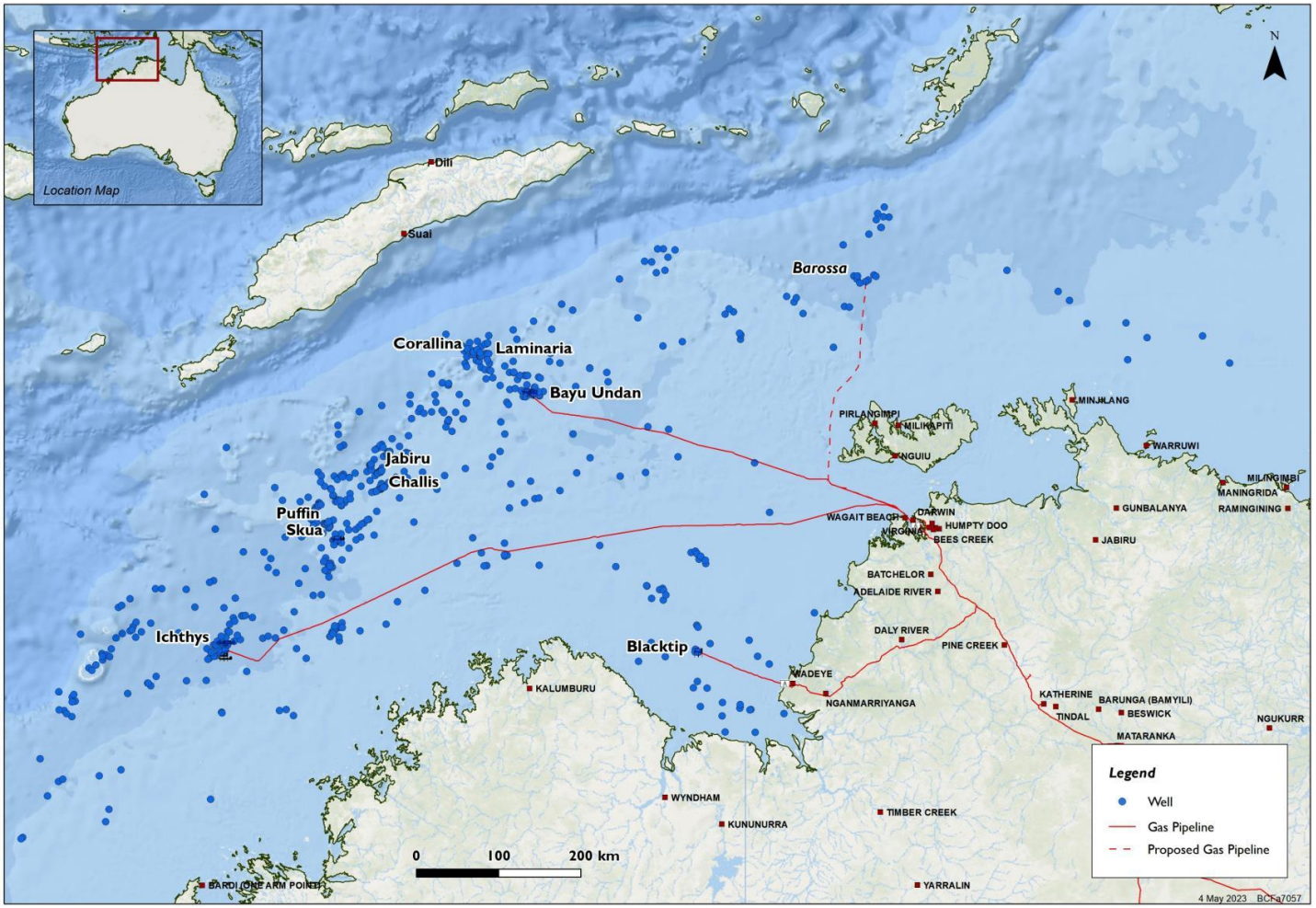
At Santos, our commitment is to be a global leader in the transition to cleaner energy and clean fuels, by helping the world decarbonise to reach net-zero emissions in an affordable and sustainable way.

Santos is one of Australia's biggest domestic gas suppliers and a leading LNG supplier in the Asia Pacific region.

Our business focus: Safe, reliable operations & Minimise our social and environmental impacts.

Wells Oil & Gas Drilled by All Industry Since 1969

Santos



These are not all Santos owned and operated.

This map shows all wells drilled in the NT area.

Not all wells are used.

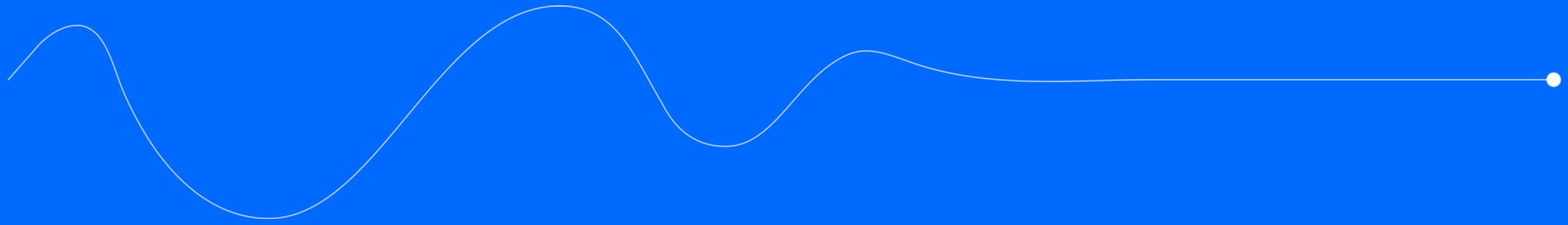
Darwin LNG Facility & Operations

Santos

- Located in Darwin at Wickham Point Darwin LNG (DLNG) is a single train liquefaction and storage facility that started production in 2006.
- The Bayu-Undan facility, which supplies gas to DLNG via 26-inch subsea pipeline, is located approximately 500 kilometers north-west of Darwin in the Timor Sea.
- The facility includes a central production Storage and Offloading vessel for condensate and LPG products and an unmanned wellhead platform.
- Approx 140 local Darwin people work at the LNG Facility.
- 100% Darwin residential Santos employee workforce.
- DLNG established the NT's first LNG Process Operator Traineeships in 2010.
  - ~10% of those who have completed identified as an Aboriginal or Torres Strait Islander.

Santos

ENGAGEMENT & CONSULTATION EXPLAINED



Consultation for Environment Plans

Commonwealth waters – National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA)

"In the course of preparing an Environment Plan, a titleholder must consult with relevant persons in accordance with Division 2.2A, Regulation 11A…

"The purpose of consultation under regulation 11A of the Environment Regulations is to ensure that authorities, persons or organisations that are potentially affected by activities are consulted and their input considered in the development of environment plans."

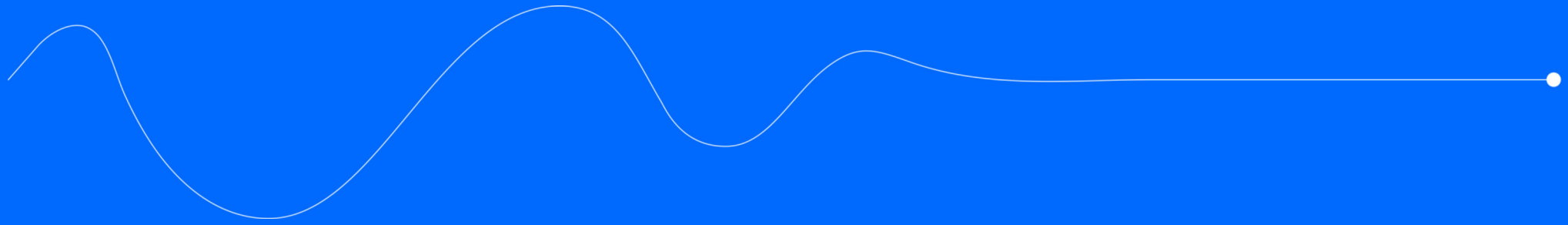
Guideline - Consultation in the course of preparing an environment plan, NOPSEMA

NOPSEMA

Information provided by relevant persons in consultation may also help titleholders **better understand the values and sensitivities of the environment** and inform the evaluation of the **potential impacts and risks** associated with the activity and **how to manage them** appropriately

Santos

BAROSSA GAS PROJECT & DARWIN PIPELINE DUPLICATION ENVIRONMENT PLAN CONSULTATION



WA & NT Environment Plan Consultation

Presented by **Barossa Team**

Barossa Gas Project - Overview

Santos

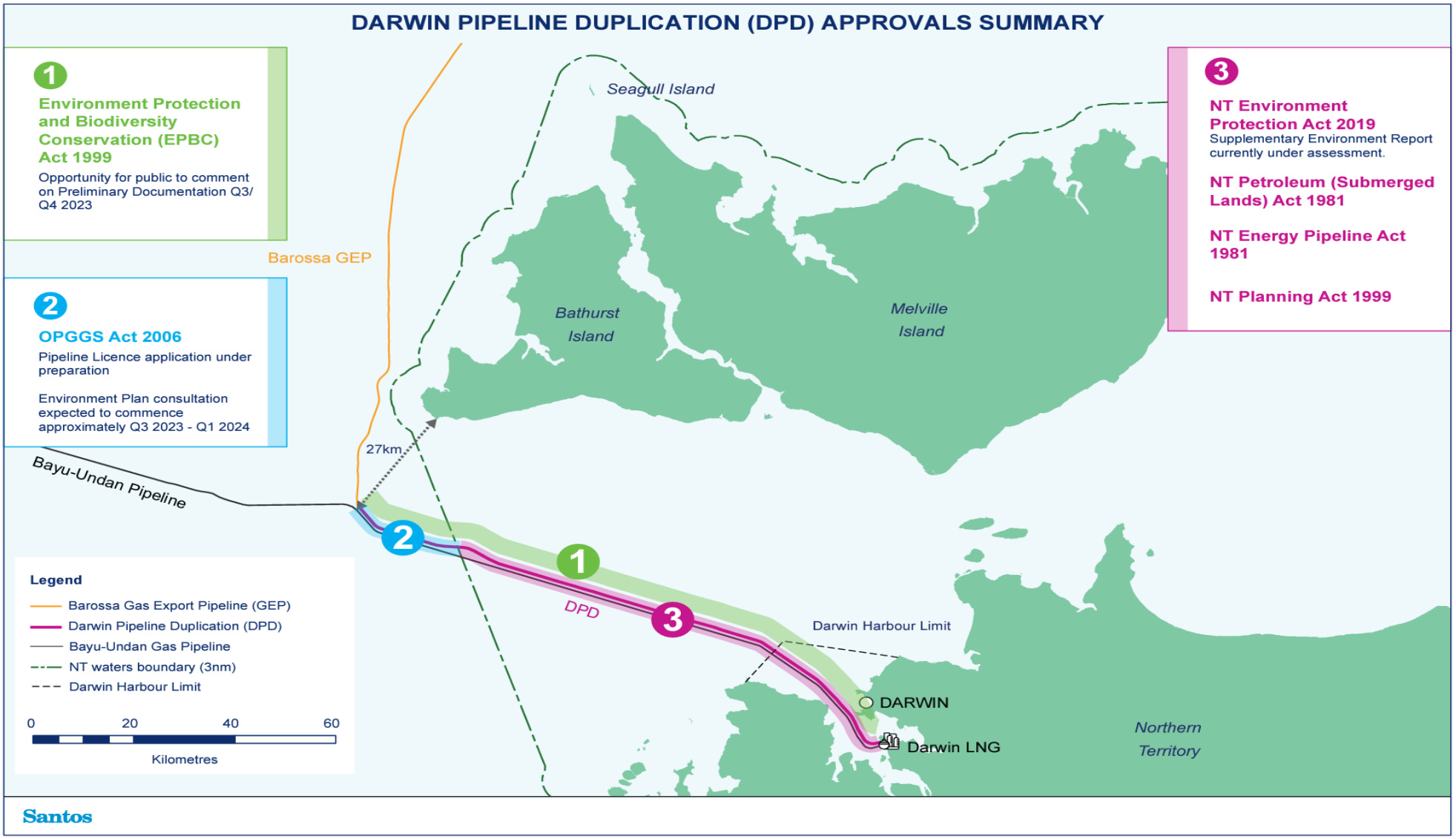
- The Santos-operated Barossa Gas Project is an offshore gas and condensate project that proposes to provide a new source of gas to the existing Darwin liquified natural gas (DLNG) facility in Darwin.
- The Barossa gas field is approximately 285 kilometres offshore north-north west from Darwin.
- Natural gas would be extracted from the Barossa field and transported via a gas pipeline (Gas Export Pipeline (GEP) and Darwin Pipeline Duplication (DPD) to the existing DLNG facility.
- Infrastructure would includes a Floating Production Storage and Offloading (FPSO) facility, a subsea production system, supporting in-field subsea infrastructure, the GEP and the DPD.
- Up to 8 subsea wells are planned to be drilled in the Barossa field (6 wells from 3 drill centres, with plans for an additional 2 wells).
- Gas and condensate would be gathered from the wells through the subsea production system and then brought to the FPSO facility via a network of subsea infrastructure.
- Initial processing would occur at the FPSO facility, to separate the natural gas, water and condensate extracted from the Barossa field.
- The dry natural gas would be transported through the gas pipeline for onshore processing at the DLNG facility.
- Condensate would be transferred from the FPSO to -specialised tankers for export.

Santos

Barossa Gas Project Overview Video

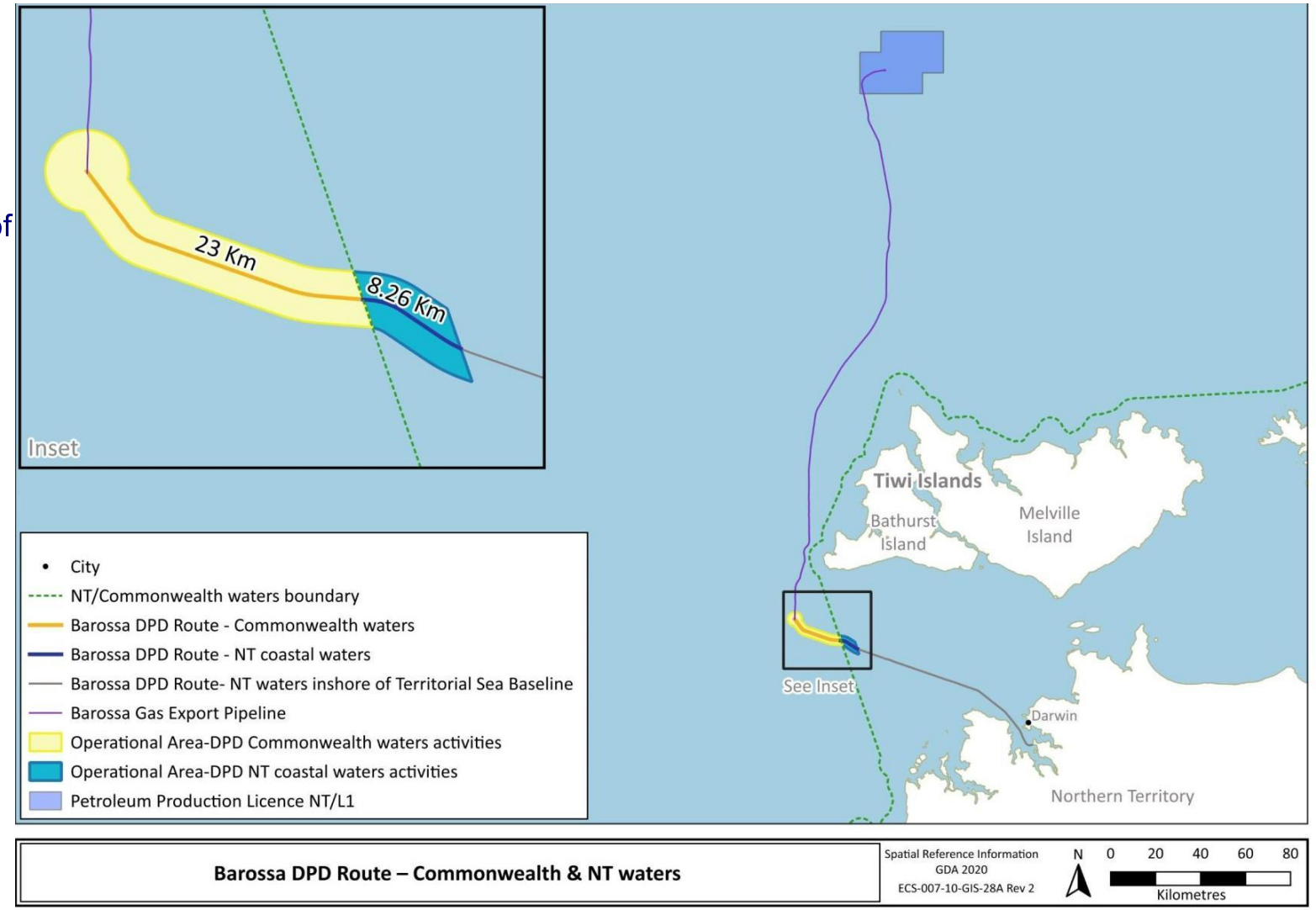
DPD Approvals

Santos



Darwin Pipeline Duplication (DPD) - Overview Santos

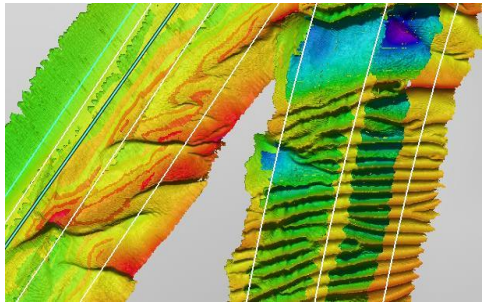
- The DPD will connect to the Barossa gas export pipeline and will send gas to Darwin
- The pipeline will run from approximately 27km south-west of the Tiwi Islands, 285 kms from Darwin
- Activities include acoustic positioning, surveys, pipeline and structure installation, pipeline testing, refuelling, connecting the DPD to the Barossa gas export pipeline and unplanned maintenance/repairs
- activities are currently planned to start end of of 2024 (Q3) and mid 2025 (Q2)
- Pipelay activities are planned to take approximately 3 months



Key DPD Installation Steps

Santos

Pre-lay Survey



Pre-lay Span Correction

Concrete mattresses are installed to support the pipeline where the seabed is rough.

Pipelay and Survey

Approximately 31km of pipeline is installed in Commonwealth and coastal waters by a pipelay vessel. Survey and post lay span correction, if required, is performed as pipelay progresses.

Pipeline Testing

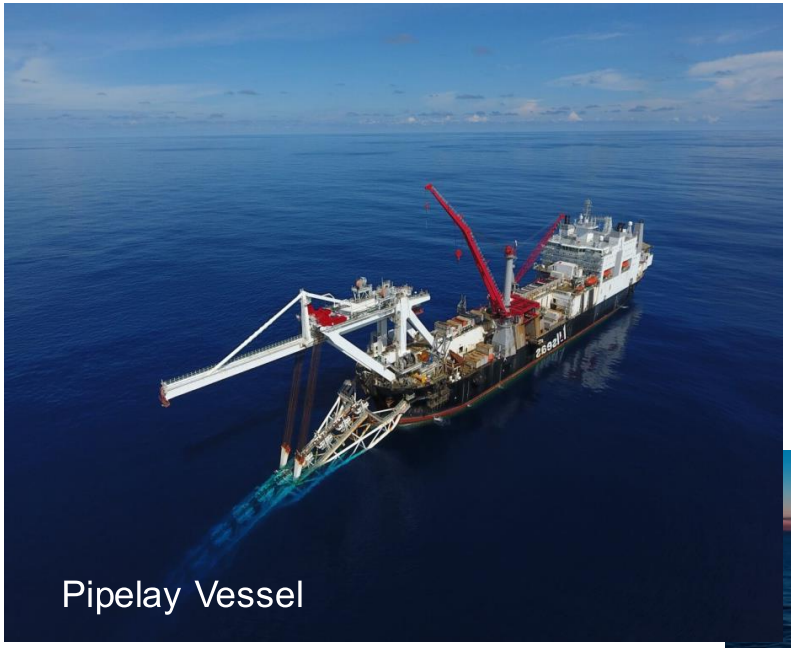
The DPD will be flooded with treated seawater and leak tested before the water is removed and the DPD is prepared for introduction of gas.

Connect DPD to the Gas Export Pipeline and Test

A spool shall be installed connecting the offshore gas export pipeline to the DPD. Once installed the spool will be leak tested.

DPD Installation Activities – Key Vessels

Santos



Pipelay Vessel

Survey and Construction Support Vessel

Supply Vessel

DPD impacts (Planned- things we know will happen)

Santos

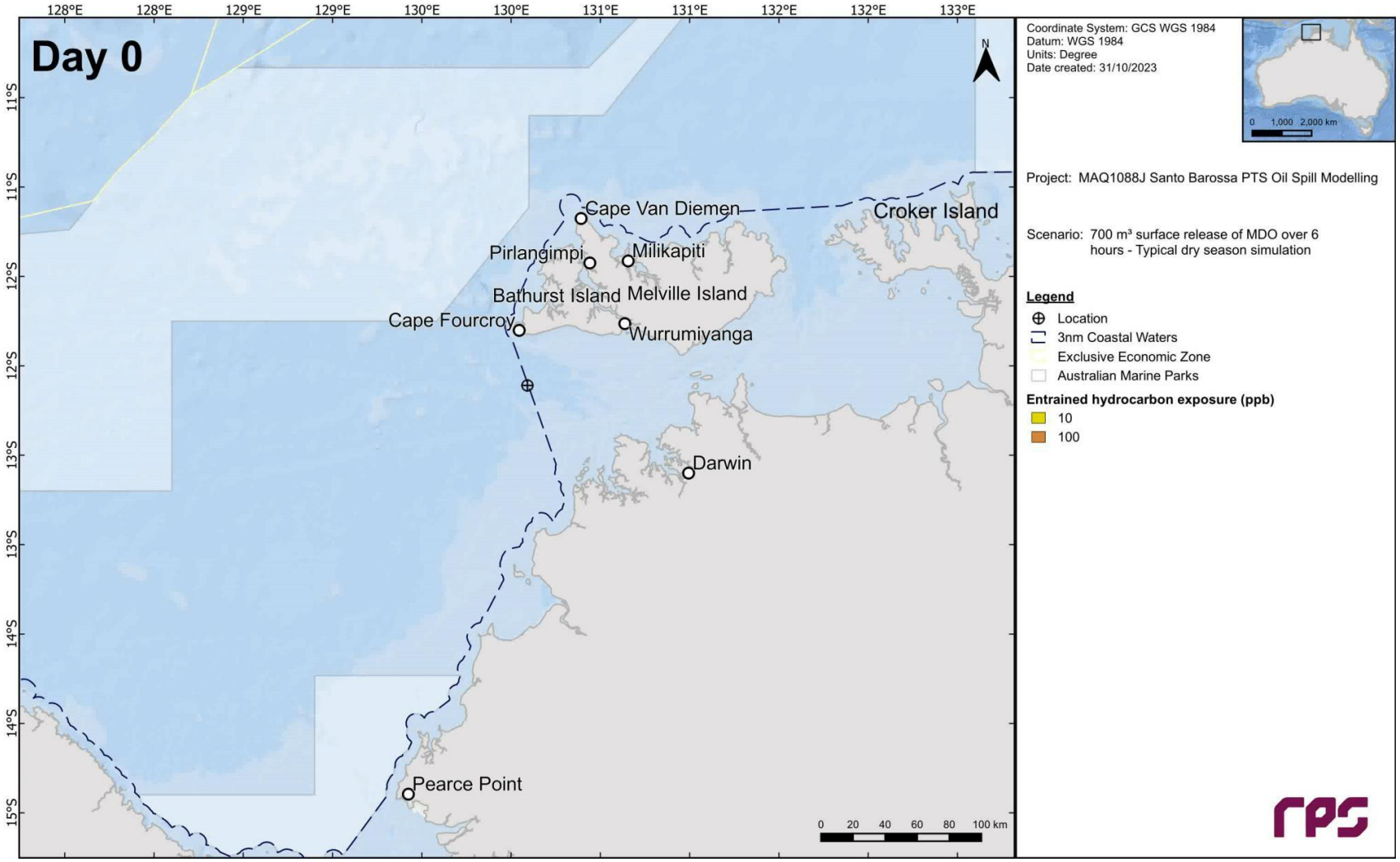
Planned events	How we manage (the rules we follow)
Light disturbance	We only use lights where needed for safe operations and to comply with relevant safety rules. We turn off lights when not required.
Noise disturbance	We follow procedures and look out for marine life (e.g., whales, dolphins, turtles) and we slow down and move away from them where possible if they are too close. Boats and equipment will be maintained to minimise noise.
Seabed disturbance	We are putting equipment on a mainly flat sandy seabed close to an existing pipeline. We record the position of installed equipment so we can collect it at a later date.
Discharges (boat discharges, pipeline testing)	We will manage discharges to acceptable levels and follow the standard rules for what boats can discharge. We will select water treatment chemicals that are environmentally acceptable, and we will limit its use.
Air emissions	We ensure engines and other equipment are looked after and low emission fuel will be used.
Disturbance to other boats	We will communicate to other boats where we are and what we are doing. We mark the location of equipment on charts.

DPD risks (unplanned- accidents)

Unplanned events (Accidents)	How we manage (the rules we follow)
Dropped objects	We follow strict procedures to stop objects dropping overboard and we pick up objects when it is safe to do so.
Disturbing marine animals	We look out for marine life (e.g., whales, dolphins, turtles) and we slow down and move away from them where possible if they are too close. We follow rules that outline how we need to interact with them.
Invasive marine life (pests- not native to area)	We inspect the boats to ensure no invasive marine life before they arrive. We have plans and equipment in place on boats to prevent pests. The Federal government has strict rules we need to follow.
Chemical spill	We select chemicals that are friendly to the environment where possible and store them carefully. We have procedures for using and cleaning up chemicals.
Gas release (dry gas or nitrogen) - Bayu-Undan pipeline	We follow strict rules for lifting to prevent dropped objects. We have procedures in place to minimise loss of gas from Bayu-Undan pipeline.
Diesel spill	We make sure all the boats are following the rules for preventing collisions. We let other boats know where we are and what we are doing. We follow strict procedures for refueling. We have plans and equipment for responding to spills.

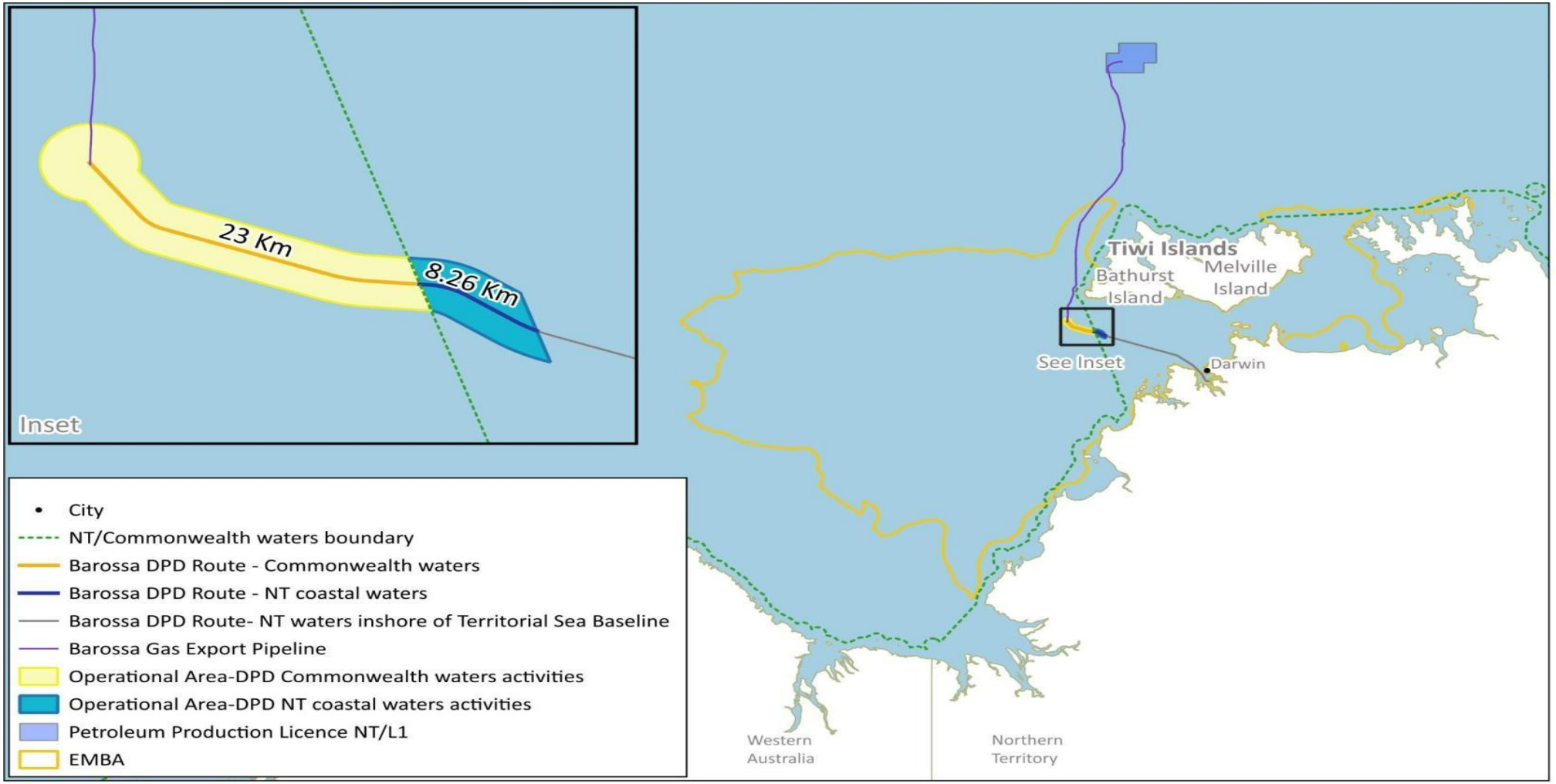
DPD Diesel Spill Animation – typical dry season simulation

Santos



DPD Environment That May Be Affected – Diesel spill

Santos



Barossa DPD Route and EMBA in Commonwealth & NT waters

Spatial Reference Information
GDA 2020
ECS-007-10-GIS-28B Rev 2

N

0 40 80 120 160
Kilometres

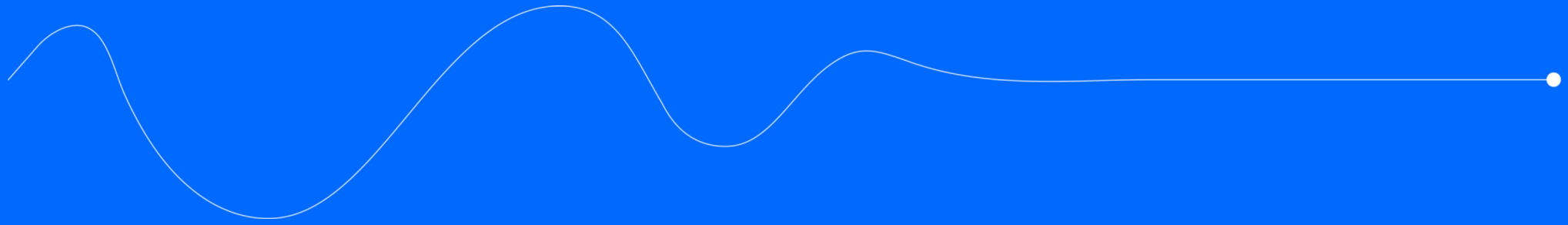
Santos

DPD QUESTIONS?

Santos

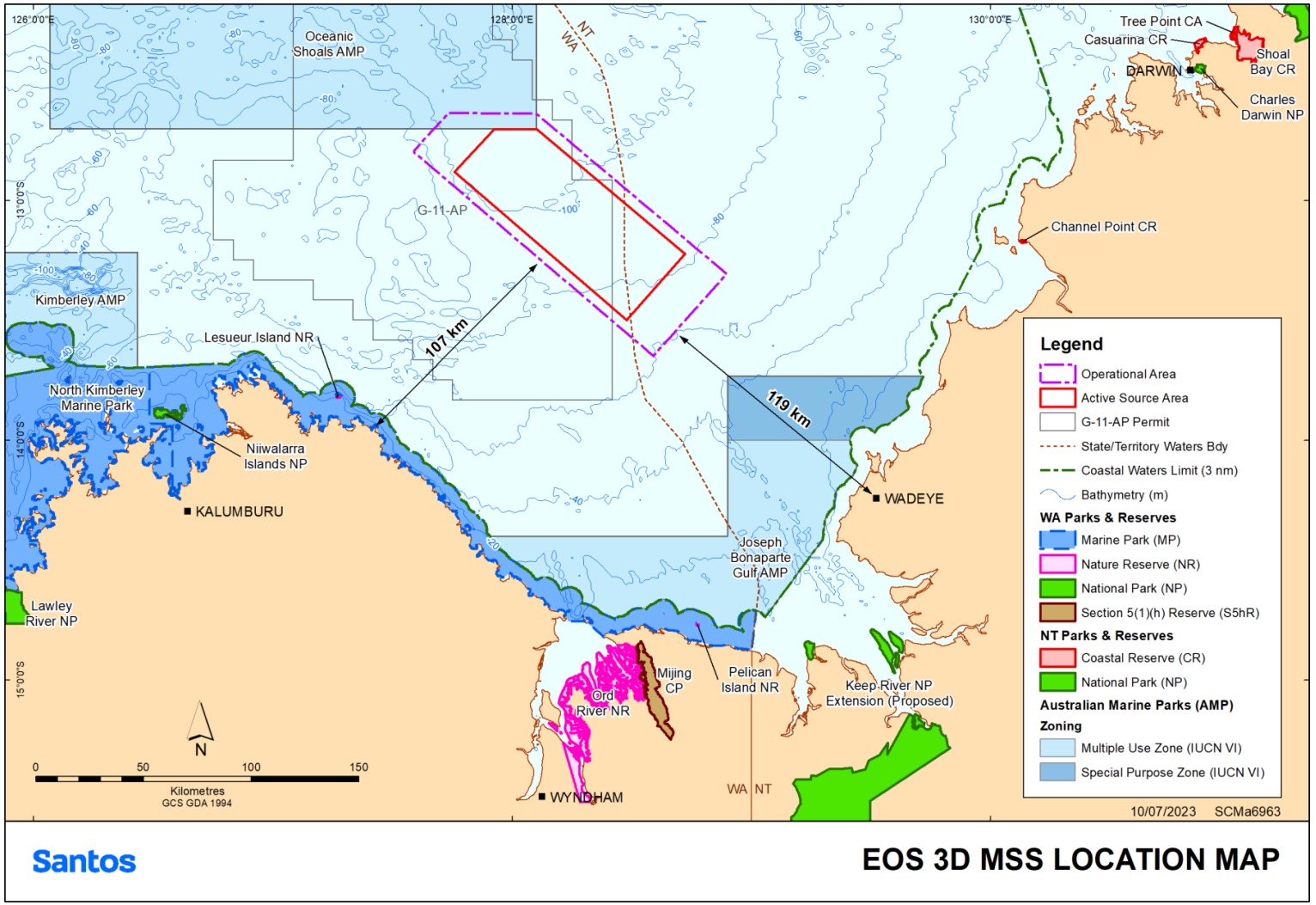
BONAPARTE BASIN CONSULTATION

EOS 3D MARINE SEISMIC SURVEY



WA & NT Environment Plan Consultation

Eos 3D MSS - Location



Eos 3D Marine Seismic Survey

What is a marine seismic survey?

https://www.youtube.com/watch?v=T1yzHW5x1HE

Eos 3D Marine Seismic Survey- Overview

- Santos is planning a three-dimensional (3D) marine seismic survey in Commonwealth waters in the Bonaparte Basin.
- The proposed activity is required to complete an appraisal of the carbon storage potential of Santos' greenhouse gas assessment (GHG) permit.

Why do the survey?:

- Understand the rocks (geology) under the seabed to confirm suitability for injection and storage of carbon dioxide (gas we breathe out)

Time to complete:

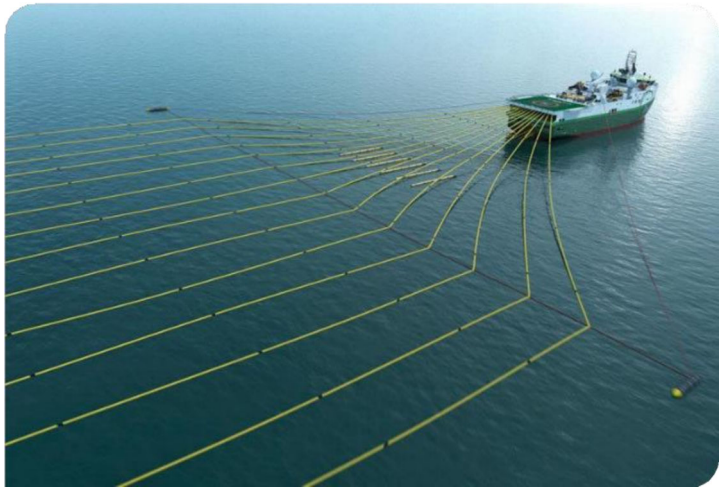
- 50 days, (42 days plus 8 days for bad weather, equipment breakdowns etc)
- 24 hours per day, 7 days per week.

Active Source Area:

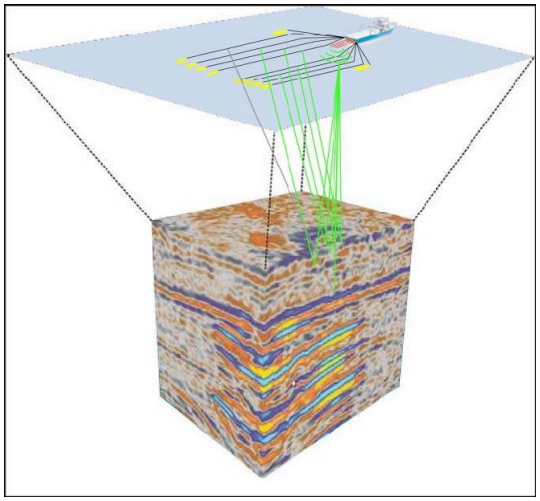
- Area within which the seismic source will be operated to acquire the seismic data and achieve the geophysical objectives of the survey.
- 67 to 111 m water depth.

Project vessels (boats & helicopters):

- Seismic survey vessel
- Up to two Support Vessels (one being a chase vessel)
- Helicopters and drones

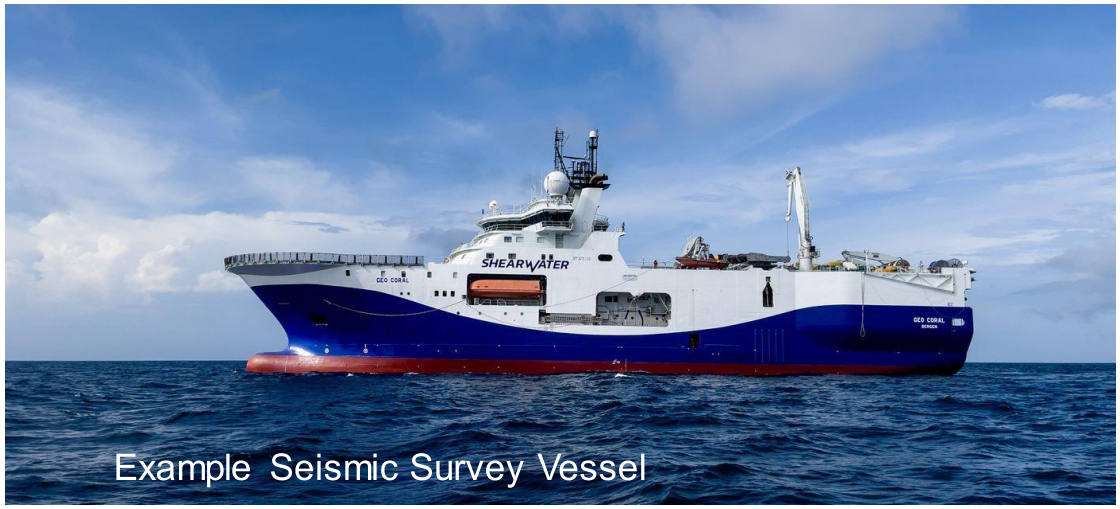


Example of a seismic array and Marine Seismic Vessel for 3D or 4D surveys



3D seismic survey, showing simplified configuration of seismic vessel and subsurface cube of data (Cameselle, 2020)

Eos 3D MSS – Vessels & Vehicles



Example Seismic Survey Vessel

Example Support Vessel

Example Chase Vessel

Example Helicopter

Eos 3D MSS - Impacts

Santos

Planned events	How we manage (the rules we follow)
Disturbance to commercial fishers	We will communicate to fishing boats where we are and what we are doing.
Disturbance to other boats	We will communicate to other boats where we are and what we are doing and provide notifications in advance of the survey starting.
Light disturbance	We only use lights where needed for safe operations. We turn off lights when not needed.
Noise disturbance	We look out for marine life (e.g., whales, dolphins, turtles) before the survey begins Animal spotters stay on the vessel during the survey and monitor. We use a soft start up- meaning the noise slowly gets louder giving marine animals time to move away from the sound.
Air emissions	We ensure engines and other equipment are looked after. Fuel use and waste incineration standards are maintained.
Discharges	We will follow the standard rules and procedures for what boats can discharge.
Impacts from other seismic surveys	We will communicate with other companies that may also be doing seismic surveys in the area and keep a large distance between other seismic vessels.

Eos 3D MSS – Risks (unplanned accidents)

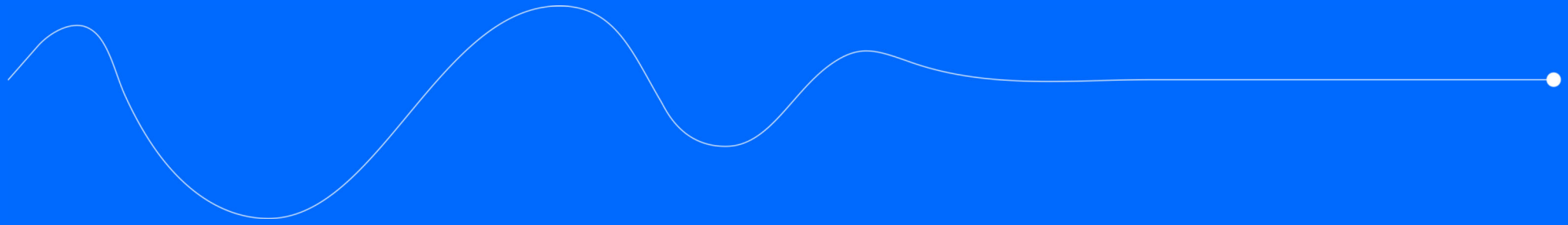
Santos

Unplanned events (Accidents)	How we manage (the rules we follow)
Diesel spill	We make sure all the boats are following the rules for preventing collisions. We let other boats know where we are and what we are doing. We follow strict procedures for refuelling.
Falling objects overboard	Where possible and safe to do so, we will recover any waste or equipment that accidentally falls overboard into the ocean.
Disturbing marine animals	We look out for marine life (e.g., whales, dolphins, turtles) and the support vessel will slow down and move away from them where possible if they are too close while the survey is taking place.
Invasive marine life (pests- not native to area)	We will use an anti-foulant system and follow strict procedures to avoid any introduction of invasive marine life.
Chemical spill	We select chemicals that are friendly to the environment where possible and store them carefully. We have procedures for using and cleaning up chemicals.
Oil spill response	We have plans and resources to be used if there is an accidental oil spill.

Santos

BONAPARTE BASIN CONSULTATION

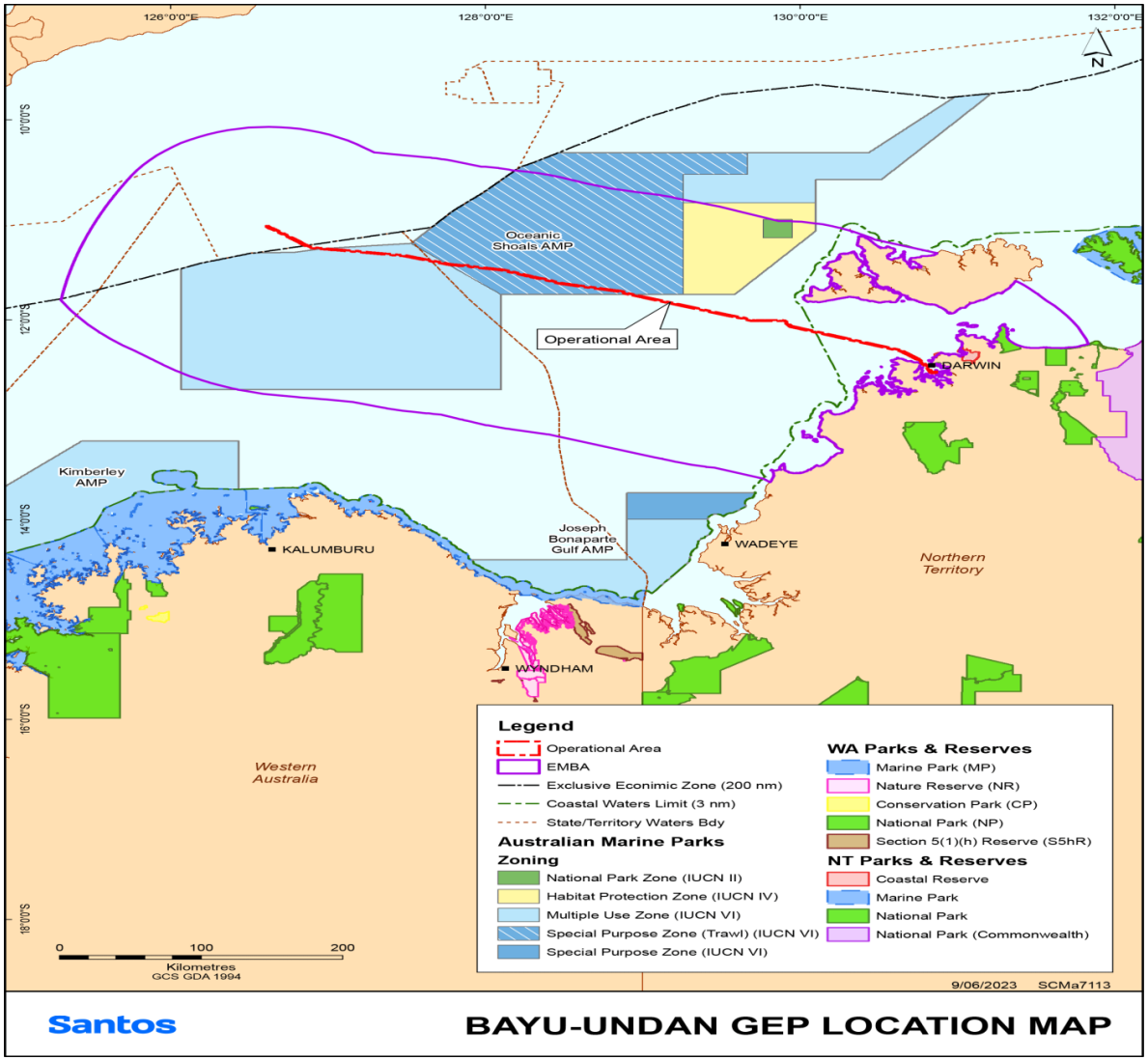
BAYU-UNDAN PIPELINE



WA & NT Environment Plan Consultation

Bayu-Undan Gas Export Pipeline EP

- Santos is the operator of the existing 502km Gas Export Pipeline.
- The pipeline transports dry natural gas from the Bayu-Undan Field (Timor-Leste waters) to the onshore Darwin liquefied natural gas (DLNG) plant.
- The pipeline has been operational since 2005.
- As the Field is approaching the end of life, the pipeline will transition from operations to a preservation state.
- The original EP for operations was accepted by NOPSEMA in 2019.
- The EP has been updated to include the final stages of operations (linepacking and back-feed), plus a preservation phase (gas-filled).

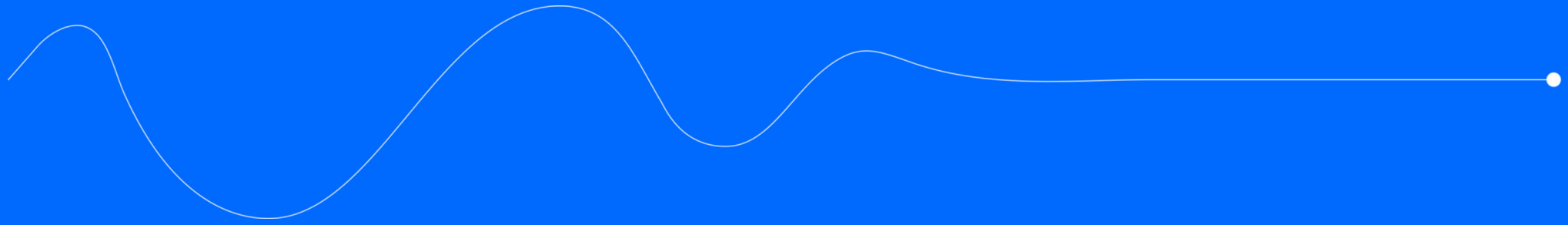


Santos

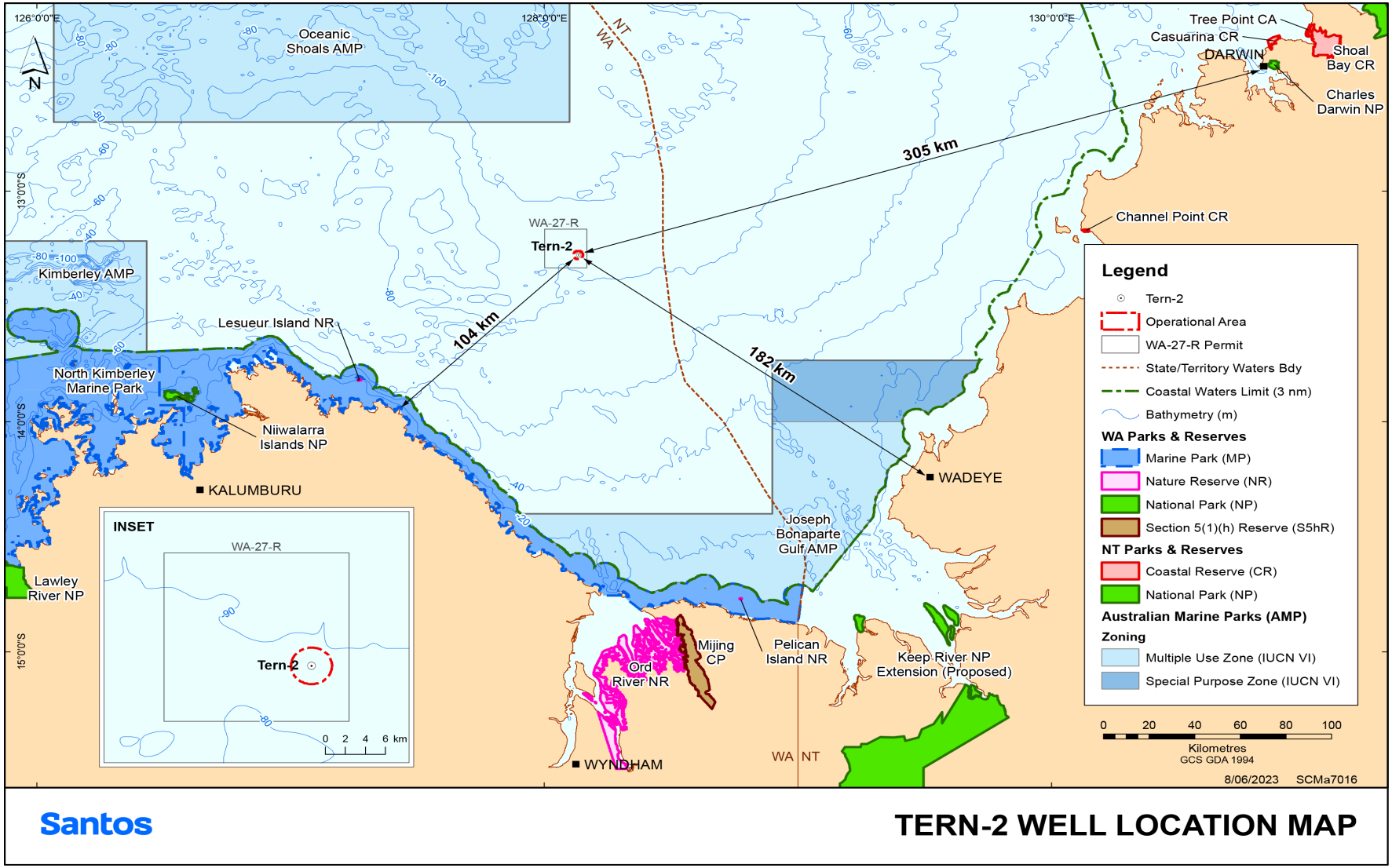
Santos

BONAPARTE BASIN CONSULTATION

TERN-2 PLUG AND ABANDONMENT



Tern-2 P&A - Location



Tern-2 P&A - Overview

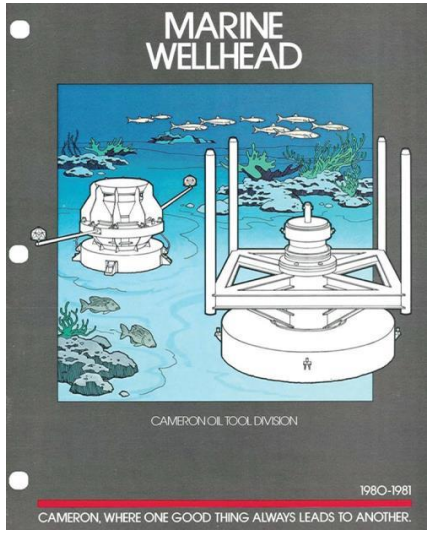
- Tern-2 is an appraisal well located within the Tern field of retention lease licence WA-27-R, approximately 300 km WSW of Darwin. The well was drilled in 1981 and 82. It was temporarily abandoned with cement barriers in January 1982.

- Key objectives of P&A activity:
  - Installing and verifying additional well barriers to supplement the existing system of well barriers.
  - Removing the wellhead and any structural evidence of the well from the seabed as best as practical to eliminate future hazards to the environment or other users of the area.

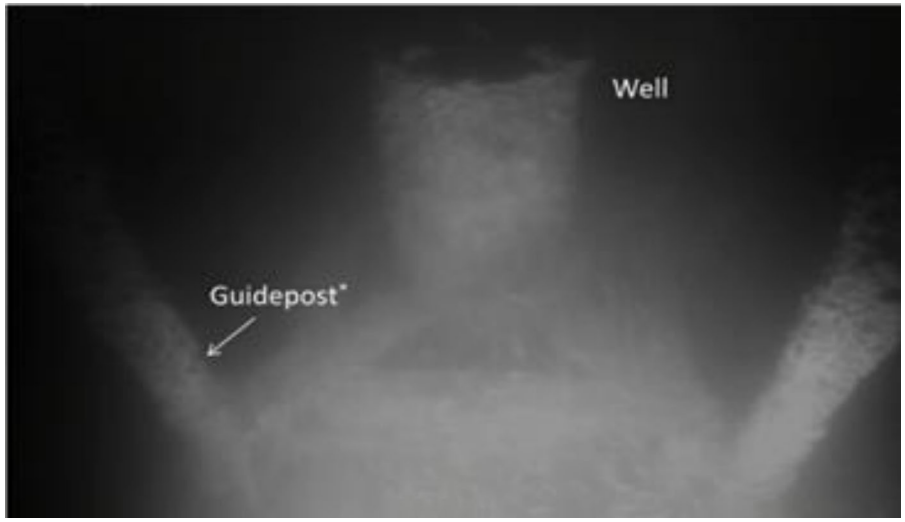
- Estimated activity duration:
  - ~10 days (Continuous operations, 24 hours per day, 7 days per week).
  - Up to 40 days in the event of unforeseen delays and poor metocean conditions.

- The Operational Area:
  - A circular area with a 2 km radius around the Tern-2 wellhead.
  - ~ 106 km from the closest shoreline
  - ~ 62 km southwest of Petrel-1 and ~ 9.8 km southeast of Tern-1 well.
  - Average water depth is ~ 83 m.

- The petroleum activities require the following vessels:
  - Light Well Intervention Vessel (LWIV)
  - Support vessel
  - Remotely Operated Vehicle (ROV)
  - Helicopters



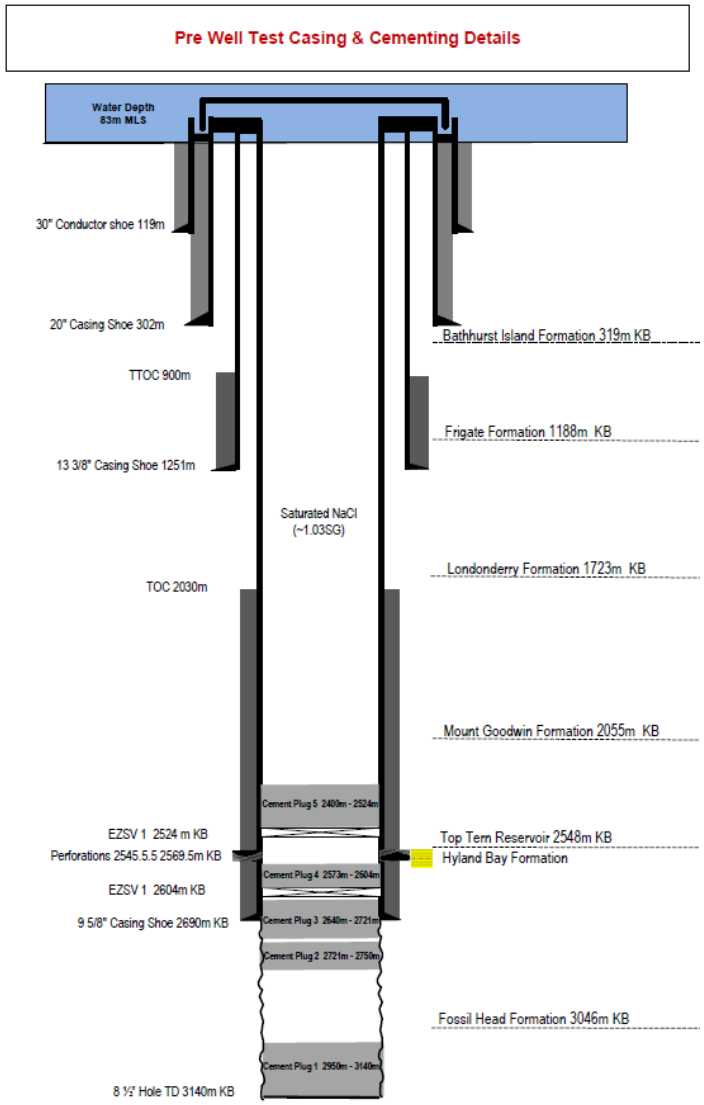
Example of the Tern-2 wellhead.



Example of wellhead at Tern-2 wellhead location.

Tern-2 P&A - Activity

- Utilising a Light Well Intervention Vessel for the following scope:
  - Clean and remove wellhead debris cap
  - Inspect and evaluate condition inside well
  - Using wireline, install additional P&A barriers into the well
  - Cut and remove wellhead
  - Contingency to place wellhead on seabed only if needed
  - Move wellhead to the vessel using ROV
  - If the wellhead is in poor condition and can't be removed it will be left on the seabed



Tern-2 wellhead schematic

Tern-2 P&A – Vessels & Vehicles

Example Light Well Intervention Vessel (LWIV)

Example Support Vessel

Example ROV

Example Helicopter

The Oil & Gas lifecycle

Santos

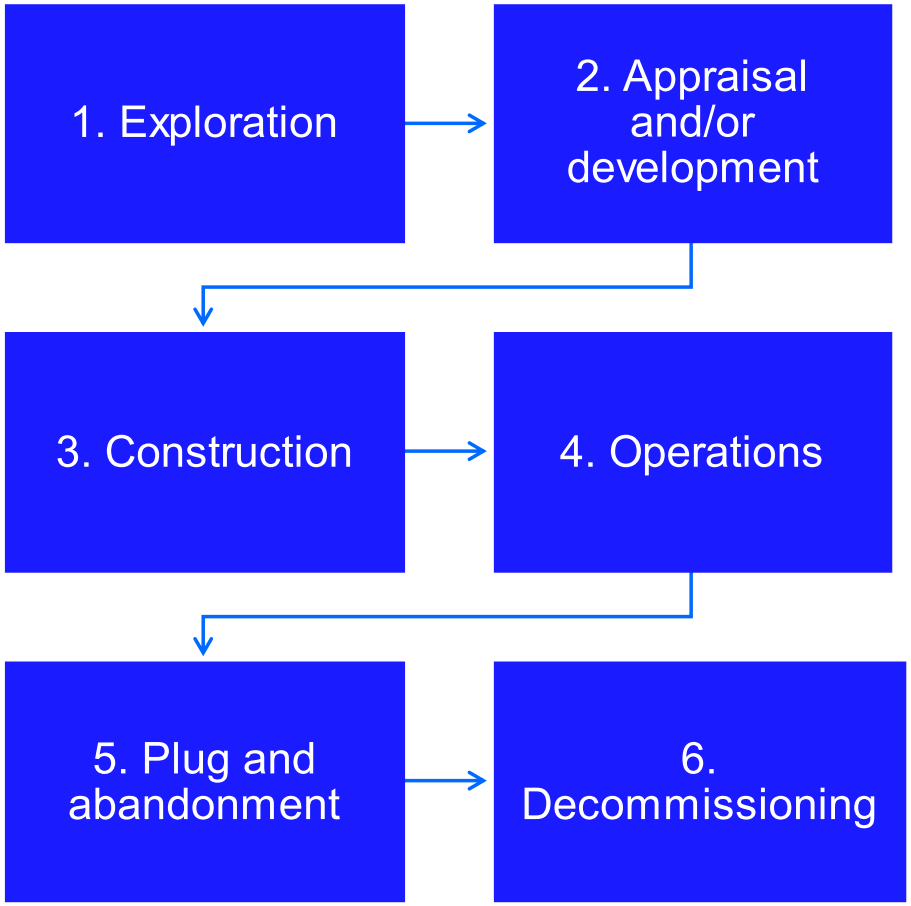
The oil & gas lifecycle involves the exploration, extraction, and use of these resources. Followed by closing the site when complete.

It starts with searching for gas deep underground using seismic surveys and drilling exploration wells, followed by the construction of infrastructure to extract and produce them.

Afterward, the products are transported to end-users.

When the resources are depleted, there's a process to close down operations and ensure environmental compliance. This is called decommissioning.

Current Santos projects are at various stages of this lifecycle.



Tern-2 P&A - Impacts

Santos

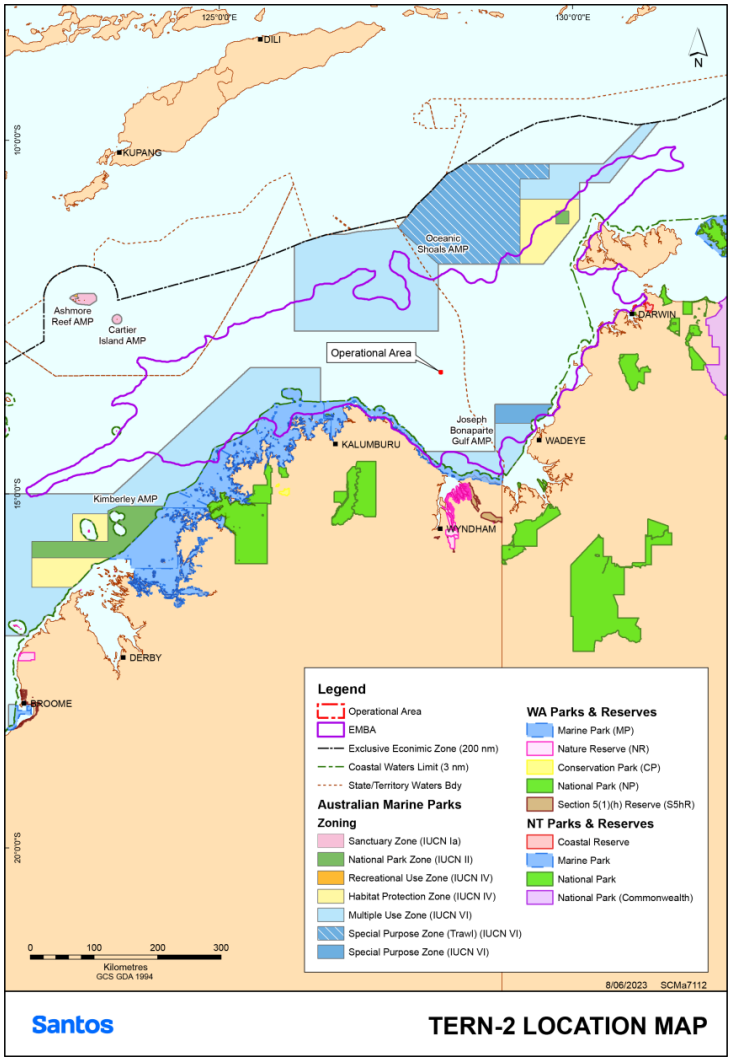
Planned events	How we manage (the rules we follow)
Disturbance to other boats	We will communicate to other boats where we are and what we are doing. We mark the location of equipment on charts.
Seabed disturbance	We are putting equipment on a flat sandy seabed. We only put equipment in the approved location.
Light disturbance	We only use lights where needed for safe operations. We turn off lights when not needed.
Noise disturbance	We look out for marine life (e.g., whales, dolphins, turtles). Noise levels are not expected to impact at population level or have a significant impact on foraging behaviours of marine turtles.
Air emissions	We ensure engines and other equipment is looked after and fuel use and waste incineration standards are maintained.
Discharges	We will reduce discharges to only those necessary for operations and we follow the standard rules for what boats can discharge.
Wellhead left on seabed	We will leave the wellhead on the seabed only if it cannot be removed easily due to technical difficulties.

Tern-2 P&A - Risks

Santos

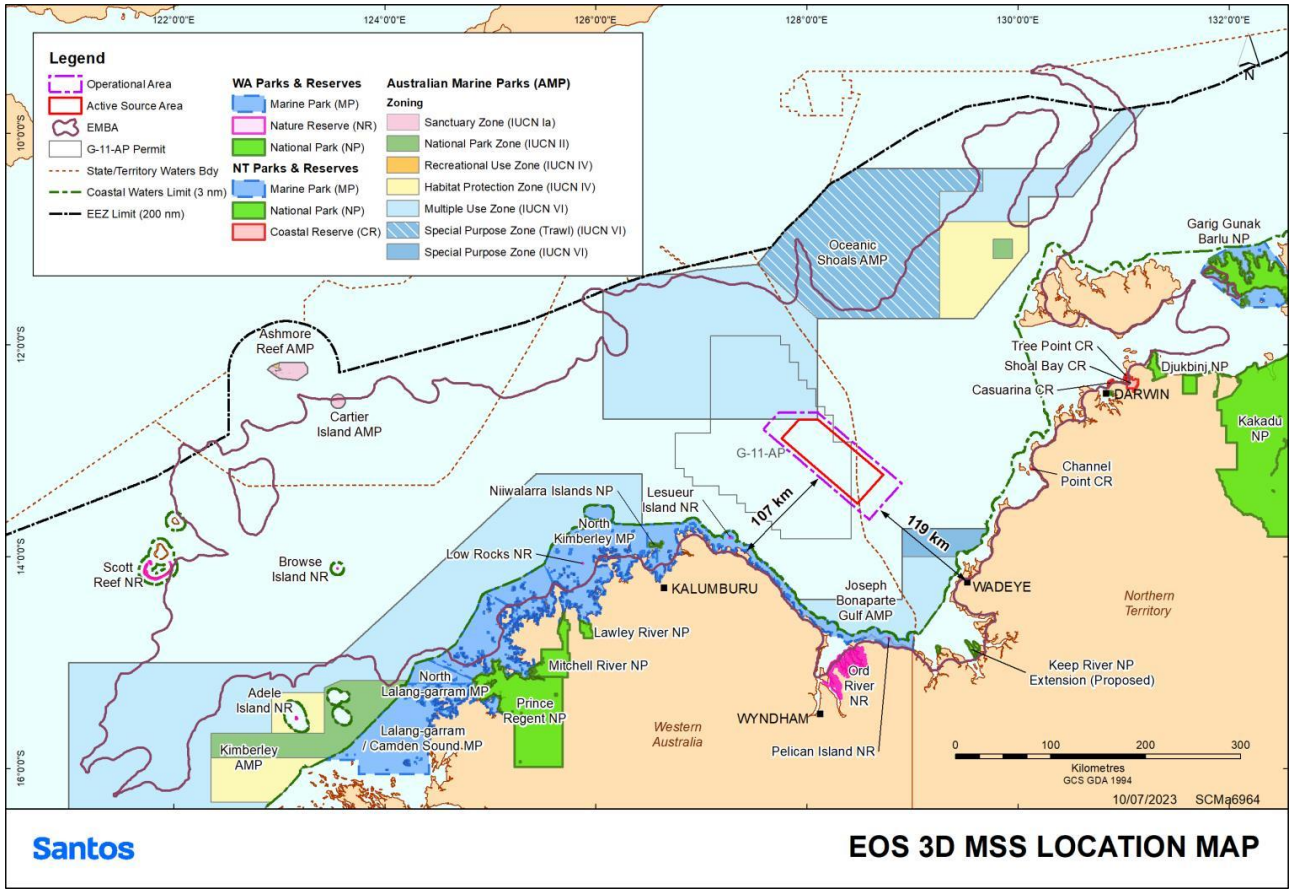
Unplanned events (Accidents)	How we manage (the rules we follow)
Diesel spill	We make sure all the boats are following the rules for preventing collisions. We let other boats know where we are and what we are doing. We will not refuel within the operational area.
Dropped objects	We follow strict procedures to stop objects dropping overboard and we pick up objects when it is safe to do so.
Disturbing marine animals	We look out for marine life (e.g., whales, dolphins, turtles) when transiting within and to and from the operational area and we slow down and move away from them where possible if they are too close.
Invasive marine life	We will use an anti-foulant system and follow strict procedures to avoid any introduction of invasive marine life.
Chemical spill	We select chemicals that are friendly to the environment where possible and store them carefully. We have procedures for using and cleaning up chemicals.
Disturbance to other boats	We let other boats know where we are and what we are doing. We will let other boats, fishing groups, and the government know if the wellhead cannot be removed and will be left on the seabed.

Spill Risk



Santos

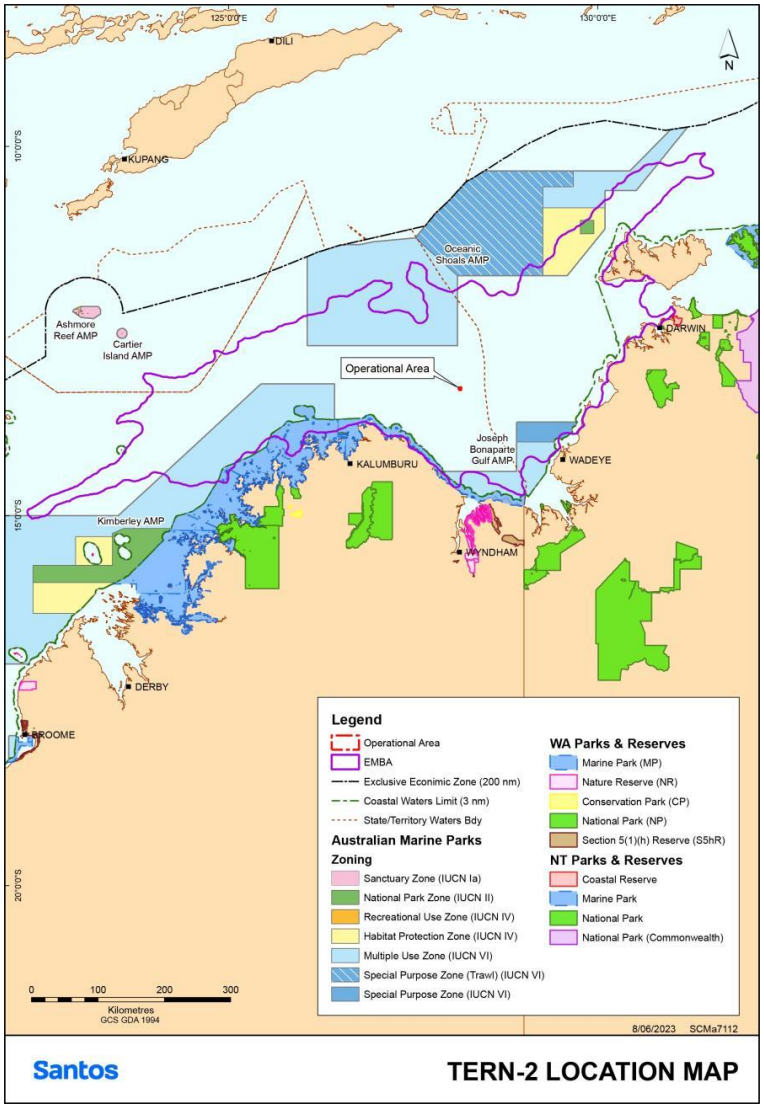
TERN-2 LOCATION MAP



Santos

EOS 3D MSS LOCATION MAP

Tern-2 P&A – Environment That May Be Affected



Feature	Public Information Review
Aboriginal Heritage	Aboriginal Heritage sites are present along the southern and eastern boundaries of the Environment That May Be Affected (EMBA).
Biologically Important Areas (BIAs)	The Operational Area includes BIAs for turtles only, the EMBA includes BIAs for dolphins, seabirds, sharks, whales and turtles.
Cultural Heritage	No known sites of shipwrecks, sunken aircraft or Aboriginal and Torres Strait Islander Underwater Cultural Heritage have been identified within the Operational Area. Within the EMBA the nearest shipwreck, the SEDCO Helen, is approximately 60 km northeast of the Operational Area located in depths of approximately 100 m .
Defence	Operational area overlaps practice and training areas that comprise the North Australian Exercise Area (NAZA) a maritime military zone administered by the Australian Defence Force, as well as restricted airspace.
Energy industry	Several offshore petroleum projects are in operation and there is exploration activity within the EMBA. The nearest platform is the ENI Blacktip Platform approximately 75 km to the southeast of the operational area.
Fishing	A number of Commonwealth, State and Territory fisheries management areas overlap the Operational Area and EMBA however, neither Commonwealth nor WA state-managed fisheries show activity within the Operational Area between 2010-2020.
	Traditional Australian Indigenous fishing activities are generally concentrated within 3 nm of the Northern Territory / Western Australian coastline.
	No interaction with recreational or charter boat fishers is anticipated given the remoteness of the Operational Area (~106 km from nearest coastline).
Key Ecological Features (KEFs)	The EMBA includes KEFs for the carbonate bank and terrace system of the Van Diemen Rise, the carbonate bank and terrace system of the Sahul Shelf, ancient coastline at 125m depth contour, continental slope Demersal Fish communities, the shelf break and slope of the Arafura Shelf, and the Pinnacles of the Bonaparte Basin.
Protected Areas (nearest Commonwealth and Territory)	In Commonwealth Waters the EMBA overlaps with the Oceanic Shoals Marine Park, Joseph Bonaparte Gulf AMP and the Kimberley AMP. The closest being the Oceanic Shoals AMP which is approximately 63 km north of the Operational Area.
	The North Kimberley State Marine Park is approximately 182 km west from the Operational Area and overlaps with the EMBA.
Shipping	The Operational Area does not overlap any shipping fairways, though is adjacent to vessel traffic. Vessel traffic from Wyndham may be present within the EMBA at periods of the year.
Telecommunications	The North West Cable System (NWCS) connects offshore oil and gas facilities in the Browse, Bonaparte and Carnarvon Basins to onshore locations and is approximately 140 km north-north-east of the Operational Area.
Tourism	Remoteness of the Operational Area and water depth limits opportunities for tourism. Tourism is likely within the EMBA.
Towns/Communities	Darwin is the nearest capital city and is approximately 300 km northeast from the Operational Area.

Eos 3D MSS - Activity

- The process of collecting seismic data is known as ‘acquisition’.
- Marine seismic surveys are carried out by specialised vessels that tow an array of acoustic sources (airguns) and receivers (hydrophones) across a defined acquisition area.
- The seismic survey vessel will tow a seismic source array (up to 3,500 in3) and up to 12 streamers, approximately 113 m apart, and will travel back and forth across the survey area in a “race track” pattern, lines separated by approximately 500-700m within an overall acquisition area.
- The streamer array will be approximately 8 km long and positioned 10 – 30 m below the ocean surface.
- Airguns work by rapidly releasing compressed air to form a bubble, which creates a pulse of sound. This sound energy is directed at the seafloor and penetrates into the various rock layers beneath.
- The reflected soundwaves are then captured by hydrophone receivers, which are towed behind the vessel on a series of cables known as 'streamers'.
- Support vessels will be on standby, one support vessel will be present at all times.
- 3 nm exclusion zone requested.
- Auscoast warning and/or Notice to Mariners will be issued prior to the start of the activity.
- The seismic survey vessel will display appropriate day shapes and lights to indicate it is under tow and is therefore restricted in it’s ability to manoeuvre, and the streamers will tow surface tail buoys fitted with radar reflectors.
- A visual and radar watch will be maintained on the bridge at all times.

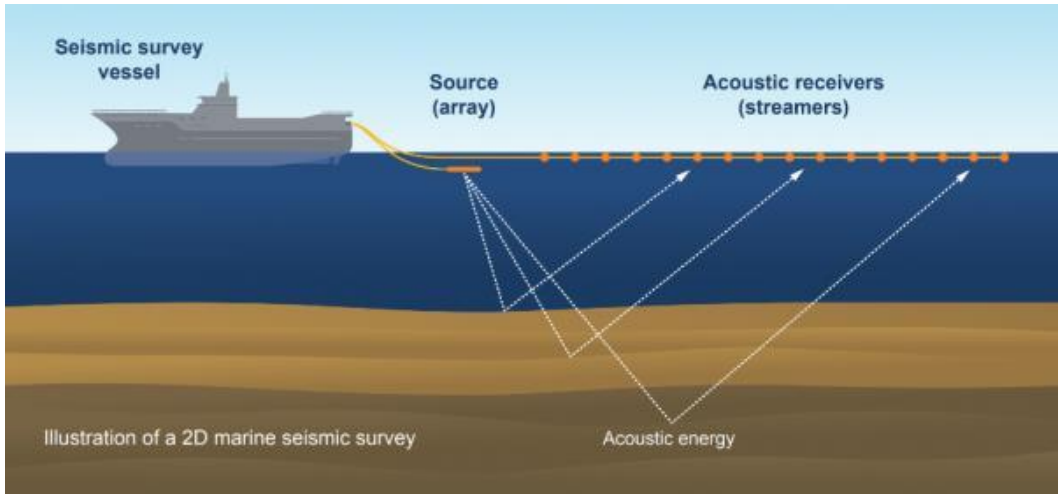
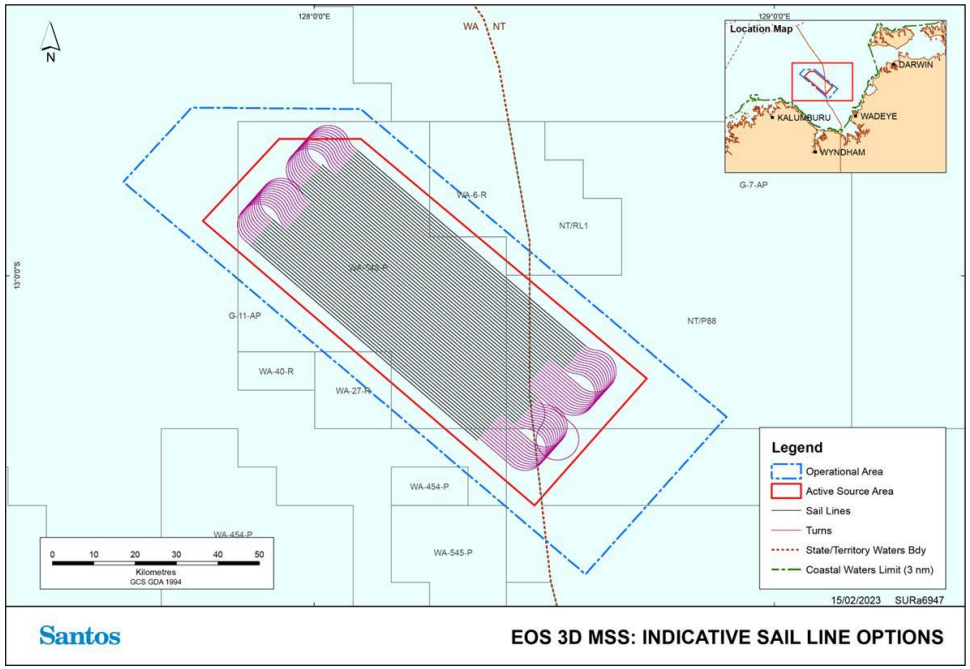


Diagram of a marine seismic survey (Source: NOPSEMA).



Eos 3D MSS – Environment That May Be Affected

Feature	Public Information Review
Aboriginal Heritage	Aboriginal Heritage sites are present along the coastline along the southern boundary of the EMBA.
Biologically Important Areas (BIAs)	The Operational Area includes BIAs for turtles.
Cultural Heritage	No known sites of shipwrecks, sunken aircraft or Aboriginal and Torres Strait Islander Underwater Cultural Heritage have been identified within the Operational Area. The nearest shipwreck, the SEDCO Helen, is approximately 11 km northeast of the Operational Area.
Defence	Operational area overlaps practice and training areas that comprise the North Australian Exercise Area (NAZA) a maritime military zone administered by the Australian Defence Force, as well as restricted airspace.
Energy Industry	Petroleum exploration and production activities have been undertaken within the EMBA and the Bonaparte Basin is an established hydrocarbon province with a number of commercial operations. Several exploration permits overlap the Operational Area with the closest production licence being the Eni Australia B.V. located 21 km south of the Operational Area.
Fishing	Five Commonwealth, thirteen Western Australia and ten Northern Territory fisheries overlap the EMBA, some of which are active in the Operational Area.
	Traditional Australian Indigenous fishing activities are generally concentrated within 3 nm of the Northern Territory / Weste rn Australian coastline.
	Fishing charter vessels may transit through the Operational Area and EMBA. Northern Prawn Fishery (NPF) fishing season (within the NPF licence area) is annually from August to November.
Key Ecological Features (KEFs)	The Operational Area overlaps one KEF for the Carbonate Bank and Terrace System of the Sahul Shelf.
Protected Areas (nearest Commonwealth and Territory)	The Operational Area overlaps the Oceanic Shoals Marine Park and four additional Australian Marine Parks overlap the EMBA. .
	Eighteen state/territory marine parks overlap the EMBA with the closest being the North Kimberley Marine Park located approximately 100 km south-west of the Operational Area.
Shipping	The Operational Area does not overlap any shipping fairways, however there is vessel traffic that passes through the northern end of the Operational Area. High vessel traffic to be expected from largest exporter of cattle out of Wyndham during Q3.
Telecommunications	The North West Cable System (NWCS) connects offshore oil and gas facilities in the Browse, Bonaparte and Carnarvon Basins to onshore locations and is approximately 125 km north-north- east of the Operational Area.
Tourism	Remoteness of the Operational Area and water depth limits opportunities for tourism. Tourism is likely within the EMBA.
Towns/Communities	Darwin is the nearest capital city and is approximately 230 km northeast from the Operational Area.
	Wadeye is the nearest community and is approximately 119 km southeast from the Operational Area.

Eos 3D MSS - Activity

- The process of collecting seismic data is known as ‘acquisition’.
- Marine seismic surveys are carried out by specialised vessels that tow an array of acoustic sources (airguns) and receivers (hydrophones) across a defined acquisition area.
- The seismic survey vessel will tow a seismic source array (up to 3,500 in3) and up to 12 streamers, approximately 113 m apart, and will travel back and forth across the survey area in a “race track” pattern, lines separated by approximately 500-700m within an overall acquisition area.
- The streamer array will be approximately 8 km long and positioned 10 – 30 m below the ocean surface.
- Airguns work by rapidly releasing compressed air to form a bubble, which creates a pulse of sound. This sound energy is directed at the seafloor and penetrates into the various rock layers beneath.
- The reflected soundwaves are then captured by hydrophone receivers, which are towed behind the vessel on a series of cables known as 'streamers'.
- Support vessels will be on standby, one support vessel will be present at all times.
- 3 nm exclusion zone requested.
- Auscoast warning and/or Notice to Mariners will be issued prior to the start of the activity.
- The seismic survey vessel will display appropriate day shapes and lights to indicate it is under tow and is therefore restricted in it’s ability to manoeuvre, and the streamers will tow surface tail buoys fitted with radar reflectors.
- A visual and radar watch will be maintained on the bridge at all times.

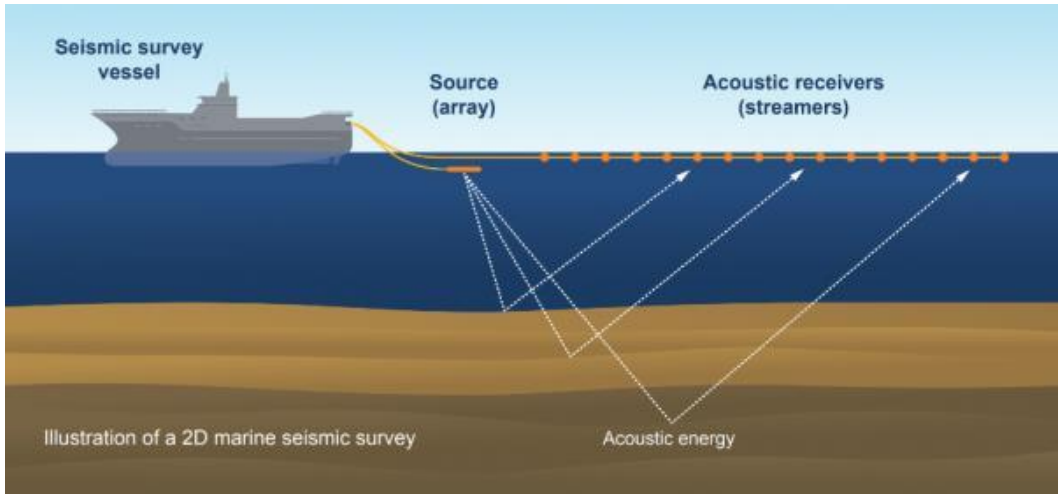
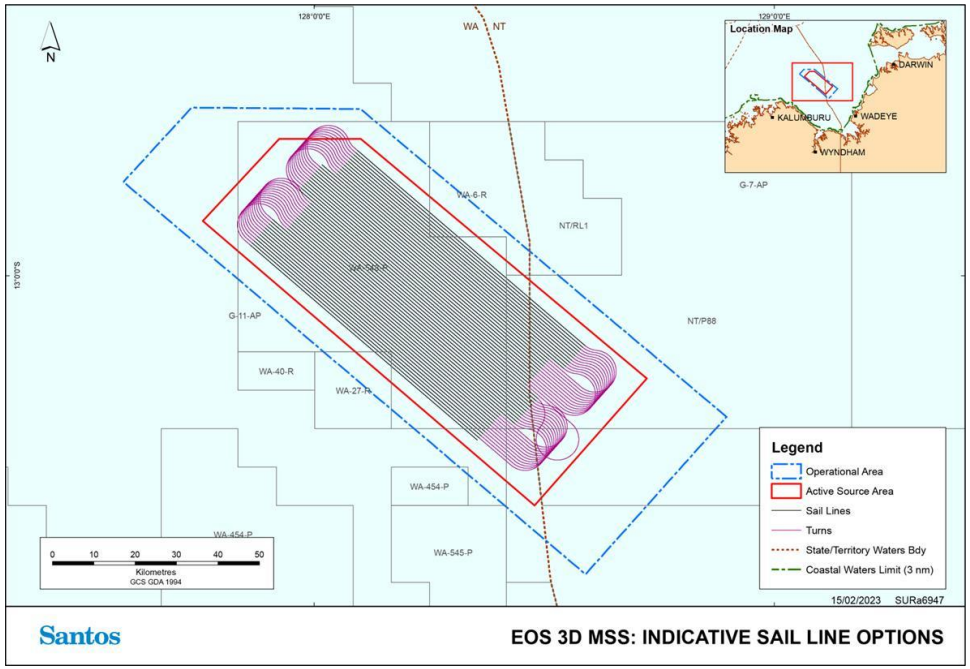


Diagram of a marine seismic survey (Source: NOPSEMA).



Eos 3D MSS – Commercial Fishers

Co-existence approach

- Minimise the extent of interruption by the seismic survey activities on commercial fishing operators' activities to the lowest practicable level.
- Mitigate the effects of the interruptions.
- Apply an equitable 'commercial fishers payment claim protocol'.

Commercial fishers payment claim protocol

- The survey will potentially impact commercial fishers whose fishing operations overlap with the seismic survey.
- Santos has a process to enable commercial fishers to lodge evidence-based payment claims for temporary loss of fish catch, displacement costs and equipment damage or loss directly caused by the seismic survey.
- Santos will also assess requests for administrative support to help fishers collate historical fishing data required for an evidence-based payment claim.
- The control measures identified within the draft Environment Plan, to outline how the potentially competing demands of commercial fishing operators and Santos' seismic survey may be managed, are consistent with those adopted for other Santos marine seismic surveys.

Commercial prawn and indicator fish species spawning	J	F	M	A	M	J	J	A	S	O	N	D	Source
Banana prawn spawning													AFMA 2020
Juvenile banana prawn migration													Longeran et al. 2002
Brown tiger prawn spawning													AFMA 2020
Grooved tiger prawn spawning													AFMA 2020
Blue endeavour prawn spawning													AFMA 2020
Red endeavour prawn spawning													AFMA 2020
Red emperor													DPIRD 2019
Goldband snapper													DPIRD 2019
Spanish mackerel (Kimberley stock)													DPIRD 2019

Key

Sensitivity/activity occurs

Extended peak spawning period

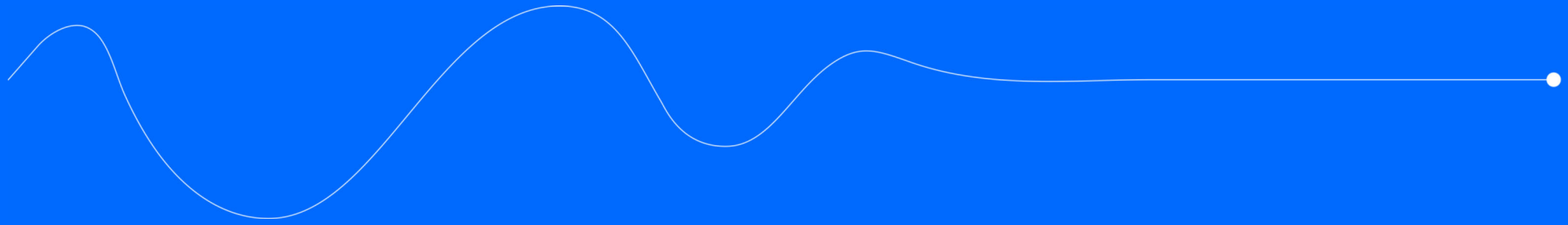
Peak spawning/migration period

*Extended peak spawning period – applies only to Goldband Snapper and Spanish Mackerel

NT & WA 11A Consultation_2023_Four EPs_Wadeye

Santos

NORTHERN TERRITORY & WESTERN AUSTRALIA PROJECT CONSULTATION SESSION



WA & NT Environment Plan Consultation

Presented by **Santos Team**

Santos

Privacy Statement

Santos Ltd and its related bodies corporate (together, we, our, us or Santos) collect personal information about you, such as your name and sensitive information about your indigenous heritage. We use this information to record your attendance at any meeting or other discussion with us, to provide you with information about our projects, to receive and respond to any information that you provide, to answer any questions you might have and for other purposes that we tell you about during your meeting or other discussion with us. Santos will handle any information that you provide in accordance with our Code of Conduct and our Confidentiality, IP and Privacy Procedure. You can ask us for a copy of this Privacy Notice or these other documents.

If you do not provide your personal information, we may not be able to identify you as the person who provided information, or we may be unable to discuss any information you have provided with you further or respond to your questions. We may disclose your information to other companies within the Santos group, to third parties that help us run our business and to relevant government agencies and government departments.

Due to the global nature of our operations and business, your personal information may be accessed by or disclosed to Santos personnel outside Australia. We may also use overseas third parties to collect, transfer, store and handle your personal information. Some of the overseas countries that your personal information may be accessed from, disclosed or transmitted to or stored in include but are not limited to, Papua New Guinea and the United States of America.

You have a right to request a copy of any personal information that we hold about you, as well as a right to request that we correct any information that we hold about you that is inaccurate, out-of-date, incomplete, irrelevant or misleading. You can also make a complaint about how we have handled your personal information. Our Consultation Privacy Policies explain in more detail how you can exercise these rights, including how we will respond to your access or correction request or to any privacy complaint that you make. The Barossa Gas Project Consultation Privacy Policy is available on our website at **www.santos.com/barossa/barossa-gas-project-consultation-privacy-policy**, and the Western Australia and Northern Territory Consultation Privacy Policy is available on our website at **https://www.santos.com/offshore-wa-and-nt-consultation-privacy-policy/.** You can also contact us to request copies be provided to you.

You can contact us by:

- posting a letter addressed to us at 60 Flinders Street, Adelaide, South Australia, 5000;
- telephoning us on +61 8 8116 5000; or
- sending us an email at offshore.consultation@santos.com and compliance@santos.com.

Santos

Acknowledgement of Country

Santos acknowledges the Traditional Owners of the land on which we meet today.

We pay our respects to Elders past, present and emerging.

Santos

Welcome & Introductions

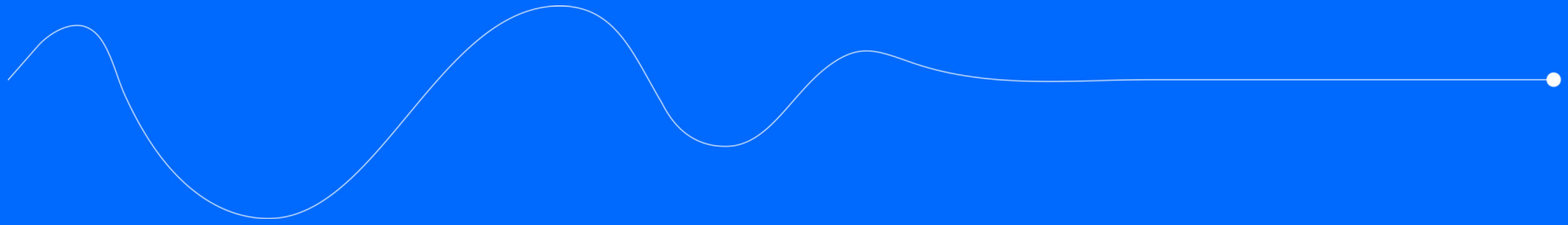
We are here today to share information about our company & operations and to listen to your questions about Santos & upcoming projects.

Peter Kirkpatrick *– General Manager, Darwin*

Michael Marren *– Barossa Consultation Advisor*

Santos

SANTOS OPERATIONS & DARWIN LNG



WA & NT Environment Plan Consultation

Presented by **Barossa Team**

SANTOS - South Australia, Northern Territory Oil Search

Santos is a global energy company committed to increasingly cleaner energy and fuels production, with operations across Australia, Papua New Guinea, Timor-Leste and North America (Alaska).

At Santos, our commitment is to be a global leader in the transition to cleaner energy and clean fuels, by helping the world decarbonise to reach net-zero emissions in an affordable and sustainable way.

For more than 65 years, Santos has been working in partnership with local communities, providing local jobs and business opportunities, safely developing its natural gas resources, and powering industries and households.

Santos is one of Australia's biggest domestic gas suppliers and a leading LNG supplier in the Asia Pacific region.

We are committed to supplying critical fuels such as oil and gas in a more sustainable way through decarbonising projects, including the Moomba CCS Project, while we all transition to cleaner fuels.

Our business focus: Safe, reliable operations & Minimise our social and environmental impacts.

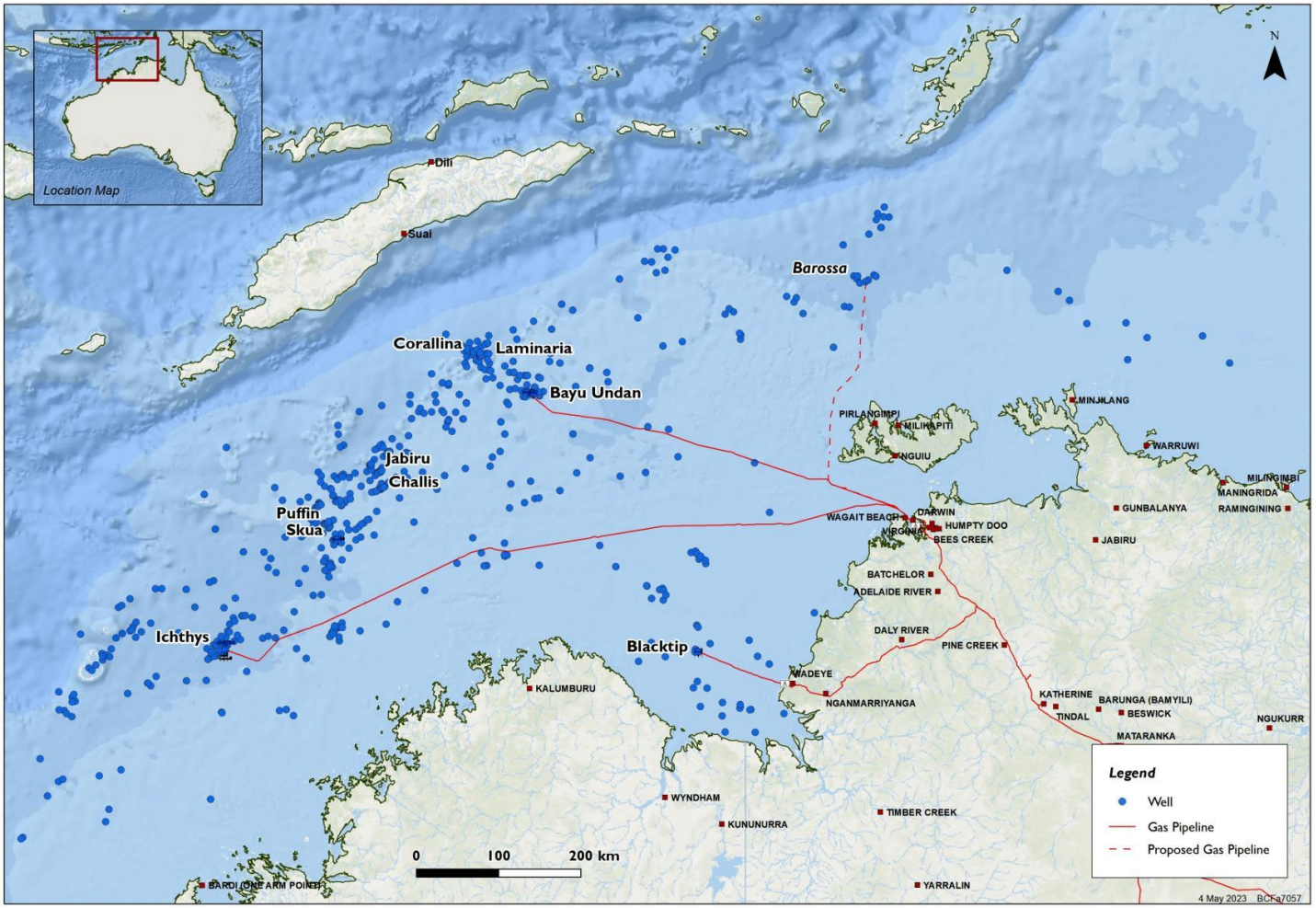
Darwin LNG Facility & Operations

Santos

- Located in Darwin at Wickham Point Darwin LNG (DLNG) is a single train liquefaction and storage facility that started production in 2006.
- The Bayu-Undan facility, which supplies gas to DLNG via 26-inch subsea pipeline, is located approximately 500 kilometers north-west of Darwin in the Timor Sea.
- The facility includes a central production Storage and Offloading vessel for condensate and LPG products and an unmanned wellhead platform.
- Approx 140 local Darwin people work at the LNG Facility.
- 100% Darwin residential Santos employee workforce.
- DLNG established the NT's first LNG Process Operator Traineeships in 2010.
  - ~10% of those who have completed identified as an Aboriginal or Torres Strait Islander.

Wells Oil & Gas Drilled by All Industry Since 1969

Santos



These are not all Santos owned and operated.

This map shows all wells drilled in the NT area.

Not all of these wells are used. Many are capped.

Santos

Barossa Gas Project - Overview

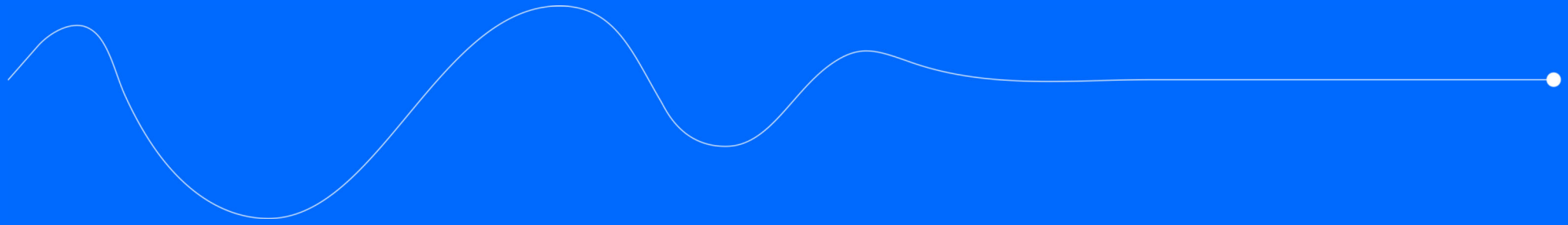
- The Santos-operated Barossa Gas Project is an offshore gas and condensate project that proposes to provide a new source of gas to the existing Darwin liquified natural gas (DLNG) facility in Darwin.
- The Barossa gas field is approximately 285 kilometres offshore north-north west from Darwin.
- Natural gas would be extracted from the Barossa field and transported via a gas pipeline (Gas Export Pipeline (GEP) and Darwin Pipeline Duplication (DPD)) to the existing DLNG facility.
- Project infrastructure would comprise a Floating Production Storage and Offloading (FPSO) facility, a subsea production system, supporting in-field subsea infrastructure, the GEP and the DPD.
- Up to eight subsea wells are planned to be drilled in the Barossa field (six wells from three drill centres, with contingency plans for an additional two wells). Gas and condensate would be gathered from the wells through the subsea production system and then brought to the FPSO facility via a network of subsea infrastructure.
- Initial processing would occur at the FPSO facility, to separate the natural gas, water and condensate extracted from the Barossa field. The dry natural gas would be transported through the gas pipeline for onshore processing at the DLNG facility. Condensate would be transferred from the FPSO to specialised tankers for export.

Santos

Barossa Gas Project Overview Video

Santos

ENGAGEMENT & CONSULTATION EXPLAINED



Consultation for Environment Plans

Commonwealth waters – National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA)

"In the course of preparing an Environment Plan, a titleholder must consult with relevant persons in accordance with Division 2.2A, Regulation 11A…

"The purpose of consultation under regulation 11A of the Environment Regulations is to ensure that authorities, persons or organisations that are potentially affected by activities are consulted and their input considered in the development of environment plans."

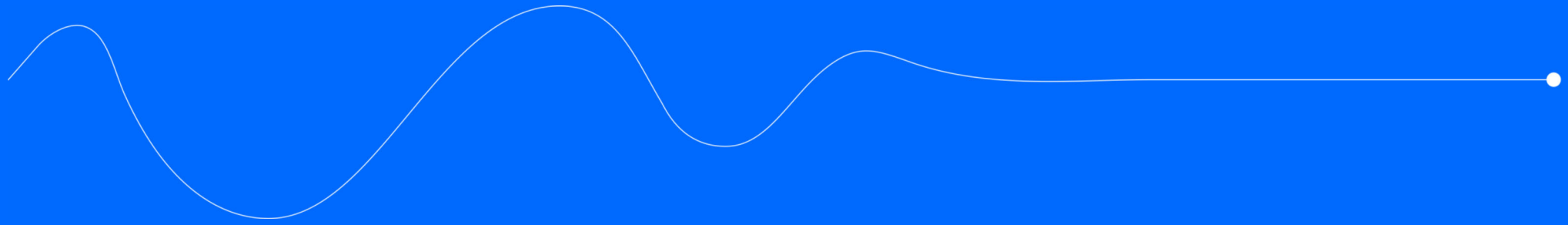
Guideline - Consultation in the course of preparing an environment plan, NOPSEMA

NOPSEMA

Information provided by relevant persons in consultation may also help titleholders **better understand the values and sensitivities of the environment** and inform the evaluation of the **potential impacts and risks** associated with the activity and **how to manage them** appropriately

Santos

BAROSSA GAS PROJECT & DARWIN PIPELINE DUPLICATION ENVIRONMENT PLAN CONSULTATION

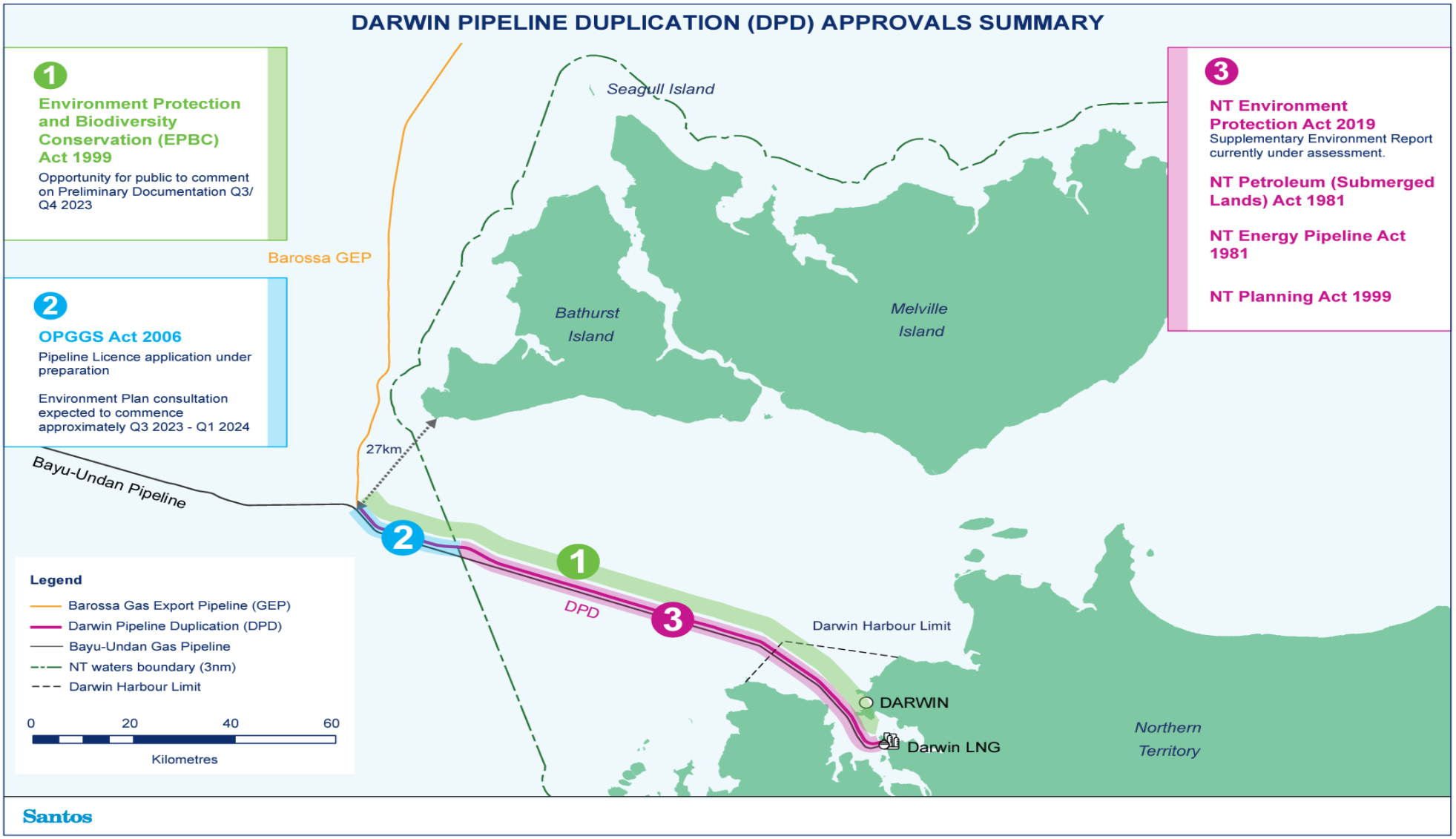


WA & NT Environment Plan Consultation

Presented by **Barossa Team**

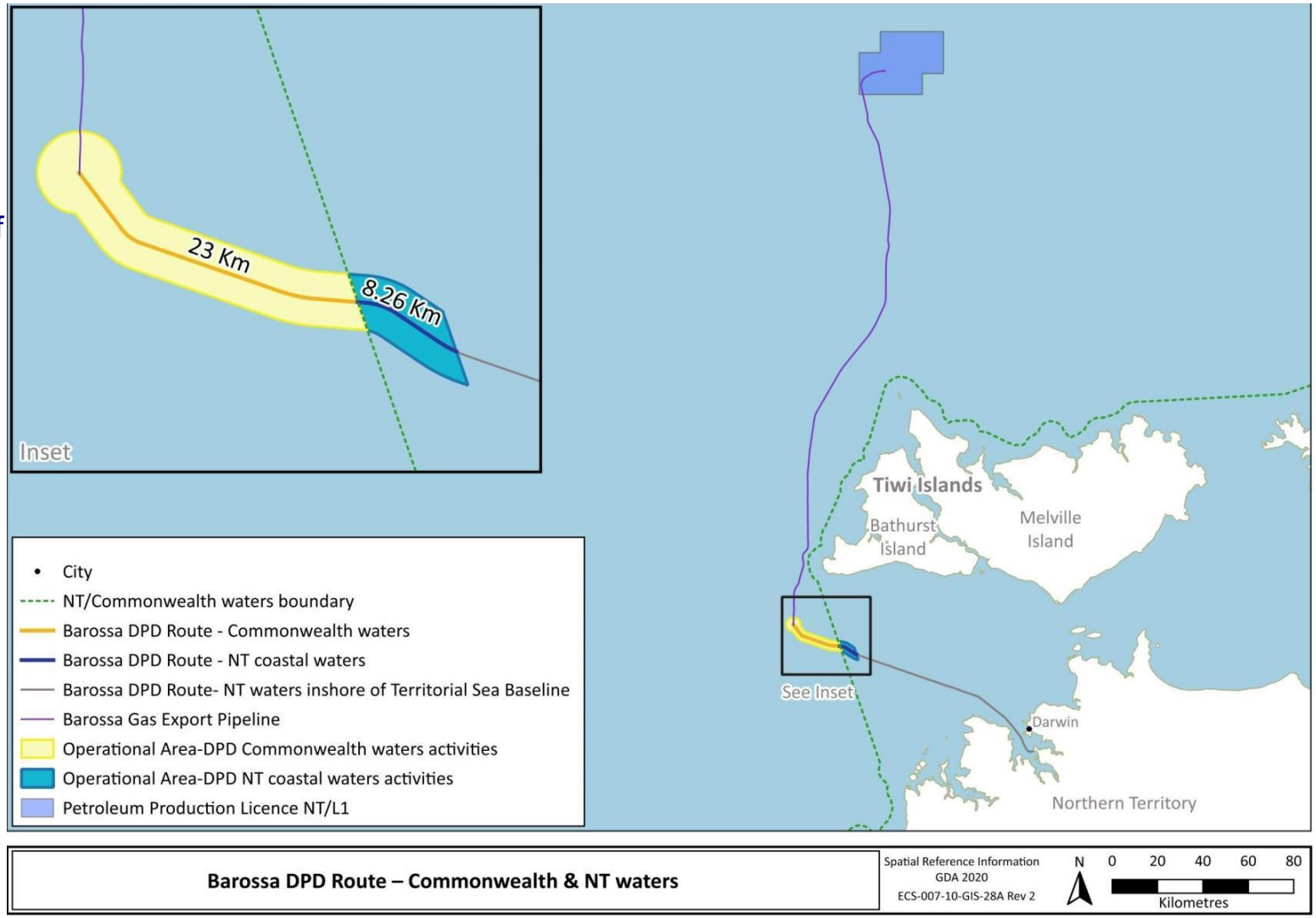
DPD Approvals

Santos



Darwin Pipeline Duplication (DPD) - Overview Santos

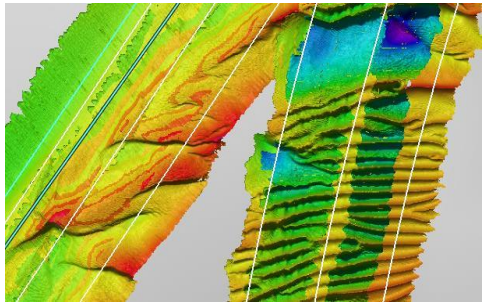
- The DPD will connect to the Barossa gas export pipeline and will send gas to Darwin.
- The pipeline will run from approximately 27km south-west of the Tiwi Islands to the gas plant in Darwin Harbour.
- Activities consist of acoustic positioning, survey, pipeline and structure installation, pipeline testing, refuelling, connecting the DPD to the Barossa gas export pipeline and unplanned maintenance/repairs.
- DPD activities are currently planned to start between Q3 of 2024 and Q2 of 2025, depending on availability of vessels and equipment, and should last 3 months)



Key DPD Installation Steps

Santos

Pre-lay Survey



Pre-lay Span Correction

Concrete mattresses are installed to support the pipeline where the seabed is rough.

Pipelay and Survey

Approximately 31km of pipeline is installed in Commonwealth and coastal waters by a pipelay vessel. Survey and post lay span correction, if required, is performed as pipelay progresses.

Pipeline Testing

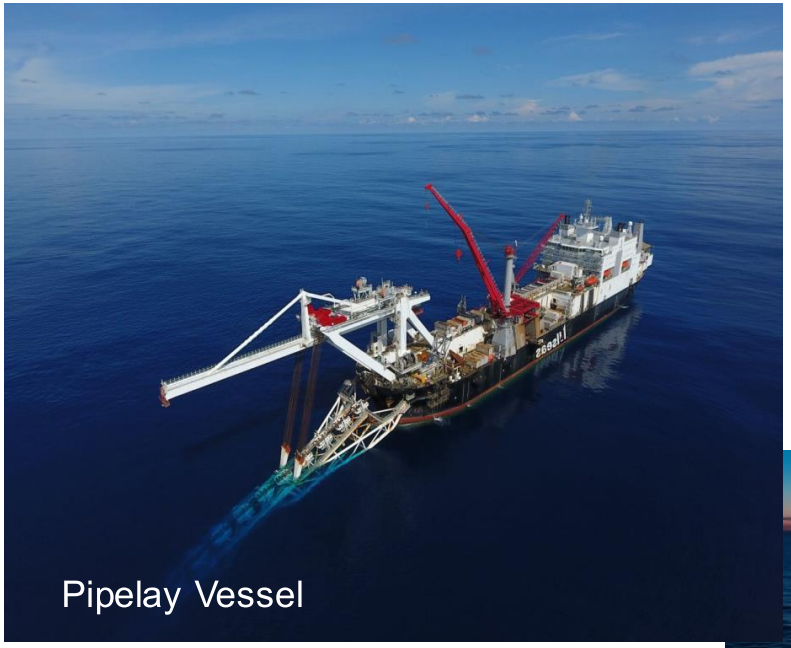
The DPD will be flooded with treated seawater and leak tested before the water is removed and the DPD is prepared for introduction of gas.

Connect DPD to the Gas Export Pipeline and Test

A spool shall be installed connecting the offshore gas export pipeline to the DPD. Once installed the spool will be leak tested.

DPD Installation Activities – Key Vessels

Santos



Pipelay Vessel

Survey and Construction Support Vessel

Supply Vessel

Santos

DPD impacts (things we know will happen)

Planned events	Expected Impact	How we manage (the rules we follow)
Light disturbance	Behavioural impact to marine life (e.g. attraction)	We only use lights where needed for safe operations and to comply with relevant safety rules. We turn off lights when not required.
Noise disturbance	Behavioural impact to marine life (e.g. avoidance)	We follow procedures and look out for marine life (e.g., whales, dolphins, turtles) and we slow down and move away from them where possible if they are too close. Boats and equipment will be maintained to minimise noise.
Seabed disturbance	Turbidity, smothering of habitat	We are putting equipment on a mainly flat sandy seabed close to an existing pipeline. We record the position of installed equipment so we can collect it at a later date.
Discharges (boat discharges, pipeline testing)	Impact to water quality	We will manage discharges to acceptable levels and follow the standard rules for what boats can discharge. We will select water treatment chemicals that are environmentally acceptable, and we will limit its use.
Air emissions	Impact to air quality, greenhouse gas emissions	We ensure engines and other equipment are looked after and low emission fuel will be used.
Disturbance to other boats	Exclude other users from activity area	We will communicate to other boats where we are and what we are doing. We mark the location of equipment on charts.

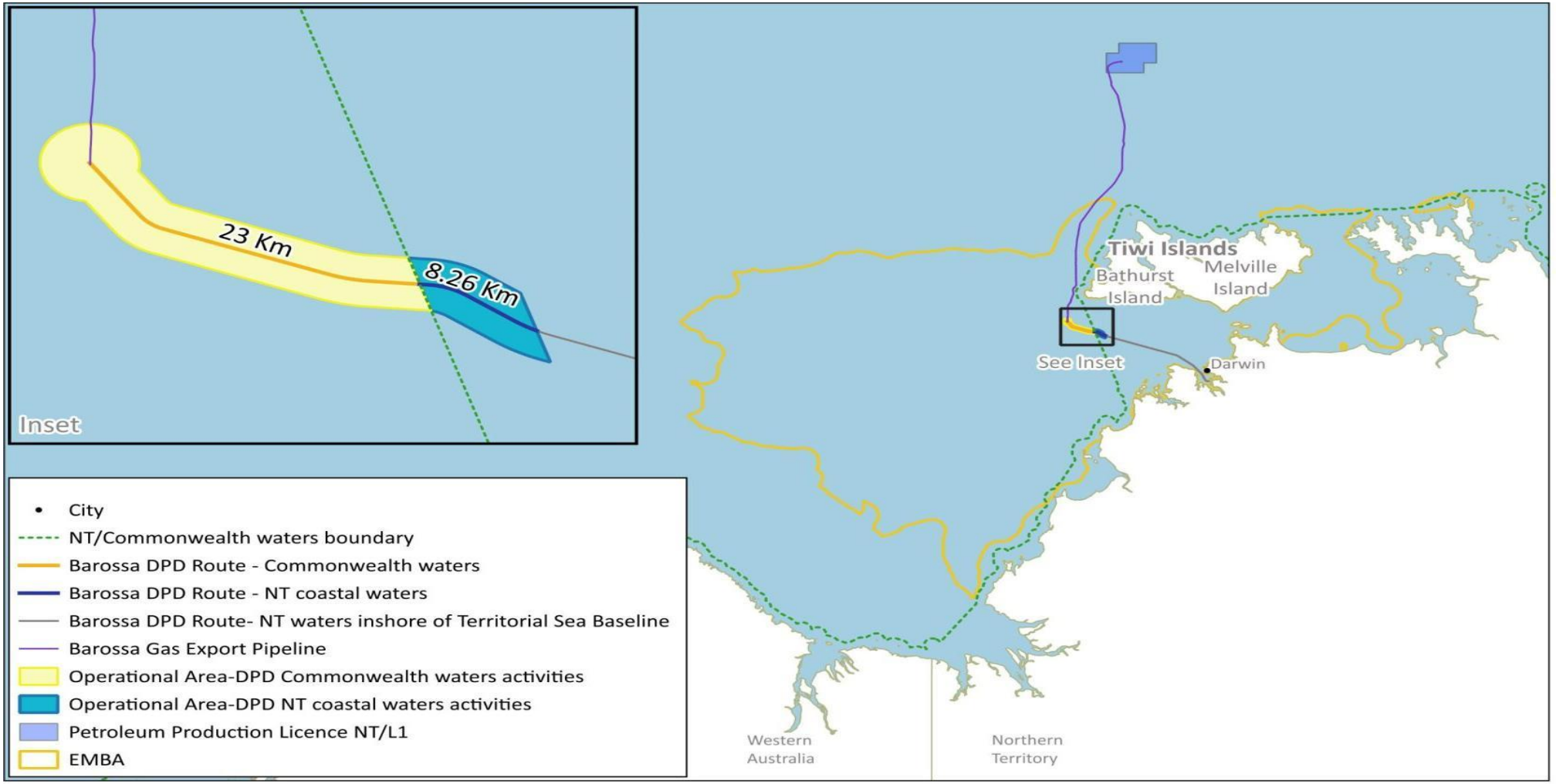
Santos

DPD risks (things we don't expect to happen)

Unplanned events (Accidents)	Unplanned Impact	How we manage (the rules we follow)
Dropped objects	Impacts to water quality, disturbance to seabed and marine life	We follow strict procedures to stop objects dropping overboard and we pick up objects when it is safe to do so.
Disturbing marine animals	Disturbance (e.g. collisions) with marine life	We look out for marine life (e.g., whales, dolphins, turtles) and we slow down and move away from them where possible if they are too close. We follow rules that outline how we need to interact with
Invasive marine life	Impacts to other marine life and industry	We inspect the boats to ensure no invasive marine life before they arrive. We have plans and equipment in place on boats to prevent invasive marine species. The Federal government has strict rules we need to follow.
Chemical spill	Water quality impacts	We select chemicals that are friendly to the environment where possible and store them carefully. We have procedures for using and cleaning up chemicals.
Gas release (dry gas or nitrogen) - Bayu-Undan pipeline	Marine life impacts, other user impacts	We follow strict rules for lifting to prevent dropped objects. We have procedures in place to minimise loss of gas from Bayu-Undan pipeline.
Diesel spill	Water quality, impacts to habitats and marine life, protected areas, socio-economic and cultural values	We make sure all the boats are following the rules for preventing collisions. We let other boats know where we are and what we are doing. We follow strict procedures for refueling. We have plans and arranegments in place for responding to spills.

DPD Environment That May Be Affected – Diesel spill

Santos



Barossa DPD Route and EMBA in Commonwealth & NT waters

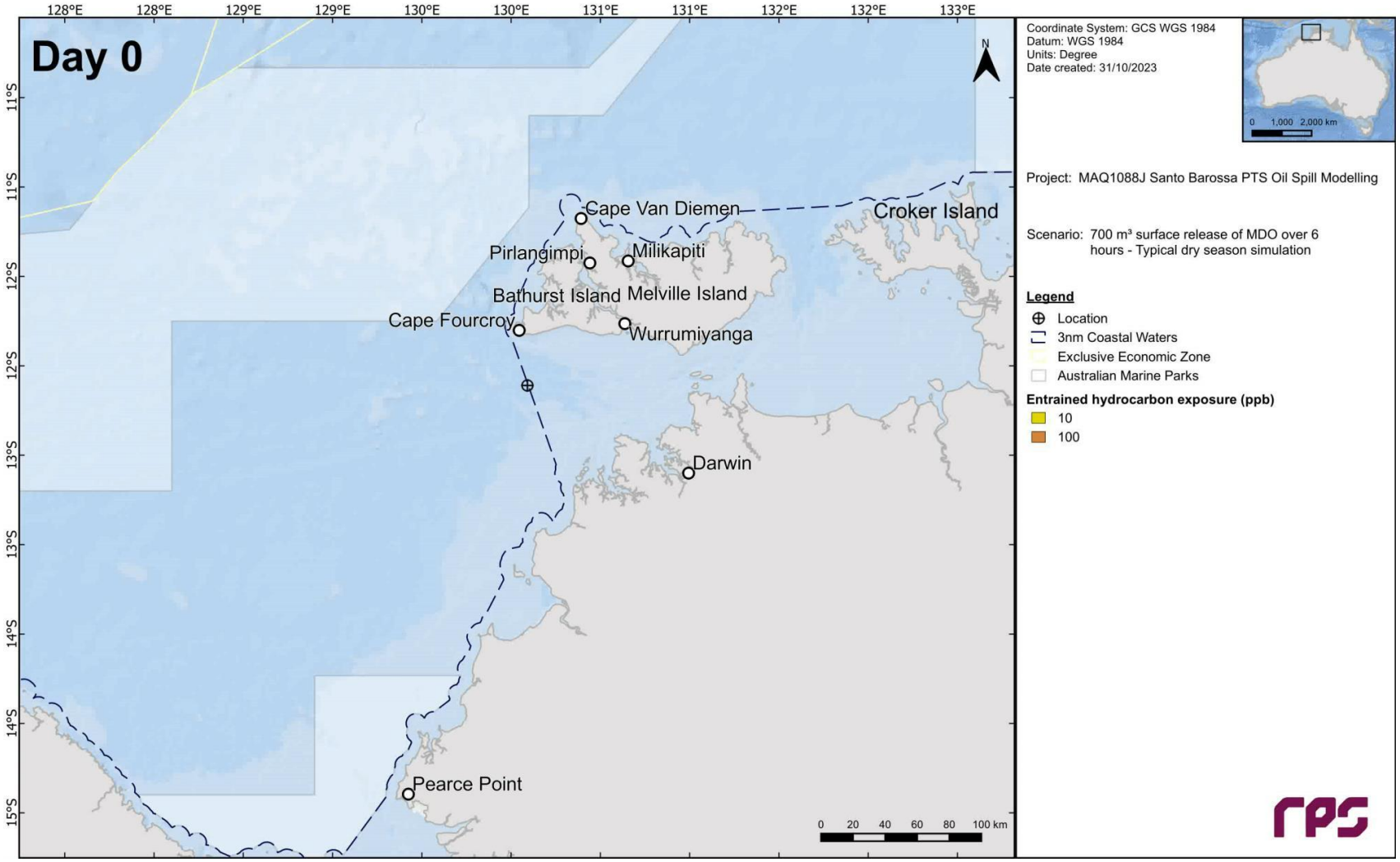
Spatial Reference Information
GDA 2020
ECS-007-10-GIS-28B Rev 2

N

0 40 80 120 160
Kilometres

DPD Diesel Spill Animation – typical dry season simulation

Santos



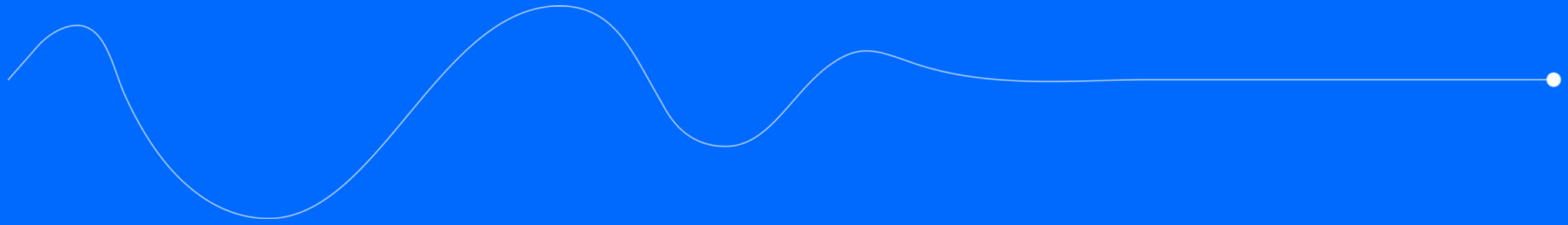
Santos

DPD QUESTIONS?

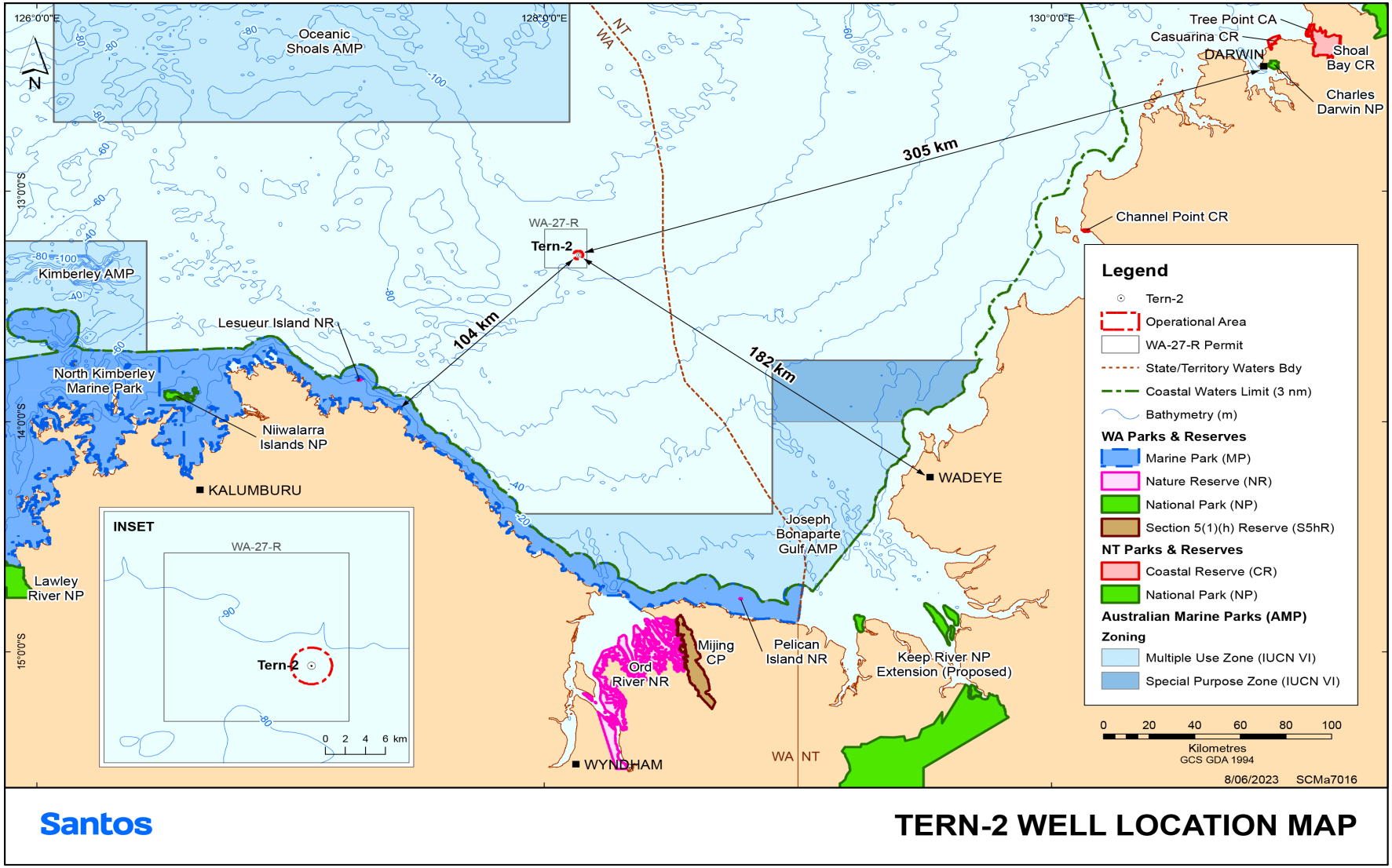
Santos

BONAPARTE BASIN CONSULTATION

TERN-2 PLUG AND ABANDONMENT



Tern-2 P&A - Location



Tern-2 P&A - Overview

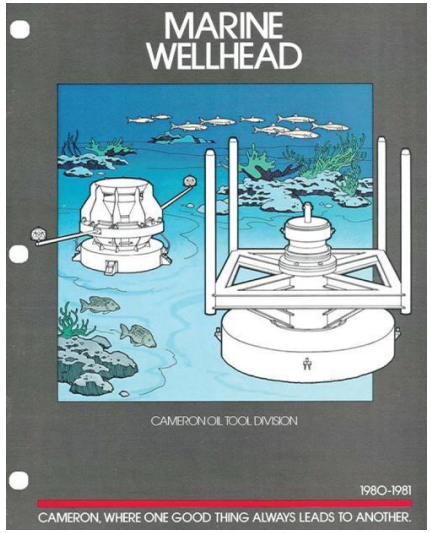
- Tern-2 is an appraisal well located within the Tern field of retention lease licence WA-27-R, approximately 300 km WSW of Darwin. The well was drilled in 1981 and 82. It was temporarily abandoned with cement barriers in January 1982.

- Key objectives of P&A activity:
  - Installing and verifying additional well barriers to supplement the existing system of well barriers.
  - Removing the wellhead and any structural evidence of the well from the seabed as best as practical to eliminate future hazards to the environment or other users of the area.

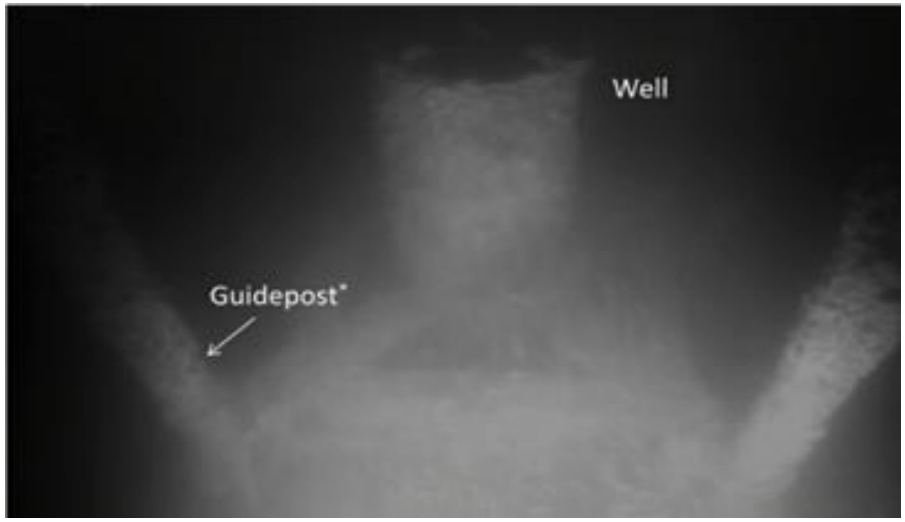
- Estimated activity duration:
  - ~10 days (Continuous operations, 24 hours per day, 7 days per week).
  - Up to 40 days in the event of unforeseen delays and poor metocean conditions.

- The Operational Area:
  - A circular area with a 2 km radius around the Tern-2 wellhead.
  - ~ 106 km from the closest shoreline
  - ~ 62 km southwest of Petrel-1 and ~ 9.8 km southeast of Tern-1 well.
  - Average water depth is ~ 83 m.

- The petroleum activities require the following vessels:
  - Light Well Intervention Vessel (LWIV)
  - Support vessel
  - Remotely Operated Vehicle (ROV)
  - Helicopters



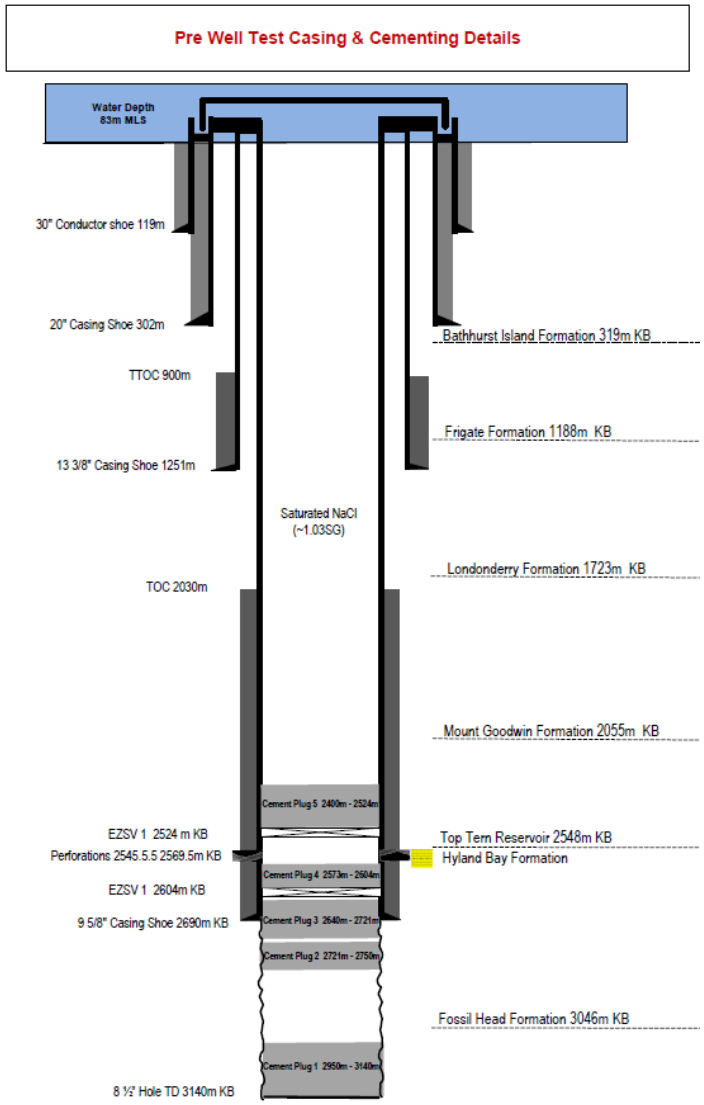
Example of the Tern-2 wellhead.



Example of wellhead at Tern-2 wellhead location.

Tern-2 P&A - Activity

- Utilising a Light Well Intervention Vessel for the following scope:
  - Clean and remove wellhead debris cap
  - Inspect and evaluate condition inside well
  - Using wireline, install additional P&A barriers into the well
  - Cut and remove wellhead
  - Contingency to place wellhead on seabed only if needed
  - Move wellhead to the vessel using ROV
  - If the wellhead is in poor condition and can't be removed it will be left on the seabed



Tern-2 wellhead schematic

Tern-2 P&A – Vessels & Vehicles

Example Light Well Intervention Vessel (LWIV)

Example Support Vessel

Example ROV

Example Helicopter

Tern-2 P&A – Impacts (things we know will happen)Santos

Planned events	How we manage (the rules we follow)
Disturbance to other boats	We will communicate to other boats where we are and what we are doing. We mark the location of equipment on charts.
Seabed disturbance	We are putting equipment on a flat sandy seabed. We only put equipment in the approved location.
Light disturbance	We only use lights where needed for safe operations. We turn off lights when not needed.
Noise disturbance	We look out for marine life (e.g., whales, dolphins, turtles). Noise levels are not expected to impact at population level or have a significant impact on foraging behaviours of marine turtles.
Air emissions	We ensure engines and other equipment is looked after and fuel use and waste incineration standards are maintained.
Discharges	We will reduce discharges to only those necessary for operations and we follow the standard rules for what boats can discharge.
Wellhead left on seabed	We will leave the wellhead on the seabed only if it cannot be removed easily due to technical difficulties.
Oil spill response	We have plans and resources to be used if there is an accidental oil spill.

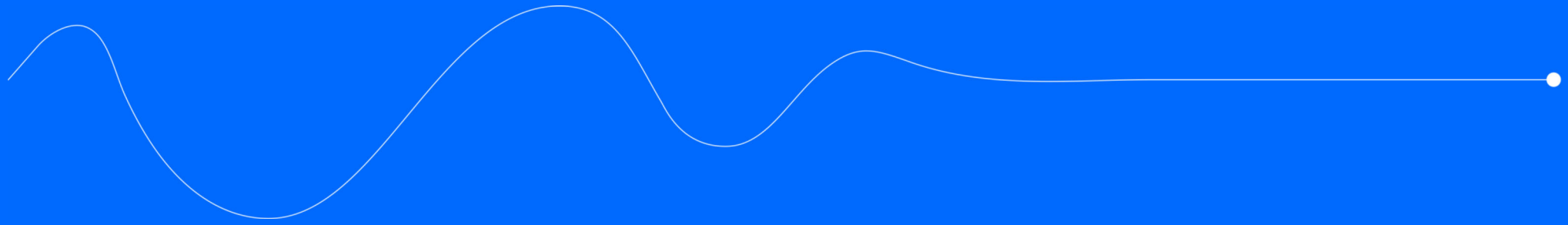
Tern-2 P&A – Risks (things we don't expect to happen)

Unplanned events (Accidents)	How we manage (the rules we follow)
Diesel spill	We make sure all the boats are following the rules for preventing collisions. We let other boats know where we are and what we are doing. We will not refuel within the operational area.
Dropped objects	We follow strict procedures to stop objects dropping overboard and we pick up objects when it is safe to do so.
Disturbing marine animals	We look out for marine life (e.g., whales, dolphins, turtles) when transiting within and to and from the operational area and we slow down and move away from them where possible if they are too close.
Invasive marine life	We will use an anti-foulant system and follow strict procedures to avoid any introduction of invasive marine life.
Chemical spill	We select chemicals that are friendly to the environment where possible and store them carefully. We have procedures for using and cleaning up chemicals.
Disturbance to other boats	We let other boats know where we are and what we are doing. We will let other boats, fishing groups, and the government know if the wellhead cannot be removed and will be left on the seabed.

Santos

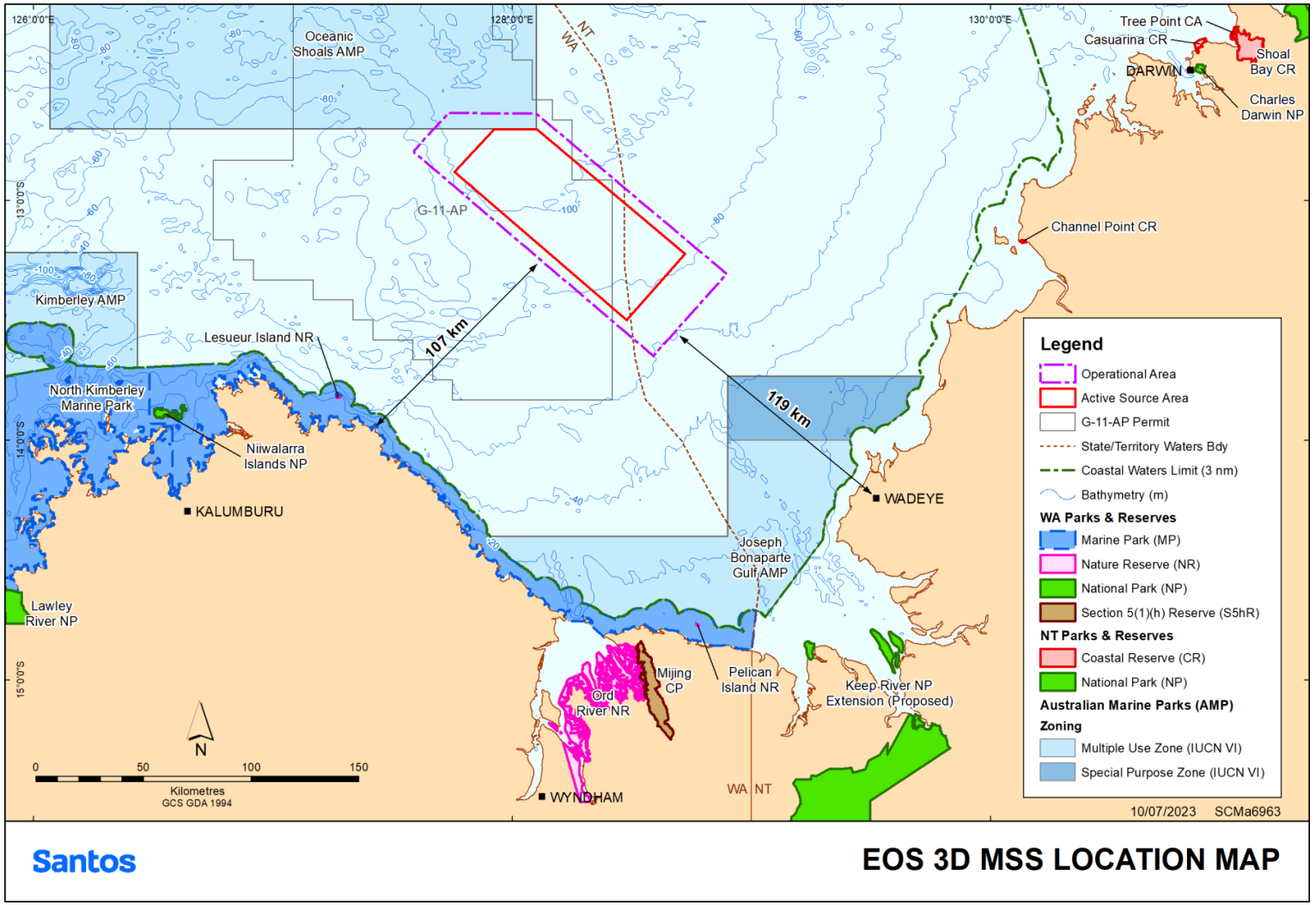
BONAPARTE BASIN CONSULTATION

EOS 3D MARINE SEISMIC SURVEY



WA & NT Environment Plan Consultation

Eos 3D MSS - Location



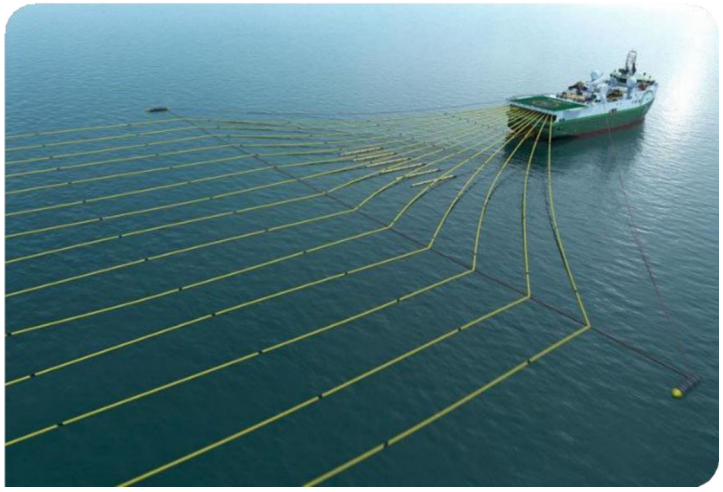
Eos 3D Marine Seismic Survey

What is a marine seismic survey?

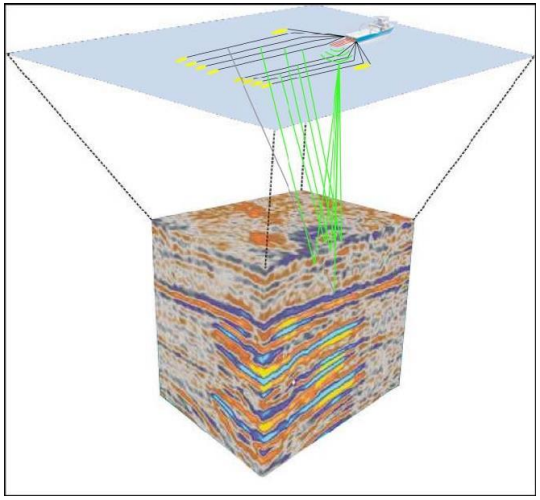
https://www.youtube.com/watch?v=T1yzHW5x1HE

Eos 3D MSS - Overview

- Santos plans to acquire a three-dimensional (3D) marine seismic survey (MSS) in Commonwealth waters in the Bonaparte Basin.
- The proposed activity is required to complete an appraisal of the carbon storage potential of Santos' greenhouse gas assessment (GHG) permit G-11-AP. The survey extends into GHG G-7-AP and overlaps petroleum permits WA-548-P and WA-6-R and surrounding waters in the Petrel Sub-Basin.
- Key objectives:
  - Facilitate future Carbon Dioxide (CO_2) injection activities by providing detailed structural and amplitude imaging of the reservoir/seal interface for each identified storage target to confirm suitability for injection and storage of CO_2.
- Timing:
  - 50 days, (42 days plus 8 days for contingency, e.g. weather, mechanical etc)
  - Continuous operations, 24 hours per day, 7 days per week.
- Operational Area:
  - Area within which the seismic survey vessel will operate during the normal conduct of the activity.
  - Includes the Active Source Area.
  - 60 to 115 m water depth.
- Active Source Area:
  - Area within which the seismic source will be operated to acquire the seismic data and achieve the geophysical objectives of the survey.
  - Area size: 4,028 km^2
  - 67 to 111 m water depth.
- Project vessels:
  - Seismic survey vessel
  - Up to two Support Vessels (one being a chase vessel)
  - Helicopters and drones

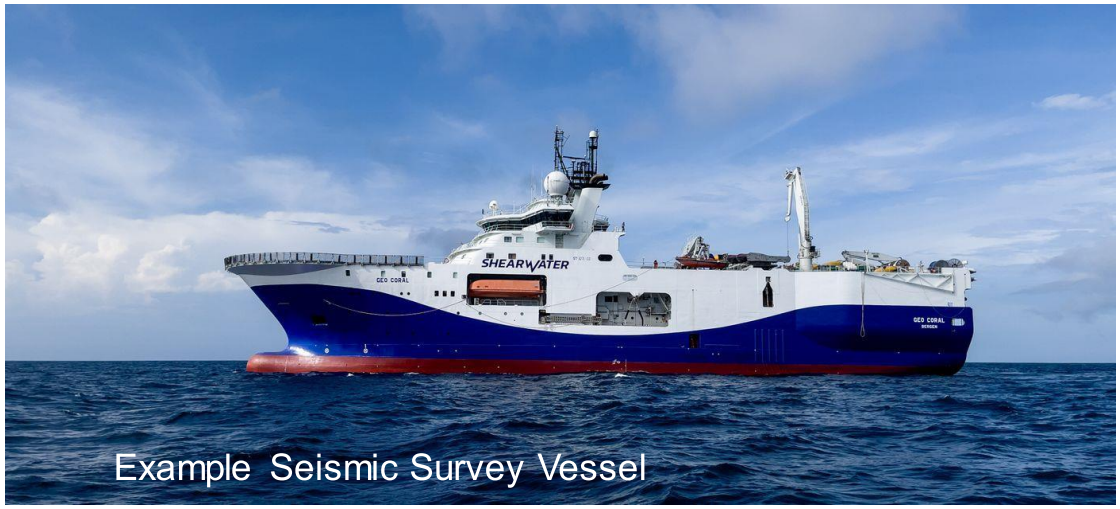


Example of a seismic array and Marine Seismic Vessel for 3D or 4D surveys



3D seismic survey, showing simplified configuration of seismic vessel and subsurface cube of data (Cameselle, 2020)

Eos 3D MSS – Vessels & Vehicles



Example Seismic Survey Vessel

Example Support Vessel

Example Chase Vessel

Example Helicopter

Eos 3D MSS – Impacts (things we know will happen)

Planned events	How we manage (the rules we follow)
Disturbance to commercial fishers	We will communicate to fishing boats where we are and what we are doing.
Disturbance to other boats	We will communicate to other boats where we are and what we are doing and provide notifications in advance of the survey starting.
Light disturbance	We only use lights where needed for safe operations. We turn off lights when not needed.
Noise disturbance	We look out for marine life (e.g., whales, dolphins, turtles) before the survey begins Animal spotters stay on the vessel during the survey and monitor. Soft start up- meaning the noise slowly gets louder giving marine animals time to move away from the sound.
Air emissions	We ensure engines and other equipment are looked after. Fuel use and waste incineration standards are maintained.
Discharges	We will follow the standard rules and procedures for what boats can discharge.
Impacts from other seismic surveys	We will communicate with other companies that may also be doing seismic surveys in the area and keep a large distance between other seismic vessels.

Eos 3D MSS – Risks (things we don't expect to happen)

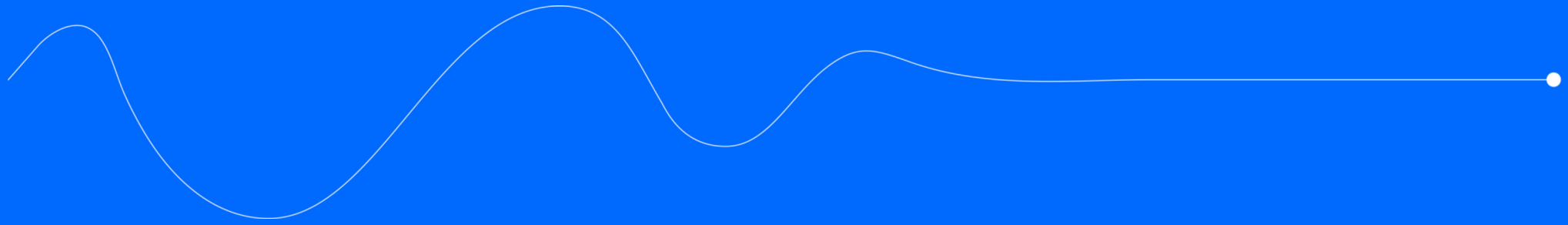
Santos

Unplanned events (Accidents)	How we manage (the rules we follow)
Diesel spill	We make sure all the boats are following the rules for preventing collisions. We let other boats know where we are and what we are doing. We follow strict procedures for refuelling.
Discharges	Where possible and safe to do so, we will recover any waste or equipment that accidentally falls overboard into the ocean.
Disturbing marine animals	We look out for marine life (e.g., whales, dolphins, turtles) and the support vessel will slow down and move away from them where possible if they are too close while the survey is taking place.
Invasive marine life	We will use an anti-foulant system and follow strict procedures to avoid any introduction of invasive marine life.
Chemical spill	We select chemicals that are friendly to the environment where possible and store them carefully. We have procedures for using and cleaning up chemicals.
Oil spill response	We have plans and resources to be used if there is an accidental oil spill.

Santos

BONAPARTE BASIN CONSULTATION

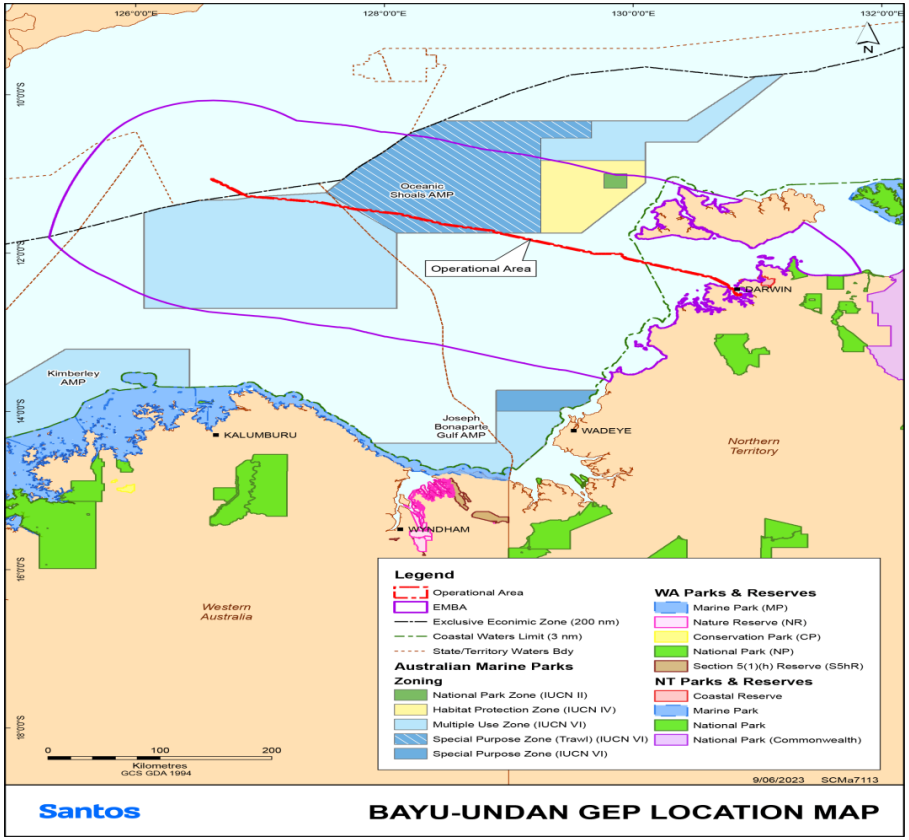
BAYU-UNDAN PIPELINE

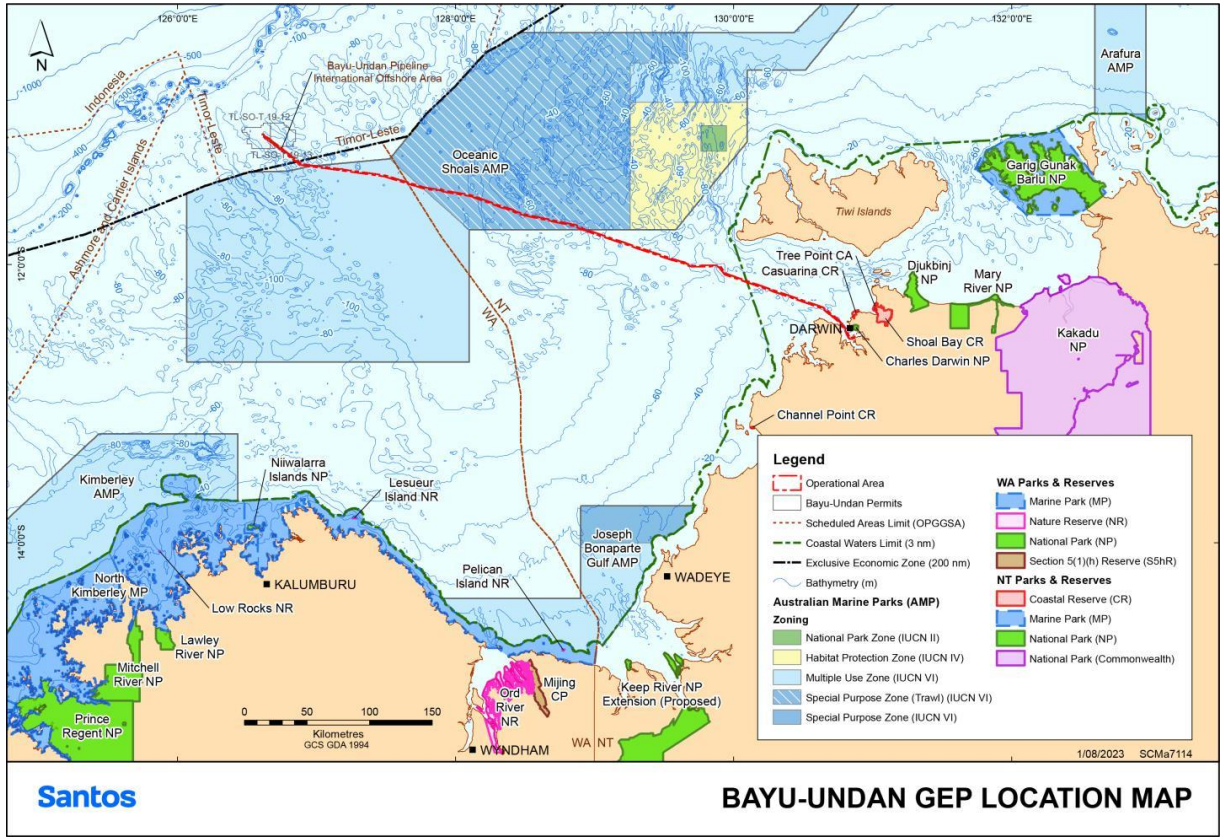


WA & NT Environment Plan Consultation

Bayu-Undan Gas Export Pipeline EP

- Santos is the operator of the existing 502km Gas Export Pipeline.
- The pipeline transports dry natural gas from the Bayu-Undan Field (Timor-Leste waters) to the onshore Darwin liquefied natural gas (DLNG) plant.
- The pipeline has been operational since 2005.
- As the Field is approaching the end of life, the pipeline will transition from operations to a preservation state.
- The original EP for operations was accepted by NOPSEMA in 2019.
- The EP has been updated to include the final stages of operations (linepacking and back-feed), plus a preservation phase (gas-filled).





Santos

The Oil & Gas lifecycle

Santos

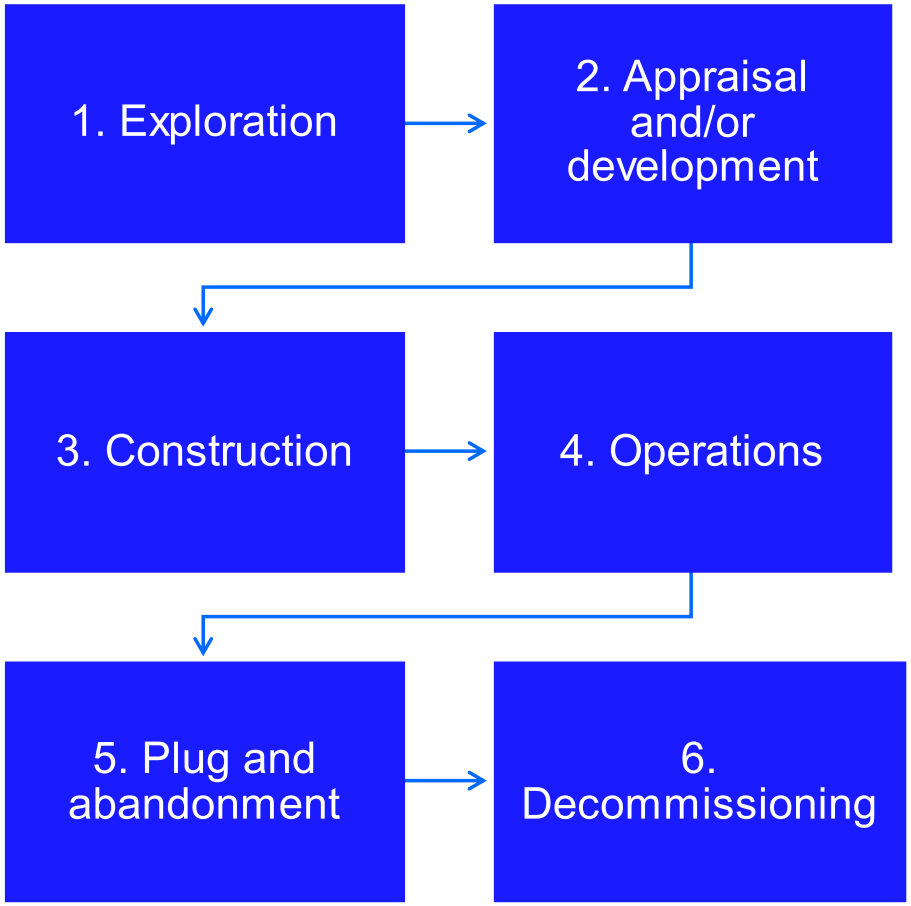
The oil & gas lifecycle involves the exploration, extraction, and use of these resources. Followed by closing the site when complete.

It starts with searching for gas deep underground using seismic surveys and drilling exploration wells, followed by the construction of infrastructure to extract and produce them.

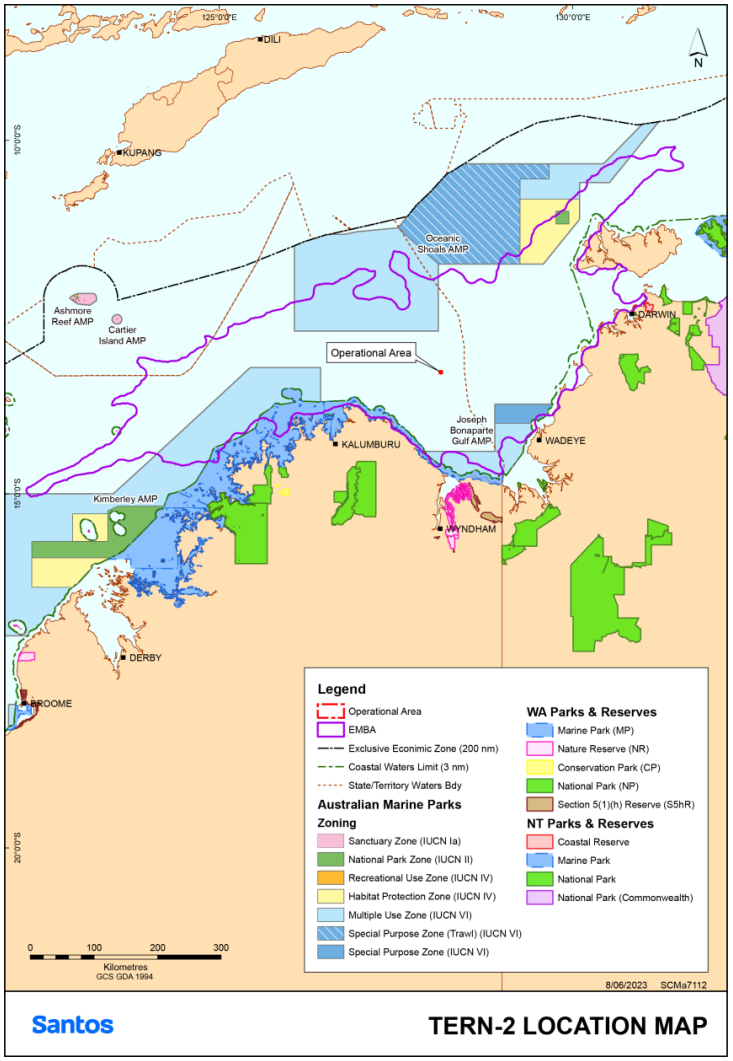
Afterward, the products are transported to end-users.

When the resources are depleted, there's a process to close down operations and ensure environmental compliance. This is called decommissioning.

Current Santos projects are at various stages of this lifecycle.

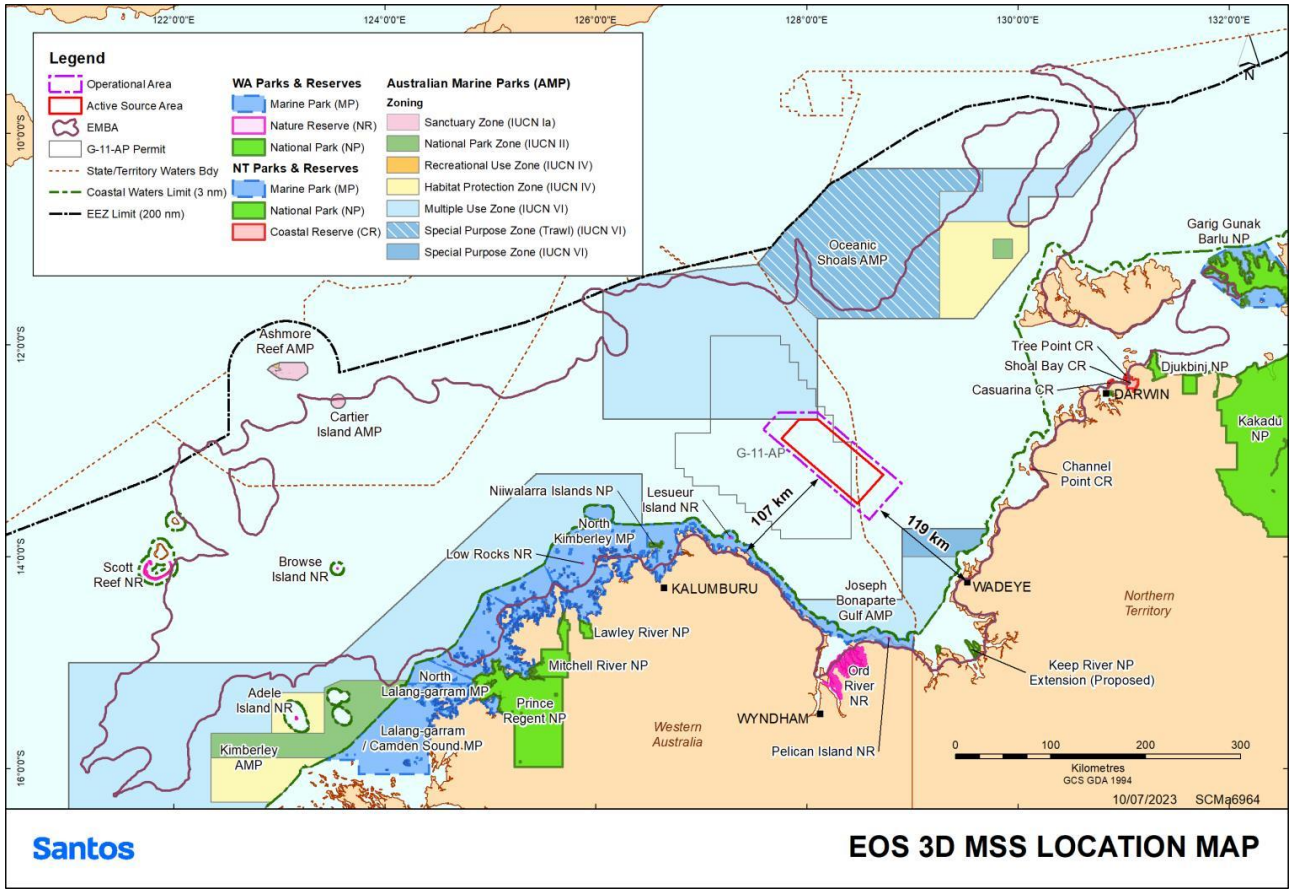


Spill Risk



Santos

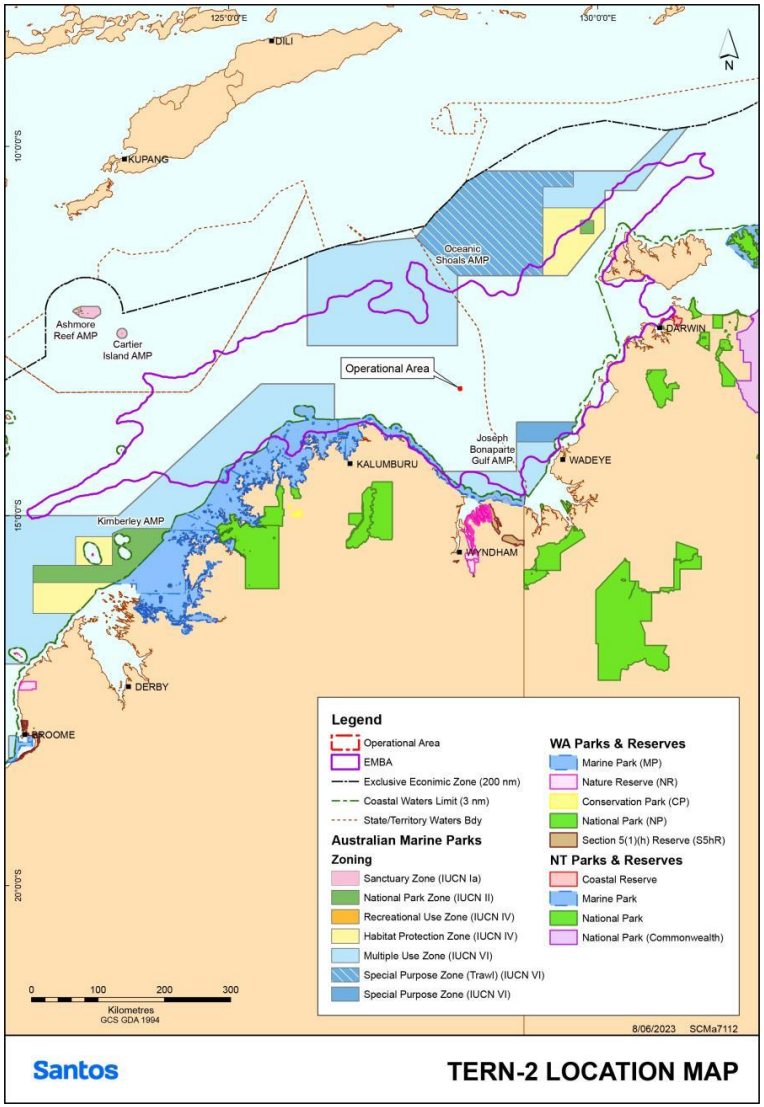
TERN-2 LOCATION MAP



Santos

EOS 3D MSS LOCATION MAP

Tern-2 P&A – Environment That May Be Affected



Feature	Public Information Review
Aboriginal Heritage	Aboriginal Heritage sites are present along the southern and eastern boundaries of the Environment That May Be Affected (EMBA).
Biologically Important Areas (BIAs)	The Operational Area includes BIAs for turtles only, the EMBA includes BIAs for dolphins, seabirds, sharks, whales and turtles.
Cultural Heritage	No known sites of shipwrecks, sunken aircraft or Aboriginal and Torres Strait Islander Underwater Cultural Heritage have been identified within the Operational Area. Within the EMBA the nearest shipwreck, the SEDCO Helen, is approximately 60 km northeast of the Operational Area located in depths of approximately 100 m .
Defence	Operational area overlaps practice and training areas that comprise the North Australian Exercise Area (NAZA) a maritime military zone administered by the Australian Defence Force, as well as restricted airspace.
Energy industry	Several offshore petroleum projects are in operation and there is exploration activity within the EMBA. The nearest platform is the ENI Blacktip Platform approximately 75 km to the southeast of the operational area.
Fishing	A number of Commonwealth, State and Territory fisheries management areas overlap the Operational Area and EMBA however, neither Commonwealth nor WA state-managed fisheries show activity within the Operational Area between 2010-2020.
	Traditional Australian Indigenous fishing activities are generally concentrated within 3 nm of the Northern Territory / Western Australian coastline.
	No interaction with recreational or charter boat fishers is anticipated given the remoteness of the Operational Area (~106 km from nearest coastline).
Key Ecological Features (KEFs)	The EMBA includes KEFs for the carbonate bank and terrace system of the Van Diemen Rise, the carbonate bank and terrace system of the Sahul Shelf, ancient coastline at 125m depth contour, continental slope Demersal Fish communities, the shelf break and slope of the Arafura Shelf, and the Pinnacles of the Bonaparte Basin.
Protected Areas (nearest Commonwealth and Territory)	In Commonwealth Waters the EMBA overlaps with the Oceanic Shoals Marine Park, Joseph Bonaparte Gulf AMP and the Kimberley AMP. The closest being the Oceanic Shoals AMP which is approximately 63 km north of the Operational Area.
	The North Kimberley State Marine Park is approximately 182 km west from the Operational Area and overlaps with the EMBA.
Shipping	The Operational Area does not overlap any shipping fairways, though is adjacent to vessel traffic. Vessel traffic from Wyndham may be present within the EMBA at periods of the year.
Telecommunications	The North West Cable System (NWCS) connects offshore oil and gas facilities in the Browse, Bonaparte and Carnarvon Basins to onshore locations and is approximately 140 km north-north-east of the Operational Area.
Tourism	Remoteness of the Operational Area and water depth limits opportunities for tourism. Tourism is likely within the EMBA.
Towns/Communities	Darwin is the nearest capital city and is approximately 300 km northeast from the Operational Area.

Eos 3D MSS - Activity

- The process of collecting seismic data is known as ‘acquisition’.
- Marine seismic surveys are carried out by specialised vessels that tow an array of acoustic sources (airguns) and receivers (hydrophones) across a defined acquisition area.
- The seismic survey vessel will tow a seismic source array (up to 3,500 in3) and up to 12 streamers, approximately 113 m apart, and will travel back and forth across the survey area in a “race track” pattern, lines separated by approximately 500-700m within an overall acquisition area.
- The streamer array will be approximately 8 km long and positioned 10 – 30 m below the ocean surface.
- Airguns work by rapidly releasing compressed air to form a bubble, which creates a pulse of sound. This sound energy is directed at the seafloor and penetrates into the various rock layers beneath.
- The reflected soundwaves are then captured by hydrophone receivers, which are towed behind the vessel on a series of cables known as 'streamers'.
- Support vessels will be on standby, one support vessel will be present at all times.
- 3 nm exclusion zone requested.
- Auscoast warning and/or Notice to Mariners will be issued prior to the start of the activity.
- The seismic survey vessel will display appropriate day shapes and lights to indicate it is under tow and is therefore restricted in it’s ability to manoeuvre, and the streamers will tow surface tail buoys fitted with radar reflectors.
- A visual and radar watch will be maintained on the bridge at all times.

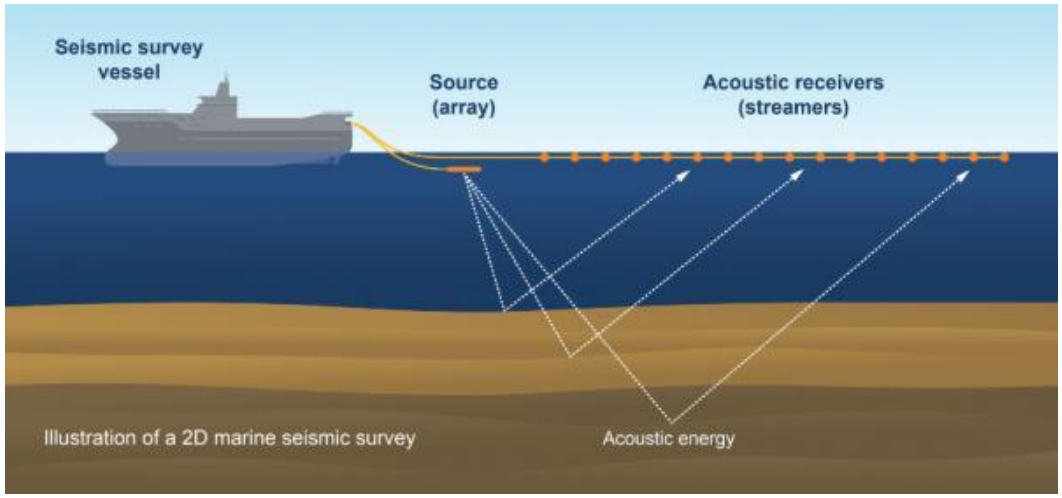
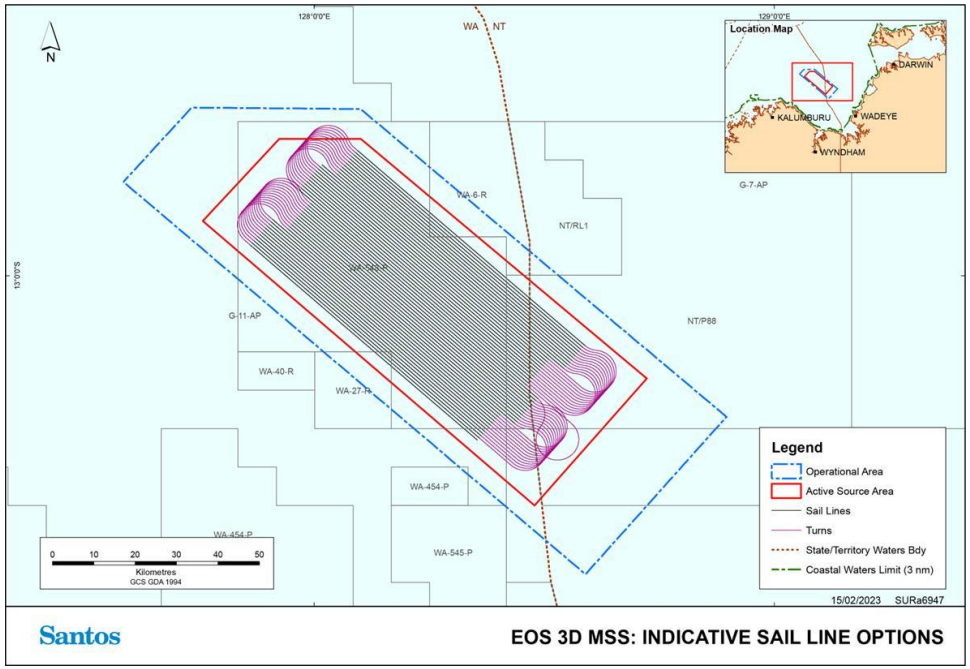


Diagram of a marine seismic survey (Source: NOPSEMA).



Eos 3D MSS – Environment That May Be Affected

Feature	Public Information Review
Aboriginal Heritage	Aboriginal Heritage sites are present along the coastline along the southern boundary of the EMBA.
Biologically Important Areas (BIAs)	The Operational Area includes BIAs for turtles.
Cultural Heritage	No known sites of shipwrecks, sunken aircraft or Aboriginal and Torres Strait Islander Underwater Cultural Heritage have been identified within the Operational Area. The nearest shipwreck, the SEDCO Helen, is approximately 11 km northeast of the Operational Area.
Defence	Operational area overlaps practice and training areas that comprise the North Australian Exercise Area (NAZA) a maritime military zone administered by the Australian Defence Force, as well as restricted airspace.
Energy Industry	Petroleum exploration and production activities have been undertaken within the EMBA and the Bonaparte Basin is an established hydrocarbon province with a number of commercial operations. Several exploration permits overlap the Operational Area with the closest production licence being the Eni Australia B.V. located 21 km south of the Operational Area.
Fishing	Five Commonwealth, thirteen Western Australia and ten Northern Territory fisheries overlap the EMBA, some of which are active in the Operational Area.
	Traditional Australian Indigenous fishing activities are generally concentrated within 3 nm of the Northern Territory / Weste rn Australian coastline.
	Fishing charter vessels may transit through the Operational Area and EMBA. Northern Prawn Fishery (NPF) fishing season (within the NPF licence area) is annually from August to November.
Key Ecological Features (KEFs)	The Operational Area overlaps one KEF for the Carbonate Bank and Terrace System of the Sahul Shelf.
Protected Areas (nearest Commonwealth and Territory)	The Operational Area overlaps the Oceanic Shoals Marine Park and four additional Australian Marine Parks overlap the EMBA. .
	Eighteen state/territory marine parks overlap the EMBA with the closest being the North Kimberley Marine Park located approximately 100 km south-west of the Operational Area.
Shipping	The Operational Area does not overlap any shipping fairways, however there is vessel traffic that passes through the northern end of the Operational Area. High vessel traffic to be expected from largest exporter of cattle out of Wyndham during Q3.
Telecommunications	The North West Cable System (NWCS) connects offshore oil and gas facilities in the Browse, Bonaparte and Carnarvon Basins to onshore locations and is approximately 125 km north-north- east of the Operational Area.
Tourism	Remoteness of the Operational Area and water depth limits opportunities for tourism. Tourism is likely within the EMBA.
Towns/Communities	Darwin is the nearest capital city and is approximately 230 km northeast from the Operational Area.
	Wadeye is the nearest community and is approximately 119 km southeast from the Operational Area.

Eos 3D MSS - Activity

- The process of collecting seismic data is known as ‘acquisition’.
- Marine seismic surveys are carried out by specialised vessels that tow an array of acoustic sources (airguns) and receivers (hydrophones) across a defined acquisition area.
- The seismic survey vessel will tow a seismic source array (up to 3,500 in3) and up to 12 streamers, approximately 113 m apart, and will travel back and forth across the survey area in a “race track” pattern, lines separated by approximately 500-700m within an overall acquisition area.
- The streamer array will be approximately 8 km long and positioned 10 – 30 m below the ocean surface.
- Airguns work by rapidly releasing compressed air to form a bubble, which creates a pulse of sound. This sound energy is directed at the seafloor and penetrates into the various rock layers beneath.
- The reflected soundwaves are then captured by hydrophone receivers, which are towed behind the vessel on a series of cables known as 'streamers'.
- Support vessels will be on standby, one support vessel will be present at all times.
- 3 nm exclusion zone requested.
- Auscoast warning and/or Notice to Mariners will be issued prior to the start of the activity.
- The seismic survey vessel will display appropriate day shapes and lights to indicate it is under tow and is therefore restricted in it’s ability to manoeuvre, and the streamers will tow surface tail buoys fitted with radar reflectors.
- A visual and radar watch will be maintained on the bridge at all times.

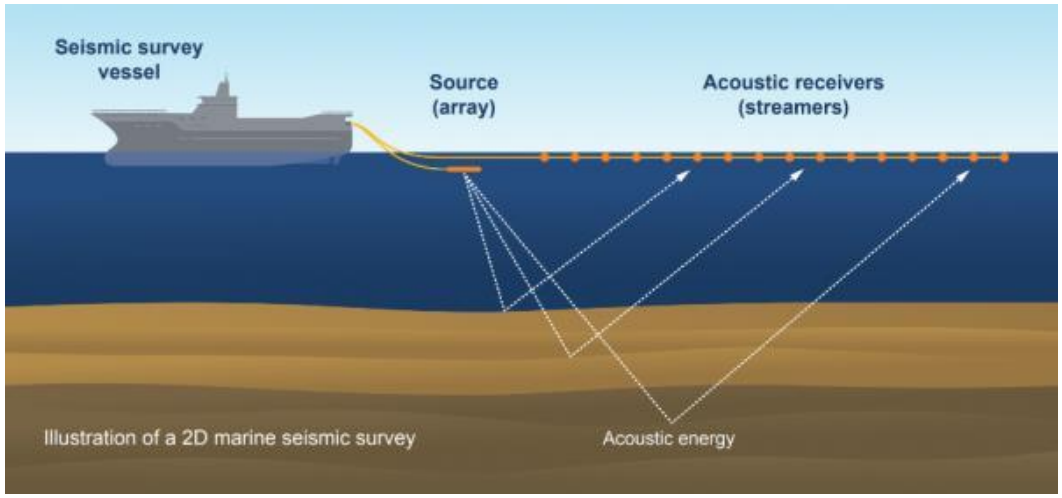
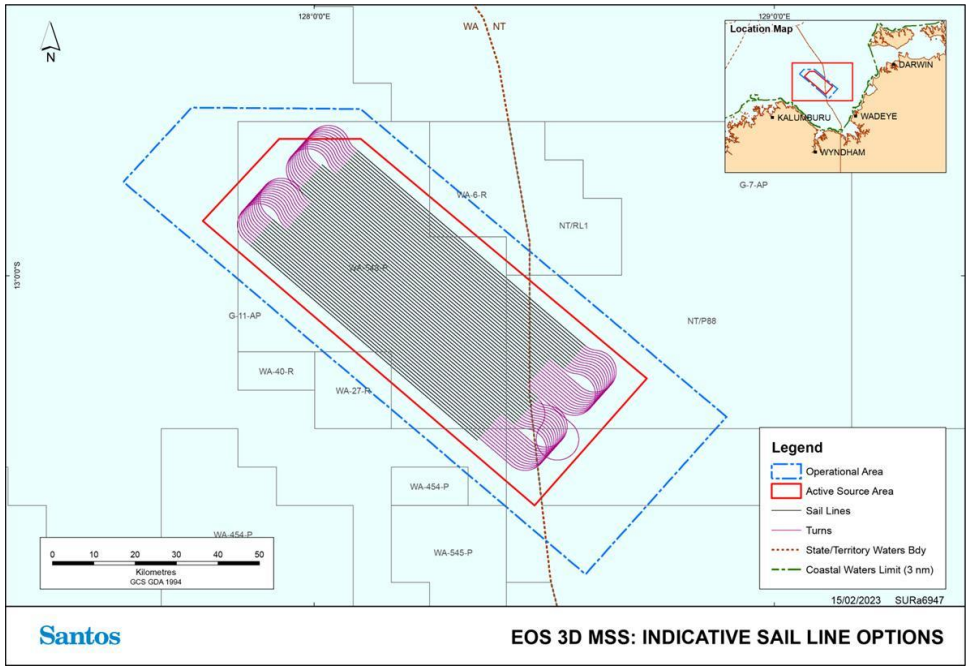


Diagram of a marine seismic survey (Source: NOPSEMA).



Eos 3D MSS – Commercial Fishers

Co-existence approach

- Minimise the extent of interruption by the seismic survey activities on commercial fishing operators' activities to the lowest practicable level.
- Mitigate the effects of the interruptions.
- Apply an equitable 'commercial fishers payment claim protocol'.

Commercial fishers payment claim protocol

- The survey will potentially impact commercial fishers whose fishing operations overlap with the seismic survey.
- Santos has a process to enable commercial fishers to lodge evidence-based payment claims for temporary loss of fish catch, displacement costs and equipment damage or loss directly caused by the seismic survey.
- Santos will also assess requests for administrative support to help fishers collate historical fishing data required for an evidence-based payment claim.
- The control measures identified within the draft Environment Plan, to outline how the potentially competing demands of commercial fishing operators and Santos' seismic survey may be managed, are consistent with those adopted for other Santos marine seismic surveys.

Commercial prawn and indicator fish species spawning	J	F	M	A	M	J	J	A	S	O	N	D	Source
Banana prawn spawning													AFMA 2020
Juvenile banana prawn migration													Longeran et al. 2002
Brown tiger prawn spawning													AFMA 2020
Grooved tiger prawn spawning													AFMA 2020
Blue endeavour prawn spawning													AFMA 2020
Red endeavour prawn spawning													AFMA 2020
Red emperor													DPIRD 2019
Goldband snapper													DPIRD 2019
Spanish mackerel (Kimberley stock)													DPIRD 2019

Key

Sensitivity/activity occurs

Extended peak spawning period

Peak spawning/migration period

*Extended peak spawning period – applies only to Goldband Snapper and Spanish Mackerel

Barossa and Bonaparte Tiwi December Consultation

Santos

BAROSSA GAS PROJECT AND BONAPARTE BASIN

DECEMBER CONSULTATION

Barossa

- Darwin Pipeline Duplication (DPD) Environment Plan
- DPD Construction Environmental Management Plan (CEMP)

Bonaparte

- Bayu-Undan Gas Export Pipeline Environment Plan
- Eos 3 Marine Seismic Survey (MSS) Environment Plan
- Tern-2 Plug and Abandonment Environment Plan

Acknowledgement of Country

Santos acknowledges the Traditional Owners of the land on which we meet today.

We pay our respects to Elders past, present and emerging.

Santos

Privacy Statement

Santos Ltd and its related bodies corporate (together, we, our, us or Santos) collect personal information about you, such as your name and sensitive information about your indigenous heritage. We use this information to record your attendance at any meeting or other discussion with us, to provide you with information about our projects, to receive and respond to any information that you provide, to answer any questions you might have and for other purposes that we tell you about during your meeting or other discussion with us. Santos will handle any information that you provide in accordance with our Code of Conduct and our Confidentiality, IP and Privacy Procedure. You can ask us for a copy of this Privacy Notice or these other documents.

If you do not provide your personal information, we may not be able to identify you as the person who provided particular information or we may be unable to discuss any information you have provided with you further or respond to your questions. We may disclose your information to other companies within the Santos group, to third parties that help us run our business and to relevant government agencies and government departments.

Due to the global nature of our operations and business, your personal information may be accessed by or disclosed to Santos personnel outside Australia. We may also use overseas third parties to collect, transfer, store and handle your personal information. Some of the overseas countries that your personal information may be accessed from, disclosed or transmitted to or stored in include but are not limited to, Papua New Guinea and the United States of America.

You have a right to request a copy of any personal information that we hold about you, as well as a right to request that we correct any information that we hold about you that is inaccurate, out-of-date, incomplete, irrelevant or misleading. You can also make a complaint about how we have handled your personal information. Our Consultation Privacy Policies explain in more detail how you can exercise these rights, including how we will respond to your access or correction request or to any privacy complaint that you make. The Barossa Gas Project Consultation Privacy Policy is available on our website at www.santos.com/barossa/barossa-gas-project-consultation-privacy-policy, and the Western Australia and Northern Territory Consultation Privacy Policy is available on our website at https://www.santos.com/offshore-wa-and-nt-consultation-privacy-policy/. You can also contact us to request copies be provided to you.

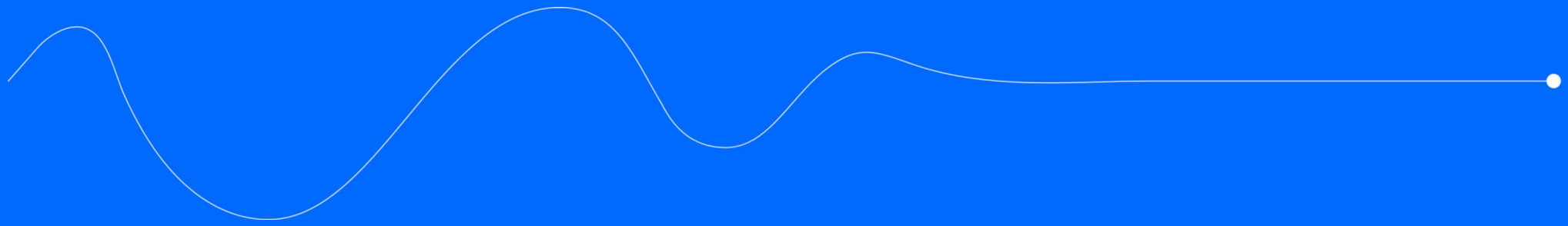
You can contact us by:

- posting a letter addressed to us at 60 Flinders Street, Adelaide, South Australia, 5000;
- telephoning us on +61 8 8116 5000; or
- sending us an email at offshore.consultation@santos.com and compliance@santos.com.

Santos

WELCOME AND INTRODUCTIONS

Peter Kirkpatrick



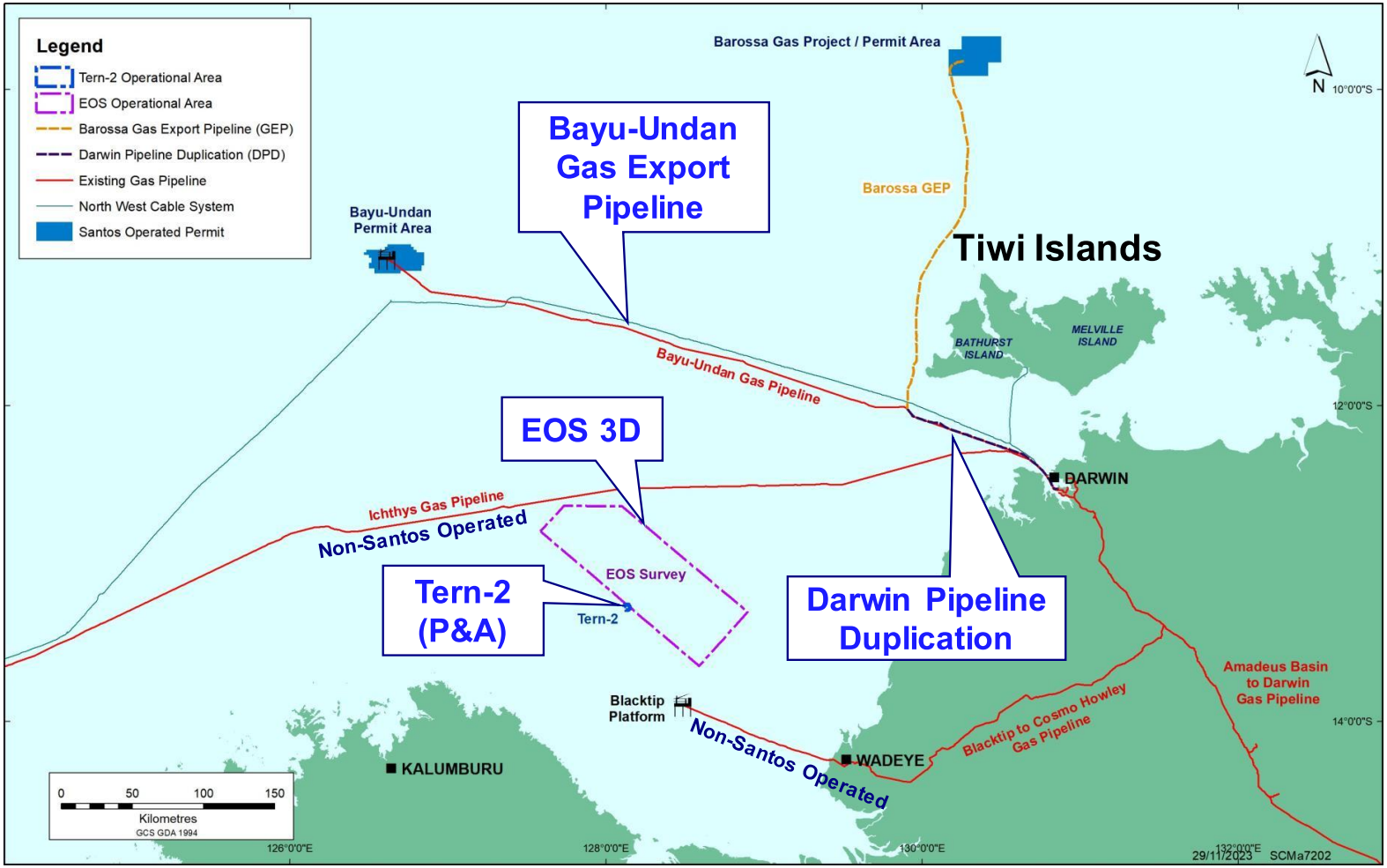
Santos

Welcome & Introductions

We are here today to share information about our company & operations, seek information from you and listen to your questions about Santos & upcoming projects.

- ***Peter Kirkpatrick*** *– General Manager, Darwin*
- ***Tony Johnson*** *- Manager Consultation and Engagement, Offshore*
- ***Lachlan MacArthur*** *– Senior Environmental Adviser*
- ***Carly Sherren*** *– Senior People Business Partner*
- ***Chris Galway*** – Barossa Subsea and Pipeline Delivery Manager
- ***Rylan Fabrici*** *– Geoscientist/Business Planner*
- ***Simon Philippides*** *– Senior Environmental Adviser*

Regional Overview



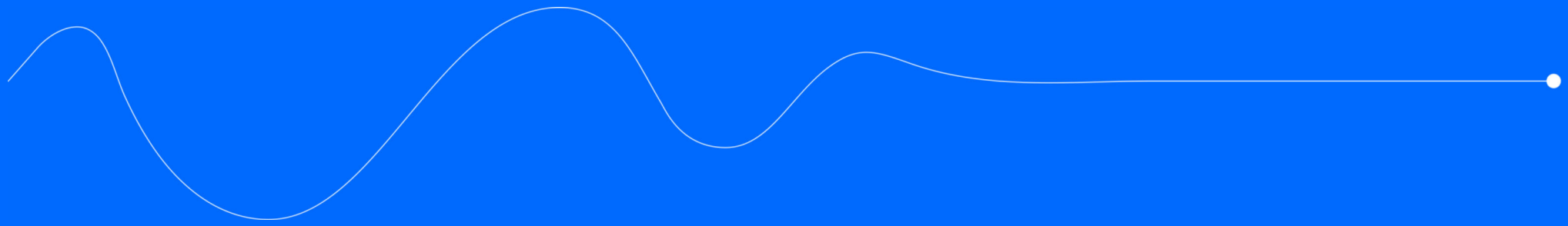
- Santos is undertaking consultation for the following proposed activities:
  - Darwin Pipeline Duplication
  - Tern-2 Plug and Abandonment (P&A)
  - EOS 3D Marine Seismic Survey
  - Bayu-Undan Gas Export Pipeline Operations

Santos Introductory Video

Santos

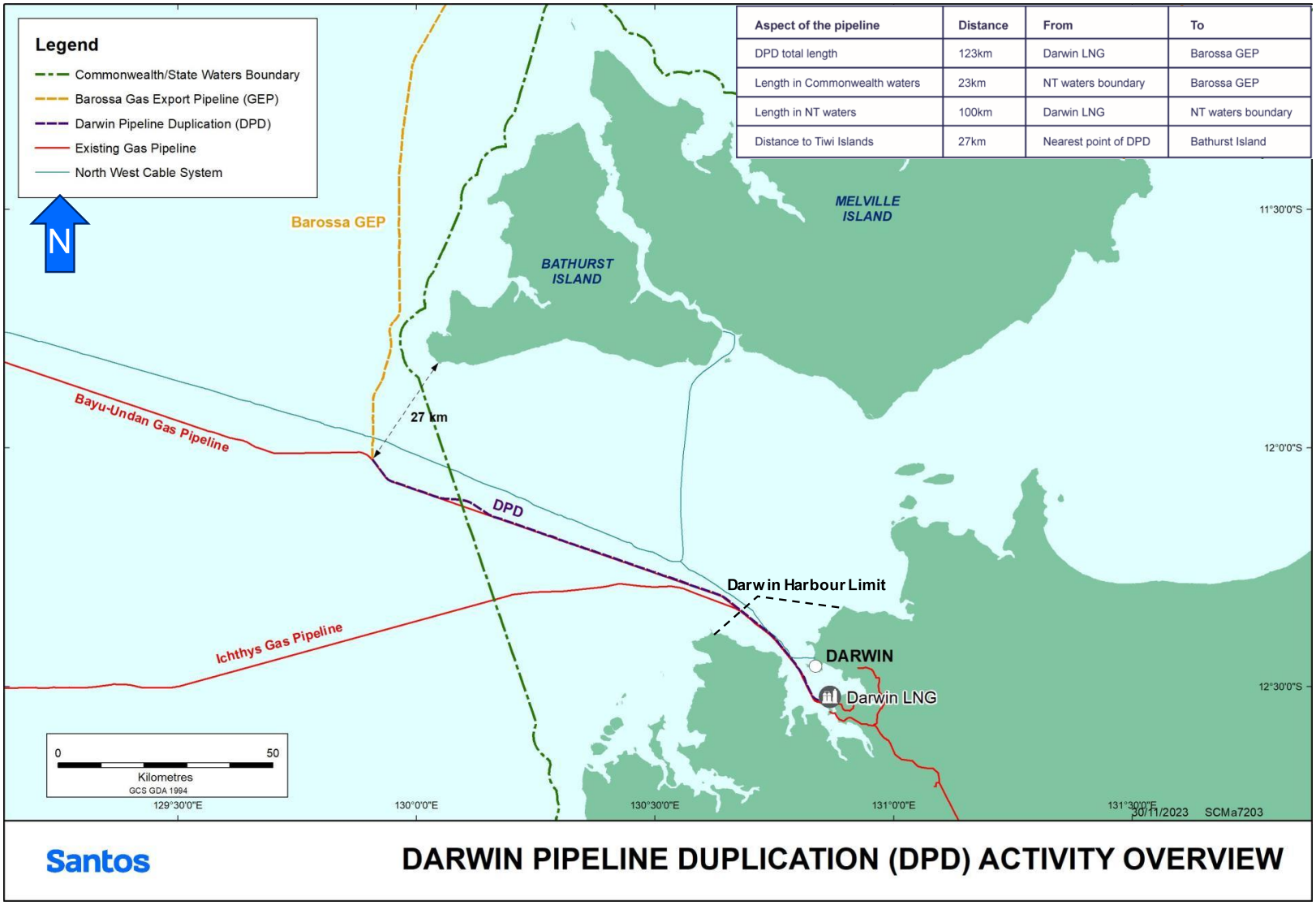
BAROSSA DARWIN PIPELINE DUPLICATION CONSULTATION

Chris Galway and Lachlan MacArthur



DPD Overview

Santos



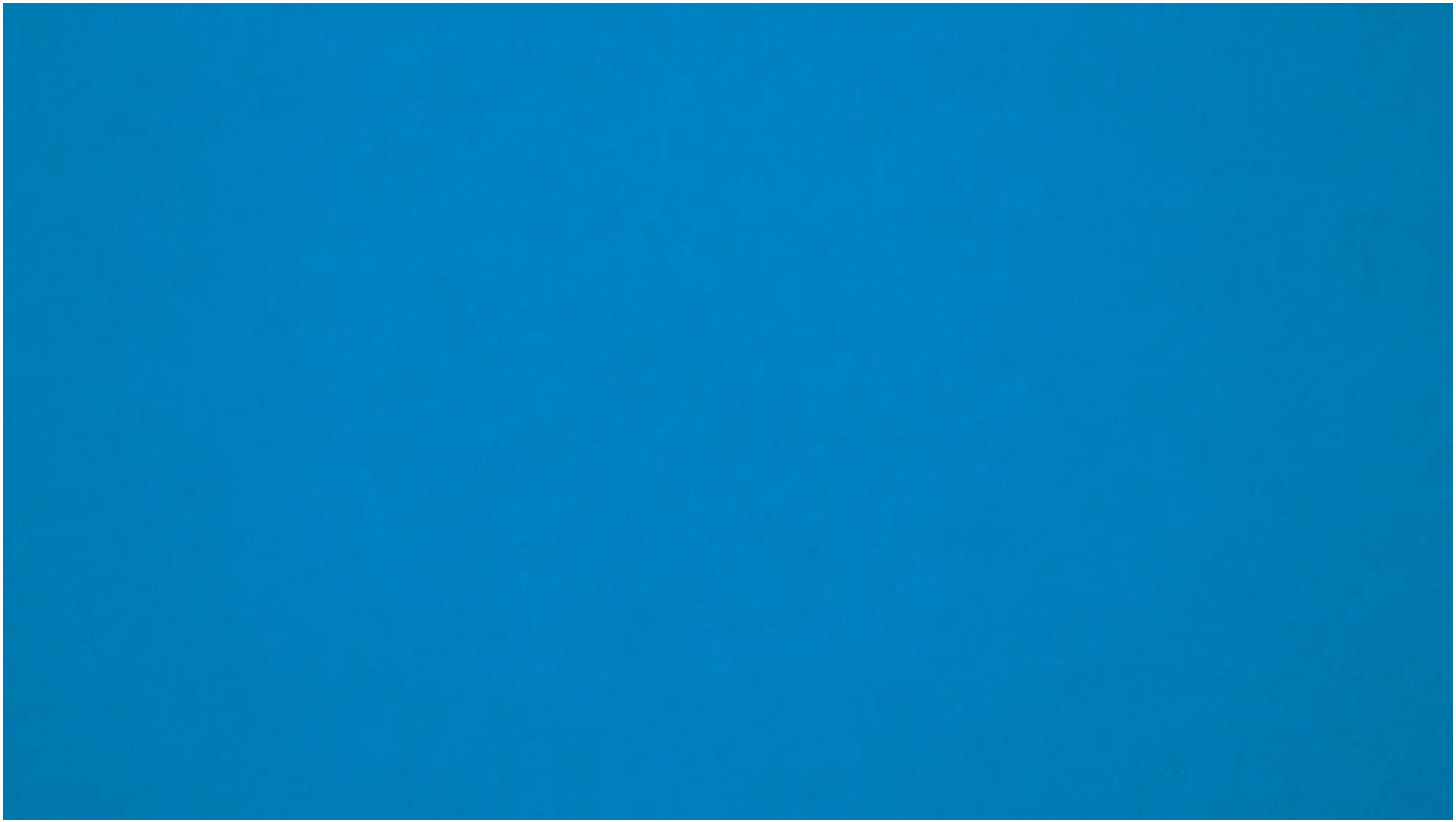
Aspect of the pipeline	Distance	From	To
DPD total length	123km	Darwin LNG	Barossa GEP
Length in Commonwealth waters	23km	NT waters boundary	Barossa GEP
Length in NT waters	100km	Darwin LNG	NT waters boundary
Distance to Tiwi Islands	27km	Nearest point of DPD	Bathurst Island

Santos

DARWIN PIPELINE DUPLICATION (DPD) ACTIVITY OVERVIEW

Barossa Darwin Pipeline Duplication Video

Santos



Santos

DPD Installation – Work in Darwin Harbour

The construction activities within Darwin Harbour extend from the gas plant to approximately 30km offshore. Activities include those shown below.

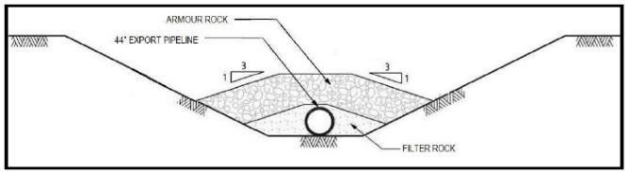
Pre-lay Trenching and Survey

Pre-lay trenching and survey is performed along the pipeline route.

Shallow Water Pipelay

Approximately 30 km of pipeline from shore will be installed using a shallow water anchored barge.

Rock Placement



Rock is installed to protect and stabilise the pipeline.

Santos

DPD Installation – Work Outside Darwin Harbour

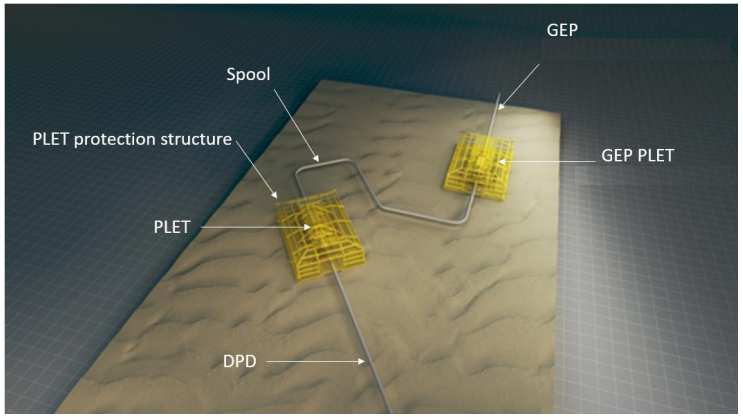
The construction activities outside of Darwin Harbour extend from the harbour limits to approximately 27km south west of the Tiwi Islands. This includes Commonwealth waters and NT Coastal waters

Pipelay Vessel

Survey and Construction Support Vessel

Construction activities include:

- Survey
- Span correction
- Pipeline and structure installation
- Pre-commissioning
- Spool installation



Pipeline End Termination and Spool

Santos

DPD Activity Impacts – Activities Outside of Darwin Harbour

Planned Events	Expected Impact	How we Manage (the rules we follow)
Light disturbance	Behavioural impact to marine life (e.g. attraction) and disturbance to other marine users	We only use lights where needed for safe operations and to comply with relevant safety rules. We turn off lights when not required.
Underwater noise disturbance	Behavioural impact to marine life (e.g. avoidance)	We follow procedures and look out for marine life (e.g. whales, dolphins, turtles) and we slow down and move away from them where possible if they are too close. Boats and equipment will be maintained to minimise noise and operated in accordance with Federal requirements.
Seabed disturbance (pipeline and equipment installation)	Temporary increase in turbidity, increasing sedimentation of habitat	We are putting equipment on a mainly flat sandy seabed close to an existing pipeline. We record the position of installed equipment so it can be removed at a later date.
Discharges (boat discharges, pipeline flooding, cleaning, gauging, testing)	Impact to water quality	We will manage discharges to acceptable levels and follow the standard rules for what boats can discharge. We will select chemicals that are environmentally acceptable, and we will limit their use to only what is needed.
Air emissions	Impact to air quality, contribution to national greenhouse gas levels	We ensure engines and other equipment are looked after and low emission fuel will be used.
Disturbance to other boats	Exclude other users from activity area	We will communicate to other boats where we are and what we are doing. We mark the location of equipment on charts.

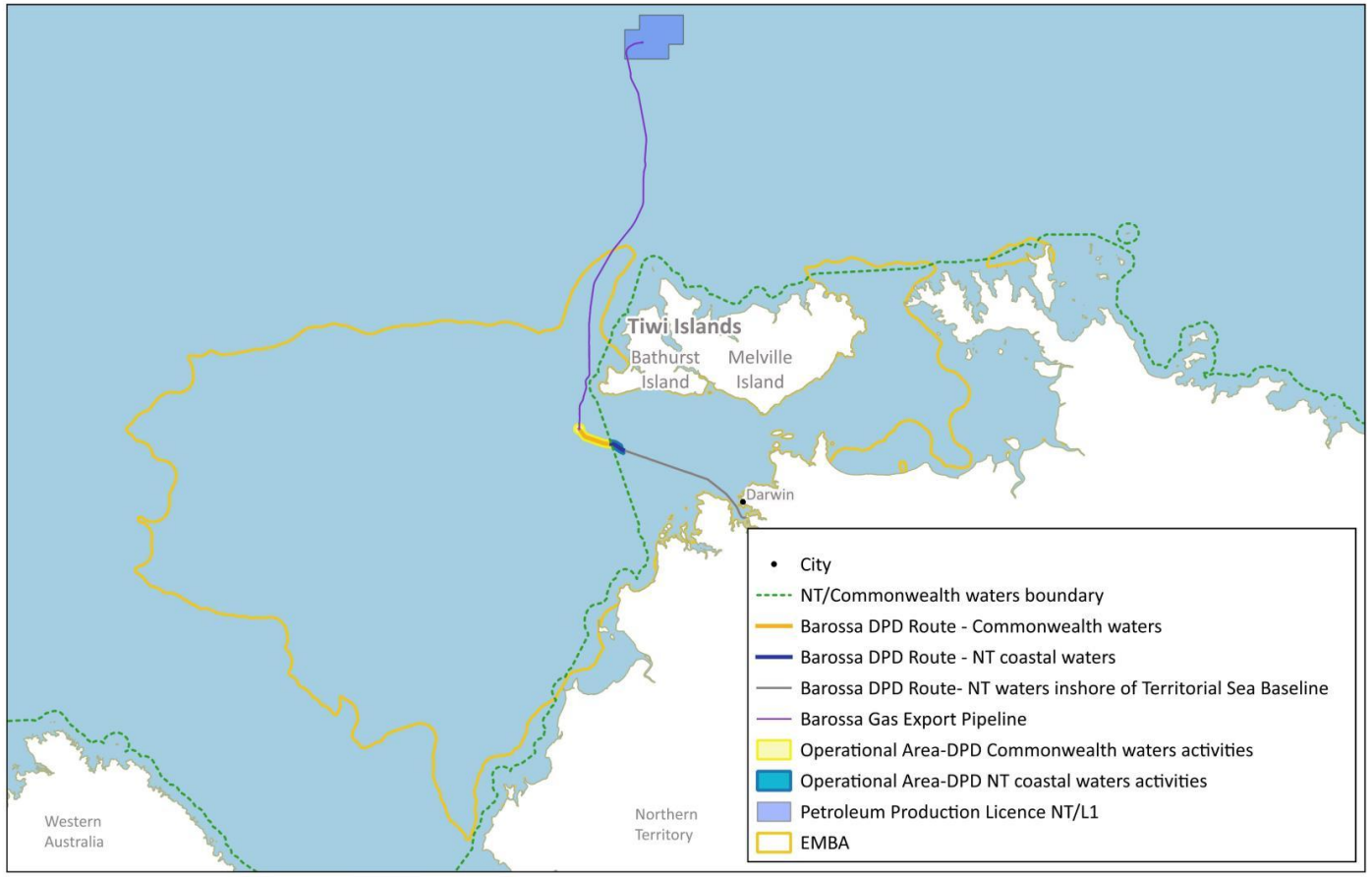
DPD Unplanned Risks – Outside of Darwin Harbour

Santos

Unplanned Events (Accidents)	Unplanned Impact	How we manage (the rules we follow)
Dropped objects	Impacts to water quality, disturbance to seabed and marine life	We follow strict procedures to stop objects dropping overboard and we pick up objects when it is safe to do so.
Disturbing marine animals	Disturbance (e.g. collisions) to marine animals	We look out for marine life (e.g., whales, dolphins, turtles) and we slow down and move away from them where possible if they are too close. We follow rules that outline how we need to interact with marine animals.
Invasive marine life (marine pests)	Impacts to other marine life and industry if pests establish	We ensure boats have low risk for carrying marine pests before they arrive. We have plans and equipment in place on boats to prevent invasive marine species. The Federal government has strict rules we need to follow.
Chemical spill	Water quality and marine life impacts	We select chemicals that are friendly to the environment where possible and store them carefully. We have procedures for using and cleaning up chemicals.
Gas release (dry gas or nitrogen) - Bayu-Undan pipeline	Impacts to marine life, water/air quality, other marine users and cultural features	We follow strict rules for lifting equipment and have emergency response procedures. We have procedures in place to minimise loss of gas from Bayu-Undan pipeline.
Diesel spill	Impacts to water quality, habitats and marine life, protected areas, other marine users and cultural values/sensitivities	We make sure all the boats are following the rules for preventing collisions. We let other boats know where we are and what we are doing. We follow strict procedures for refueling. We have plans and arrangements in place for responding to spills.

DPD Environment That May Be Affected – Diesel Spill

Santos



Audacia (pipelay vessel) – 225 m.

700,000 L of diesel is worst case spill

Bulk carrier – 187 m

Cruise ship – 298 m

Santos

DPD QUESTIONS?

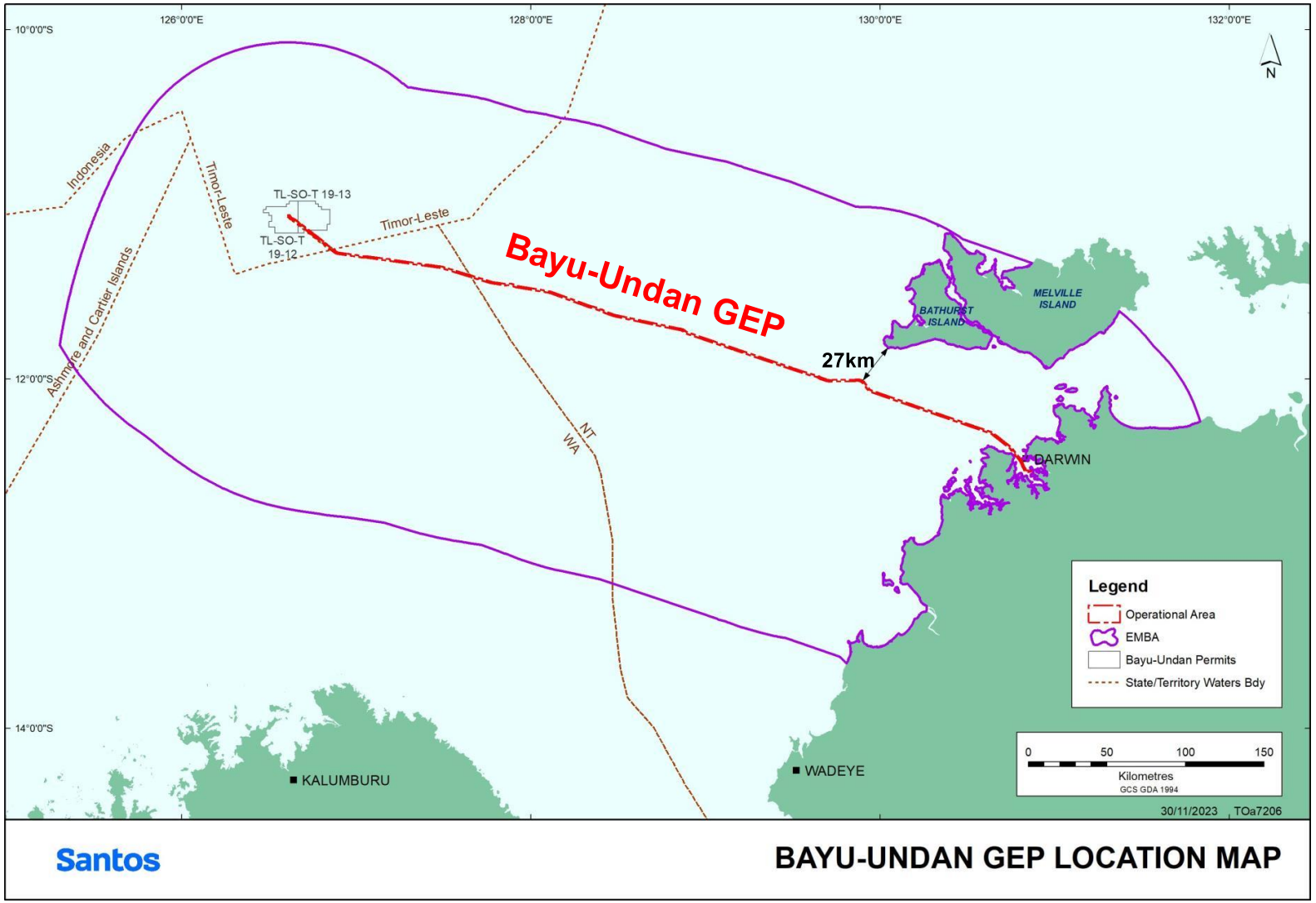
Santos

BONAPARTE BASIN CONSULTATION

Simon Philippides

- **Bayu-Undan Gas Export Pipeline Environment Plan**
- **Eos 3 Marine Seismic Survey (MSS) Environment Plan**
- **Tern-2 Plug and Abandonment Environment Plan**

Bayu-Undan Gas Export Pipeline (GEP) EP



Santos

Bayu-Undan GEP Activity Impacts

Planned Events	Expected Impact	How we Manage (the rules we follow)
Light disturbance	Behavioural impact to marine life (e.g. attraction) and disturbance to other marine users	We only use lights where needed for safe operations and to comply with relevant safety rules. We turn off lights when not required.
Underwater noise disturbance	Behavioural impact to marine life (e.g. avoidance)	We follow procedures and look out for marine life (e.g. whales, dolphins, turtles) and we slow down and move away from them where possible if they are too close. Boats and equipment will be maintained to minimise noise and operated in accordance with Federal requirements.
Seabed and benthic habitat disturbance	Temporary increase in turbidity, increasing sedimentation of habitat and marine growth removal for inspections	Recovery of all deployed temporary equipment and compliance with Santos Pipeline integrity management plan
Discharges (boat discharges, pipeline flooding, cleaning, gauging, testing)	Impact to water quality	We will manage discharges to acceptable levels and follow the standard rules for what boats can discharge. We will select chemicals that are environmentally acceptable, and we will limit their use to only what is needed.
Air emissions	Impact to air quality, contribution to national greenhouse gas levels	We ensure engines and other equipment are looked after and low emission fuel will be used.
Disturbance to other boats	Exclude other users from activity area	We will communicate to other boats where we are and what we are doing. We mark the location of equipment on charts.

Bayu-Undan GEP Unplanned Risks

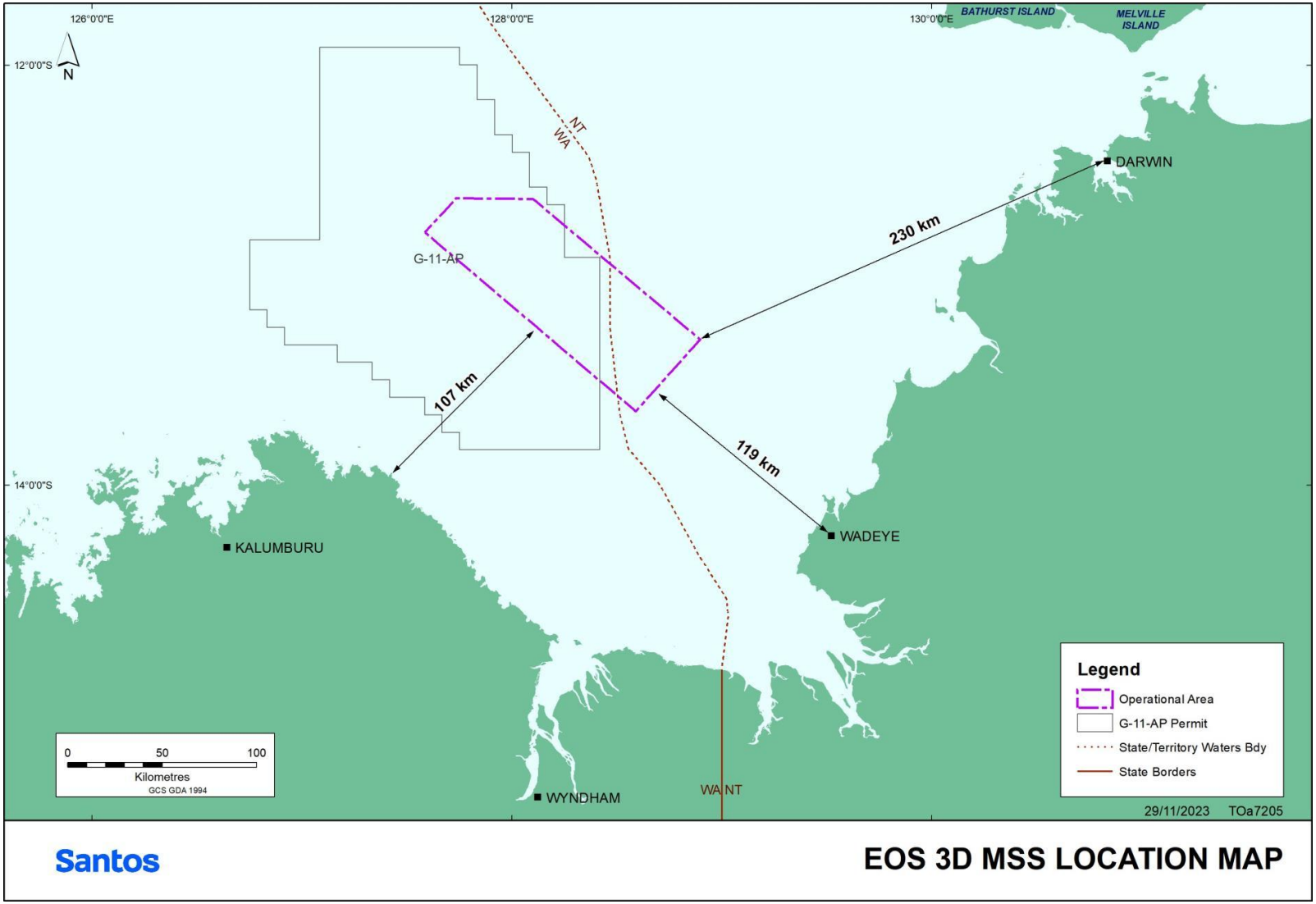
Santos

Unplanned Events (Accidents)	Unplanned Impact	How we manage (the rules we follow)
Dropped objects	Impacts to water quality, disturbance to seabed and marine life	We follow strict procedures to stop objects dropping overboard and we pick up objects when it is safe to do so.
Disturbing marine animals	Disturbance (e.g. collisions) to marine animals	We look out for marine life (e.g., whales, dolphins, turtles) and we slow down and move away from them where possible if they are too close. We follow rules that outline how we need to interact with marine animals.
Invasive marine life (marine pests)	Impacts to other marine life and industry if pests establish	We ensure boats have low risk for carrying marine pests before they arrive. We have plans and equipment in place on boats to prevent invasive marine species. The Federal government has strict rules we need to follow.
Chemical spill	Water quality and marine life impacts	We select chemicals that are friendly to the environment where possible and store them carefully. We have procedures for using and cleaning up chemicals.
Gas release (dry gas) - Bayu-Undan pipeline	Impacts to marine life, water/air quality, other marine users and cultural features	We follow strict rules for lifting equipment and have emergency response procedures. We have procedures in place to minimise loss of gas from Bayu-Undan pipeline.
Diesel spill	Impacts to water quality, habitats and marine life, protected areas, other marine users and cultural values/sensitivities	We make sure all the boats are following the rules for preventing collisions. We let other boats know where we are and what we are doing. We follow strict procedures for refueling. We have plans and arrangements in place for responding to spills.

Santos

BAYU UNDAN GEP EP QUESTIONS?

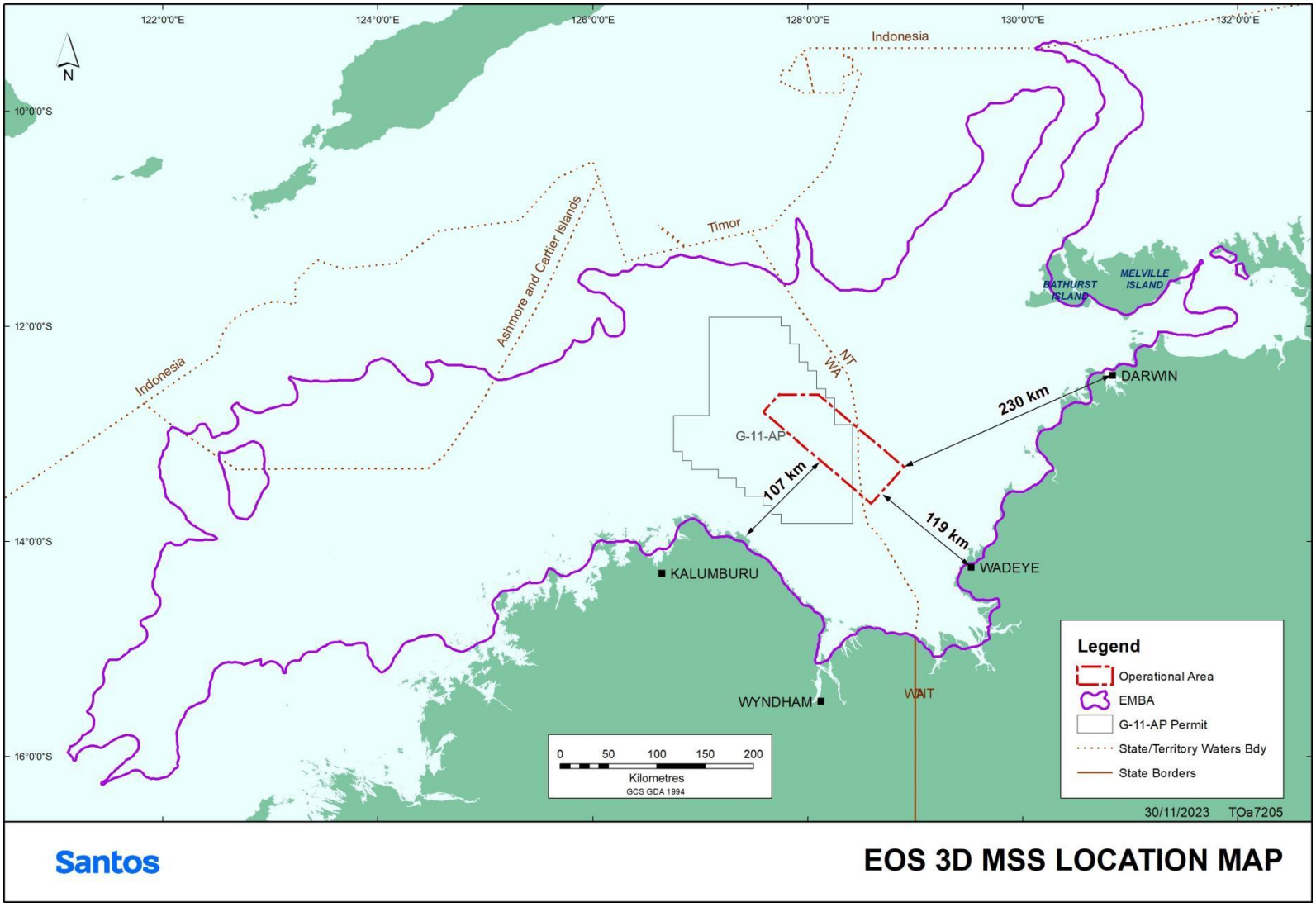
EOS 3D Marine Seismic Survey



Marine Seismic Surveys and the Environment

Santos

EOS 3D Marine Seismic Survey EMBA



Eos 3D MSS - Impacts

Santos

Planned events	How we manage (the rules we follow)
Disturbance to commercial fishers	We will communicate to fishing boats where we are and what we are doing. We have a process to enable commercial fishers to lodge evidence-based payment claims for temporary loss of fish catch, displacement costs and equipment damage or loss directly caused by the seismic survey.
Disturbance to other boats	We will communicate to other boats where we are and what we are doing and provide notifications in advance of the survey starting.
Light disturbance	We only use lights where needed for safe operations. We turn off lights when not needed.
Noise disturbance	We look out for marine life (e.g., whales, dolphins, turtles) before the survey begins Animal spotters stay on the vessel during the survey and monitor marine life. Soft start up- meaning the noise slowly gets louder giving marine animals time to move away from the sound.
Air emissions	We ensure engines and other equipment is looked after and fuel use and waste incineration standards are maintained.
Discharges	We will manage discharges to acceptable levels and follow the standard rules for what boats can discharge.
Impacts from other seismic surveys	We will communicate with other companies that may also be doing seismic surveys in the area and keep a large distance between other seismic vessels.

Eos 3D MSS - Risks

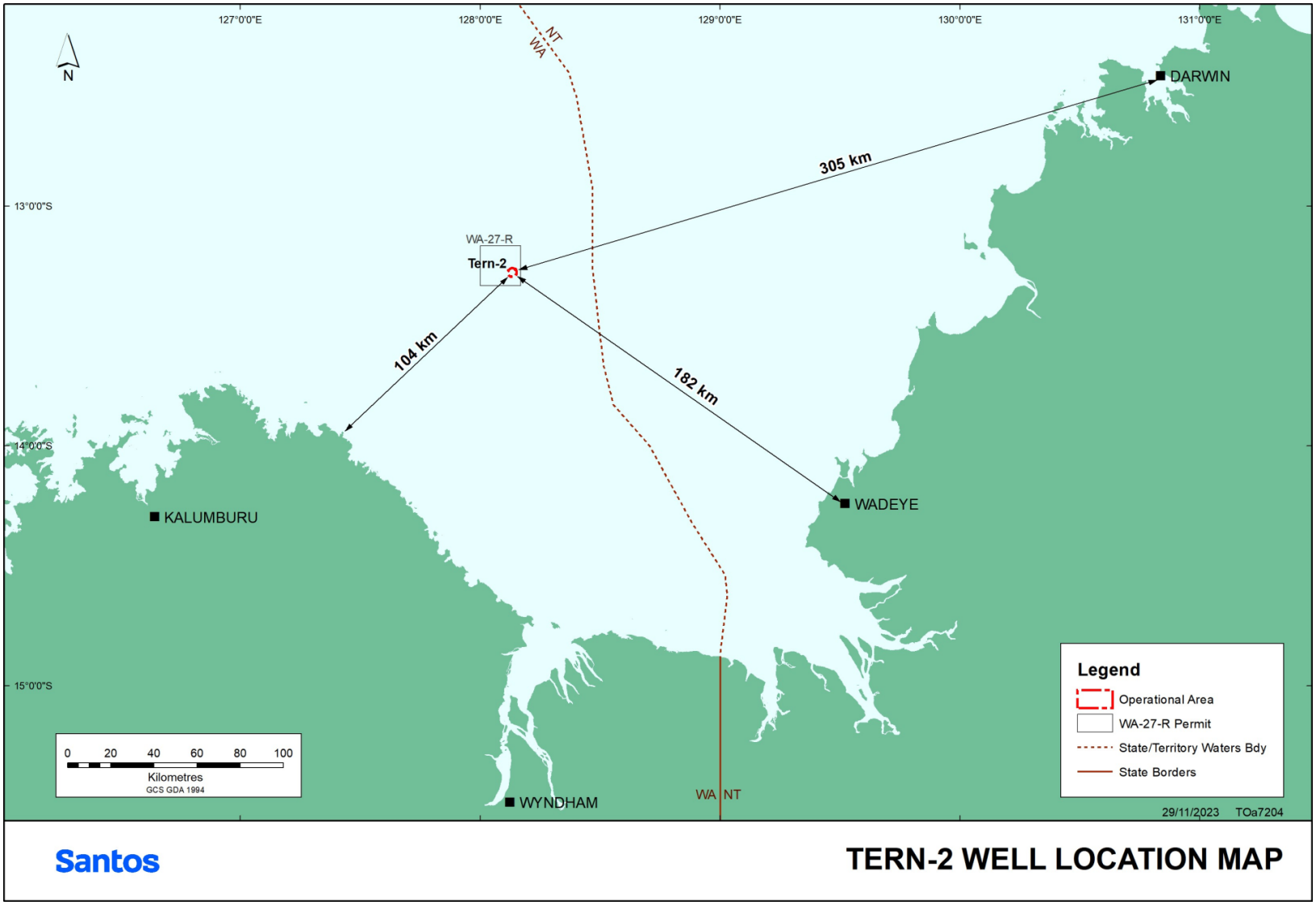
Santos

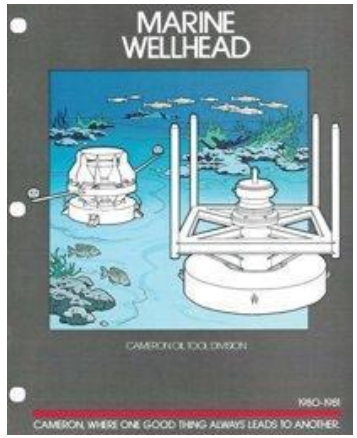
Unplanned events (Accidents)	How we manage (the rules we follow)
Diesel spill	We make sure all the boats associated with the survey are following the rules to prevent collisions. We let other boats know where we are and what we are doing. We follow strict procedures for refuelling.
Discharges/Dropped objects	Where possible and safe to do so, we will recover any waste or equipment that accidentally falls overboard into the ocean.
Disturbing marine animals	We look out for marine life (e.g., whales, dolphins, turtles) and the support vessel will slow down and move away from them where possible if they are too close while the survey is taking place. The seismic source will be stopped if certain marine life is observed too close to the seismic vessel
Invasive marine life	We will use an anti-foulant system and follow strict procedures to avoid any introduction of invasive marine life.
Chemical spill	We select chemicals that are friendly to the environment where possible and store them carefully. We have procedures for using and cleaning up chemicals.
Oil spill response	We have plans and resources to be used if there is an accidental oil spill.

Santos

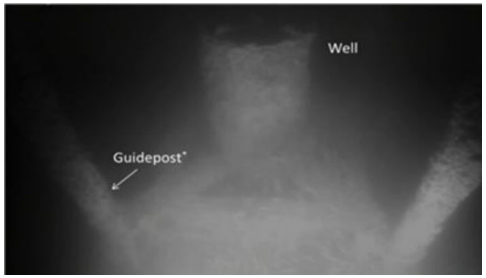
EOS 3D MSS EP QUESTIONS?

Tern-2 Plug & Abandonment



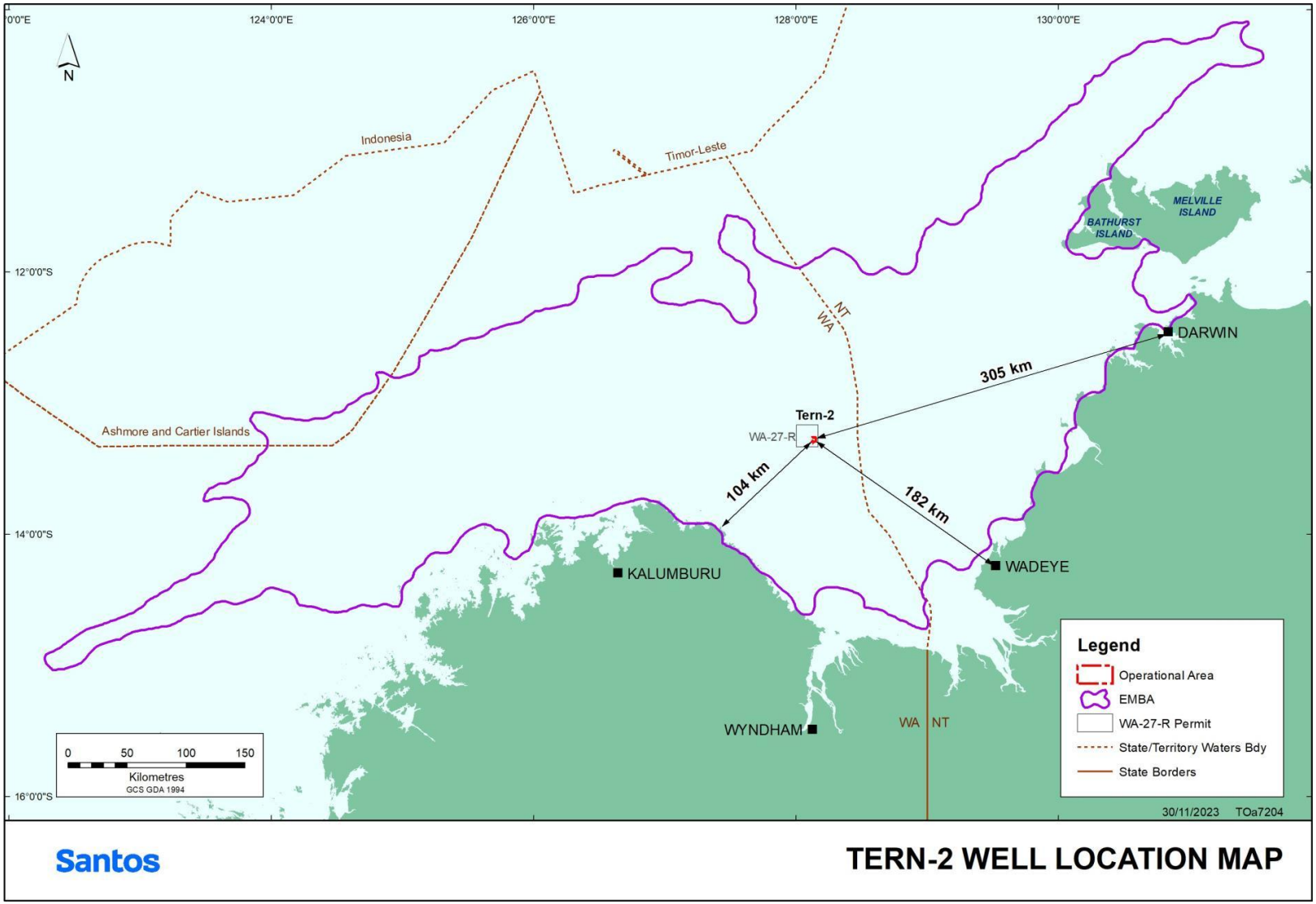


Example of the Tern-2 wellhead



Example of wellhead at
Tern-2 wellhead location

Tern-2 Plug & Abandonment EMBA



Tern-2 P&A - Impacts

Santos

Planned events	How we manage (the rules we follow)
Disturbance to other boats	We will communicate to other boats where we are and what we are doing. We mark the location of equipment on charts.
Seabed disturbance	We are putting equipment on a flat sandy seabed. We only put equipment in the approved location.
Light disturbance	We only use lights where needed for safe operations. We turn off lights when not needed.
Noise disturbance	We look out for marine life (e.g., whales, dolphins, turtles) and noise levels. Activities are not expected to impact at population level or have a significant impacts on foraging behaviours of marine turtles.
Air emissions	We ensure engines and other equipment is looked after and fuel use and waste incineration standards are maintained.
Discharges	We will manage discharges to acceptable levels and follow the standard rules for what boats can discharge.
Wellhead left on seabed	We will leave the wellhead on the seabed only if it cannot be removed easily due to technical difficulties.
Oil spill response	We have plans and resources to be used if there is an accidental oil spill.

Tern-2 P&A - Risks

Santos

Unplanned events (Accidents)	How we manage (the rules we follow)
Diesel spill	We make sure all the boats are following the rules for preventing collisions. We let other boats know where we are and what we are doing. We will not refuel within the operational area.
Dropped objects	We follow strict procedures to stop objects dropping overboard and we pick up objects when it is safe to do so.
Disturbing marine animals	We look out for marine life (e.g., whales, dolphins, turtles) when transiting within and to and from the operational area and we slow down and move away from them where possible if they are too close.
Invasive marine life	We will use an anti-foulant system and follow strict procedures to avoid any introduction of invasive marine life.
Chemical spill	We select chemicals that are friendly to the environment where possible and store them carefully. We have procedures for using and cleaning up chemicals.
Disturbance to other boats	We let other boats know where we are and what we are doing. We will let other boats, fishing groups, and the government know if the wellhead cannot be removed and will be left on the seabed.

Santos

TERN-2 P&A EP QUESTIONS?

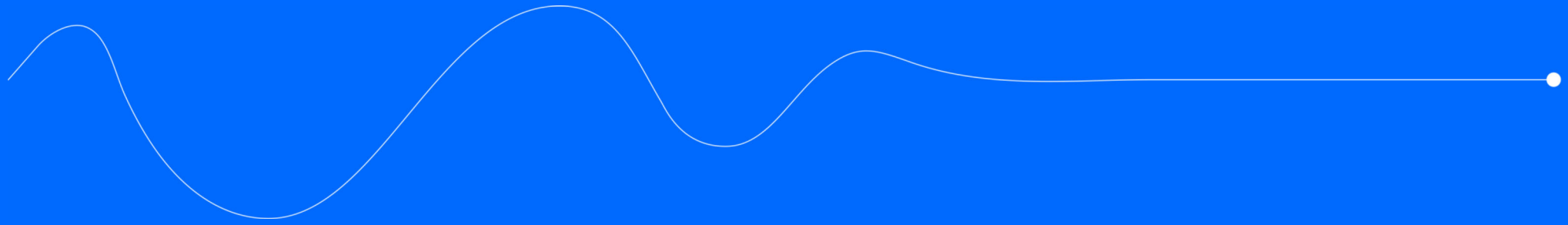
Santos

BONAPARTE QUESTIONS?

Santos

CLOSE OUT

Carly Sherren



NT & WA 11A Consultation_2023_Four EPs_Larrakia Nation 1

Santos

BAROSSA GAS PROJECT AND BONAPARTE BASIN

DECEMBER CONSULTATION

Barossa

- Darwin Pipeline Duplication (DPD) Environment Plan
- DPD Construction Environmental Management Plan (CEMP)

Bonaparte

- Bayu-Undan Gas Export Pipeline Environment Plan
- Eos 3 Marine Seismic Survey (MSS) Environment Plan
- Tern-2 Plug and Abandonment Environment Plan

Acknowledgement of Country

Santos acknowledges the Traditional Owners of the land on which we meet today.

We pay our respects to Elders past, present and emerging.

Santos

Privacy Statement

Santos Ltd and its related bodies corporate (together, we, our, us or Santos) collect personal information about you, such as your name and sensitive information about your indigenous heritage. We use this information to record your attendance at any meeting or other discussion with us, to provide you with information about our projects, to receive and respond to any information that you provide, to answer any questions you might have and for other purposes that we tell you about during your meeting or other discussion with us. Santos will handle any information that you provide in accordance with our Code of Conduct and our Confidentiality, IP and Privacy Procedure. You can ask us for a copy of this Privacy Notice or these other documents.

If you do not provide your personal information, we may not be able to identify you as the person who provided particular information or we may be unable to discuss any information you have provided with you further or respond to your questions. We may disclose your information to other companies within the Santos group, to third parties that help us run our business and to relevant government agencies and government departments.

Due to the global nature of our operations and business, your personal information may be accessed by or disclosed to Santos personnel outside Australia. We may also use overseas third parties to collect, transfer, store and handle your personal information. Some of the overseas countries that your personal information may be accessed from, disclosed or transmitted to or stored in include but are not limited to, Papua New Guinea and the United States of America.

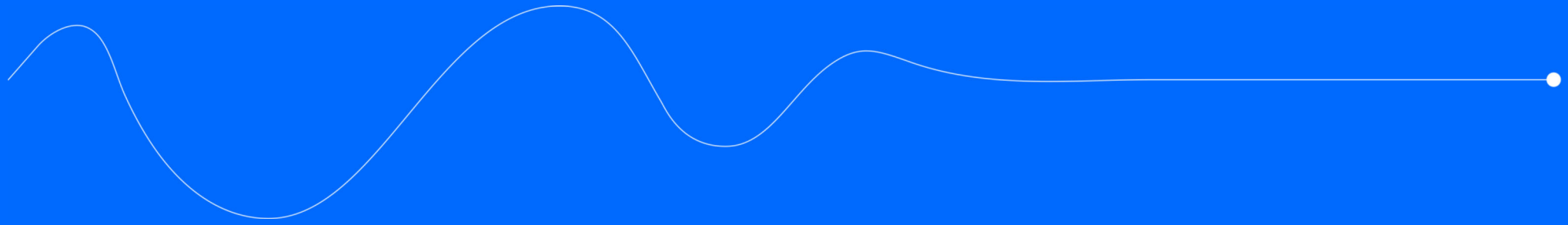
You have a right to request a copy of any personal information that we hold about you, as well as a right to request that we correct any information that we hold about you that is inaccurate, out-of-date, incomplete, irrelevant or misleading. You can also make a complaint about how we have handled your personal information. Our Consultation Privacy Policies explain in more detail how you can exercise these rights, including how we will respond to your access or correction request or to any privacy complaint that you make. The Barossa Gas Project Consultation Privacy Policy is available on our website at www.santos.com/barossa/barossa-gas-project-consultation-privacy-policy, and the Western Australia and Northern Territory Consultation Privacy Policy is available on our website at https://www.santos.com/offshore-wa-and-nt-consultation-privacy-policy/. You can also contact us to request copies be provided to you.

You can contact us by:

- posting a letter addressed to us at 60 Flinders Street, Adelaide, South Australia, 5000;
- telephoning us on +61 8 8116 5000; or
- sending us an email at offshore.consultation@santos.com and compliance@santos.com.

Santos

WELCOME AND INTRODUCTIONS



Santos

Welcome & Introductions

We are here today to share information about our company & operations, seek information from you and listen to your questions about Santos & upcoming projects.

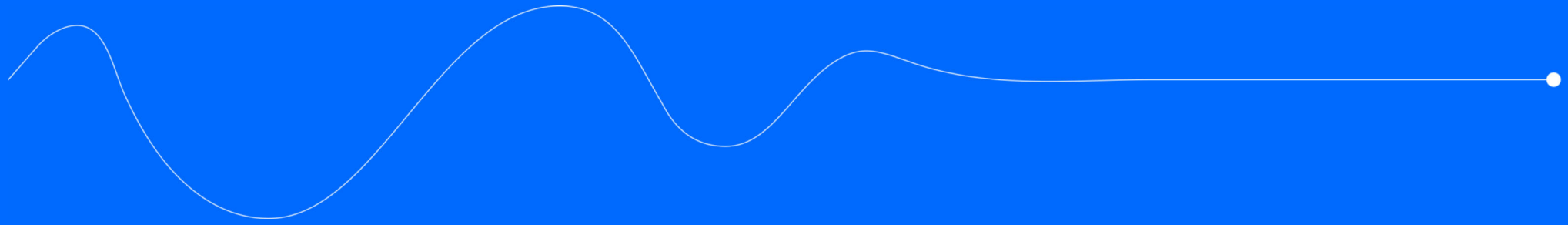
Tony Johnson *- Manager Consultation and Engagement, Offshore*

Mike Marren*- Senior Stakeholder Advisor*

Phil Sparrow- *Senior Stakeholder Advisor*

Santos

SANTOS OPERATIONS & DARWIN LNG



WA & NT Environment Plan Consultation

Presented by **Barossa Team**

SANTOS - South Australia, Northern Territory Oil Search

Santos is a global energy company committed to increasingly cleaner energy and fuels production, with operations across Australia, Papua New Guinea, Timor-Leste and North America (Alaska).

At Santos, our commitment is to be a global leader in the transition to cleaner energy and clean fuels, by helping the world decarbonise to reach net-zero emissions in an affordable and sustainable way.

For more than 65 years, Santos has been working in partnership with local communities, providing local jobs and business opportunities, safely developing its natural gas resources, and powering industries and households.

Santos is one of Australia's biggest domestic gas suppliers and a leading LNG supplier in the Asia Pacific region.

We are committed to supplying critical fuels such as oil and gas in a more sustainable way through decarbonising projects, including the Moomba CCS Project, while we all transition to cleaner fuels.

Our business focus: Safe, reliable operations & Minimise our social and environmental impacts.

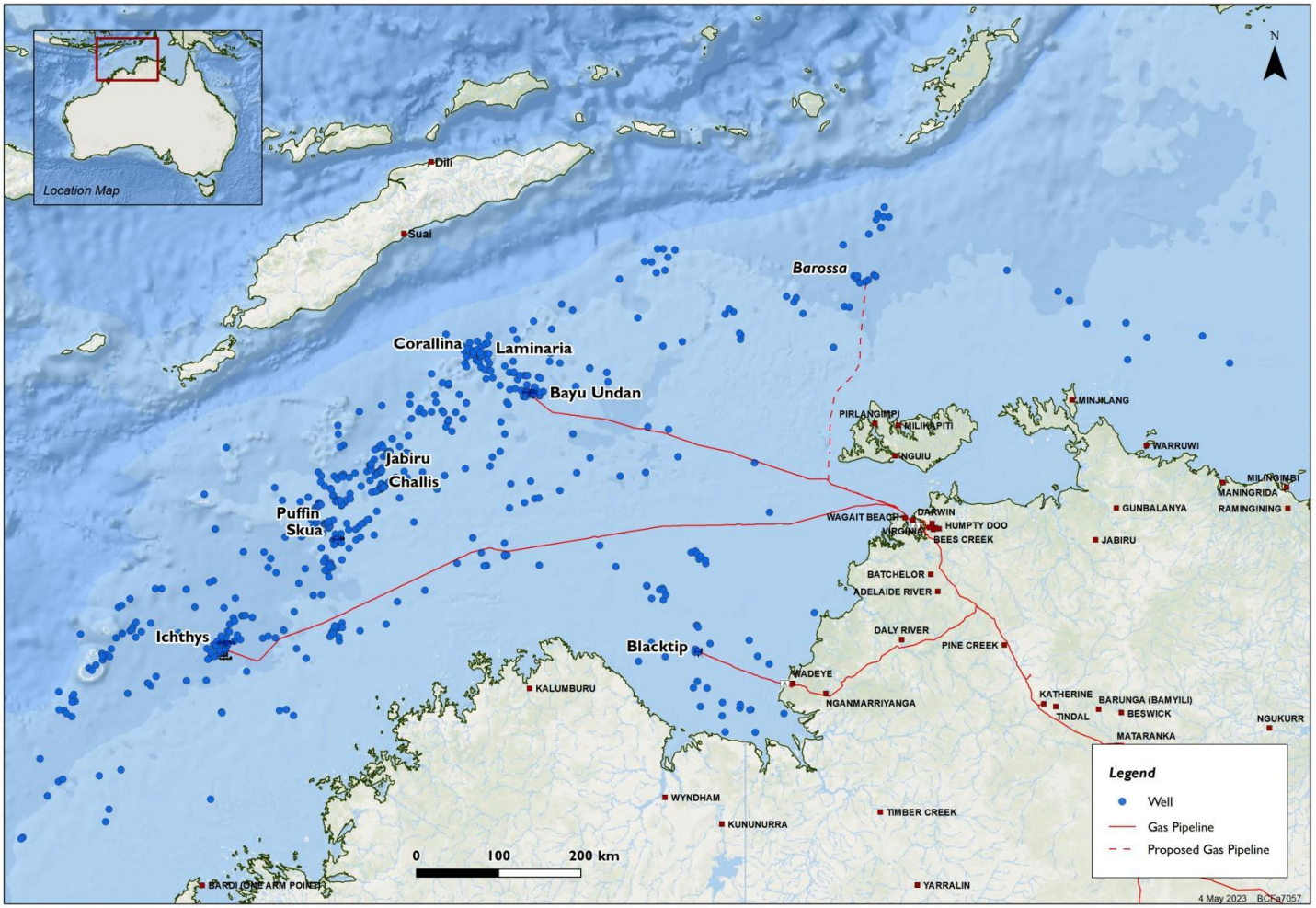
Darwin LNG Facility & Operations

Santos

- Located in Darwin at Wickham Point Darwin LNG (DLNG) is a single train liquefaction and storage facility that started production in 2006.
- The Bayu-Undan facility, which supplies gas to DLNG via 26-inch subsea pipeline, is located approximately 500 kilometers north-west of Darwin in the Timor Sea.
- The facility includes a central production Storage and Offloading vessel for condensate and LPG products and an unmanned wellhead platform.
- Approx 140 local Darwin people work at the LNG Facility.
- 100% Darwin residential Santos employee workforce.
- DLNG established the NT's first LNG Process Operator Traineeships in 2010.
  - ~10% of those who have completed identified as an Aboriginal or Torres Strait Islander.

Wells Oil & Gas Drilled by All Industry Since 1969

Santos

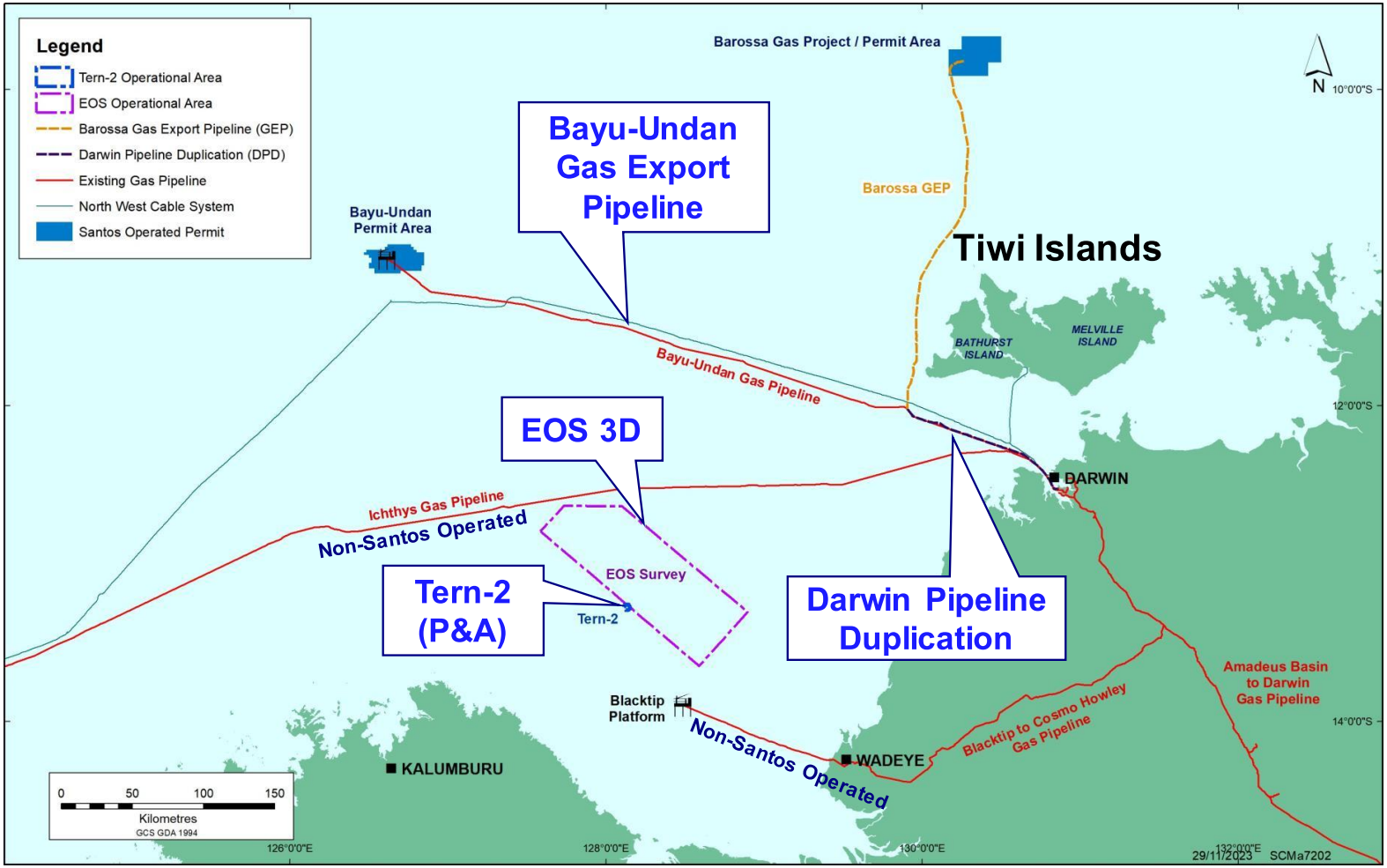


These are not all Santos owned and operated.

This map shows all wells drilled in the NT area.

Not all of these wells are used. Many are capped.

Regional Overview



- Santos is undertaking consultation for the following proposed activities:
  - Darwin Pipeline Duplication
  - Tern-2 Plug and Abandonment (P&A)
  - EOS 3D Marine Seismic Survey
  - Bayu-Undan Gas Export Pipeline Operations

Santos

Barossa Gas Project - Overview

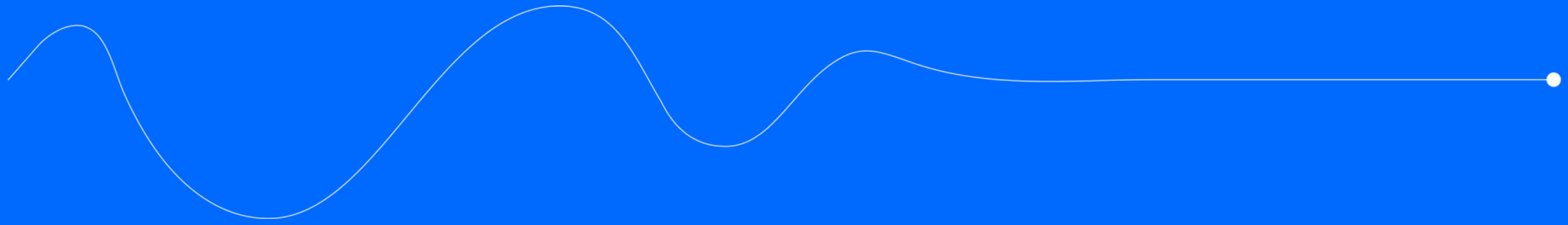
- The Santos-operated Barossa Gas Project is an offshore gas and condensate project that proposes to provide a new source of gas to the existing Darwin liquified natural gas (DLNG) facility in Darwin.
- The Barossa gas field is approximately 285 kilometres offshore north-north west from Darwin.
- Natural gas would be extracted from the Barossa field and transported via a gas pipeline (Gas Export Pipeline (GEP) and Darwin Pipeline Duplication (DPD)) to the existing DLNG facility.
- Project infrastructure would comprise a Floating Production Storage and Offloading (FPSO) facility, a subsea production system, supporting in-field subsea infrastructure, the GEP and the DPD.
- Up to eight subsea wells are planned to be drilled in the Barossa field (six wells from three drill centres, with contingency plans for an additional two wells). Gas and condensate would be gathered from the wells through the subsea production system and then brought to the FPSO facility via a network of subsea infrastructure.
- Initial processing would occur at the FPSO facility, to separate the natural gas, water and condensate extracted from the Barossa field. The dry natural gas would be transported through the gas pipeline for onshore processing at the DLNG facility. Condensate would be transferred from the FPSO to specialised tankers for export.

Santos

Barossa Gas Project Overview Video

Santos

ENGAGEMENT & CONSULTATION EXPLAINED



Consultation for Environment Plans

Commonwealth waters – National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA)

"In the course of preparing an Environment Plan, a titleholder must consult with relevant persons in accordance with Division 2.2A, Regulation 11A…

"The purpose of consultation under regulation 11A of the Environment Regulations is to ensure that authorities, persons or organisations that are potentially affected by activities are consulted and their input considered in the development of environment plans."

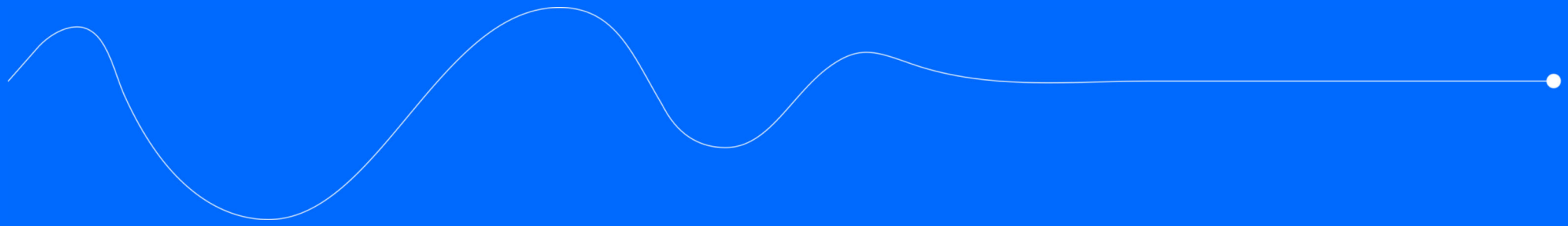
Guideline - Consultation in the course of preparing an environment plan, NOPSEMA

NOPSEMA

Information provided by relevant persons in consultation may also help titleholders **better understand the values and sensitivities of the environment** and inform the evaluation of the **potential impacts and risks** associated with the activity and **how to manage them** appropriately

Santos

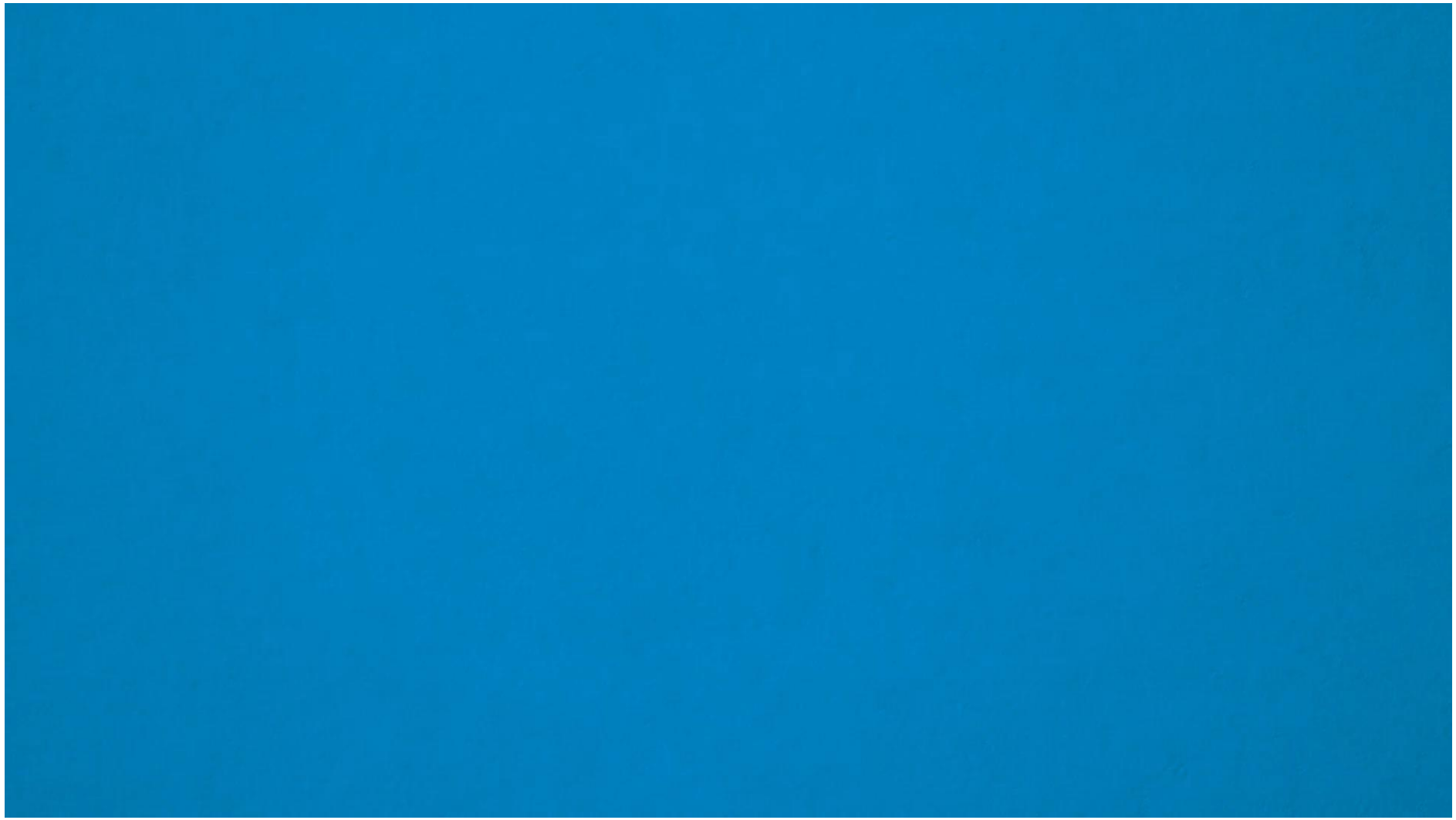
BAROSSA DARWIN PIPELINE DUPLICATION CONSULTATION



WA & NT Environment Plan Consultation

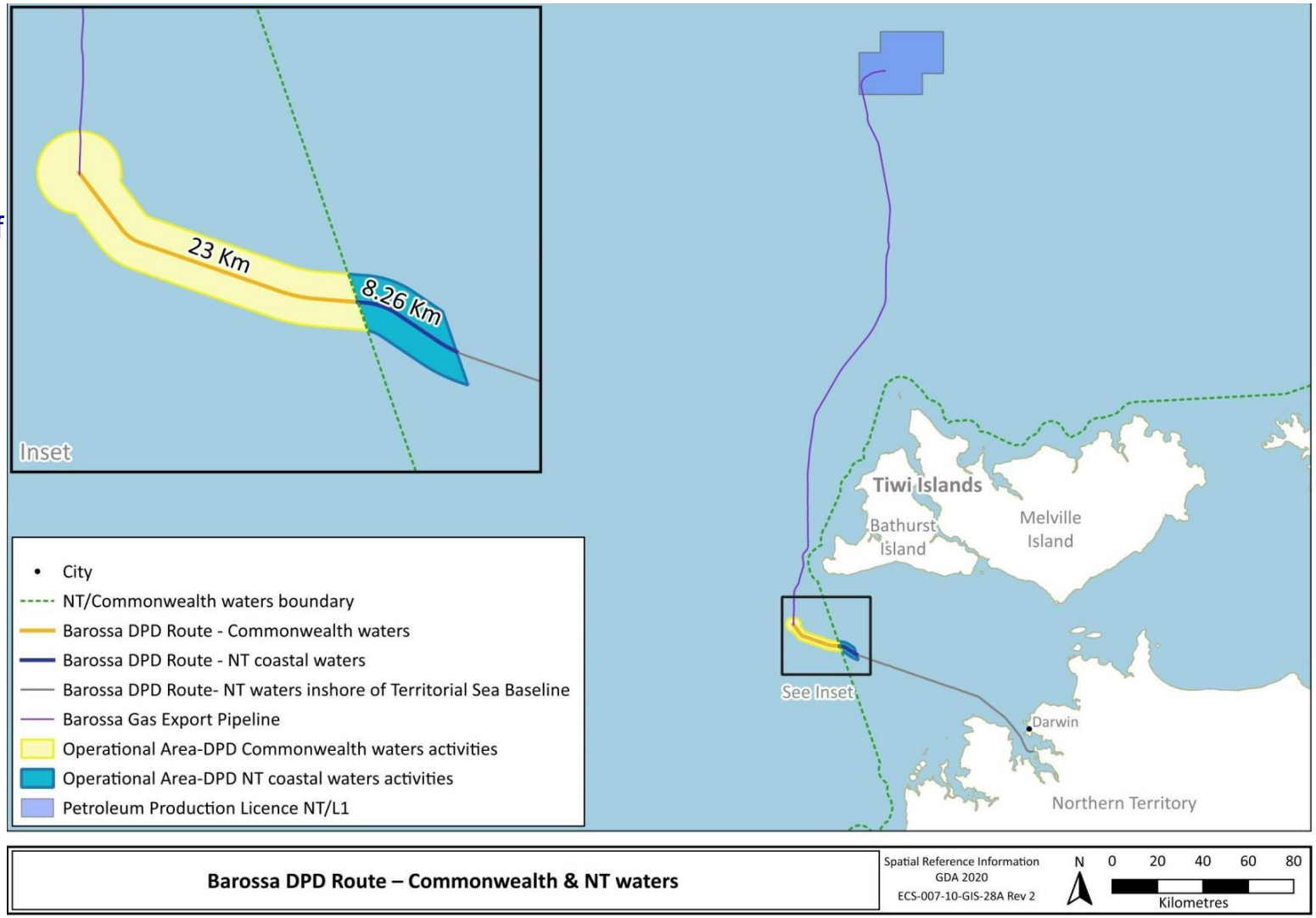
Barossa Darwin Pipeline Duplication Video

Santos



Darwin Pipeline Duplication (DPD) - Overview Santos

- The DPD will connect to the Barossa gas export pipeline and will send gas to Darwin.
- The pipeline will run from approximately 27km south-west of the Tiwi Islands to the gas plant in Darwin Harbour.
- Activities consist of acoustic positioning, survey, pipeline and structure installation, pipeline testing, refuelling, connecting the DPD to the Barossa gas export pipeline and unplanned maintenance/repairs.
- DPD activities are currently planned to start between Q3 of 2024 and Q2 of 2025, depending on availability of vessels and equipment, and should last 3 months)



Santos

DPD Installation – Work in Darwin Harbour

The construction activities within Darwin Harbour extend from the gas plant to approximately 30km offshore. Activities include those shown below.

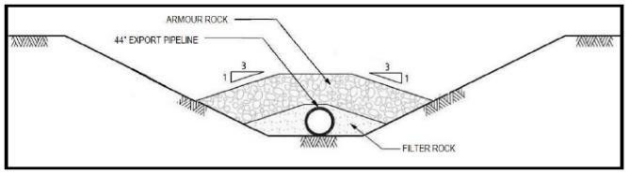
Pre-lay Trenching and Survey

Pre-lay trenching and survey is performed along the pipeline route.

Shallow Water Pipelay

Approximately 30 km of pipeline from shore will be installed using a shallow water anchored barge.

Rock Placement



Rock is installed to protect and stabilise the pipeline.

Santos

DPD Installation – Work Outside Darwin Harbour

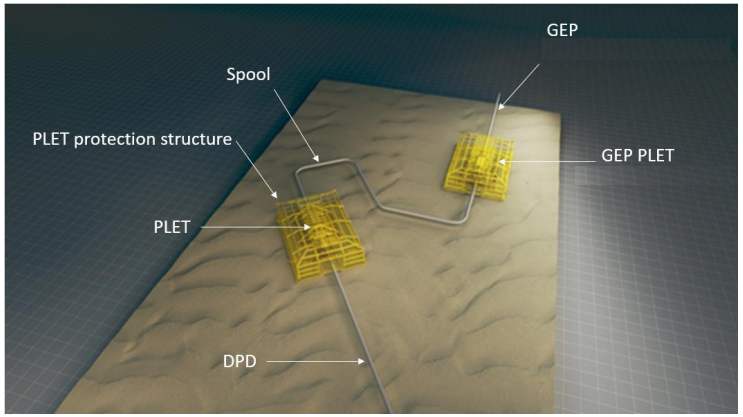
The construction activities outside of Darwin Harbour extend from the harbour limits to approximately 27km south west of the Tiwi Islands. This includes Commonwealth waters and NT Coastal waters

Pipelay Vessel

Survey and Construction Support Vessel

Construction activities include:

- Survey
- Span correction
- Pipeline and structure installation
- Pre-commissioning
- Spool installation



Pipeline End Termination and Spool

Santos

DPD Activity Impacts – Activities Outside of Darwin Harbour

Planned Events	Expected Impact	How we Manage (the rules we follow)
Light disturbance	Behavioural impact to marine life (e.g. attraction) and disturbance to other marine users	We only use lights where needed for safe operations and to comply with relevant safety rules. We turn off lights when not required.
Underwater noise disturbance	Behavioural impact to marine life (e.g. avoidance)	We follow procedures and look out for marine life (e.g. whales, dolphins, turtles) and we slow down and move away from them where possible if they are too close. Boats and equipment will be maintained to minimise noise and operated in accordance with Federal requirements.
Seabed disturbance (pipeline and equipment installation)	Temporary increase in turbidity, increasing sedimentation of habitat	We are putting equipment on a mainly flat sandy seabed close to an existing pipeline. We record the position of installed equipment so it can be removed at a later date.
Discharges (boat discharges, pipeline flooding, cleaning, gauging, testing)	Impact to water quality	We will manage discharges to acceptable levels and follow the standard rules for what boats can discharge. We will select chemicals that are environmentally acceptable, and we will limit their use to only what is needed.
Air emissions	Impact to air quality, contribution to national greenhouse gas levels	We ensure engines and other equipment are looked after and low emission fuel will be used.
Disturbance to other boats	Exclude other users from activity area	We will communicate to other boats where we are and what we are doing. We mark the location of equipment on charts.

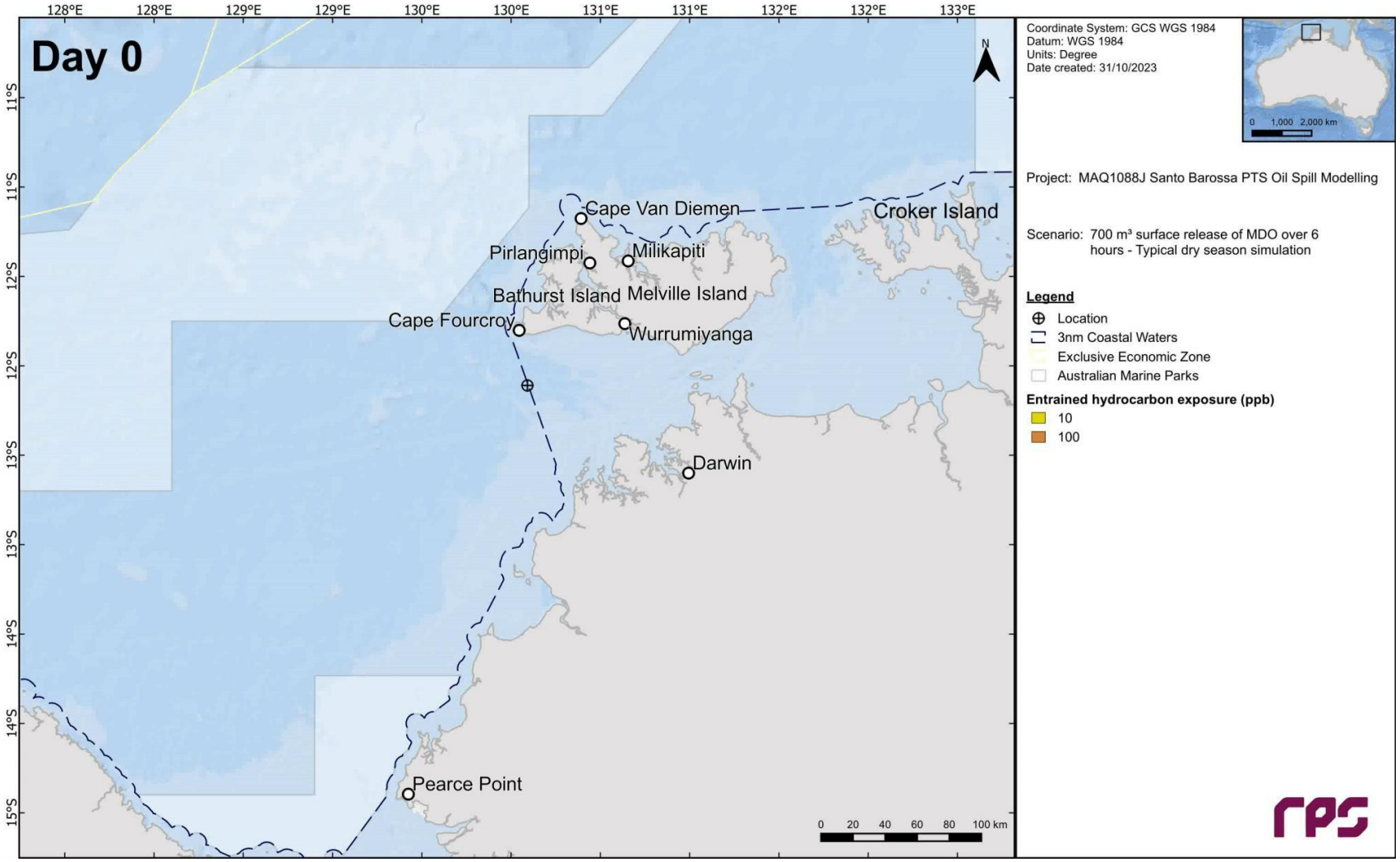
DPD Unplanned Risks – Outside of Darwin Harbour

Santos

Unplanned Events (Accidents)	Unplanned Impact	How we manage (the rules we follow)
Dropped objects	Impacts to water quality, disturbance to seabed and marine life	We follow strict procedures to stop objects dropping overboard and we pick up objects when it is safe to do so.
Disturbing marine animals	Disturbance (e.g. collisions) to marine animals	We look out for marine life (e.g., whales, dolphins, turtles) and we slow down and move away from them where possible if they are too close. We follow rules that outline how we need to interact with marine animals.
Invasive marine life (marine pests)	Impacts to other marine life and industry if pests establish	We ensure boats have low risk for carrying marine pests before they arrive. We have plans and equipment in place on boats to prevent invasive marine species. The Federal government has strict rules we need to follow.
Chemical spill	Water quality and marine life impacts	We select chemicals that are friendly to the environment where possible and store them carefully. We have procedures for using and cleaning up chemicals.
Gas release (dry gas or nitrogen) - Bayu-Undan pipeline	Impacts to marine life, water/air quality, other marine users and cultural features	We follow strict rules for lifting equipment and have emergency response procedures. We have procedures in place to minimise loss of gas from Bayu-Undan pipeline.
Diesel spill	Impacts to water quality, habitats and marine life, protected areas, other marine users and cultural values/sensitivities	We make sure all the boats are following the rules for preventing collisions. We let other boats know where we are and what we are doing. We follow strict procedures for refueling. We have plans and arrangements in place for responding to spills.

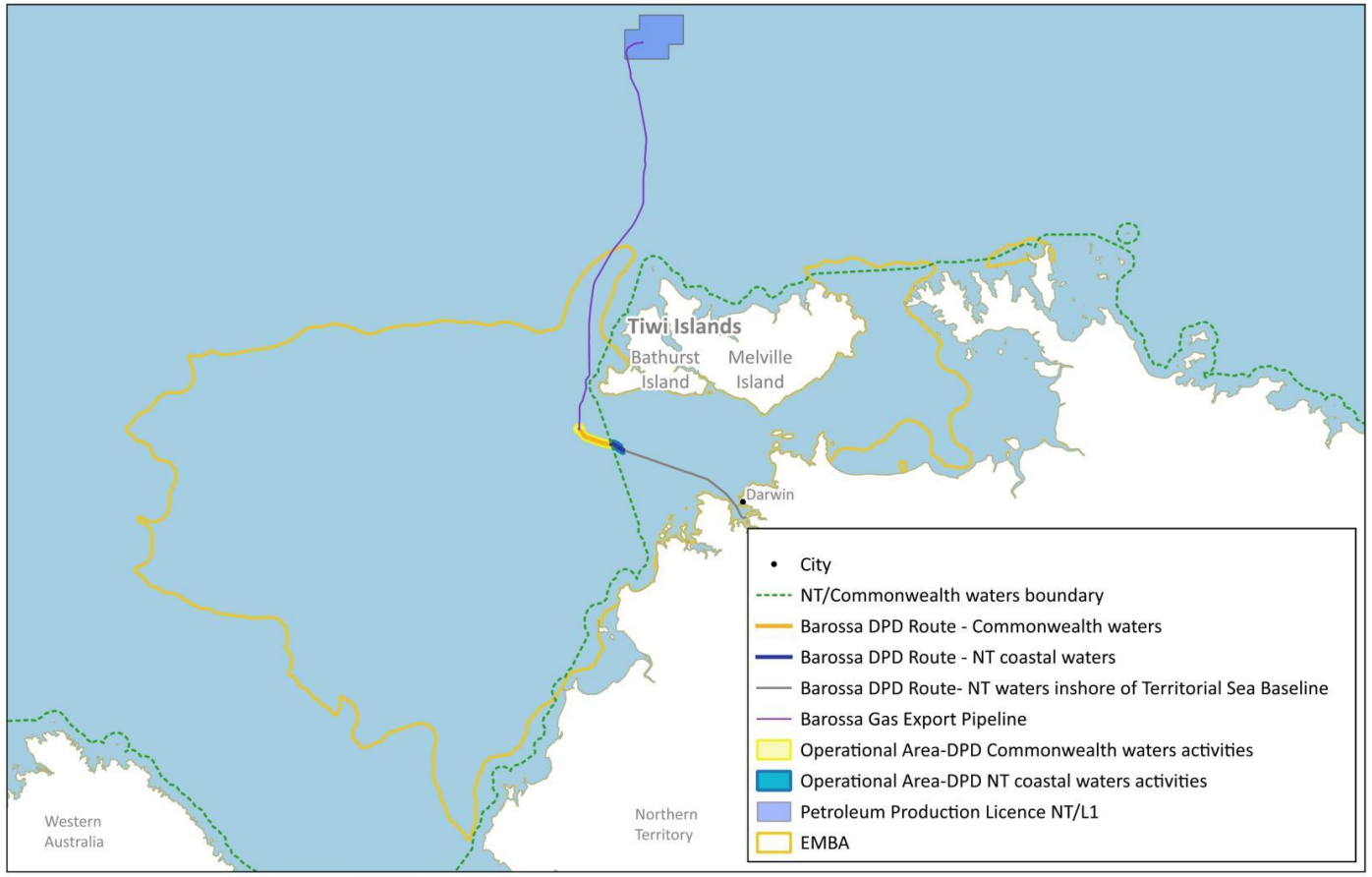
DPD Diesel Spill Animation – typical dry season simulation

Santos



DPD Environment That May Be Affected – Diesel Spill

Santos



Audacia (pipelay vessel) – 225 m.

700,000 L of diesel is worst case spill

Bulk carrier – 187 m

Cruise ship – 298 m

Santos

DPD QUESTIONS?

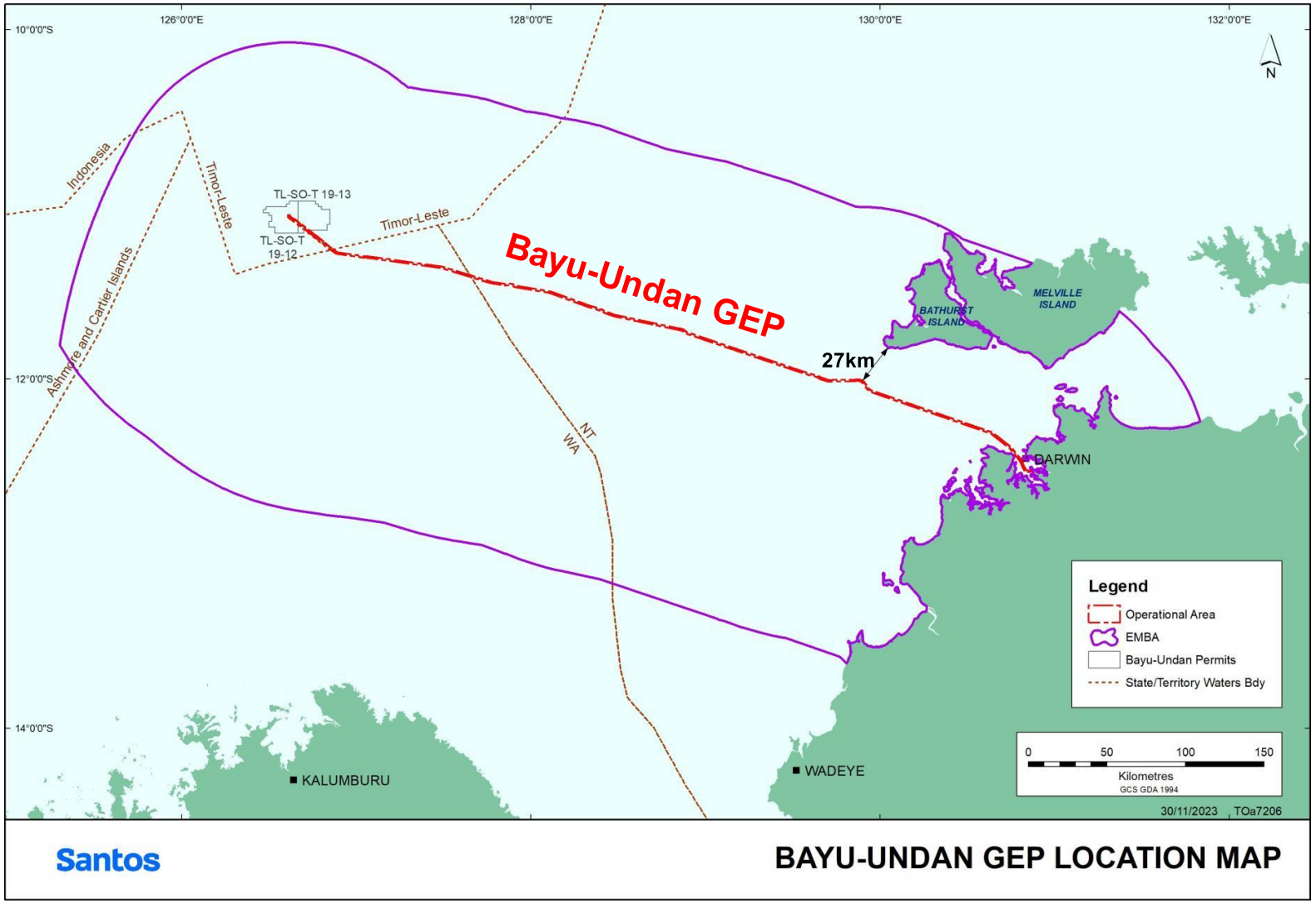
Santos

BONAPARTE BASIN CONSULTATION

Simon Philippides

- **Bayu-Undan Gas Export Pipeline Environment Plan**
- **Eos 3 Marine Seismic Survey (MSS) Environment Plan**
- **Tern-2 Plug and Abandonment Environment Plan**

Bayu-Undan Gas Export Pipeline (GEP) EP



Santos

Bayu-Undan GEP Activity Impacts

Planned Events	Expected Impact	How we Manage (the rules we follow)
Light disturbance	Behavioural impact to marine life (e.g. attraction) and disturbance to other marine users	We only use lights where needed for safe operations and to comply with relevant safety rules. We turn off lights when not required.
Underwater noise disturbance	Behavioural impact to marine life (e.g. avoidance)	We follow procedures and look out for marine life (e.g. whales, dolphins, turtles) and we slow down and move away from them where possible if they are too close. Boats and equipment will be maintained to minimise noise and operated in accordance with Federal requirements.
Seabed and benthic habitat disturbance	Temporary increase in turbidity, increasing sedimentation of habitat and marine growth removal for inspections	Recovery of all deployed temporary equipment and compliance with Santos Pipeline integrity management plan
Discharges (boat discharges, pipeline flooding, cleaning, gauging, testing)	Impact to water quality	We will manage discharges to acceptable levels and follow the standard rules for what boats can discharge. We will select chemicals that are environmentally acceptable, and we will limit their use to only what is needed.
Air emissions	Impact to air quality, contribution to national greenhouse gas levels	We ensure engines and other equipment are looked after and low emission fuel will be used.
Disturbance to other boats	Exclude other users from activity area	We will communicate to other boats where we are and what we are doing. We mark the location of equipment on charts.

Bayu-Undan GEP Unplanned Risks

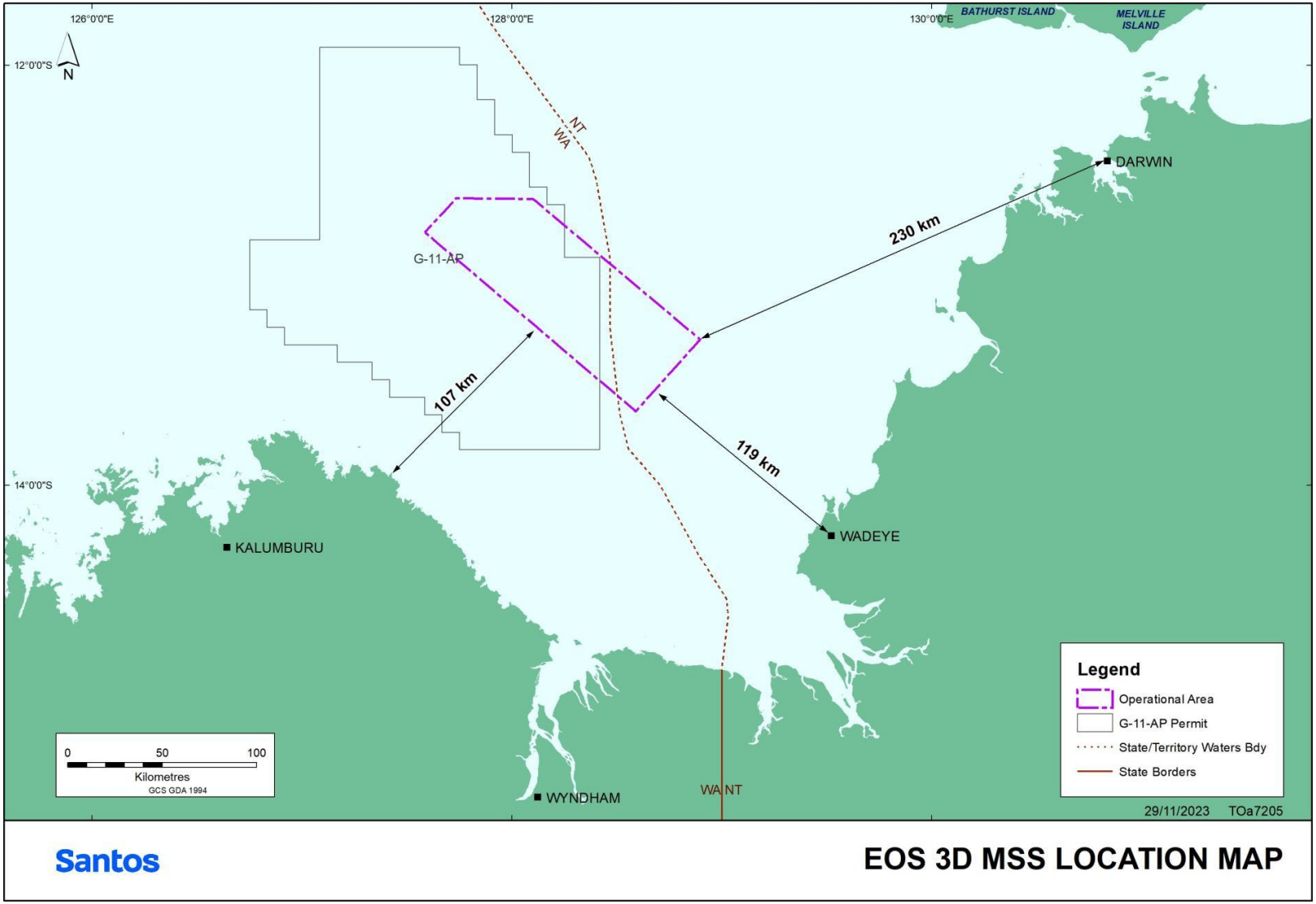
Santos

Unplanned Events (Accidents)	Unplanned Impact	How we manage (the rules we follow)
Dropped objects	Impacts to water quality, disturbance to seabed and marine life	We follow strict procedures to stop objects dropping overboard and we pick up objects when it is safe to do so.
Disturbing marine animals	Disturbance (e.g. collisions) to marine animals	We look out for marine life (e.g., whales, dolphins, turtles) and we slow down and move away from them where possible if they are too close. We follow rules that outline how we need to interact with marine animals.
Invasive marine life (marine pests)	Impacts to other marine life and industry if pests establish	We ensure boats have low risk for carrying marine pests before they arrive. We have plans and equipment in place on boats to prevent invasive marine species. The Federal government has strict rules we need to follow.
Chemical spill	Water quality and marine life impacts	We select chemicals that are friendly to the environment where possible and store them carefully. We have procedures for using and cleaning up chemicals.
Gas release (dry gas) - Bayu-Undan pipeline	Impacts to marine life, water/air quality, other marine users and cultural features	We follow strict rules for lifting equipment and have emergency response procedures. We have procedures in place to minimise loss of gas from Bayu-Undan pipeline.
Diesel spill	Impacts to water quality, habitats and marine life, protected areas, other marine users and cultural values/sensitivities	We make sure all the boats are following the rules for preventing collisions. We let other boats know where we are and what we are doing. We follow strict procedures for refueling. We have plans and arrangements in place for responding to spills.

Santos

BAYU UNDAN GEP EP QUESTIONS?

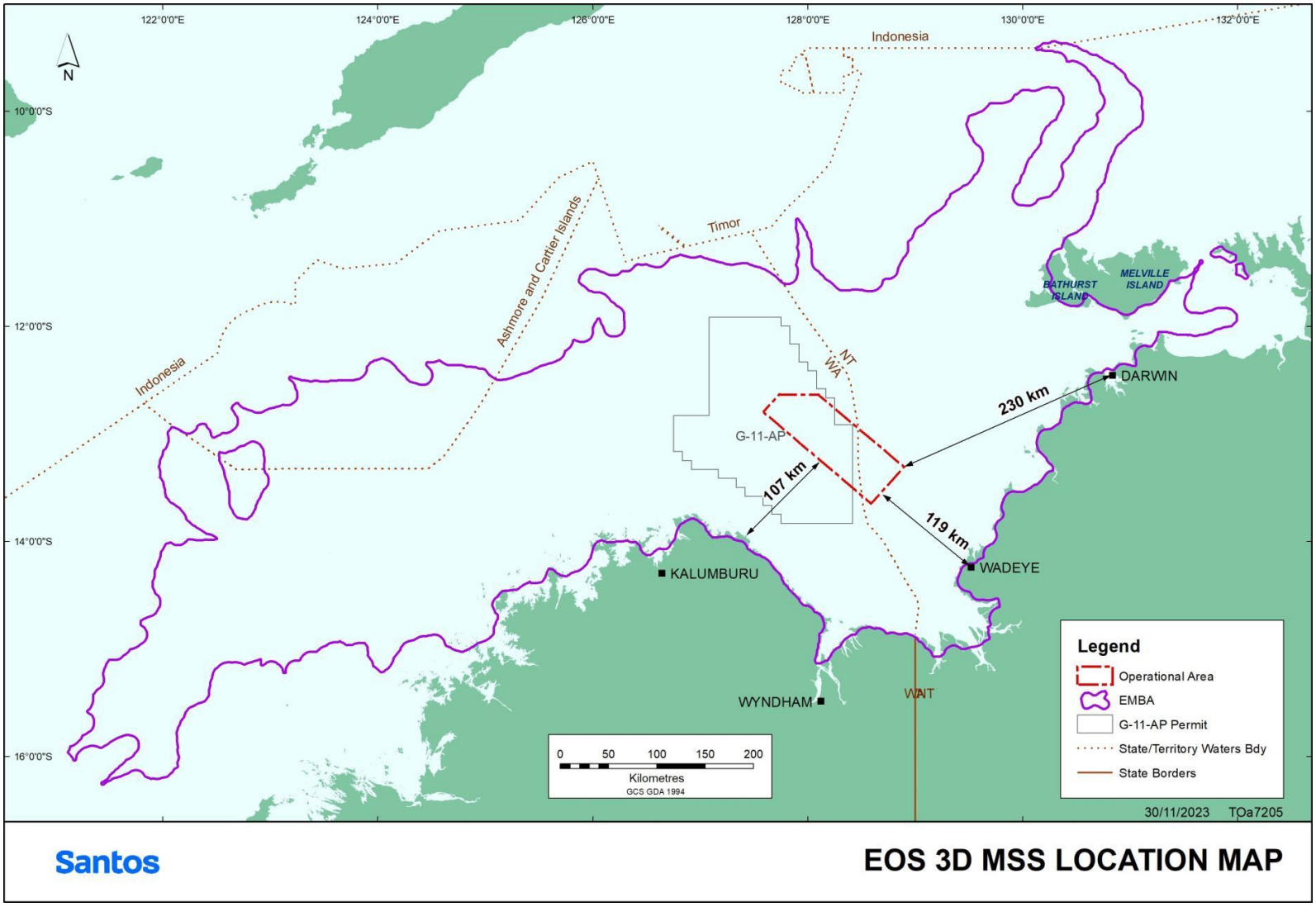
EOS 3D Marine Seismic Survey



Marine Seismic Surveys and the Environment

Santos

EOS 3D Marine Seismic Survey EMBA



Eos 3D MSS - Impacts

Santos

Planned events	How we manage (the rules we follow)
Disturbance to commercial fishers	We will communicate to fishing boats where we are and what we are doing. We have a process to enable commercial fishers to lodge evidence-based payment claims for temporary loss of fish catch, displacement costs and equipment damage or loss directly caused by the seismic survey.
Disturbance to other boats	We will communicate to other boats where we are and what we are doing and provide notifications in advance of the survey starting.
Light disturbance	We only use lights where needed for safe operations. We turn off lights when not needed.
Noise disturbance	We look out for marine life (e.g., whales, dolphins, turtles) before the survey begins Animal spotters stay on the vessel during the survey and monitor marine life. Soft start up- meaning the noise slowly gets louder giving marine animals time to move away from the sound.
Air emissions	We ensure engines and other equipment is looked after and fuel use and waste incineration standards are maintained.
Discharges	We will manage discharges to acceptable levels and follow the standard rules for what boats can discharge.
Impacts from other seismic surveys	We will communicate with other companies that may also be doing seismic surveys in the area and keep a large distance between other seismic vessels.

Eos 3D MSS - Risks

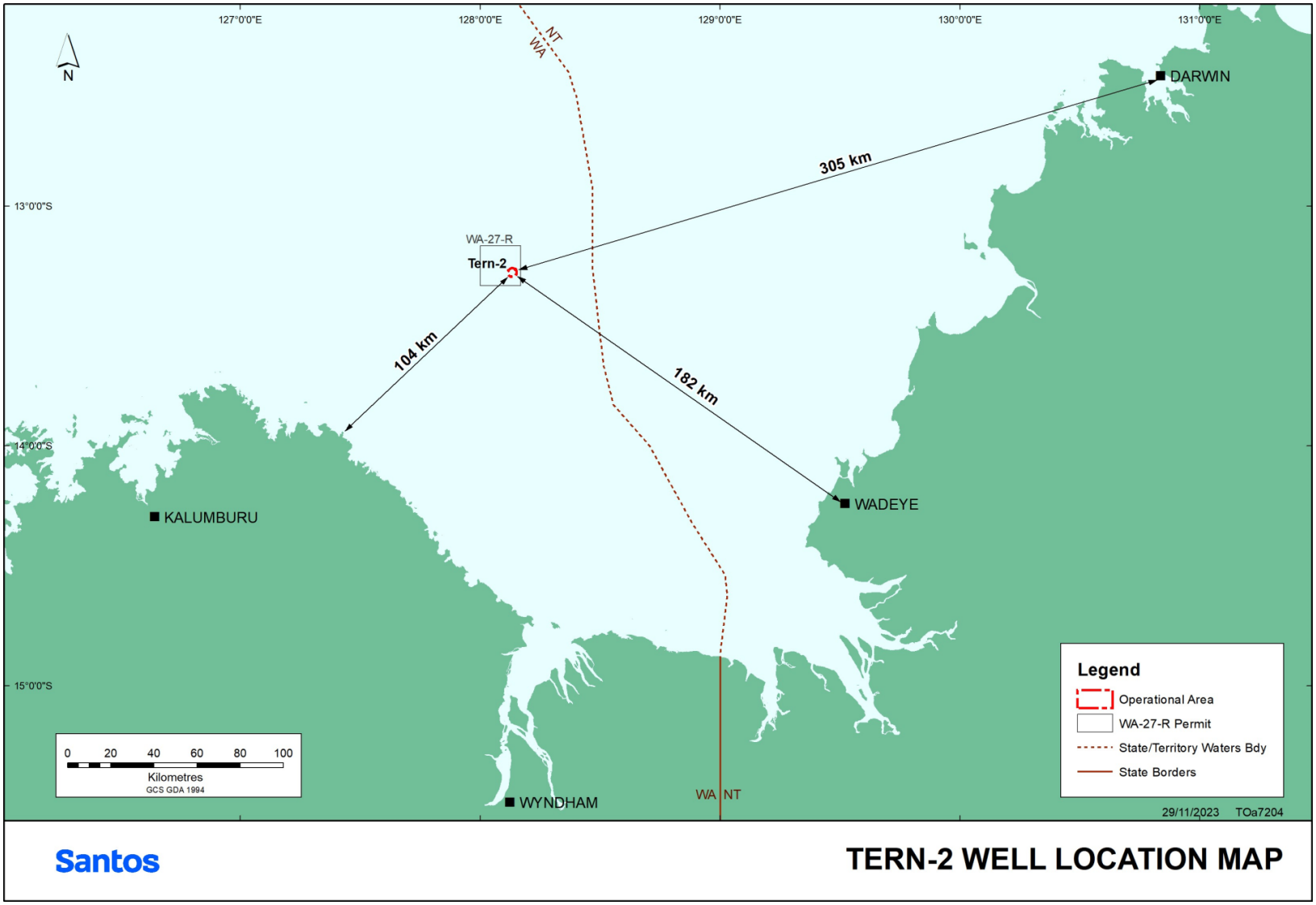
Santos

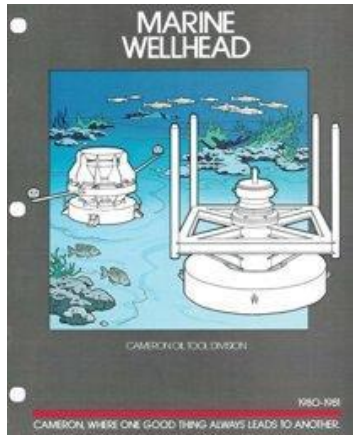
Unplanned events (Accidents)	How we manage (the rules we follow)
Diesel spill	We make sure all the boats associated with the survey are following the rules to prevent collisions. We let other boats know where we are and what we are doing. We follow strict procedures for refuelling.
Discharges/Dropped objects	Where possible and safe to do so, we will recover any waste or equipment that accidentally falls overboard into the ocean.
Disturbing marine animals	We look out for marine life (e.g., whales, dolphins, turtles) and the support vessel will slow down and move away from them where possible if they are too close while the survey is taking place. The seismic source will be stopped if certain marine life is observed too close to the seismic vessel
Invasive marine life	We will use an anti-foulant system and follow strict procedures to avoid any introduction of invasive marine life.
Chemical spill	We select chemicals that are friendly to the environment where possible and store them carefully. We have procedures for using and cleaning up chemicals.
Oil spill response	We have plans and resources to be used if there is an accidental oil spill.

Santos

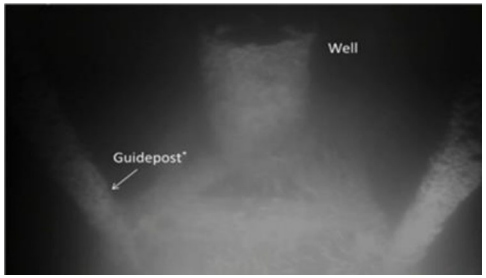
EOS 3D MSS EP QUESTIONS?

Tern-2 Plug & Abandonment



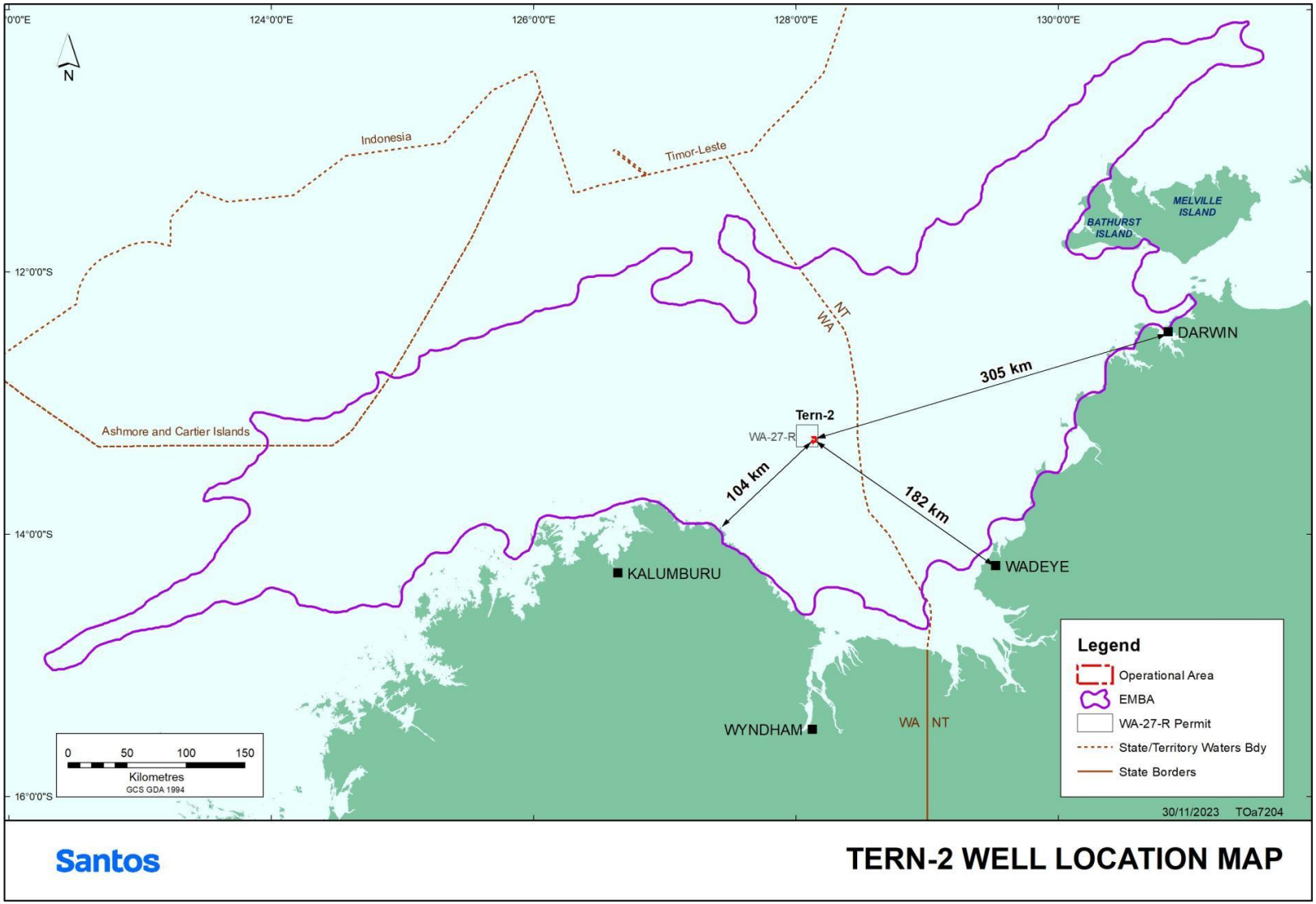


Example of the Tern-2 wellhead



Example of wellhead at
Tern-2 wellhead location

Tern-2 Plug & Abandonment EMBA



Tern-2 P&A - Impacts

Santos

Planned events	How we manage (the rules we follow)
Disturbance to other boats	We will communicate to other boats where we are and what we are doing. We mark the location of equipment on charts.
Seabed disturbance	We are putting equipment on a flat sandy seabed. We only put equipment in the approved location.
Light disturbance	We only use lights where needed for safe operations. We turn off lights when not needed.
Noise disturbance	We look out for marine life (e.g., whales, dolphins, turtles) and noise levels. Activities are not expected to impact at population level or have a significant impacts on foraging behaviours of marine turtles.
Air emissions	We ensure engines and other equipment is looked after and fuel use and waste incineration standards are maintained.
Discharges	We will manage discharges to acceptable levels and follow the standard rules for what boats can discharge.
Wellhead left on seabed	We will leave the wellhead on the seabed only if it cannot be removed easily due to technical difficulties.
Oil spill response	We have plans and resources to be used if there is an accidental oil spill.

Tern-2 P&A - Risks

Santos

Unplanned events (Accidents)	How we manage (the rules we follow)
Diesel spill	We make sure all the boats are following the rules for preventing collisions. We let other boats know where we are and what we are doing. We will not refuel within the operational area.
Dropped objects	We follow strict procedures to stop objects dropping overboard and we pick up objects when it is safe to do so.
Disturbing marine animals	We look out for marine life (e.g., whales, dolphins, turtles) when transiting within and to and from the operational area and we slow down and move away from them where possible if they are too close.
Invasive marine life	We will use an anti-foulant system and follow strict procedures to avoid any introduction of invasive marine life.
Chemical spill	We select chemicals that are friendly to the environment where possible and store them carefully. We have procedures for using and cleaning up chemicals.
Disturbance to other boats	We let other boats know where we are and what we are doing. We will let other boats, fishing groups, and the government know if the wellhead cannot be removed and will be left on the seabed.

Santos

TERN-2 P&A EP QUESTIONS?

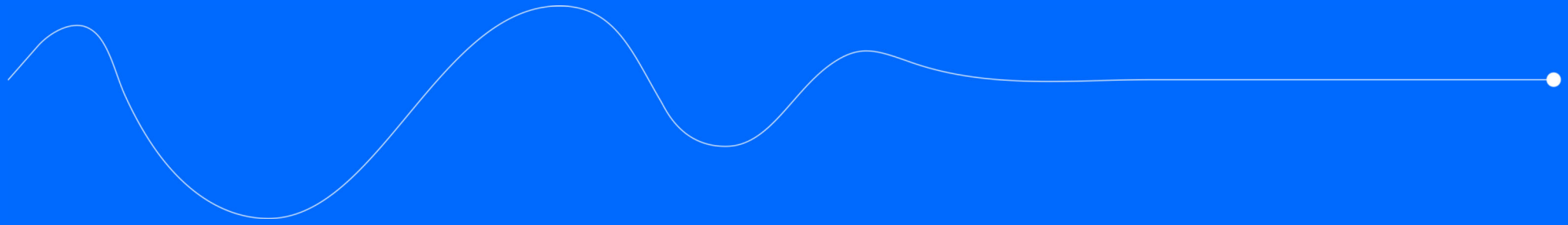
Santos

BONAPARTE QUESTIONS?

Santos

CLOSE OUT

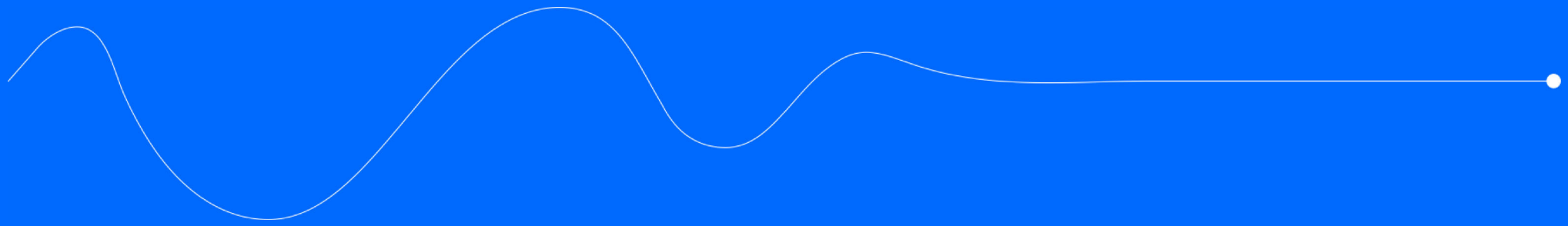
Carly Sherren



Bonaparte Basin Consultation - Territory Families Housing and Community - Heritage 20231205

Santos

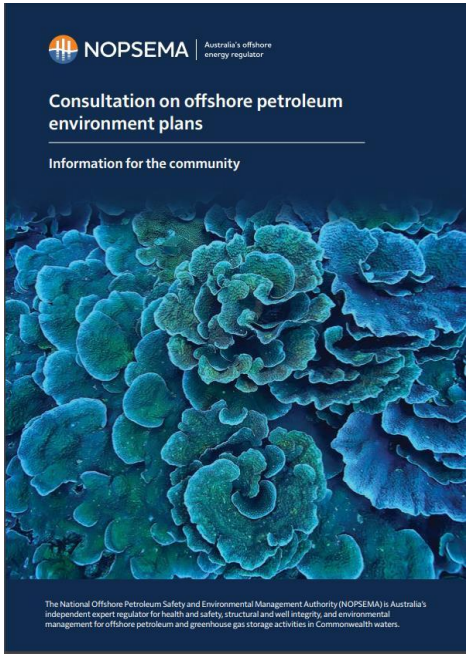
CONSULTATION – BONAPARTE BASIN



November 2023

Regulatory Consultation

Commonwealth waters – National Offshore Petroleum Safety and Environmental Management Authority



"In the course of preparing an Environment Plan, a titleholder must consult with relevant persons in accordance with Division 2.2A, Regulation 11A…

"The purpose of consultation under regulation 11A of the Environment Regulations is to ensure that authorities, persons or organisations that are potentially affected by activities are consulted and their input considered in the development of environment plans."

Guideline - Consultation in the course of preparing an environment plan, NOPSEMA

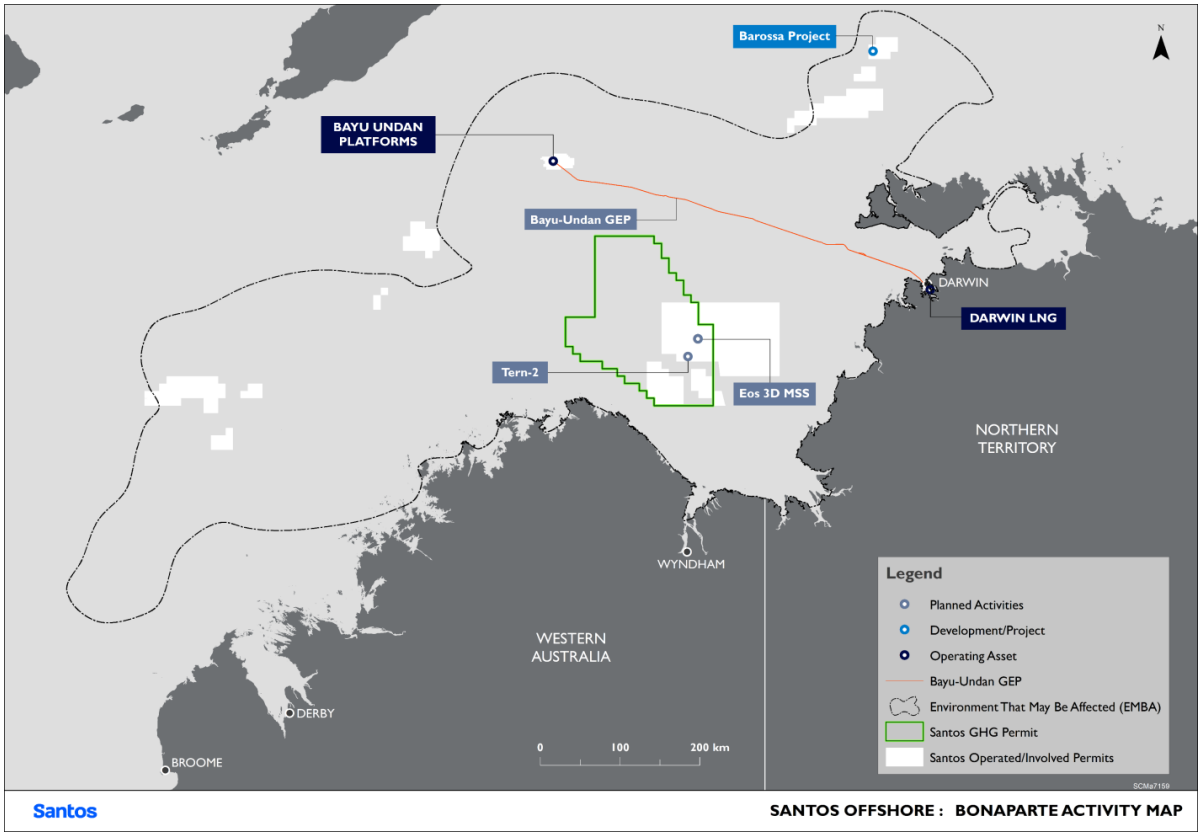
A **relevant person** is an authority, a person or an organisation whose functions, interests or activities may be affected by proposed activities.

Bonaparte Basin

Santos

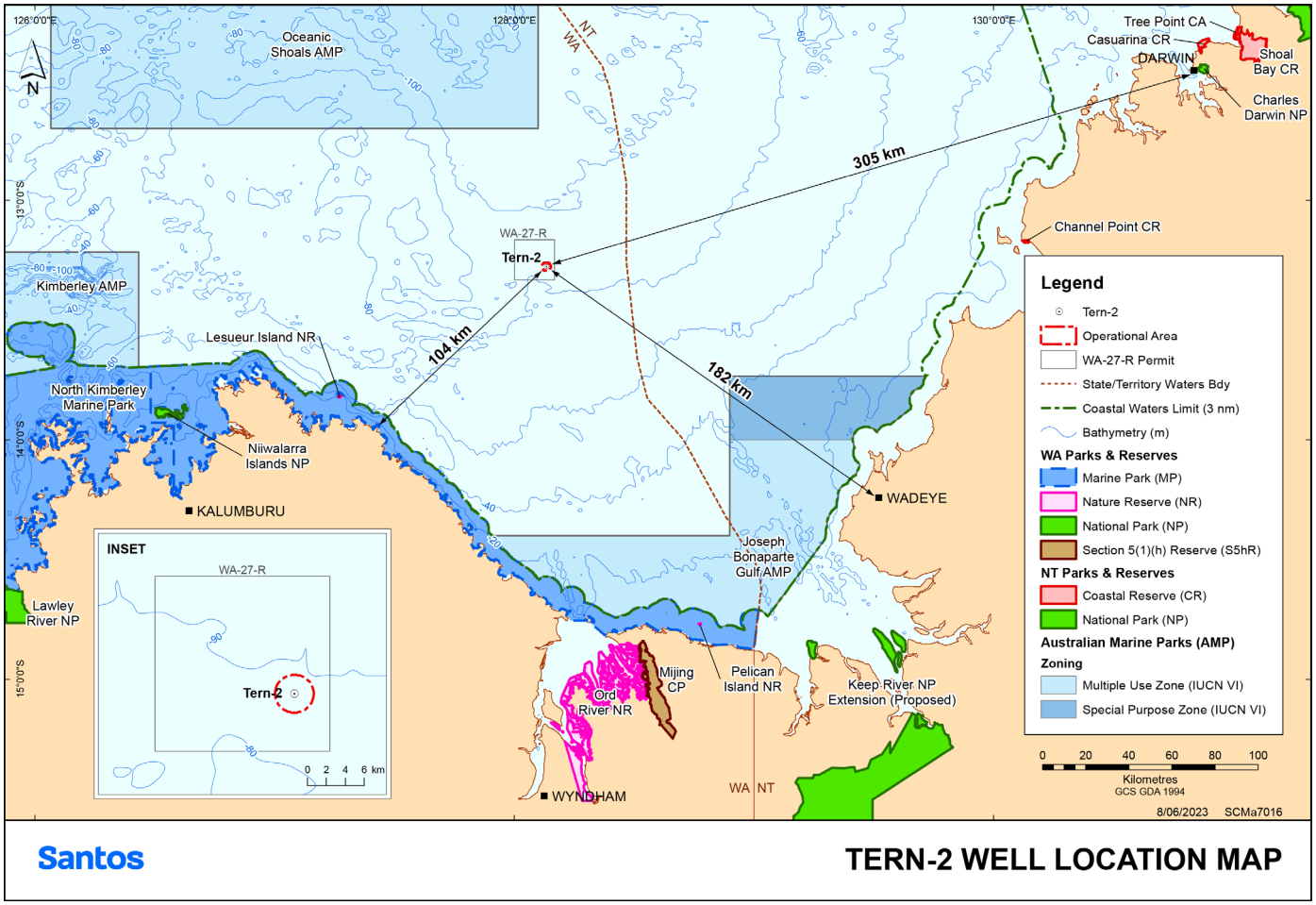
- Santos is proposing to undertake activities Consultation for our Bonaparte Basin activities (outside of Barossa Gas Project activities) starts on **27 October 2023** and closes on **27 November 2023**.
- Proposed activities are:
  - Tern-2 Plug and Abandonment
  - Eos 3D Marine Seismic Survey
  - Bayu-Undan Gas Export Pipeline Operations

- **Email** – offshore.consultation@santos.com
- **Web** – www.Santos.com/offshoreconsultation
- **Phone** – 1800 267 600



Tern-2 Plug and Abandonment

Santos



Santos

TERN-2 WELL LOCATION MAP

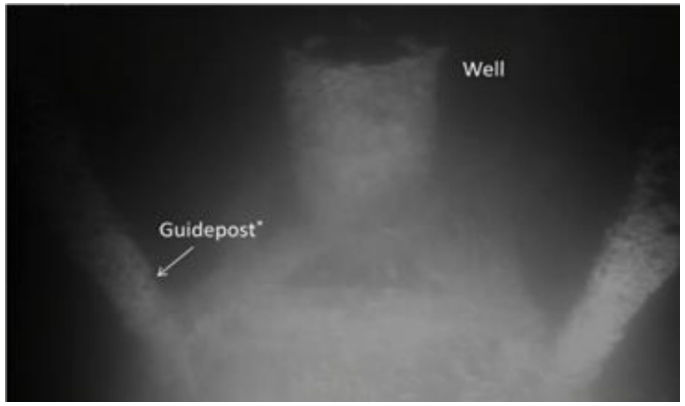
Wellhead	Title	Approx. Water Depth (m)	Coordinates (Datum/Projection: GDA 94 Zone 50)	
			Latitude	Longitude
Tern-2	WA-27-R	83	13° 16' 37.36" S	128° 08' 02.68" E

Tern-2 Plug and Abandonment

Santos

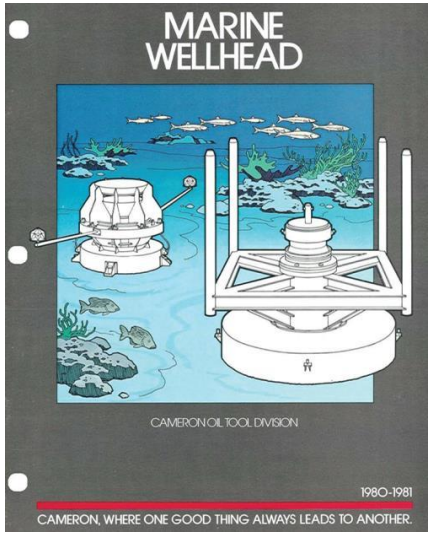
Activity overview:

- Install and verify additional well barriers to supplement the existing system of well barriers
- Operation Area is approximately 300 km WSW of Darwin, 106 km from the closest shoreline, 62 km southwest of Petrel-1 and 9.8 km southeast of Tern-1 well
- Operational Area is circular with a 2 km radius from the Tern-2 wellhead
- Removing the wellhead as best as practical to remove any structural evidence of the well from the seabed and eliminate future hazards to the environment or other users of the area



Timing

- Approximately 10 days (continuous operations, 24 hours per day, 7 days per week)
- Up to 40 days in the event of unforeseen delays and poor metocean conditions



Vessels:

- Light Well Intervention Vessel (LWIV)
- Support vessel
- Remotely Operated Vehicle (ROV)
- Helicopters

Eos 3D Marine Seismic Survey

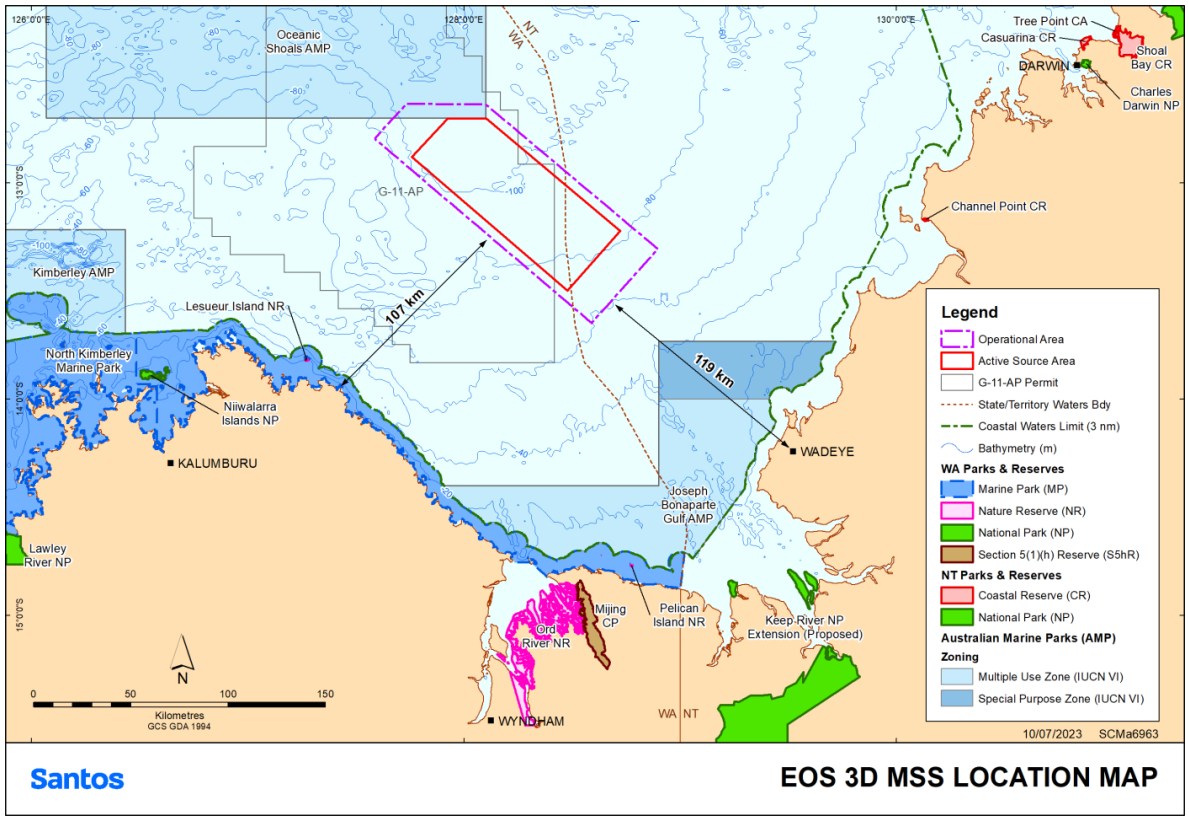
Santos

Activity Overview:

- Identify and image detailed subsea geological formations for the potential injection and storage of Carbon Dioxide (CO_2)
- Operational Area is approximately 107 km from the nearest coastline, and approximately 119 km from Wadeye in the Northern Territory
- Exclusion zone 3 nm (5.6 km) exclusion (safety) zone around the seismic vessel and trailing streamers
- Streamer length: Approximately 8 km
- Seismic streamer spread width: Approximately 1,350 m

Timing:

- From Q3 2024 with activity duration approximately 50 days, subject to activity schedule requirements, vessel availability and weather
- Time to traverse a single sail line: approx. 8 hrs and 30 mins.
- Line turns: 2-4 hrs
- Expected duration is a forecast and is subject to change based on vessel availability, adverse weather conditions or technical/equipment issues that may arise during the activity.



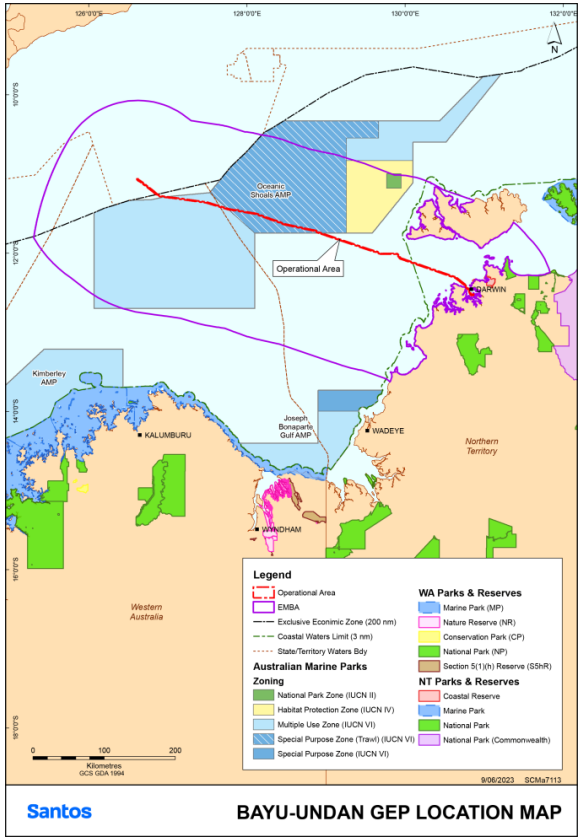
Vessels:

- One purpose built seismic survey vessel.
- Up to two dedicated support vessels (one being a chase vessel) will accompany the seismic survey vessel to provide logistical, safety and equipment management duties.
- Specific vessel details are unknown at this time.

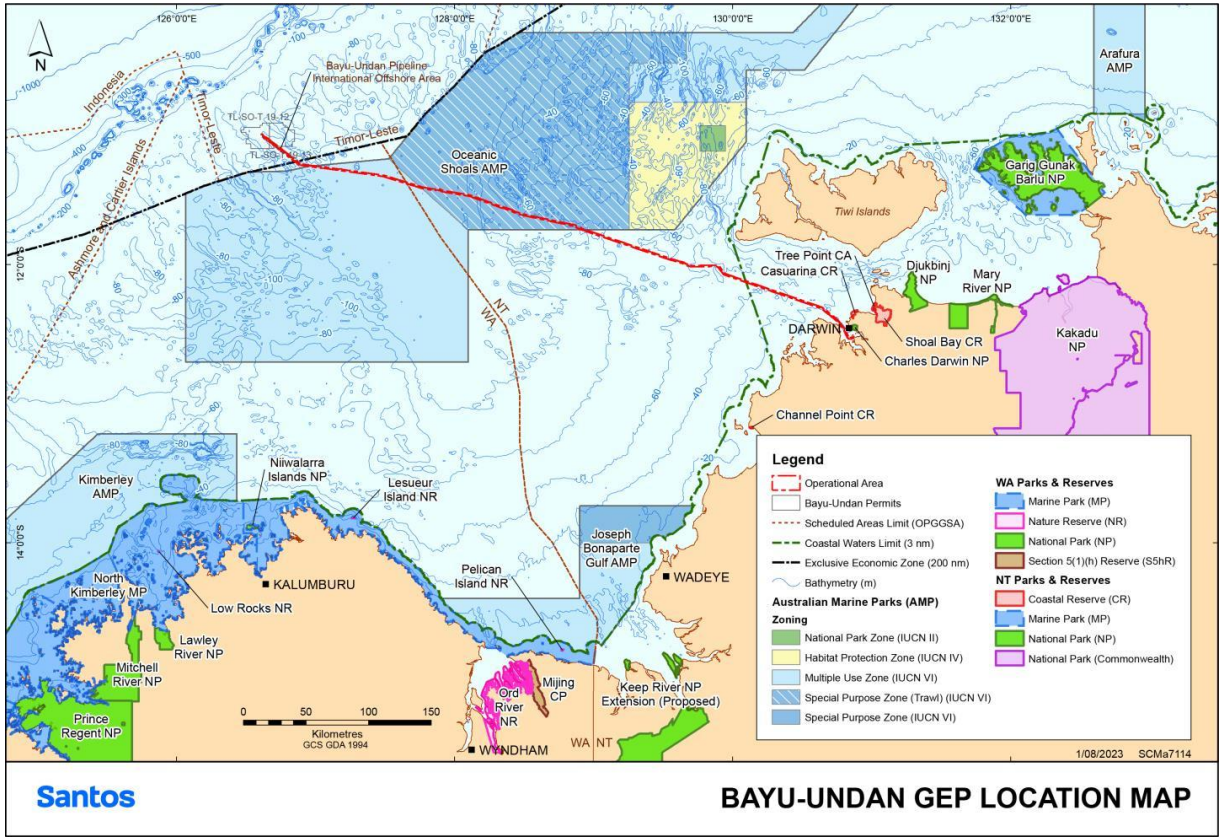
Bayu-Undan Gas Export Pipeline EP

Santos

- Santos is the operator of the existing 502km Gas Export Pipeline.
- The pipeline transports dry natural gas from the Bayu-Undan Field (Timor-Leste waters) to the onshore Darwin liquefied natural gas (DLNG) plant.
- The pipeline has been operational since 2005.
- As the Field is approaching the end of life, the pipeline will transition from operations to a preservation state.
- The original EP for operations was accepted by NOPSEMA in 2019.
- The EP has been updated to include the final stages of operations (linepacking and back-feed), plus a preservation phase (gas-filled).



Santos BAYU-UNDAN GEP LOCATION MAP

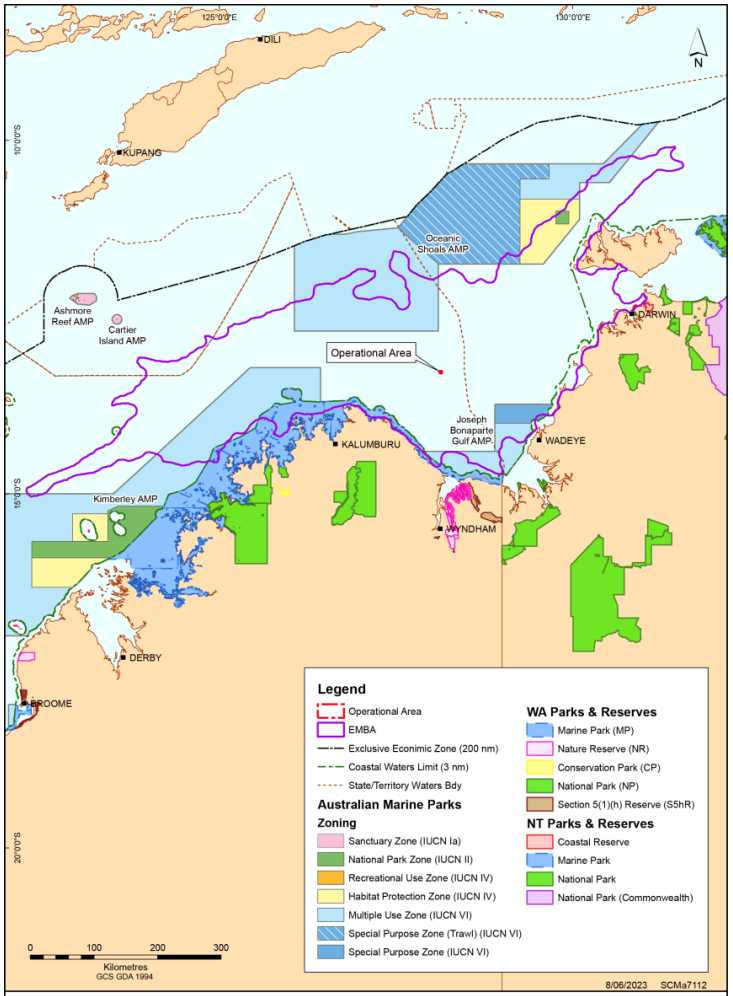


Santos BAYU-UNDAN GEP LOCATION MAP

Santos

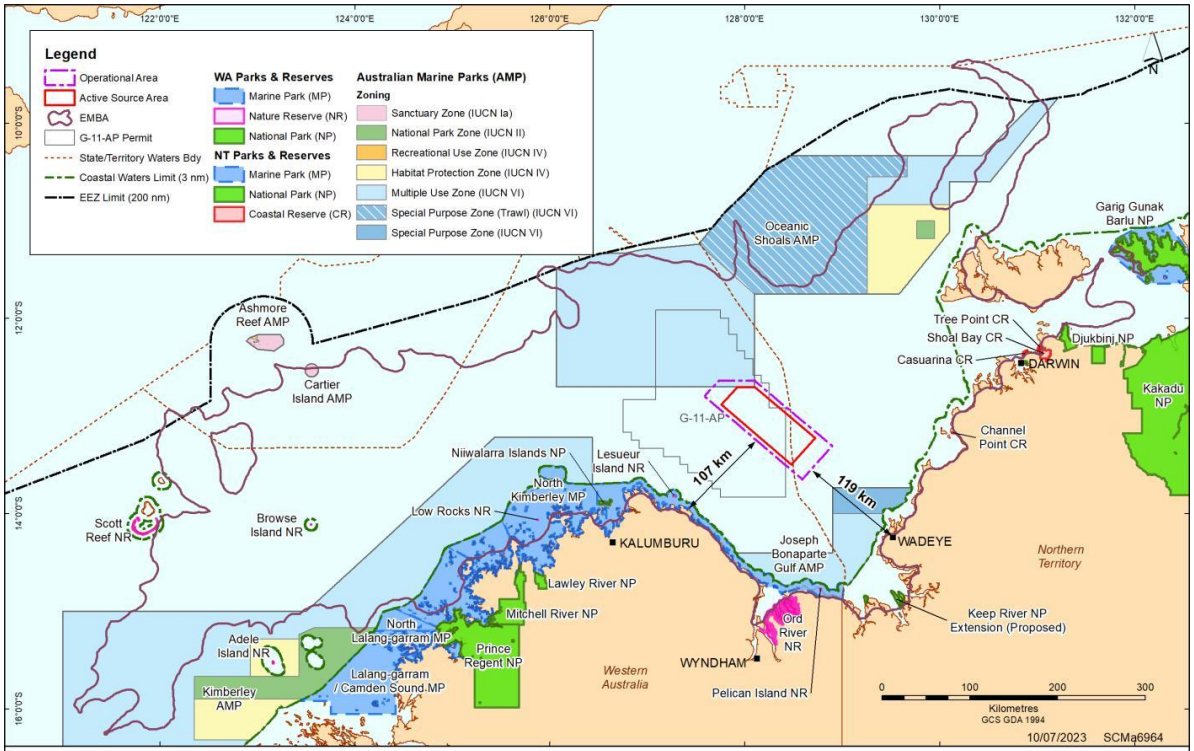
Spill Risk

Santos



Santos

TERN-2 LOCATION MAP



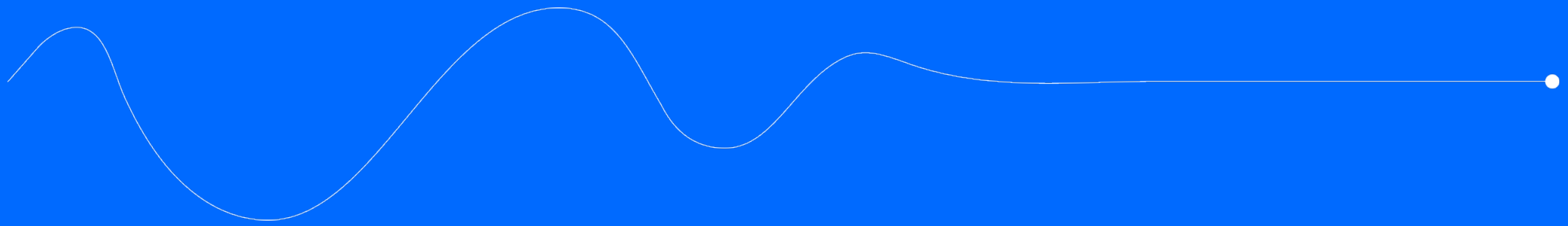
Santos

EOS 3D MSS LOCATION MAP

Bonaparte Basin Consultation - BCCI 20231109

Santos

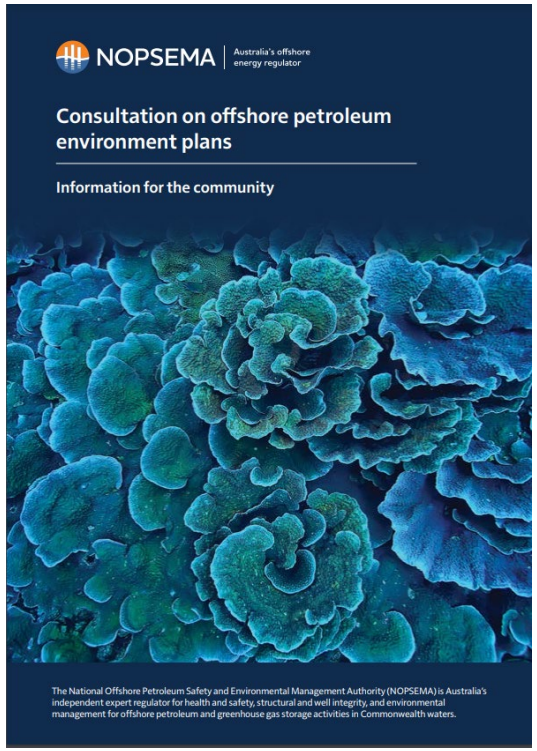
CONSULTATION – BONAPARTE BASIN



November 2023

Regulatory Consultation

Commonwealth waters – National Offshore Petroleum Safety and Environmental Management Authority



"In the course of preparing an Environment Plan, a titleholder must consult with relevant persons in accordance with Division 2.2A, Regulation 11A…

"The purpose of consultation under regulation 11A of the Environment Regulations is to ensure that authorities, persons or organisations that are potentially affected by activities are consulted and their input considered in the development of environment plans."

Guideline - Consultation in the course of preparing an environment plan, NOPSEMA

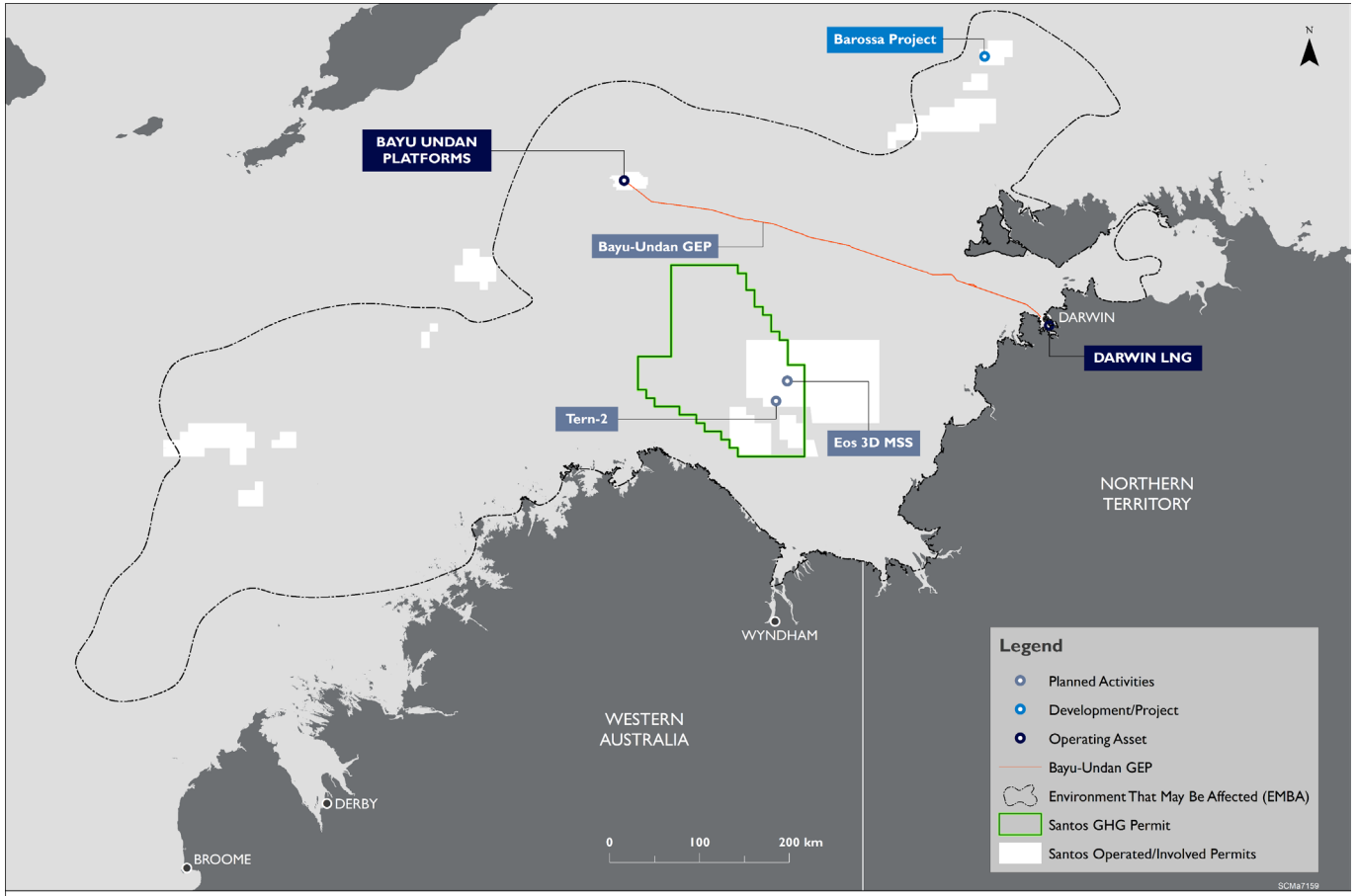
A **relevant person** is an authority, a person or an organisation whose functions, interests or activities may be affected by proposed activities.

Bonaparte Basin

Santos

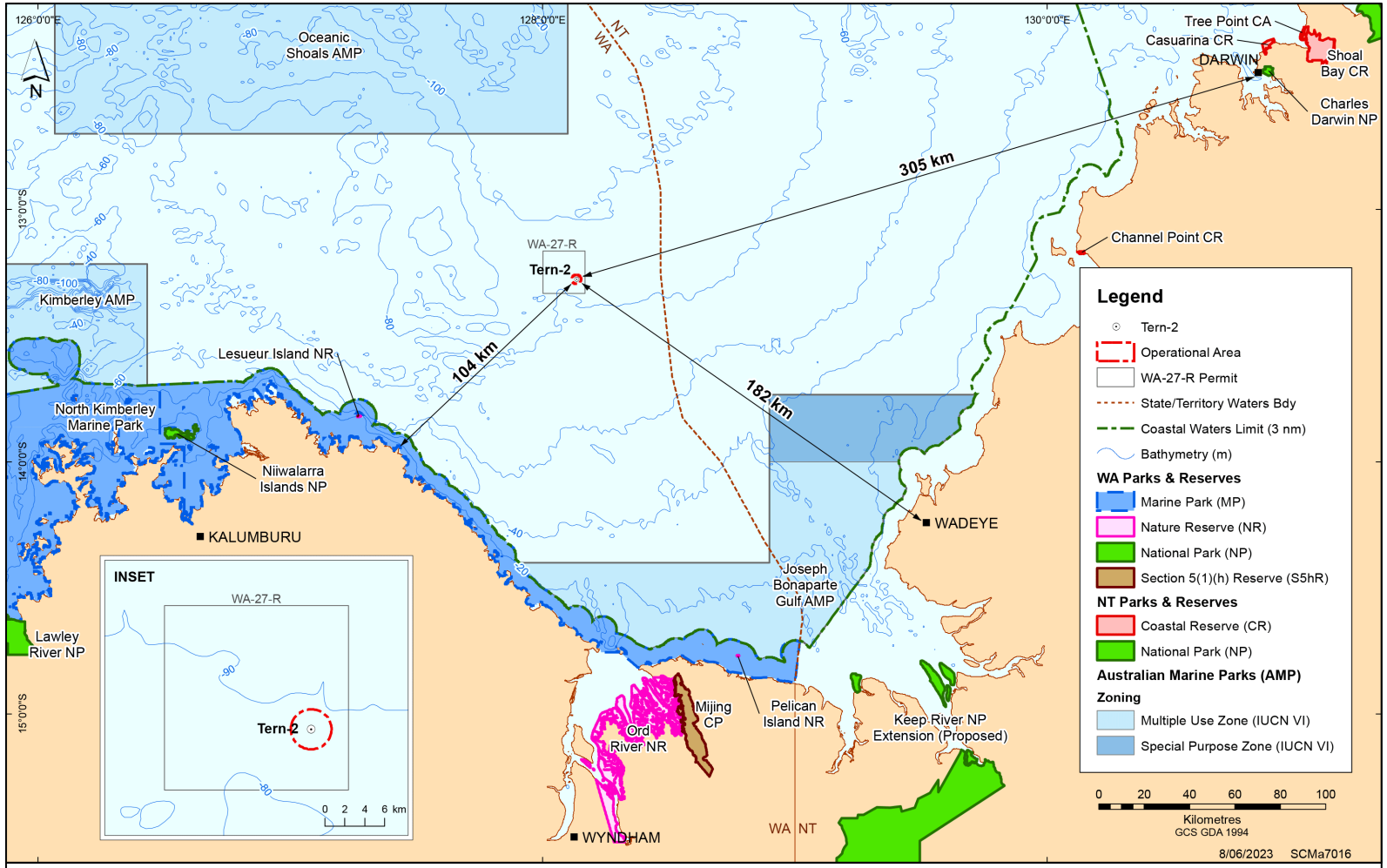
- Santos is proposing to undertake activities Consultation for our Bonaparte Basin activities (outside of Barossa Gas Project activities) starts on **27 October 2023** and closes on **27 November 2023**.
- Proposed activities are:
  - Tern-2 Plug and Abandonment
  - Eos 3D Marine Seismic Survey
  - Bayu-Undan Gas Export Pipeline Operations

- **Email** – offshore.consultation@santos.com
- **Web** – www.Santos.com/offshoreconsultation
- **Phone** – 1800 267 600



Tern-2 Plug and Abandonment

Santos



Santos

TERN-2 WELL LOCATION MAP

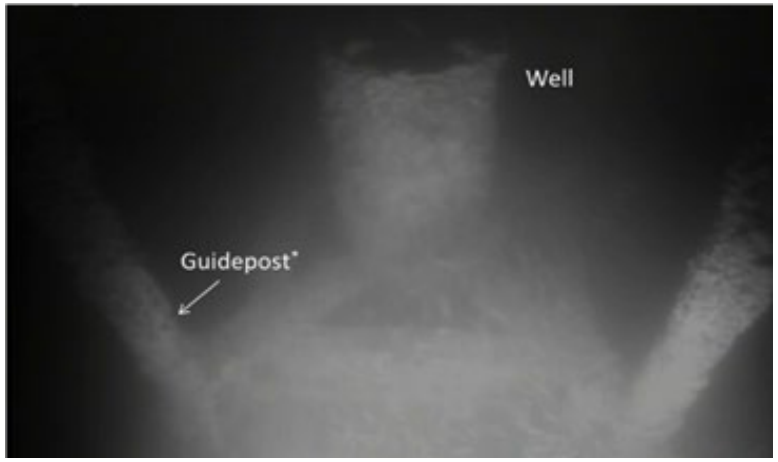
Wellhead	Title	Approx. Water Depth (m)	Coordinates (Datum/Projection: GDA 94 Zone 50)	
			Latitude	Longitude
Tern-2	WA-27-R	83	13° 16' 37.36" S	128° 08' 02.68" E

Tern-2 Plug and Abandonment

Santos

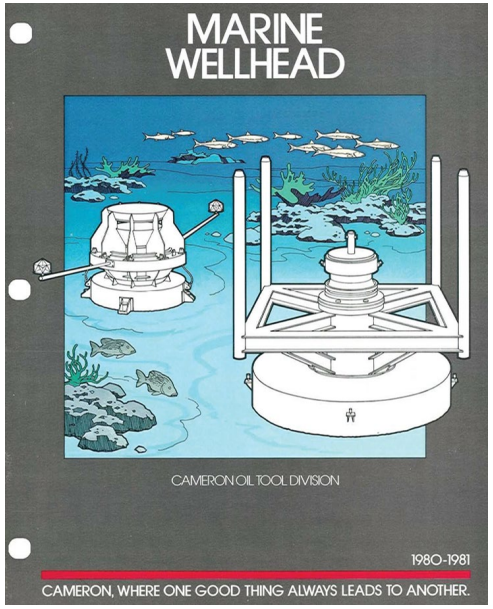
Activity overview:

- Install and verify additional well barriers to supplement the existing system of well barriers
- Operation Area is approximately 300 km WSW of Darwin, 106 km from the closest shoreline, 62 km southwest of Petrel-1 and 9.8 km southeast of Tern-1 well
- Operational Area is circular with a 2 km radius from the Tern-2 wellhead
- Removing the wellhead as best as practical to remove any structural evidence of the well from the seabed and eliminate future hazards to the environment or other users of the area



Timing

- Approximately 10 days (continuous operations, 24 hours per day, 7 days per week)
- Up to 40 days in the event of unforeseen delays and poor metocean conditions



Vessels:

- Light Well Intervention Vessel (LWIV)
- Support vessel
- Remotely Operated Vehicle (ROV)
- Helicopters

Eos 3D Marine Seismic Survey

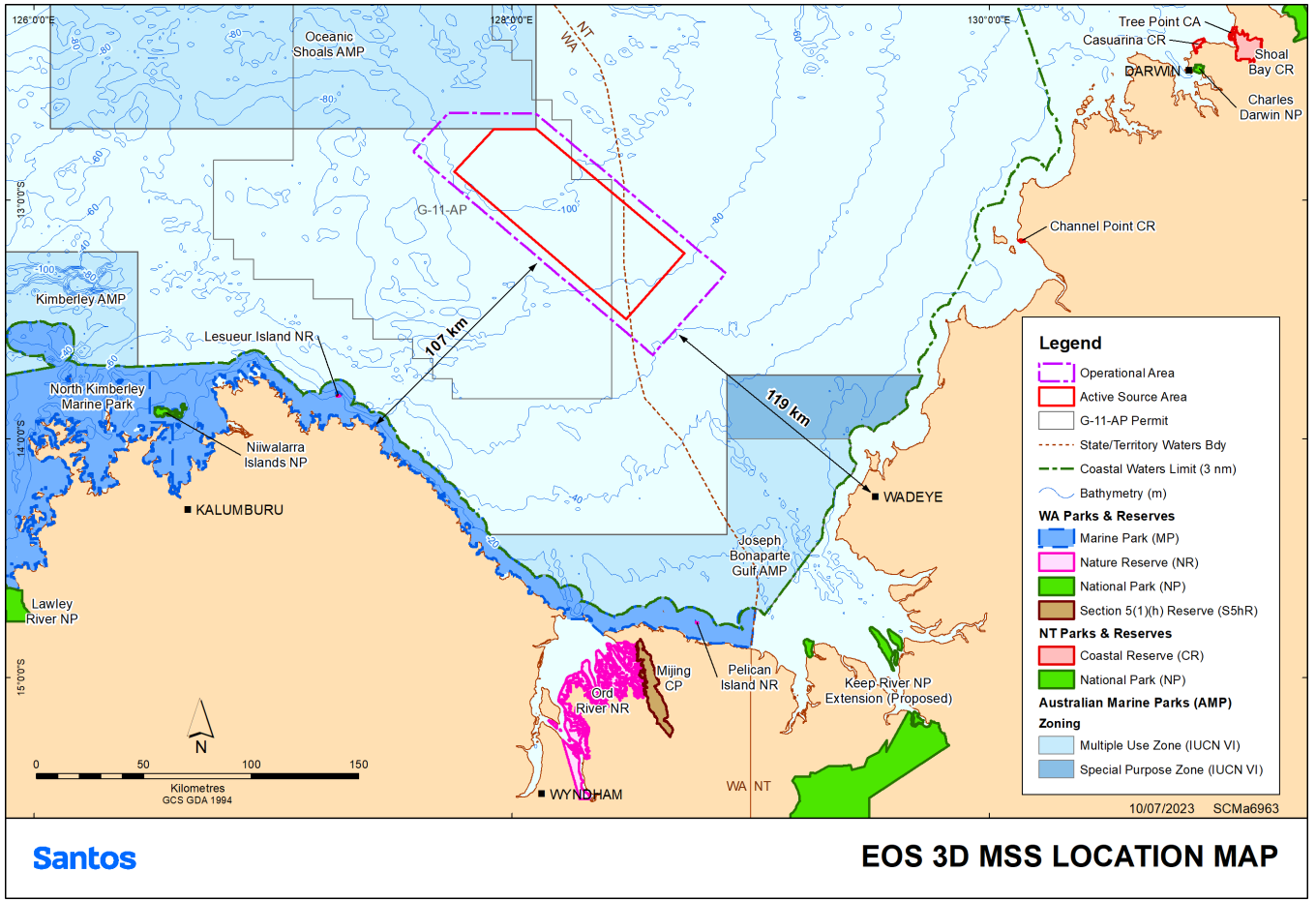
Santos

Activity Overview:

- Identify and image detailed subsea geological formations for the potential injection and storage of Carbon Dioxide (CO_2)
- Operational Area is approximately 107 km from the nearest coastline, and approximately 119 km from Wadeye in the Northern Territory
- Exclusion zone 3 nm (5.6 km) exclusion (safety) zone around the seismic vessel and trailing streamers
- Streamer length: Approximately 8 km
- Seismic streamer spread width: Approximately 1,350 m

Timing:

- From Q3 2024 with activity duration approximately 50 days, subject to activity schedule requirements, vessel availability and weather
- Time to traverse a single sail line: approx. 8 hrs and 30 mins.
- Line turns: 2-4 hrs
- Expected duration is a forecast and is subject to change based on vessel availability, adverse weather conditions or technical/equipment issues that may arise during the activity.



Vessels:

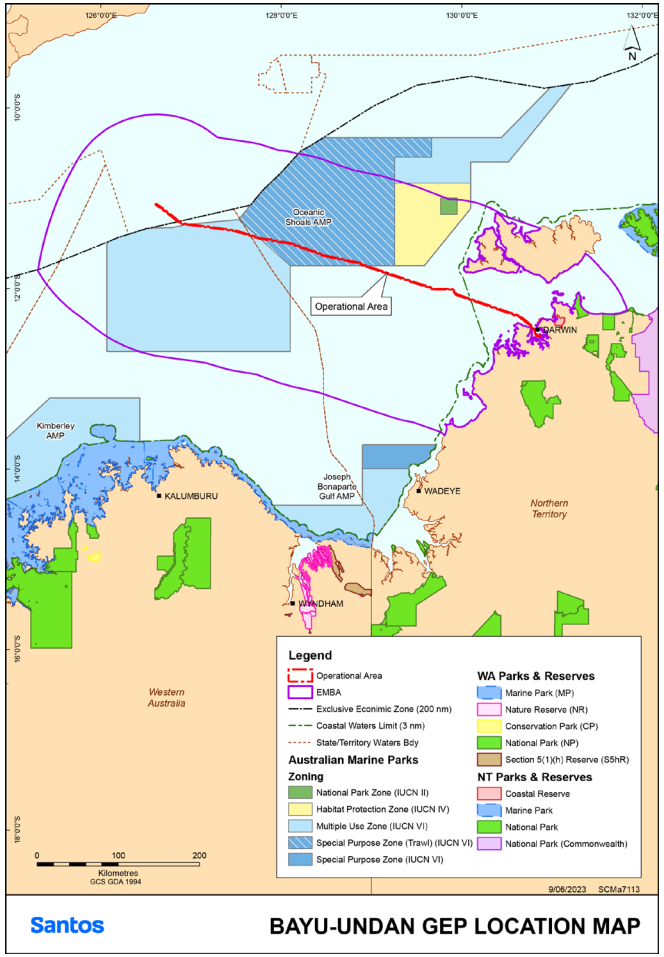
- One purpose built seismic survey vessel.
- Up to two dedicated support vessels (one being a chase vessel) will accompany the seismic survey vessel to provide logistical, safety and equipment management duties.
- Specific vessel details are unknown at this time.

Santos

Bayu-Undan Gas Export Pipeline EP

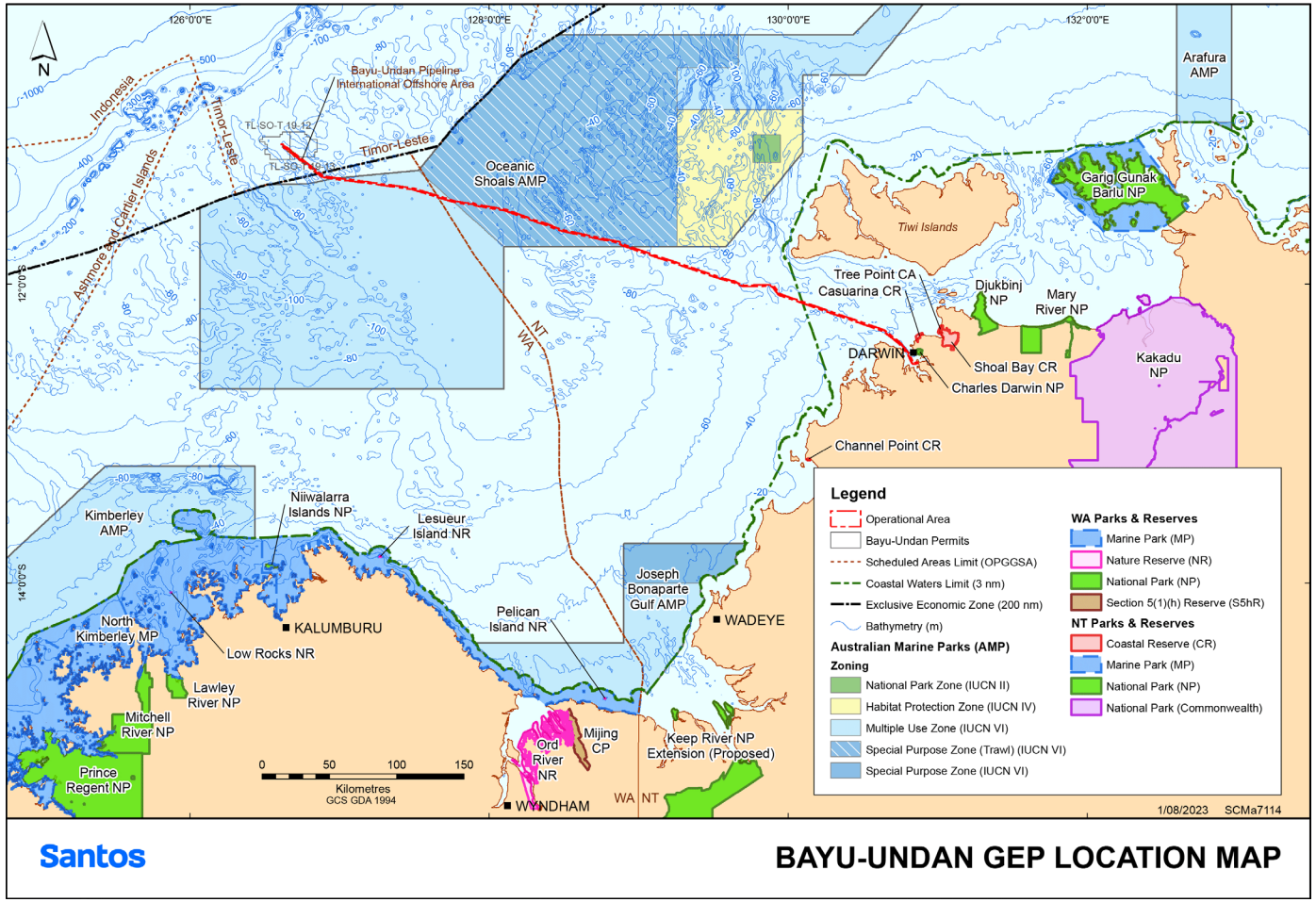
Santos

- Santos is the operator of the existing 502km Gas Export Pipeline.
- The pipeline transports dry natural gas from the Bayu-Undan Field (Timor-Leste waters) to the onshore Darwin liquefied natural gas (DLNG) plant.
- The pipeline has been operational since 2005.
- As the Field is approaching the end of life, the pipeline will transition from operations to a preservation state.
- The original EP for operations was accepted by NOPSEMA in 2019.
- The EP has been updated to include the final stages of operations (linepacking and back-feed), plus a preservation phase (gas-filled).



Santos

BAYU-UNDAN GEP LOCATION MAP

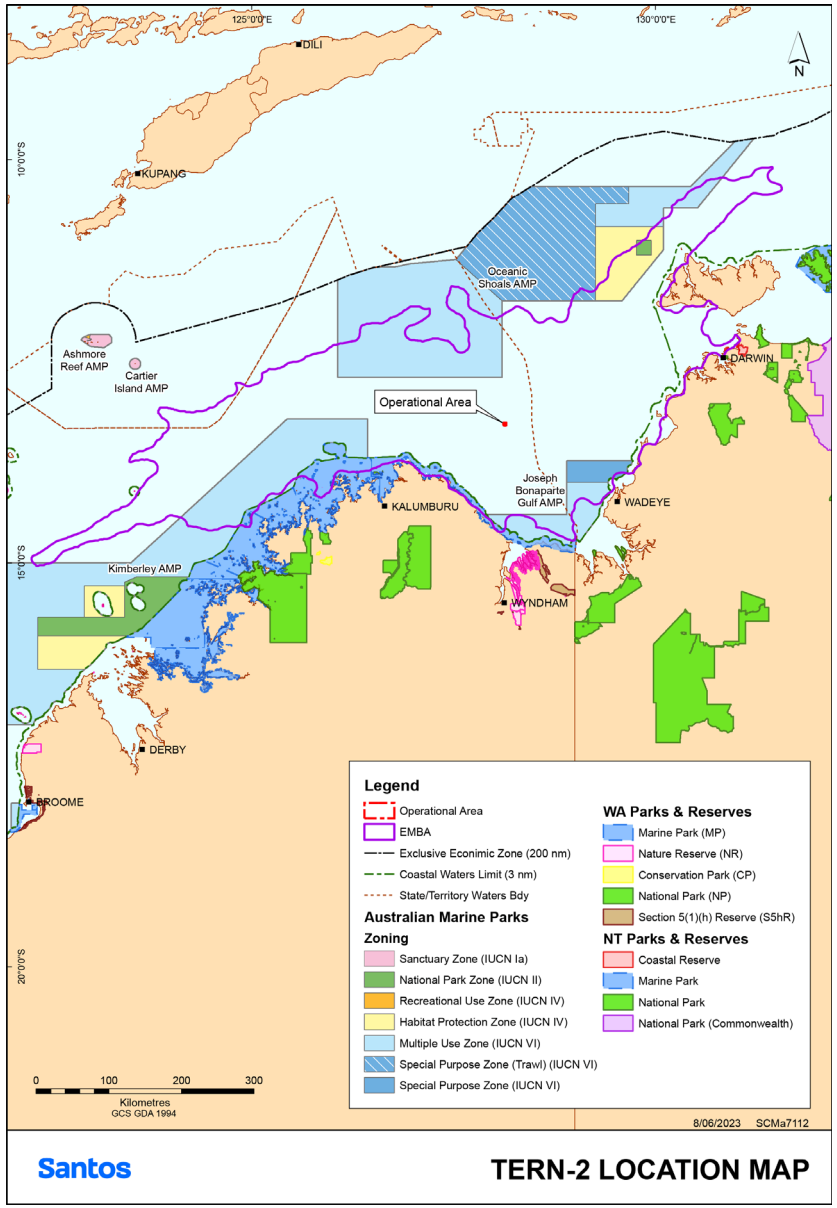


Santos

BAYU-UNDAN GEP LOCATION MAP

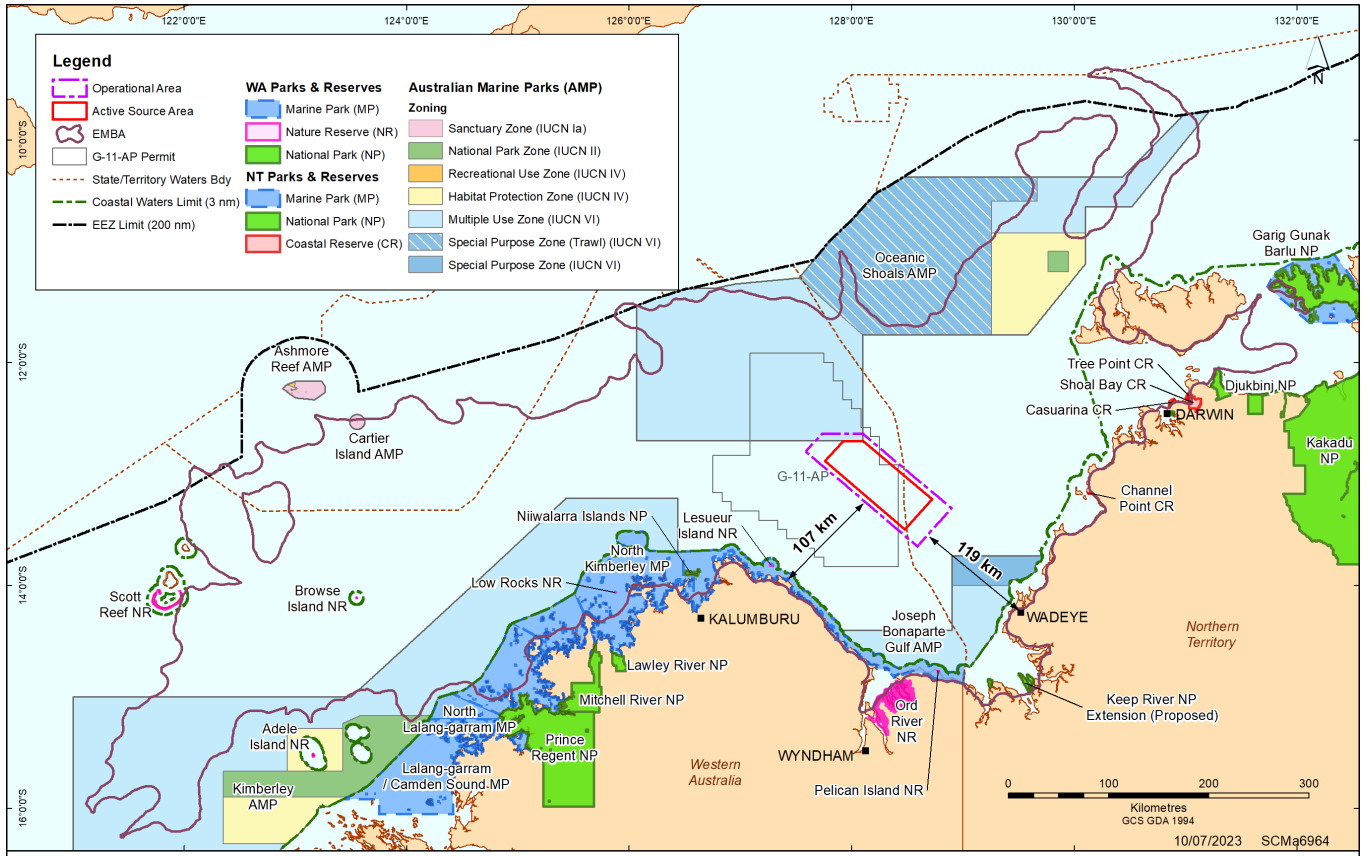
Spill Risk

Santos



Santos

TERN-2 LOCATION MAP



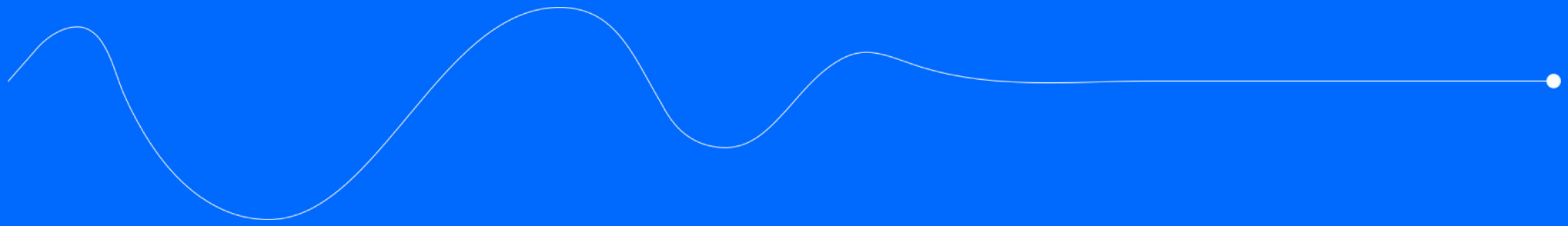
Santos

EOS 3D MSS LOCATION MAP

Bonaparte Basin Preliminary Consultation_20231009

Santos

PRELIMINARY CONSULTATION – BONAPARTE BASIN



October 2023

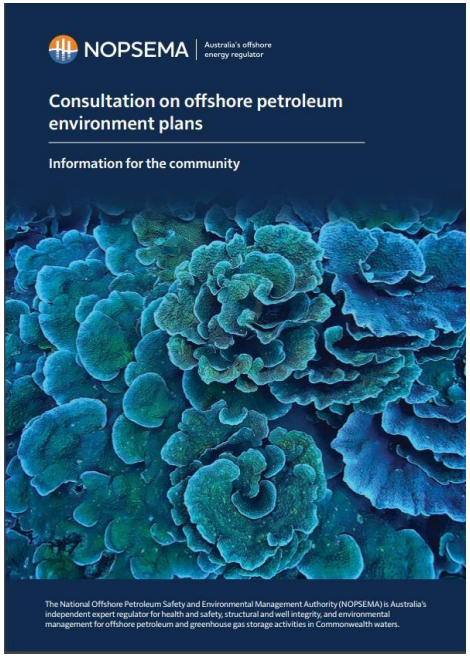
Engaging First Nations people and groups

Relationships

Regulatory consultation	• Commonwealth Government offshore approvals • WA State Government offshore and onshore approvals
Cultural heritage	• Identification, assessment and protection
Legal agreements	• Indigenous Land Use Agreements • Commercial agreements
Community benefits	• Employment and development opportunities • Support of worthwhile community projects • Support Indigenous businesses through our supply chain

Regulatory Consultation

Commonwealth waters – National Offshore Petroleum Safety and Environmental Management Authority



"In the course of preparing an Environment Plan, a titleholder must consult with relevant persons in accordance with Division 2.2A, Regulation 11A…

"The purpose of consultation under regulation 11A of the Environment Regulations is to ensure that authorities, persons or organisations that are potentially affected by activities are consulted and their input considered in the development of environment plans."

Guideline - Consultation in the course of preparing an environment plan, NOPSEMA

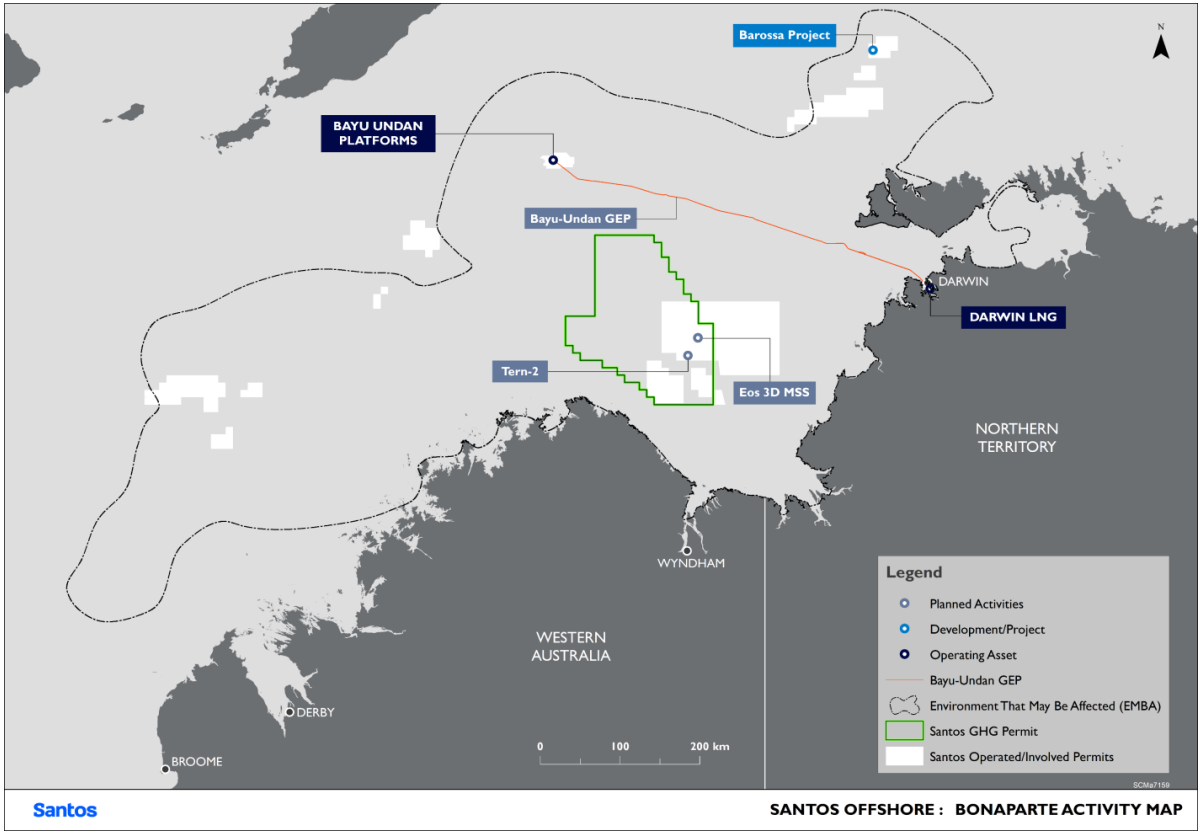
A **relevant person** is an authority, a person or an organisation whose functions, interests or activities may be affected by proposed activities.

Bonaparte Basin

Santos

- Santos is proposing to undertake activities Consultation for our Bonaparte Basin activities (outside of Barossa Gas Project activities) starts on **27 October 2023** and closes on **27 November 2023**.
- Proposed activities are:
  - Tern-2 Plug and Abandonment
  - Eos 3D Marine Seismic Survey
  - Bayu-Undan Gas Export Pipeline Operations

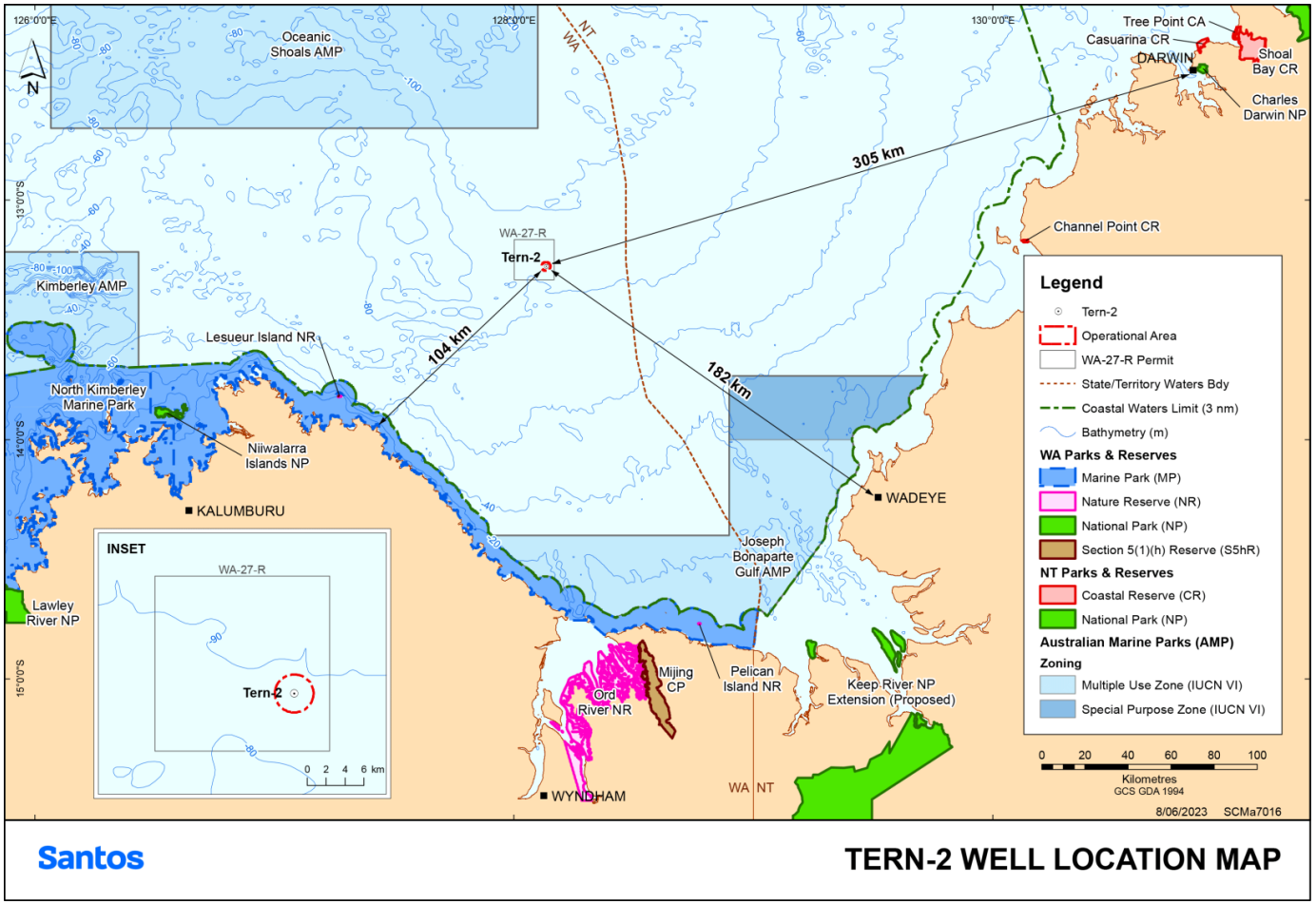
- **Email** – offshore.consultation@santos.com
- **Web** – www.Santos.com/offshoreconsultation
- **Phone** – 1800 267 600



Santos

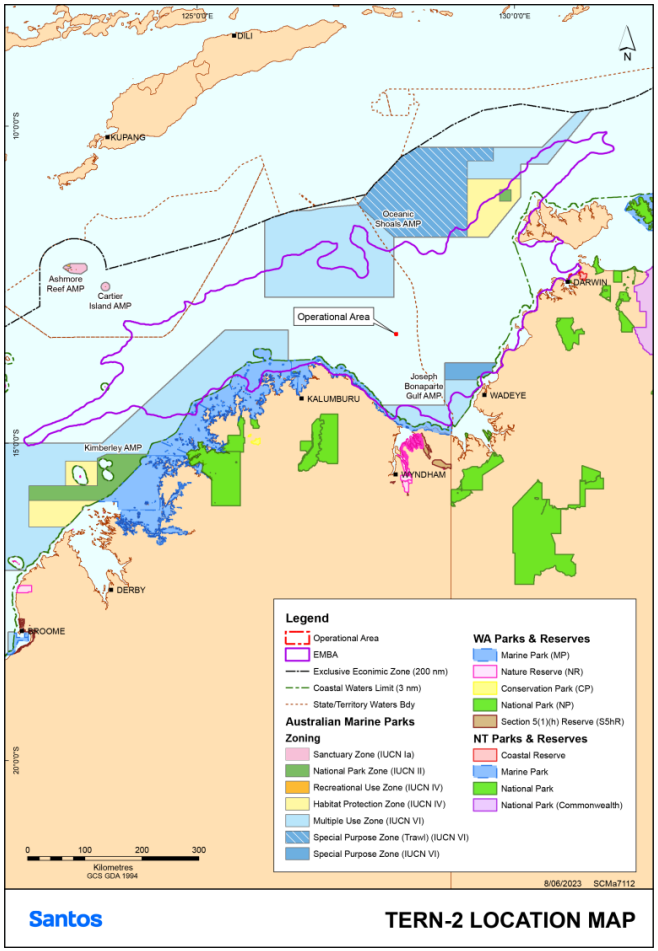
Tern-2 Plug and Abandonment

Santos



Santos

TERN-2 WELL LOCATION MAP

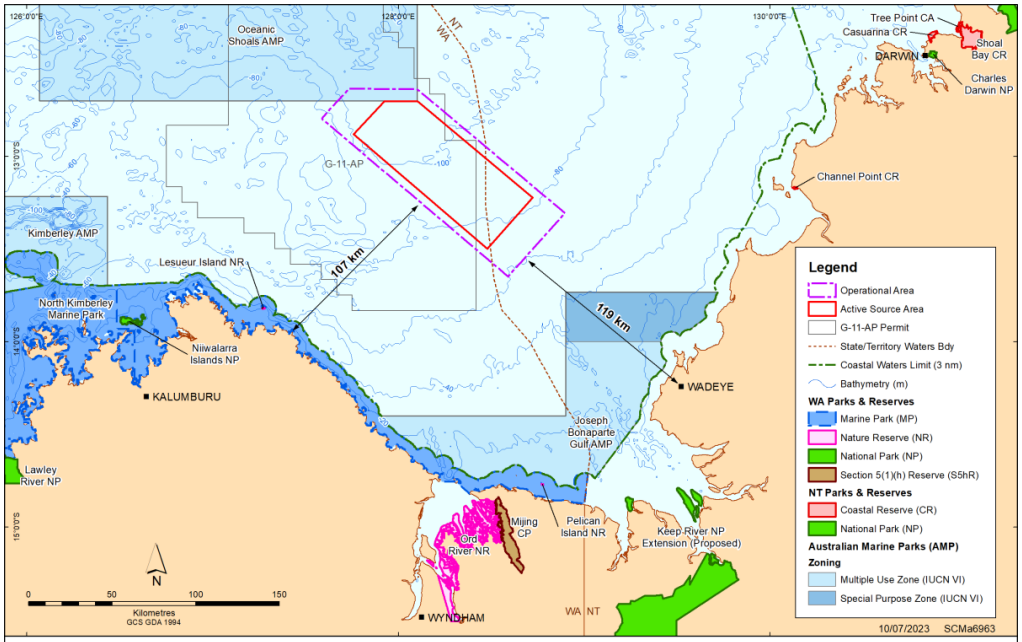


Santos

TERN-2 LOCATION MAP

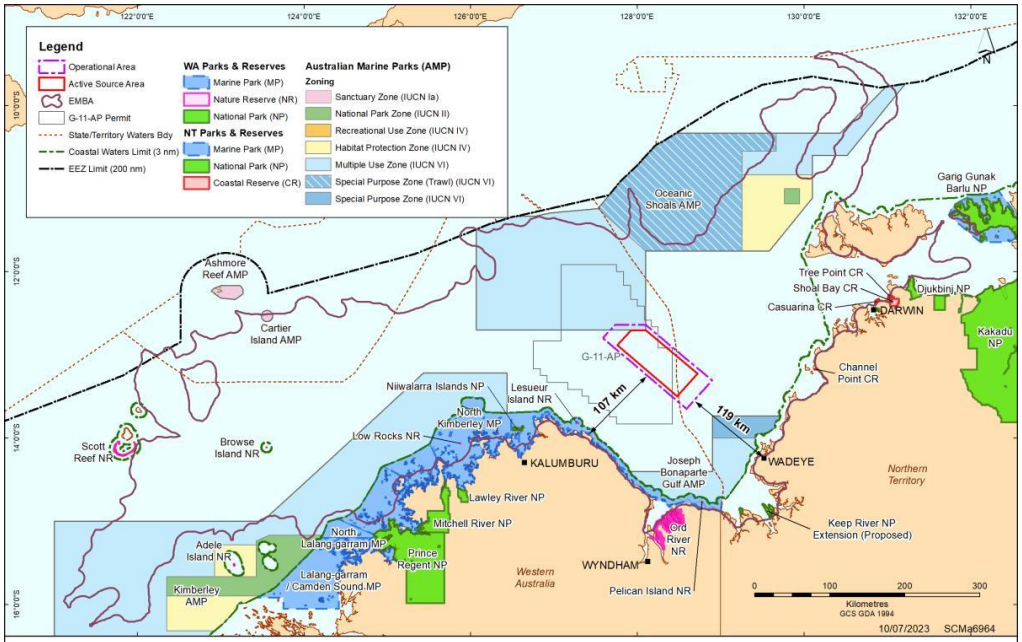
Eos 3D Marine Seismic Survey

Santos



Santos

EOS 3D MSS LOCATION MAP

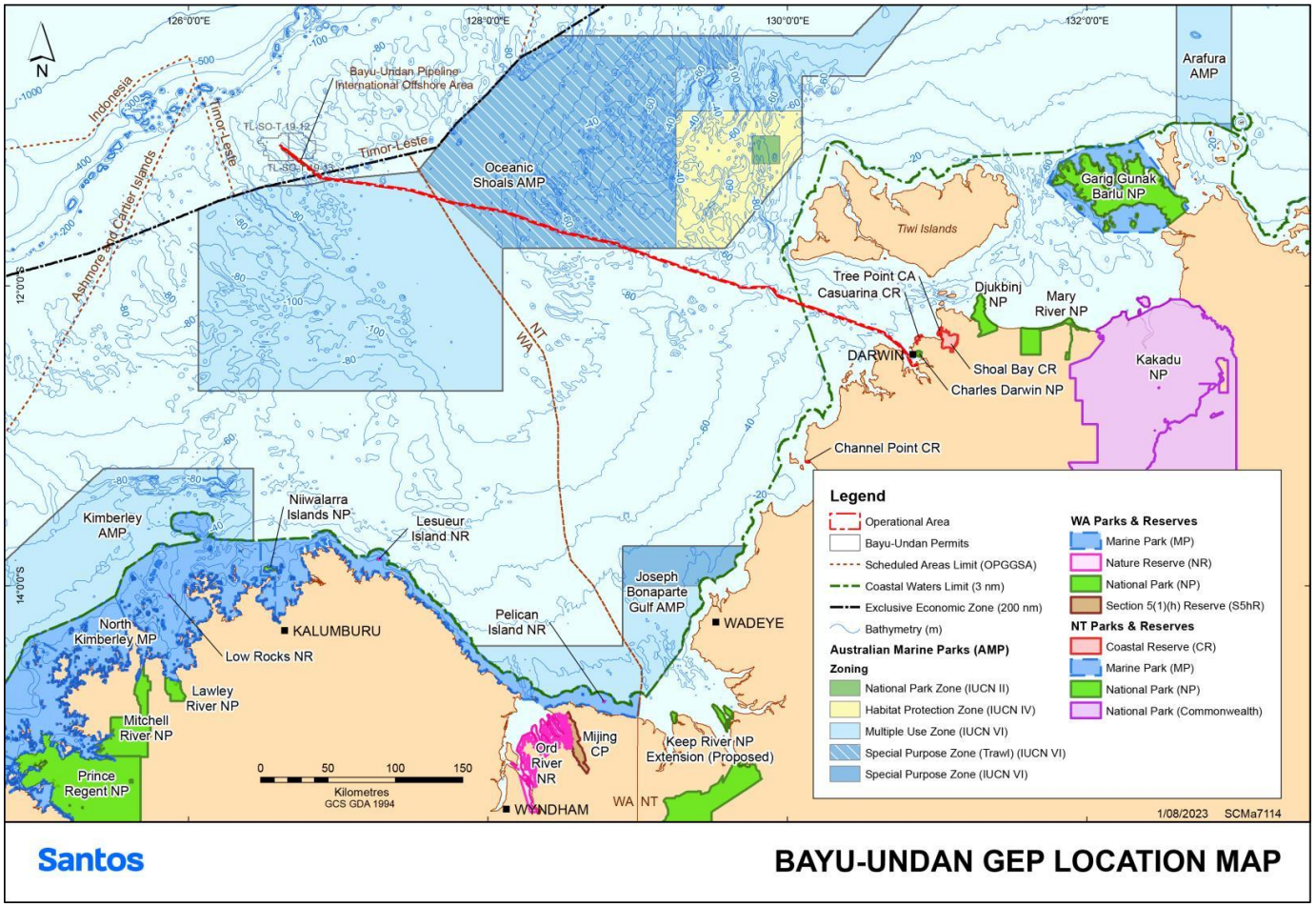


Santos

EOS 3D MSS LOCATION MAP

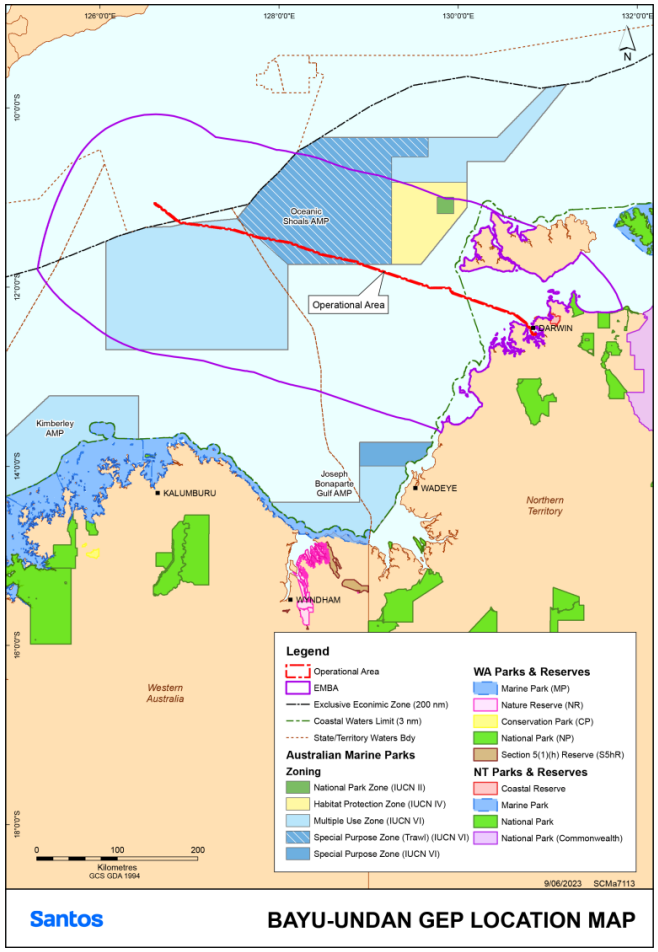
Tern-2 Plug and Abandonment

Santos



Santos

BAYU-UNDAN GEP LOCATION MAP



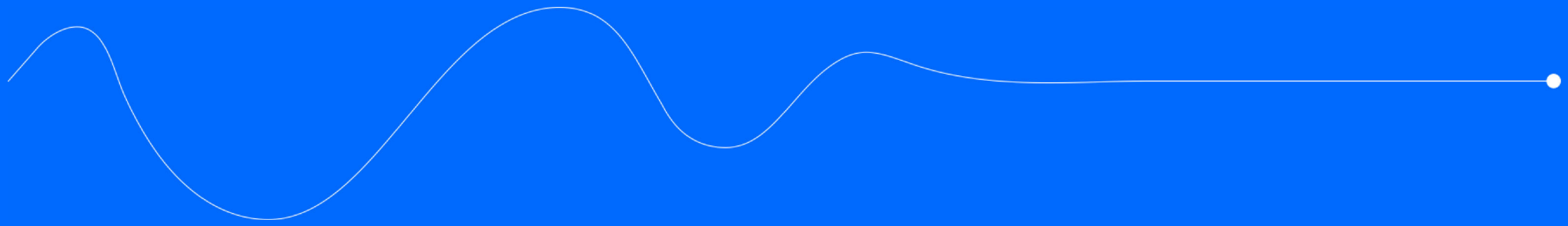
Santos

BAYU-UNDAN GEP LOCATION MAP

Bonaparte Basin Consultation - The Wilderness Society_20231211

Santos

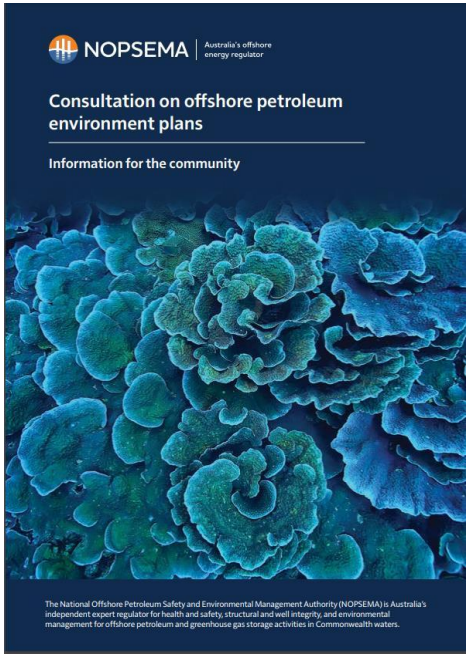
CONSULTATION – BONAPARTE BASIN



December 2023

Regulatory Consultation

Commonwealth waters – National Offshore Petroleum Safety and Environmental Management Authority



"In the course of preparing an Environment Plan, a titleholder must consult with relevant persons in accordance with Division 2.2A, Regulation 11A…

"The purpose of consultation under regulation 11A of the Environment Regulations is to ensure that authorities, persons or organisations that are potentially affected by activities are consulted and their input considered in the development of environment plans."

Guideline - Consultation in the course of preparing an environment plan, NOPSEMA

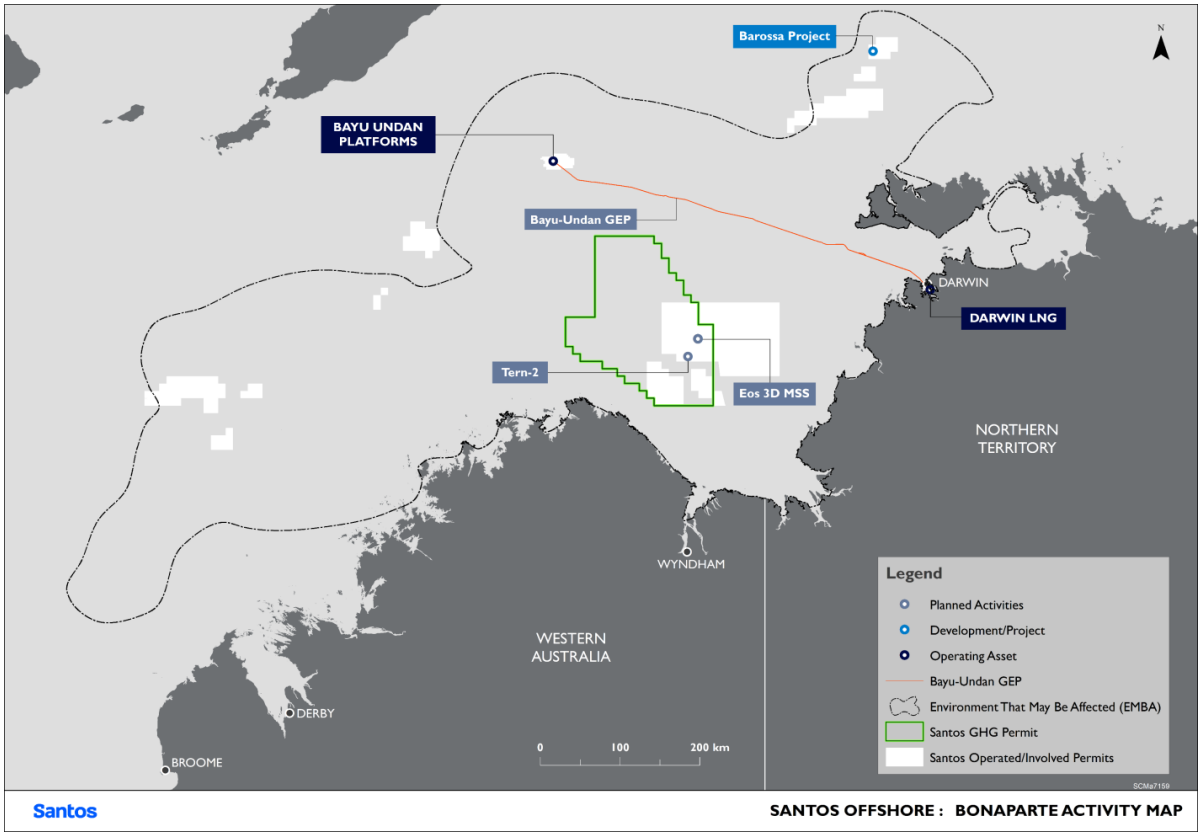
A **relevant person** is an authority, a person or an organisation whose functions, interests or activities may be affected by proposed activities.

Bonaparte Basin

Santos

- Santos is proposing to undertake activities Consultation for our Bonaparte Basin activities (outside of Barossa Gas Project activities) starts on **27 October 2023** and closes on **27 November 2023**.
- Proposed activities are:
  - Tern-2 Plug and Abandonment
  - Eos 3D Marine Seismic Survey
  - Bayu-Undan Gas Export Pipeline Operations

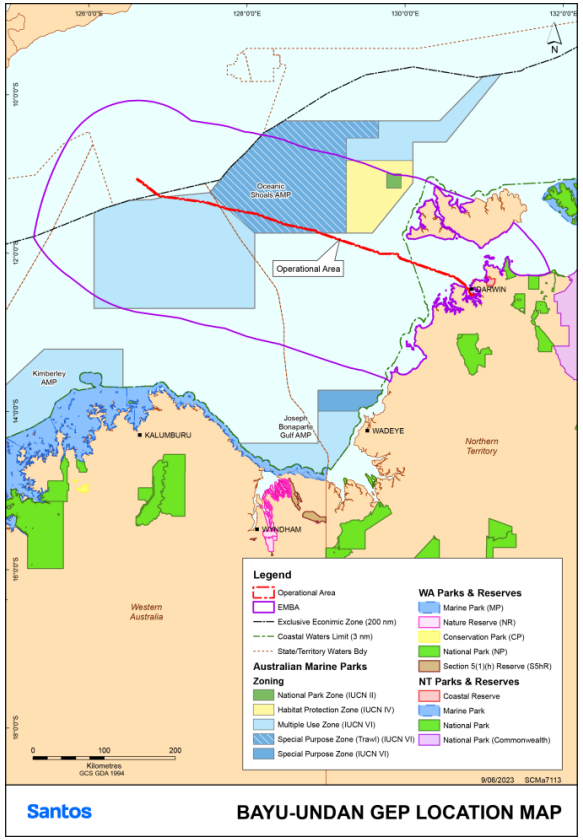
- **Email** – offshore.consultation@santos.com
- **Web** – www.Santos.com/offshoreconsultation
- **Phone** – 1800 267 600



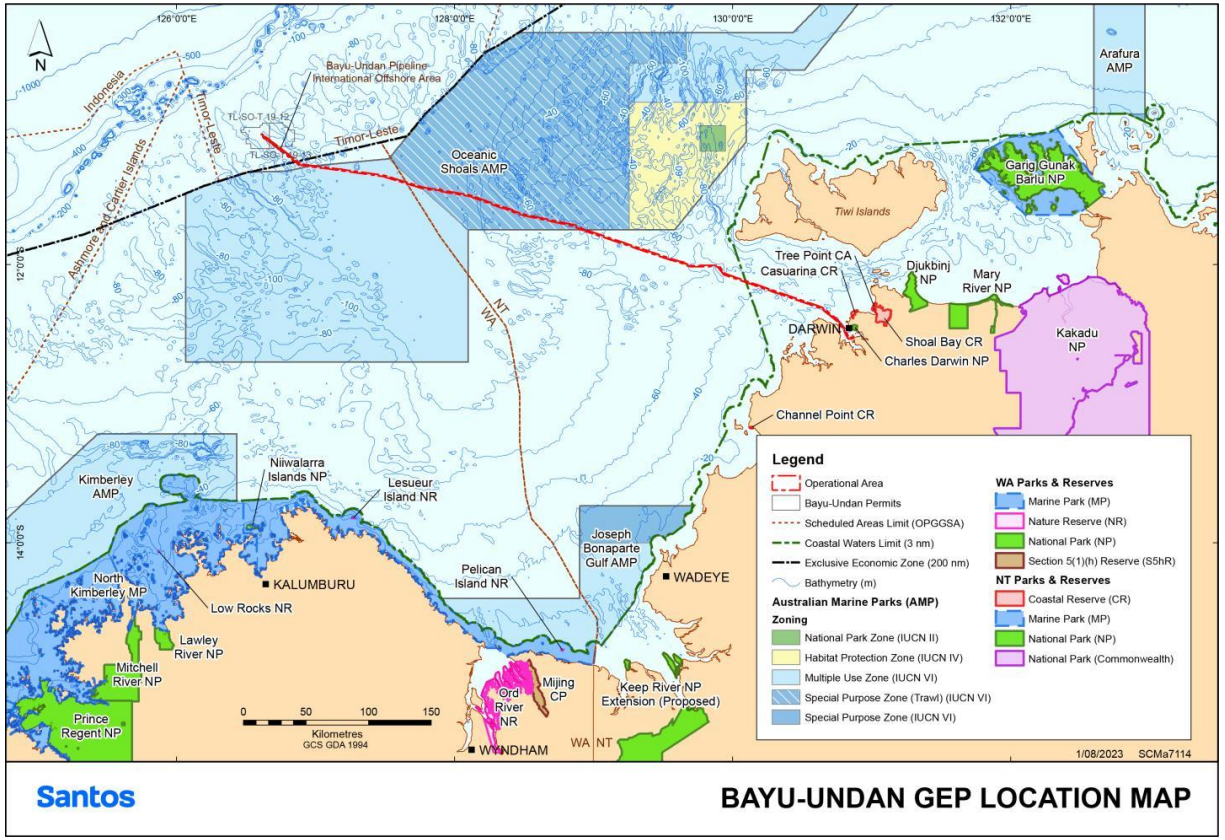
Bayu-Undan Gas Export Pipeline EP

Santos

- Santos is the operator of the existing 502km Gas Export Pipeline.
- The pipeline transports dry natural gas from the Bayu-Undan Field (Timor-Leste waters) to the onshore Darwin liquefied natural gas (DLNG) plant.
- The pipeline has been operational since 2005.
- As the Field is approaching the end of life, the pipeline will transition from operations to a preservation state.
- The original EP for operations was accepted by NOPSEMA in 2019.
- The EP has been updated to include the final stages of operations (linepacking and back-feed), plus a preservation phase (gas-filled).



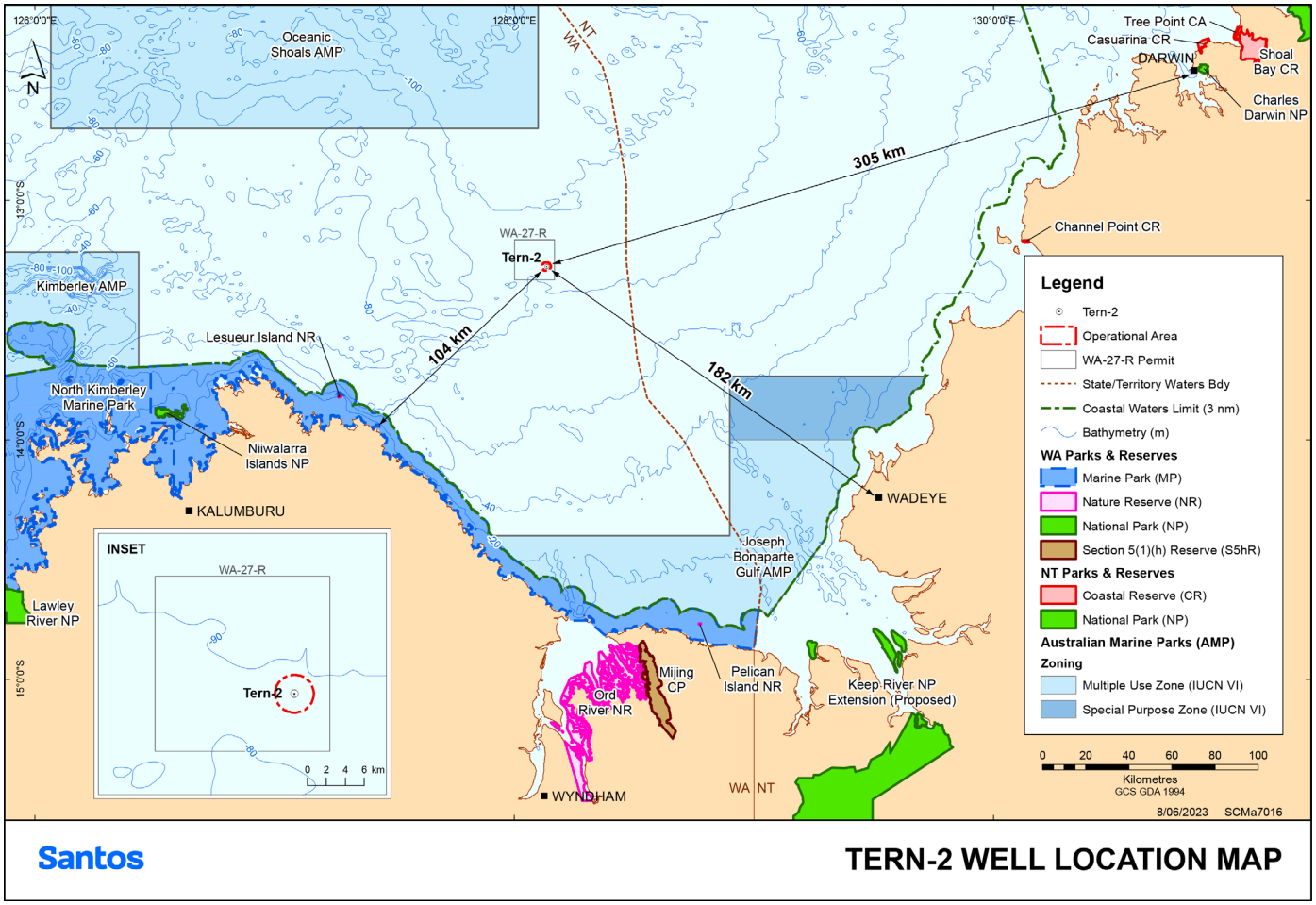
Santos BAYU-UNDAN GEP LOCATION MAP



Santos BAYU-UNDAN GEP LOCATION MAP

Tern-2 Plug and Abandonment

Santos



Santos

TERN-2 WELL LOCATION MAP

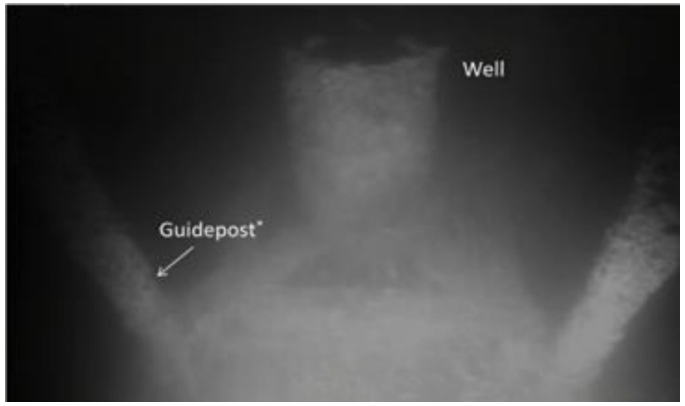
Wellhead	Title	Approx. Water Depth (m)	Coordinates (Datum/Projection: GDA 94 Zone 50)	
			Latitude	Longitude
Tern-2	WA-27-R	83	13° 16' 37.36" S	128° 08' 02.68" E

Tern-2 Plug and Abandonment

Santos

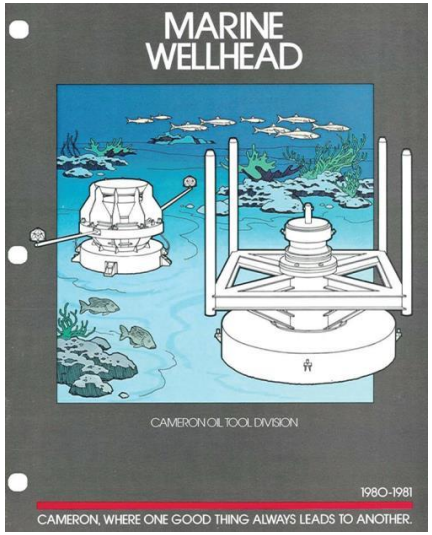
Activity overview:

- Install and verify additional well barriers to supplement the existing system of well barriers
- Operation Area is approximately 300 km WSW of Darwin, 106 km from the closest shoreline, 62 km southwest of Petrel-1 and 9.8 km southeast of Tern-1 well
- Operational Area is circular with a 2 km radius from the Tern-2 wellhead
- Removing the wellhead as best as practical to remove any structural evidence of the well from the seabed and eliminate future hazards to the environment or other users of the area



Timing

- Approximately 10 days (continuous operations, 24 hours per day, 7 days per week)
- Up to 40 days in the event of unforeseen delays and poor metocean conditions



Vessels:

- Light Well Intervention Vessel (LWIV)
- Support vessel
- Remotely Operated Vehicle (ROV)
- Helicopters

Eos 3D Marine Seismic Survey

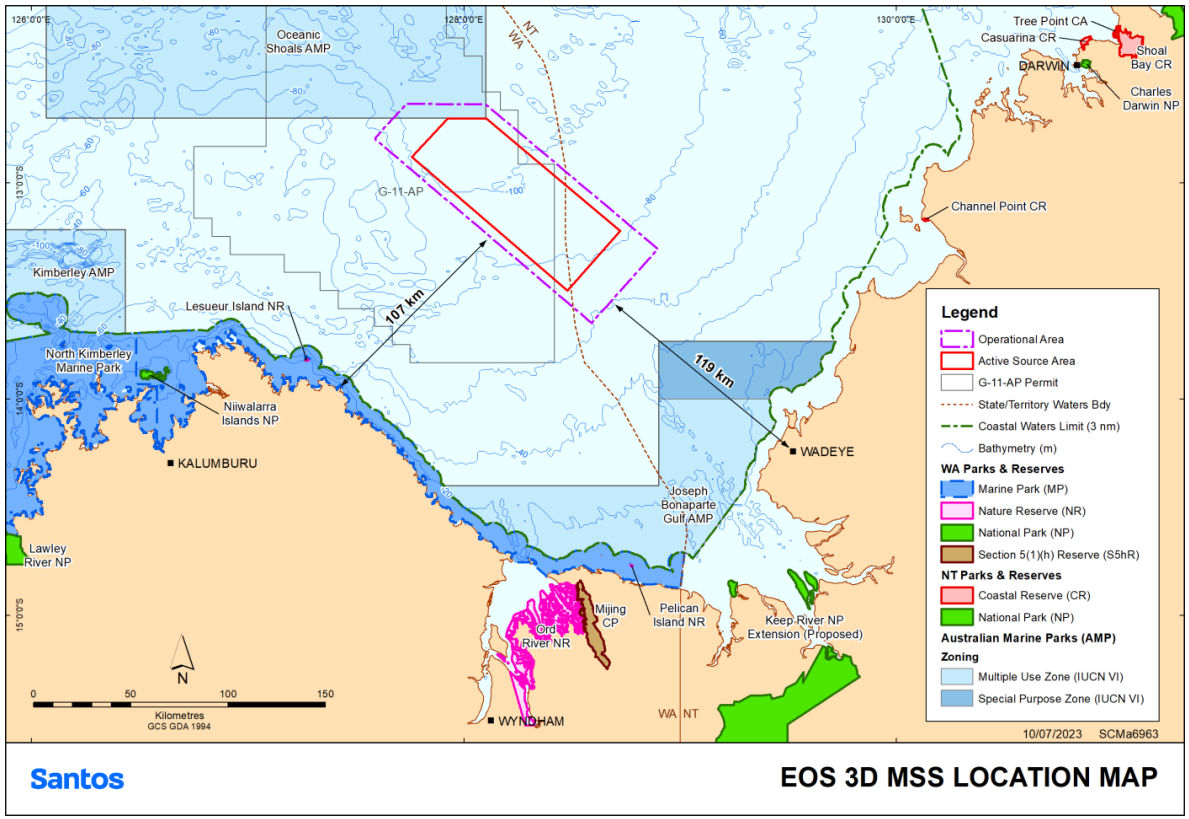
Santos

Activity Overview:

- Identify and image detailed subsea geological formations for the potential injection and storage of Carbon Dioxide (CO_2)
- Operational Area is approximately 107 km from the nearest coastline, and approximately 119 km from Wadeye in the Northern Territory
- Exclusion zone 3 nm (5.6 km) exclusion (safety) zone around the seismic vessel and trailing streamers
- Streamer length: Approximately 8 km
- Seismic streamer spread width: Approximately 1,350 m

Timing:

- From Q3 2024 with activity duration approximately 50 days, subject to activity schedule requirements, vessel availability and weather
- Time to traverse a single sail line: approx. 8 hrs and 30 mins.
- Line turns: 2-4 hrs
- Expected duration is a forecast and is subject to change based on vessel availability, adverse weather conditions or technical/equipment issues that may arise during the activity.



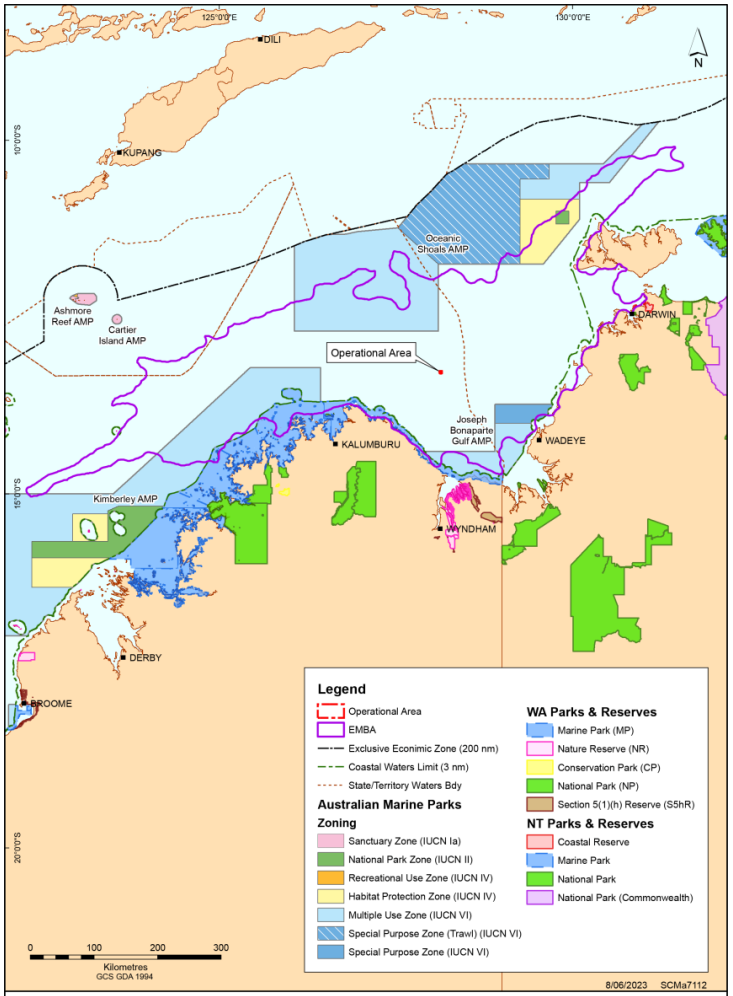
Vessels:

- One purpose built seismic survey vessel.
- Up to two dedicated support vessels (one being a chase vessel) will accompany the seismic survey vessel to provide logistical, safety and equipment management duties.
- Specific vessel details are unknown at this time.

Santos

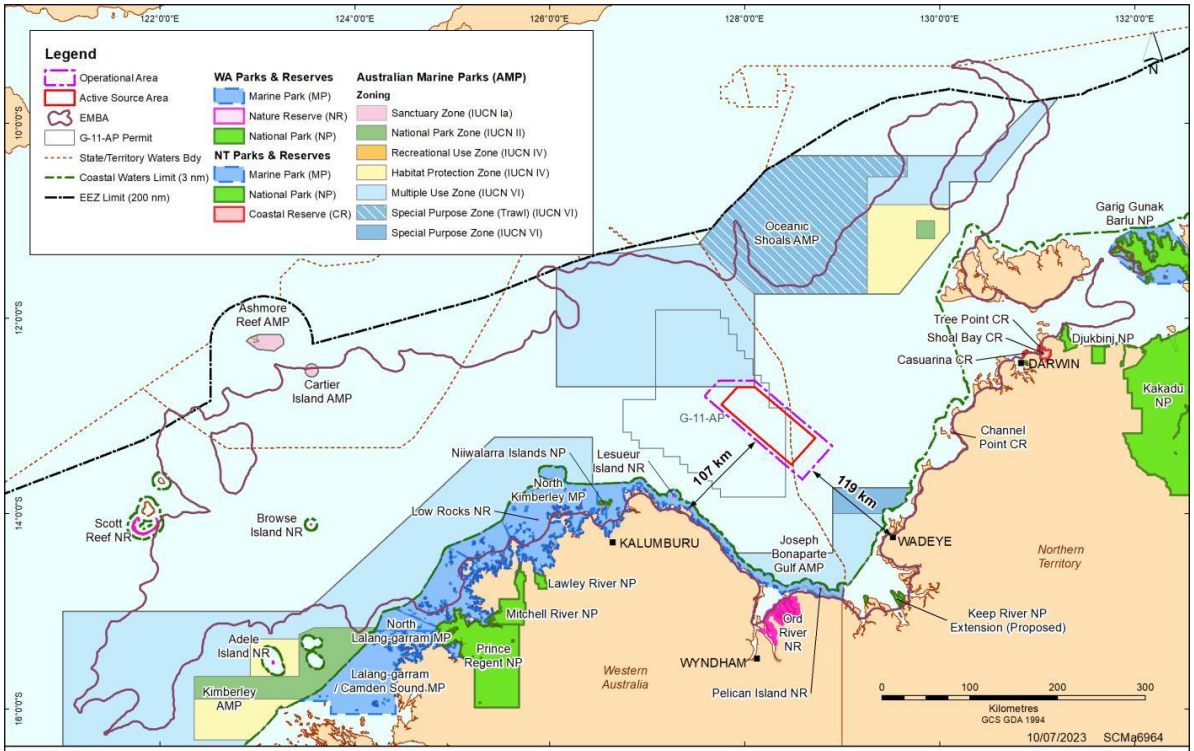
Spill Risk

Santos



Santos

TERN-2 LOCATION MAP



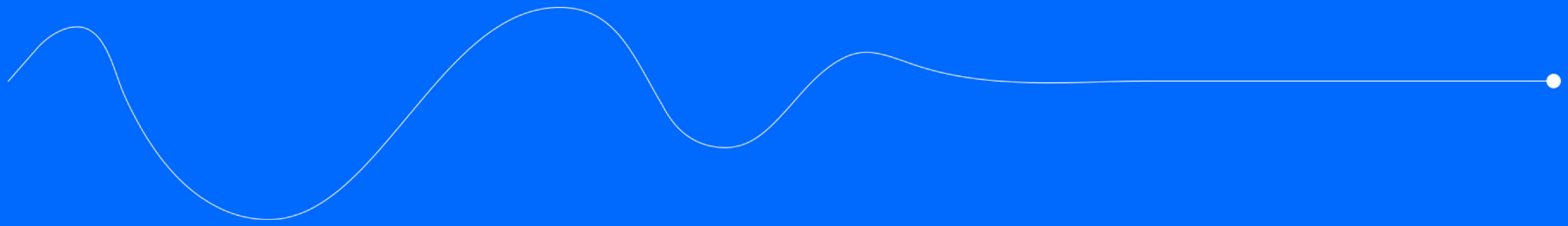
Santos

EOS 3D MSS LOCATION MAP

Wickham Point Reference Group_20231003

Santos

PRELIMINARY CONSULTATION – BONAPARTE BASIN



October 2023

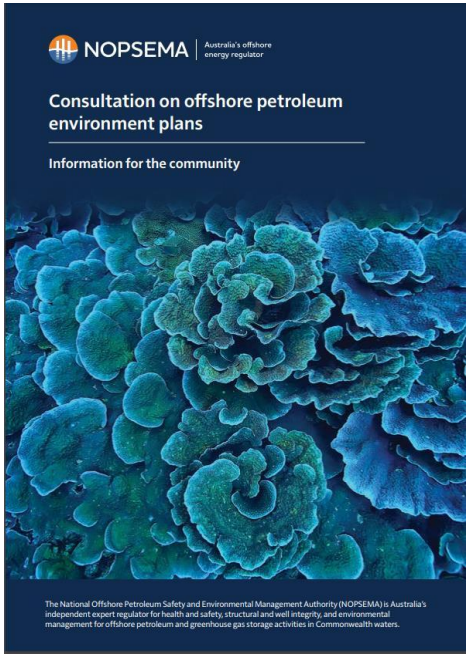
Engaging First Nations people and groups

Relationships

Regulatory consultation	• Commonwealth Government offshore approvals • WA State Government offshore and onshore approvals
Cultural heritage	• Identification, assessment and protection
Legal agreements	• Indigenous Land Use Agreements • Commercial agreements
Community benefits	• Employment and development opportunities • Support of worthwhile community projects • Support Indigenous businesses through our supply chain

Regulatory Consultation

Commonwealth waters – National Offshore Petroleum Safety and Environmental Management Authority



"In the course of preparing an Environment Plan, a titleholder must consult with relevant persons in accordance with Division 2.2A, Regulation 11A…

"The purpose of consultation under regulation 11A of the Environment Regulations is to ensure that authorities, persons or organisations that are potentially affected by activities are consulted and their input considered in the development of environment plans."

Guideline - Consultation in the course of preparing an environment plan, NOPSEMA

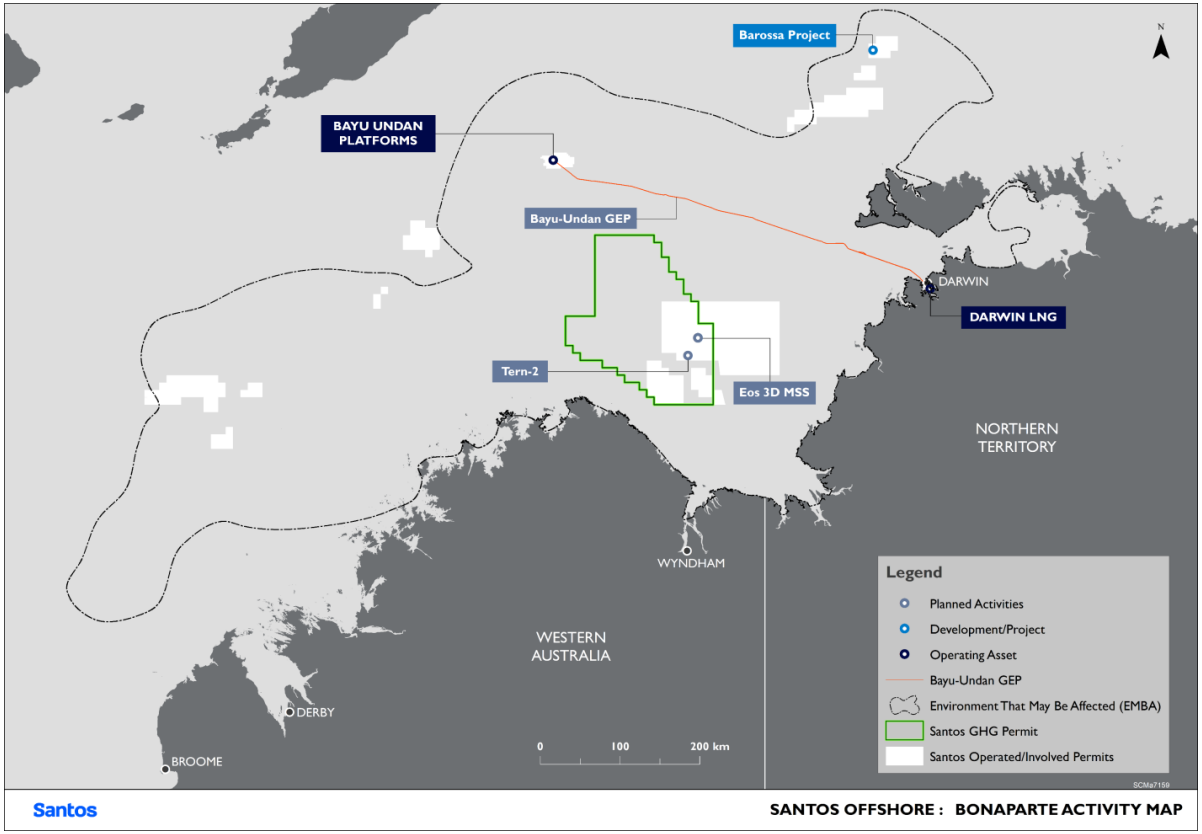
A **relevant person** is an authority, a person or an organisation whose functions, interests or activities may be affected by proposed activities.

Bonaparte Basin

Santos

- Santos is proposing to undertake activities Consultation for our Bonaparte Basin activities (outside of Barossa Gas Project activities) starts on **27 October 2023** and closes on **27 November 2023**.
- Proposed activities are:
  - Tern-2 Plug and Abandonment
  - Eos 3D Marine Seismic Survey
  - Bayu-Undan Gas Export Pipeline Operations

- **Email** – offshore.consultation@santos.com
- **Web** – www.Santos.com/offshoreconsultation
- **Phone** – 1800 267 600

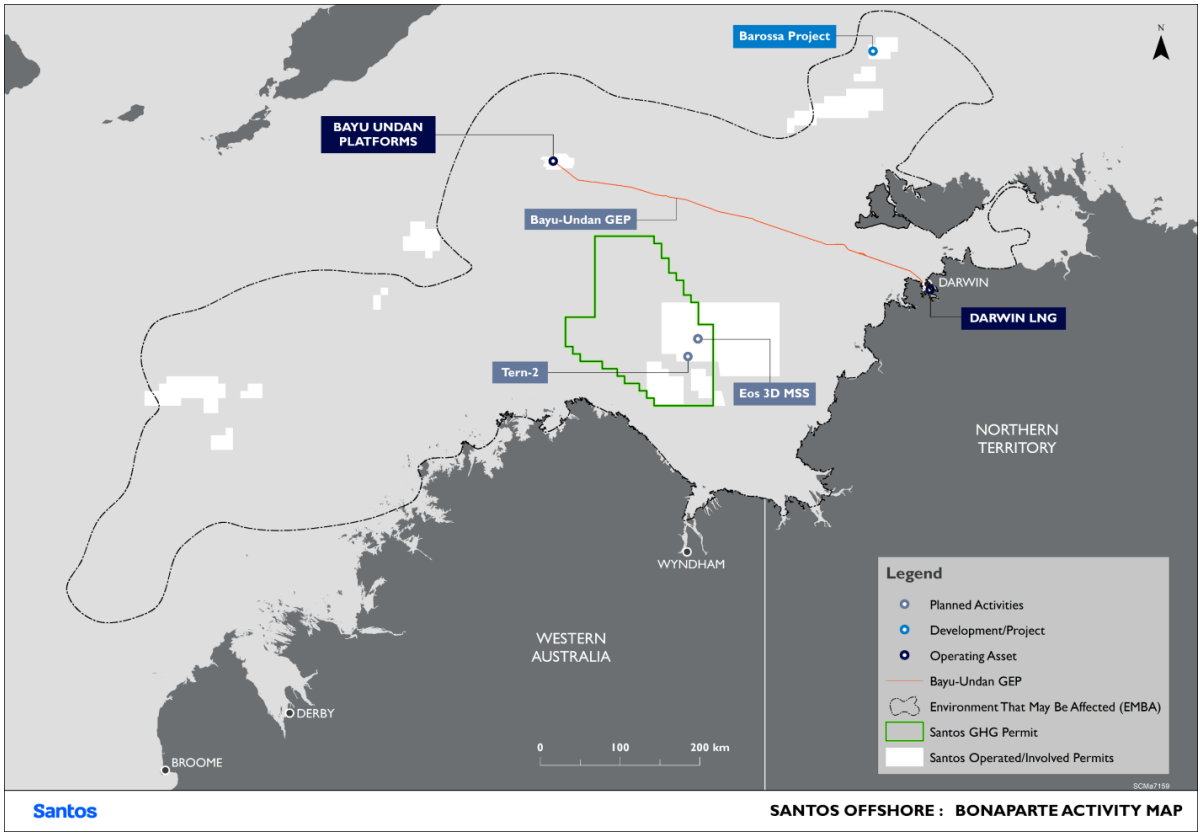


Bonaparte Basin

Santos

- Santos is proposing to undertake activities Consultation for our Bonaparte Basin activities (outside of Barossa Gas Project activities) starts on **27 October 2023** and closes on **27 November 2023**.
- Proposed activities are:
  - Tern-2 Plug and Abandonment
  - Eos 3D Marine Seismic Survey
  - Bayu-Undan Gas Export Pipeline Operations

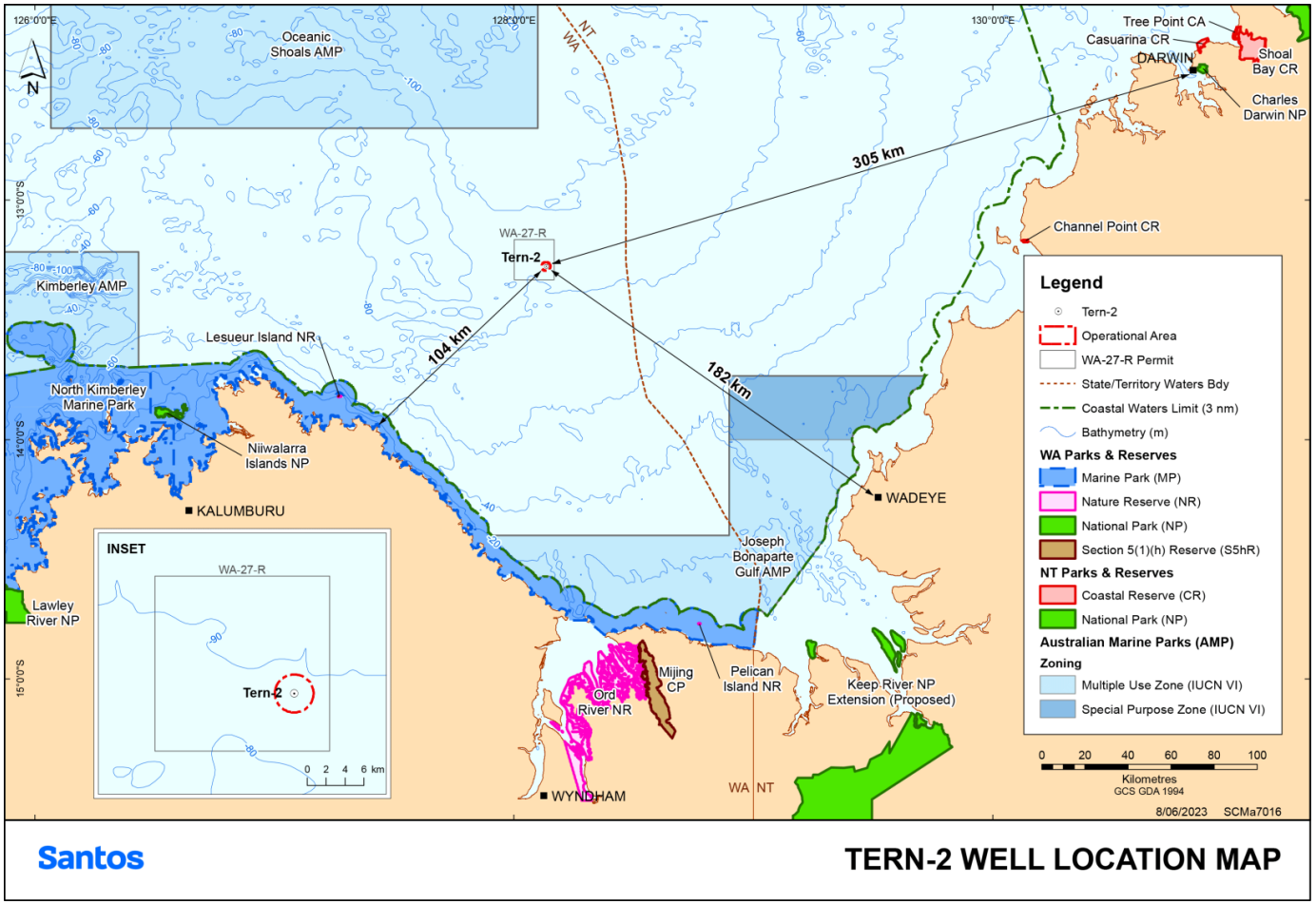
- **Email** – offshore.consultation@santos.com
- **Web** – www.Santos.com/offshoreconsultation
- **Phone** – 1800 267 600



Santos

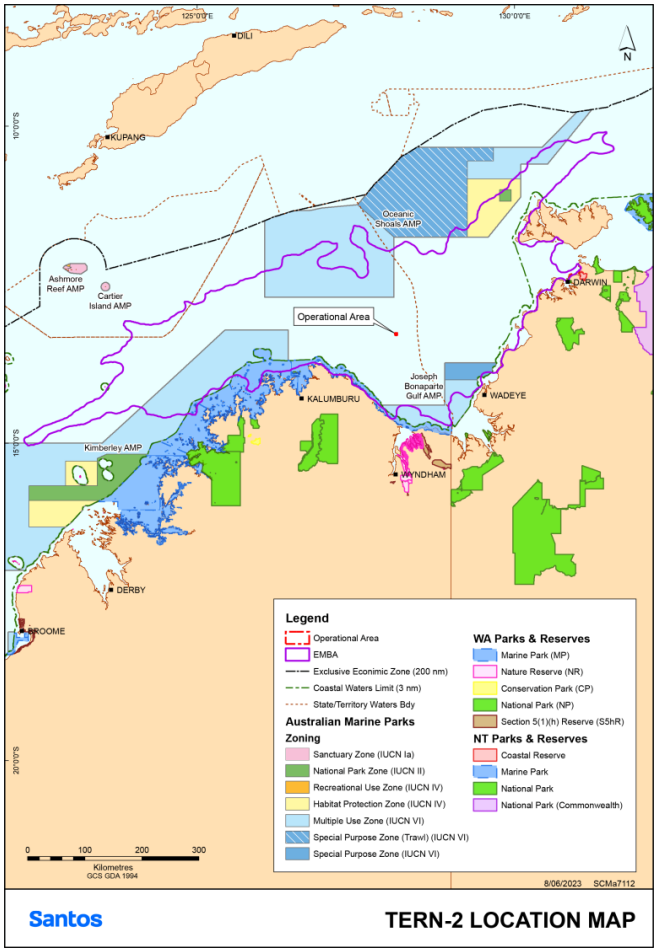
Tern-2 Plug and Abandonment

Santos



Santos

TERN-2 WELL LOCATION MAP

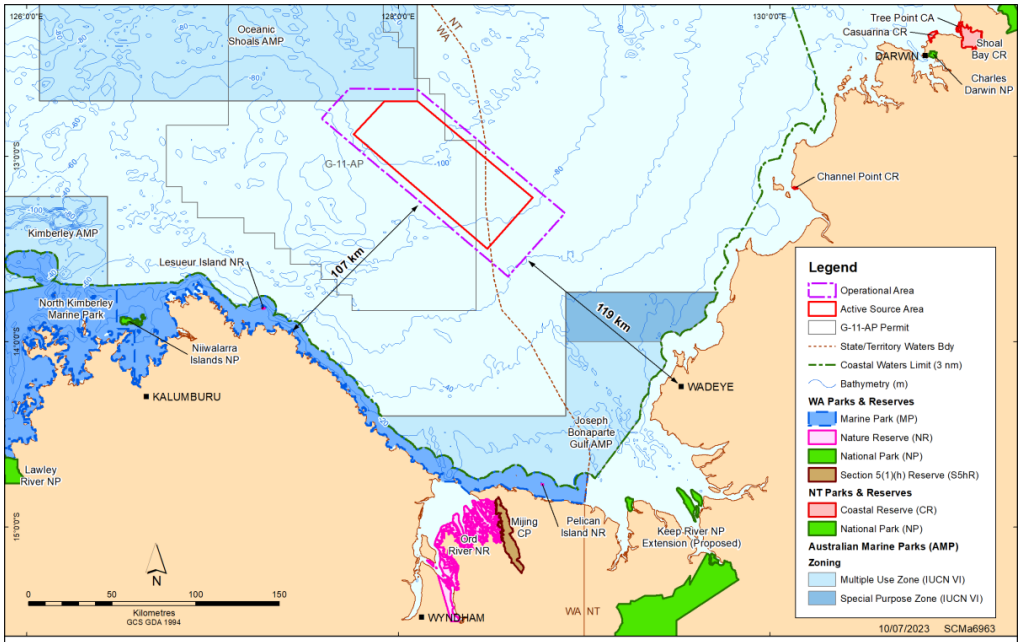


Santos

TERN-2 LOCATION MAP

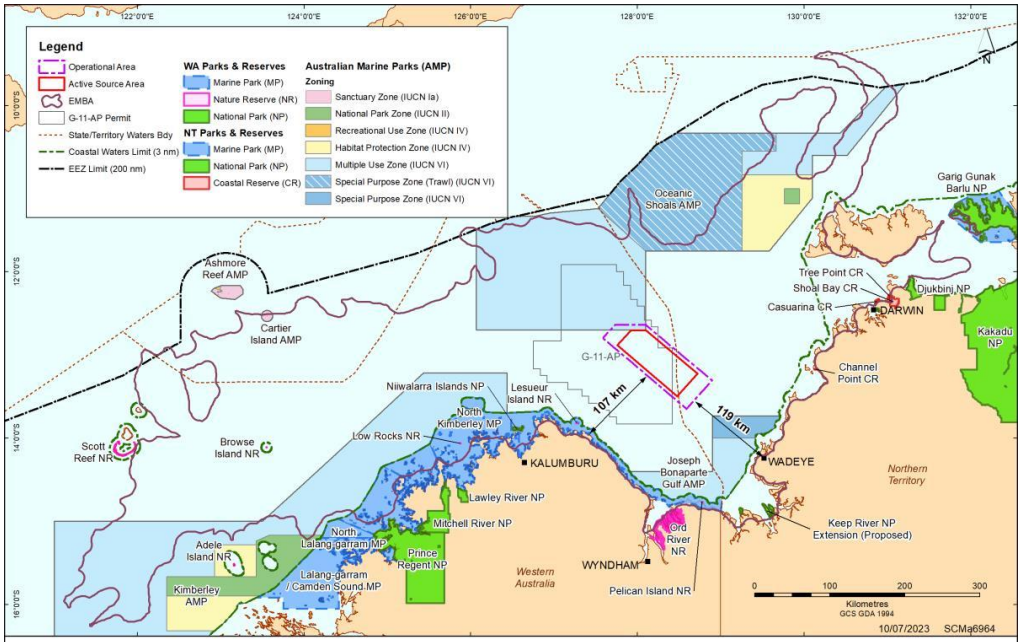
Eos 3D Marine Seismic Survey

Santos



Santos

EOS 3D MSS LOCATION MAP

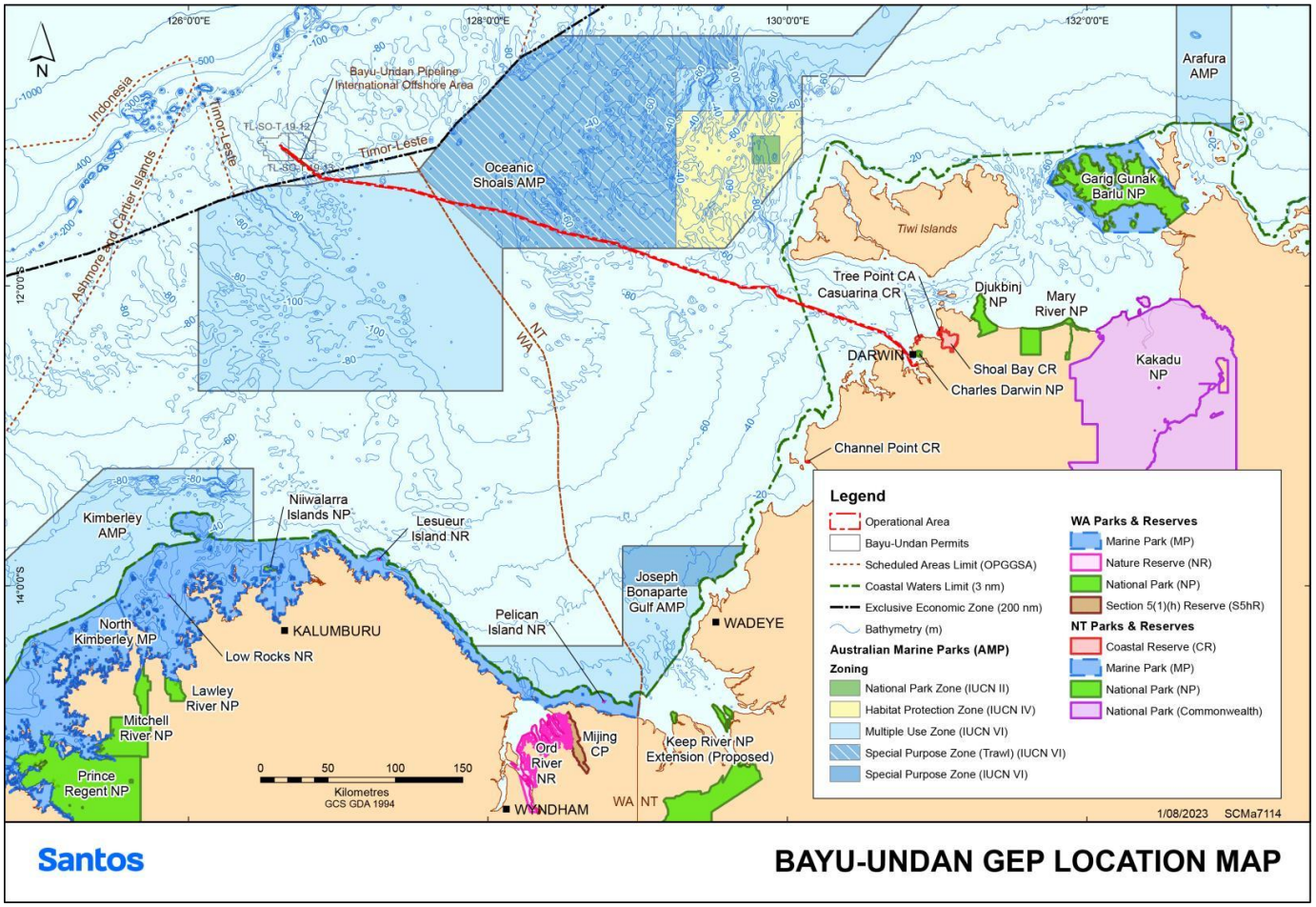


Santos

EOS 3D MSS LOCATION MAP

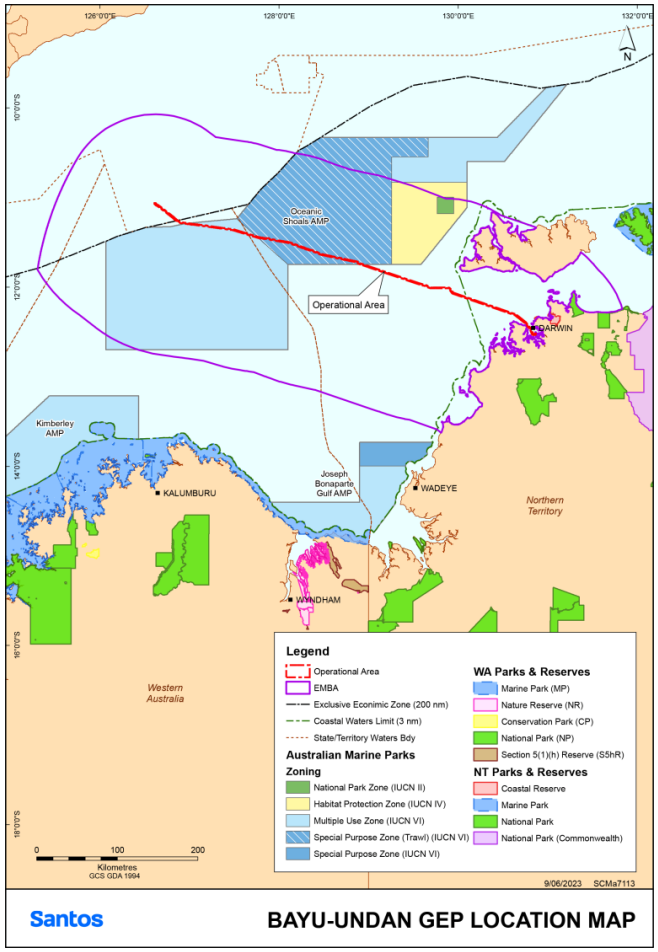
Tern-2 Plug and Abandonment

Santos



Santos

BAYU-UNDAN GEP LOCATION MAP



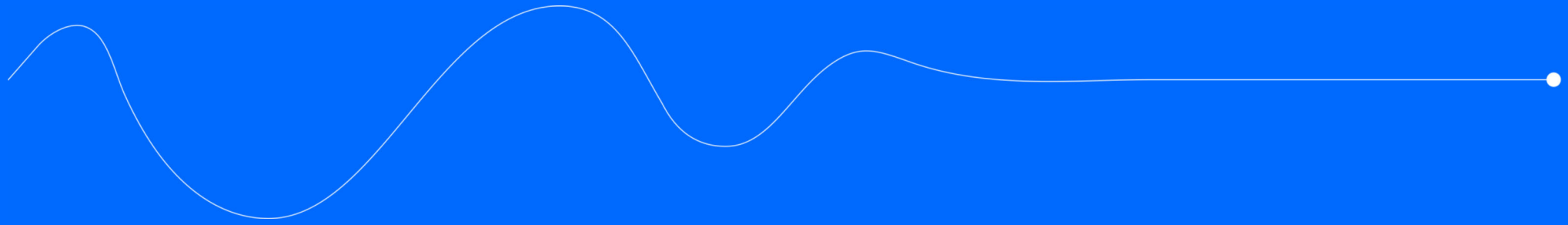
Santos

BAYU-UNDAN GEP LOCATION MAP

Bonaparte Basin Consultation - NPFI 20231103

Santos

NORTHERN TERRITORY & WESTERN AUSTRALIA PROJECT CONSULTATION SESSION



WA & NT Environment Plan Consultation

Presented by **Santos Team**

Santos

Privacy Statement

Santos Ltd and its related bodies corporate (together, we, our, us or Santos) collect personal information about you, such as your name and sensitive information about your indigenous heritage. We use this information to record your attendance at any meeting or other discussion with us, to provide you with information about our projects, to receive and respond to any information that you provide, to answer any questions you might have and for other purposes that we tell you about during your meeting or other discussion with us. Santos will handle any information that you provide in accordance with our Code of Conduct and our Confidentiality, IP and Privacy Procedure. You can ask us for a copy of this Privacy Notice or these other documents.

If you do not provide your personal information, we may not be able to identify you as the person who provided information, or we may be unable to discuss any information you have provided with you further or respond to your questions. We may disclose your information to other companies within the Santos group, to third parties that help us run our business and to relevant government agencies and government departments.

Due to the global nature of our operations and business, your personal information may be accessed by or disclosed to Santos personnel outside Australia. We may also use overseas third parties to collect, transfer, store and handle your personal information. Some of the overseas countries that your personal information may be accessed from, disclosed or transmitted to or stored in include but are not limited to, Papua New Guinea and the United States of America.

You have a right to request a copy of any personal information that we hold about you, as well as a right to request that we correct any information that we hold about you that is inaccurate, out-of-date, incomplete, irrelevant or misleading. You can also make a complaint about how we have handled your personal information. Our Consultation Privacy Policies explain in more detail how you can exercise these rights, including how we will respond to your access or correction request or to any privacy complaint that you make. The Barossa Gas Project Consultation Privacy Policy is available on our website at **www.santos.com/barossa/barossa-gas-project-consultation-privacy-policy**, and the Western Australia and Northern Territory Consultation Privacy Policy is available on our website at **https://www.santos.com/offshore-wa-and-nt-consultation-privacy-policy/.** You can also contact us to request copies be provided to you.

You can contact us by:

- posting a letter addressed to us at 60 Flinders Street, Adelaide, South Australia, 5000;
- telephoning us on +61 8 8116 5000; or
- sending us an email at offshore.consultation@santos.com and compliance@santos.com.

Santos

Acknowledgement of Country

Santos acknowledges the Traditional Owners of the land on which we meet today.

We pay our respects to Elders past, present and emerging.

Santos

Welcome & Introductions

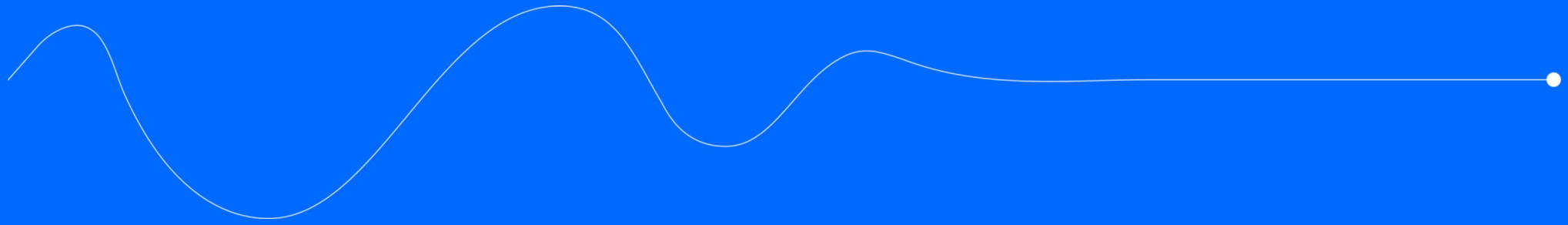
We are here today to share information about our company & operations and to listen to your questions about Santos & upcoming projects.

Peter Kirkpatrick *– General Manager, Darwin*

Emma Haddon *– Senior Environmental Advisor*

Santos

SANTOS OPERATIONS & DARWIN LNG



WA & NT Environment Plan Consultation

Presented by **Barossa Team**

SANTOS - South Australia, Northern Territory Oil Search

Santos is a global energy company committed to increasingly cleaner energy and fuels production, with operations across Australia, Papua New Guinea, Timor-Leste and North America (Alaska).

For more than 65 years, Santos has been working in partnership with local communities, providing local jobs and business opportunities, safely developing its natural gas resources, and powering industries and households.

We are committed to supplying critical fuels such as oil and gas in a more sustainable way through decarbonising projects, including the Moomba CCS Project, while we all transition to cleaner fuels.

At Santos, our commitment is to be a global leader in the transition to cleaner energy and clean fuels, by helping the world decarbonise to reach net-zero emissions in an affordable and sustainable way.

Santos is one of Australia's biggest domestic gas suppliers and a leading LNG supplier in the Asia Pacific region.

Our business focus: Safe, reliable operations & Minimise our social and environmental impacts.

Darwin LNG Facility & Operations

Santos

- Located in Darwin at Wickham Point Darwin LNG (DLNG) is a single train liquefaction and storage facility that started production in 2006.
- The Bayu-Undan facility, which supplies gas to DLNG via 26-inch subsea pipeline, is located approximately 500 kilometers north-west of Darwin in the Timor Sea.
- The facility includes a central production Storage and Offloading vessel for condensate and LPG products and an unmanned wellhead platform.
- Approx 140 local Darwin people work at the LNG Facility.
- 100% Darwin residential Santos employee workforce.
- DLNG established the NT's first LNG Process Operator Traineeships in 2010.
  - ~10% of those who have completed identified as an Aboriginal or Torres Strait Islander.

The Oil & Gas lifecycle

Santos

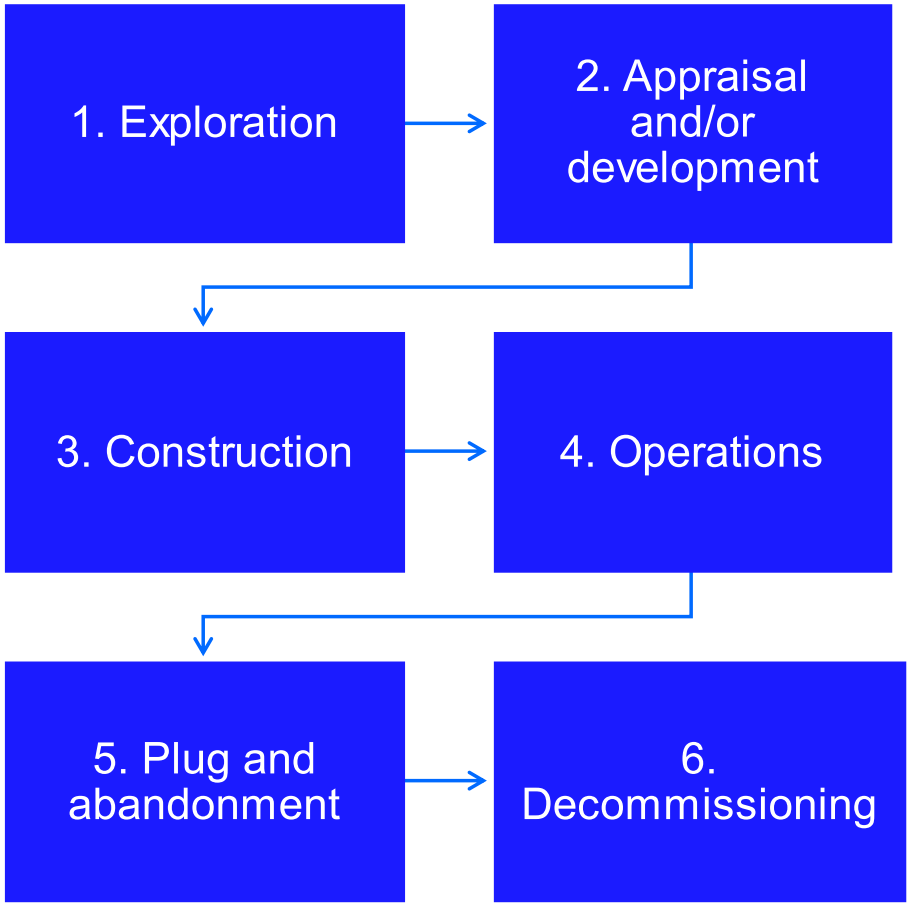
The oil & gas lifecycle involves the exploration, extraction, and use of these resources. Followed by closing the site when complete.

It starts with searching for gas deep underground using seismic surveys and drilling exploration wells, followed by the construction of infrastructure to extract and produce them.

Afterward, the products are transported to end-users.

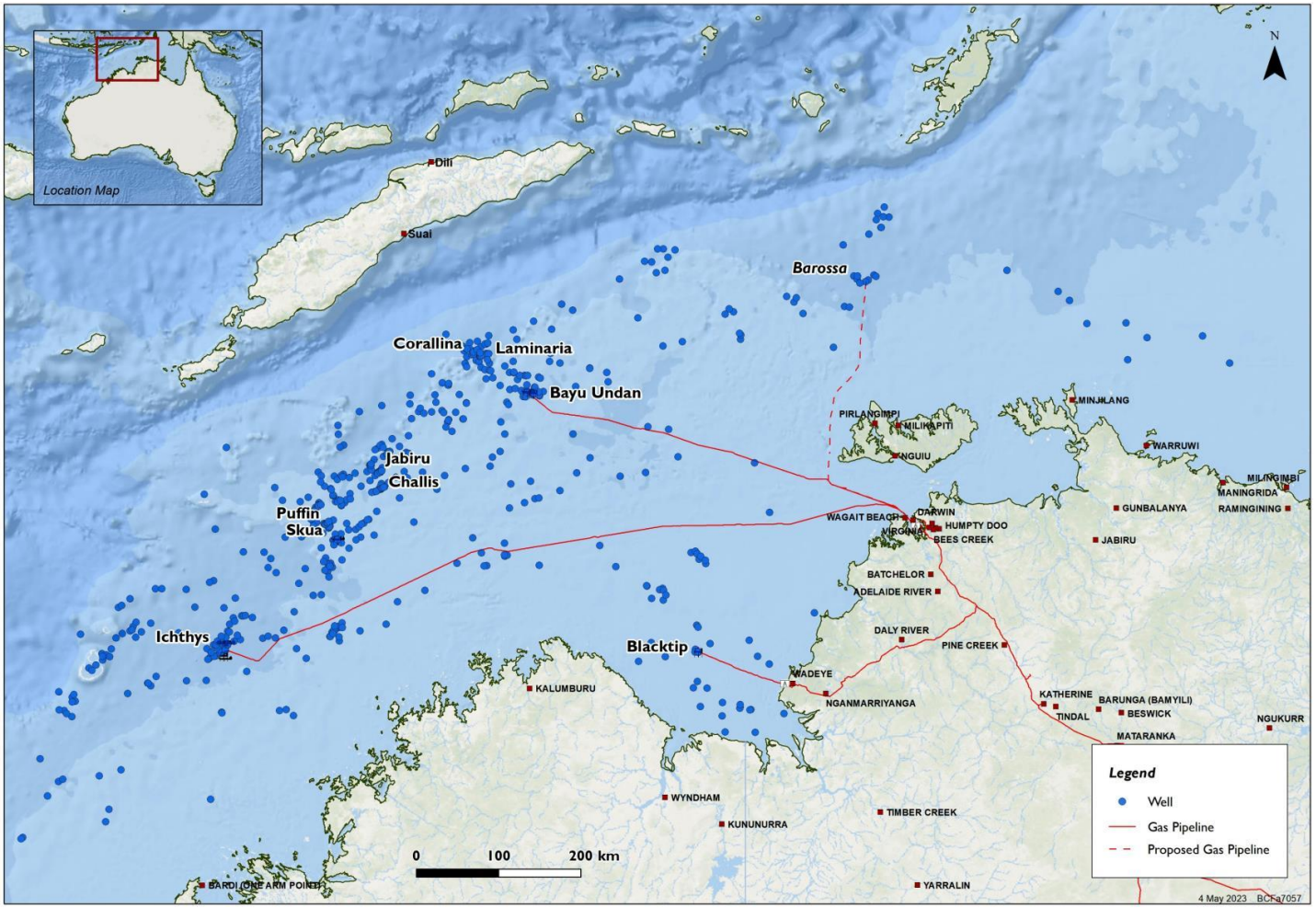
When the resources are depleted, there's a process to close down operations and ensure environmental compliance. This is called decommissioning.

Current Santos projects are at various stages of this lifecycle.



Wells Oil & Gas Drilled by All Industry Since 1969

Santos



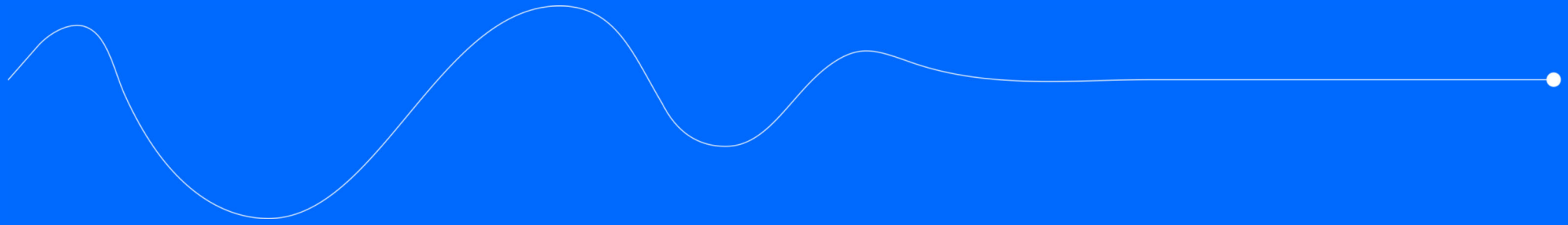
These are not all Santos owned and operated.

This map shows all wells drilled in the NT area.

Not all of these wells are used. Many are capped.

Santos

ENGAGEMENT & CONSULTATION EXPLAINED



Consultation for Environment Plans

Commonwealth waters – National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA)

"In the course of preparing an Environment Plan, a titleholder must consult with relevant persons in accordance with Division 2.2A, Regulation 11A…

"The purpose of consultation under regulation 11A of the Environment Regulations is to ensure that authorities, persons or organisations that are potentially affected by activities are consulted and their input considered in the development of environment plans."

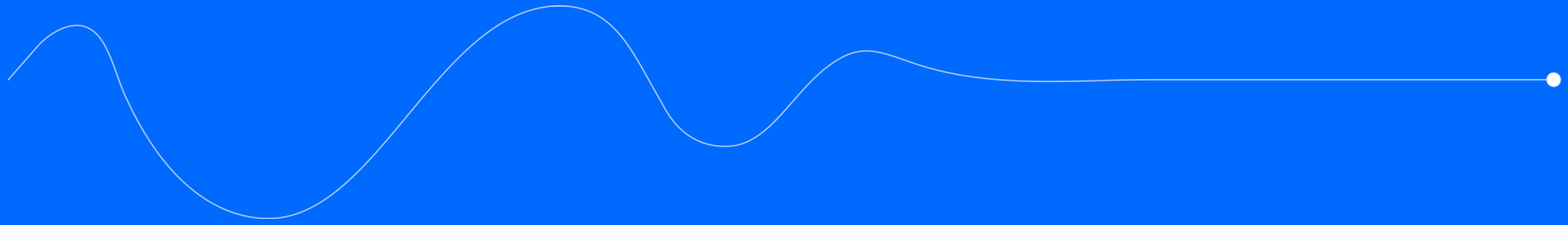
Guideline - Consultation in the course of preparing an environment plan, NOPSEMA

NOPSEMA

Information provided by relevant persons in consultation may also help titleholders **better understand the values and sensitivities of the environment** and inform the evaluation of the **potential impacts and risks** associated with the activity and **how to manage them** appropriately

Santos

BAROSSA GAS PROJECT & DARWIN PIPELINE DUPLICATION ENVIRONMENT PLAN CONSULTATION



WA & NT Environment Plan Consultation

Presented by **Barossa Team**

Santos

Barossa Gas Project - Overview

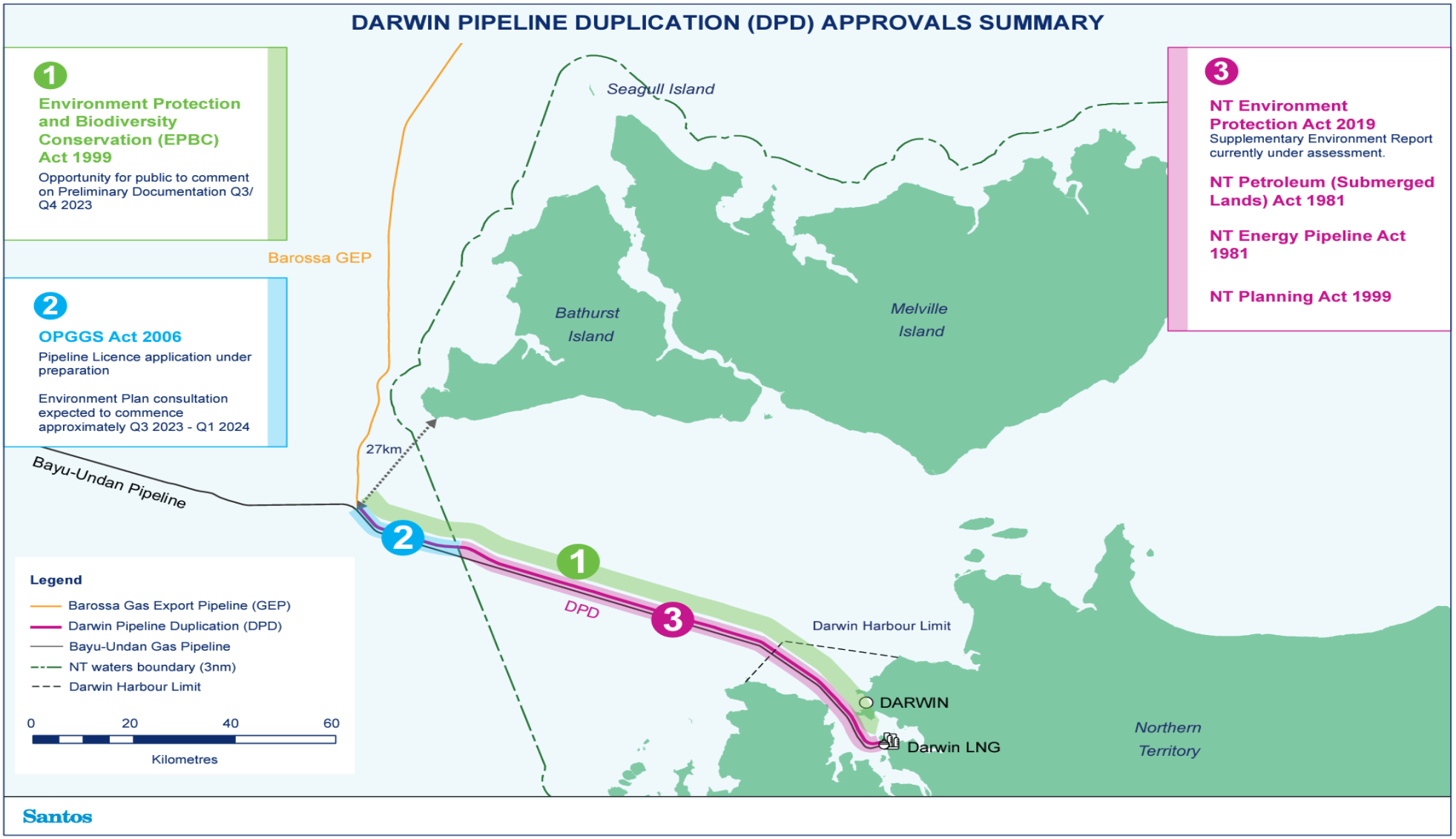
- The Santos-operated Barossa Gas Project is an offshore gas and condensate project that proposes to provide a new source of gas to the existing Darwin liquified natural gas (DLNG) facility in Darwin.
- The Barossa gas field is approximately 285 kilometres offshore north-north west from Darwin.
- Natural gas would be extracted from the Barossa field and transported via a gas pipeline (Gas Export Pipeline (GEP) and Darwin Pipeline Duplication (DPD)) to the existing DLNG facility.
- Project infrastructure would comprise a Floating Production Storage and Offloading (FPSO) facility, a subsea production system, supporting in-field subsea infrastructure, the GEP and the DPD.
- Up to eight subsea wells are planned to be drilled in the Barossa field (six wells from three drill centres, with contingency plans for an additional two wells). Gas and condensate would be gathered from the wells through the subsea production system and then brought to the FPSO facility via a network of subsea infrastructure.
- Initial processing would occur at the FPSO facility, to separate the natural gas, water and condensate extracted from the Barossa field. The dry natural gas would be transported through the gas pipeline for onshore processing at the DLNG facility. Condensate would be transferred from the FPSO to specialised tankers for export.

Santos

Barossa Gas Project Overview Video

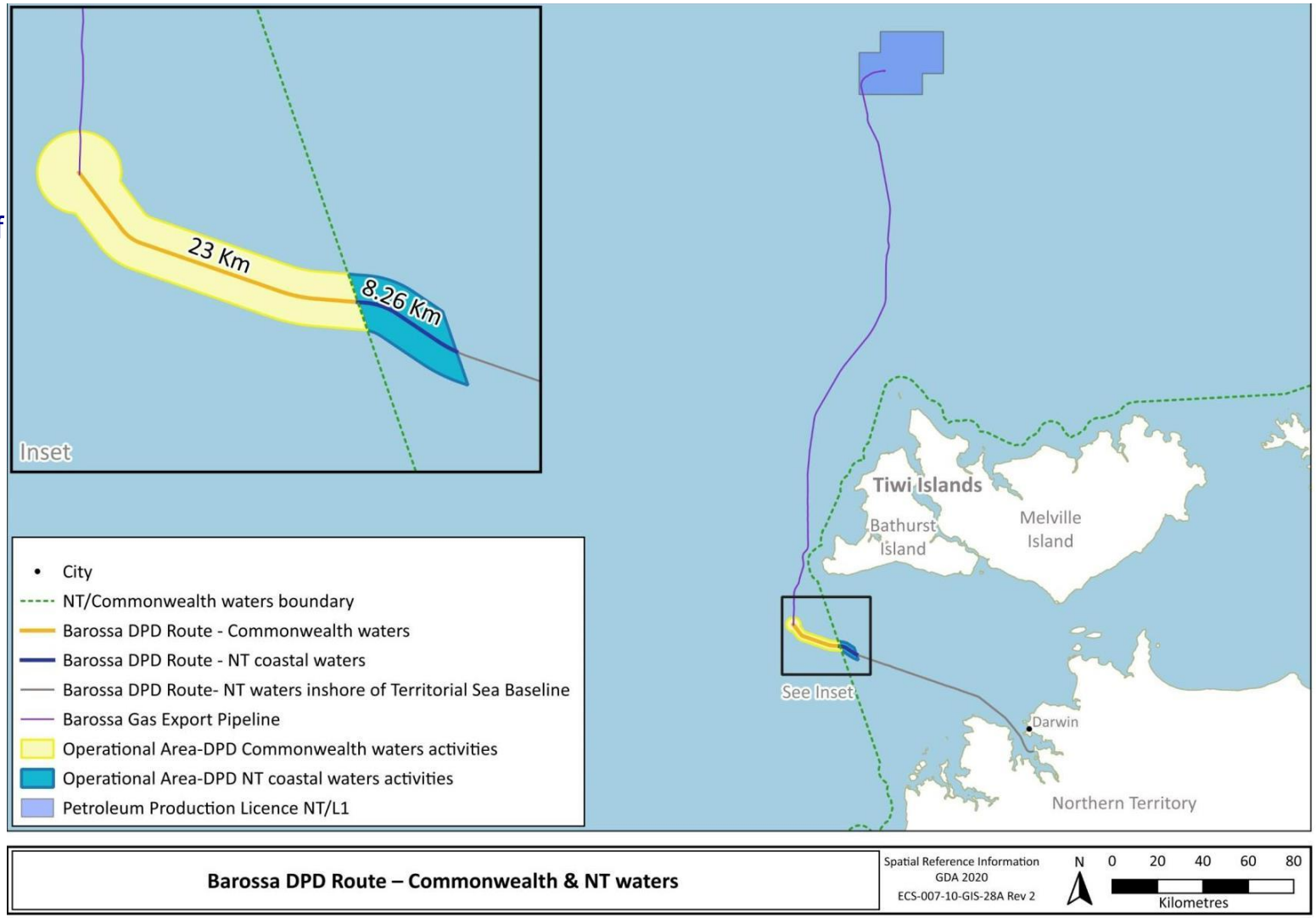
DPD Approvals

Santos



Darwin Pipeline Duplication (DPD) - Overview Santos

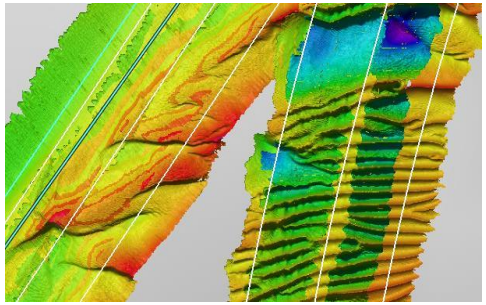
- The DPD will connect to the Barossa gas export pipeline and will send gas to Darwin.
- The pipeline will run from approximately 27km south-west of the Tiwi Islands to the gas plant in Darwin Harbour.
- Activities consist of acoustic positioning, survey, pipeline and structure installation, pipeline testing, refuelling, connecting the DPD to the Barossa gas export pipeline and unplanned maintenance/repairs.
- DPD activities are currently planned to start between Q3 of 2024 and Q2 of 2025, depending on availability of vessels and equipment, and should last 3 months)



Key DPD Installation Steps

Santos

Pre-lay Survey



Pre-lay Span Correction

Concrete mattresses are installed to support the pipeline where the seabed is rough.

Pipelay and Survey

Approximately 31km of pipeline is installed in Commonwealth and coastal waters by a pipelay vessel. Survey and post lay span correction, if required, is performed as pipelay progresses.

Pipeline Testing

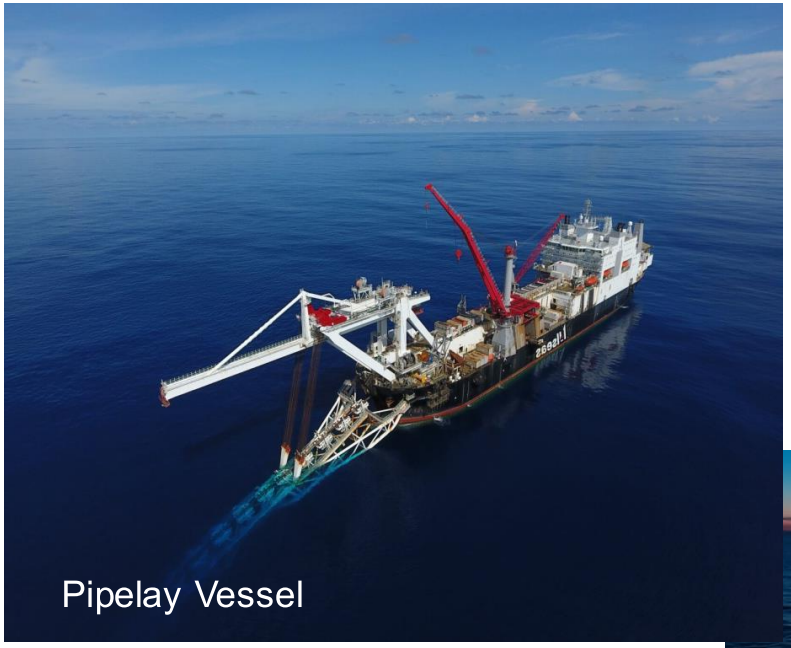
The DPD will be flooded with treated seawater and leak tested before the water is removed and the DPD is prepared for introduction of gas.

Connect DPD to the Gas Export Pipeline and Test

A spool shall be installed connecting the offshore gas export pipeline to the DPD. Once installed the spool will be leak tested.

DPD Installation Activities – Key Vessels

Santos



Pipelay Vessel

Survey and Construction Support Vessel

Supply Vessel

Santos

DPD impacts

Planned events	Expected Impact	How we manage (the rules we follow)
Light disturbance	Behavioural impact to marine life (e.g. attraction)	We only use lights where needed for safe operations and to comply with relevant safety rules. We turn off lights when not required.
Noise disturbance	Behavioural impact to marine life (e.g. avoidance)	We follow procedures and look out for marine life (e.g., whales, dolphins, turtles) and we slow down and move away from them where possible if they are too close. Boats and equipment will be maintained to minimise noise.
Seabed disturbance	Turbidity, smothering of habitat	We are putting equipment on a mainly flat sandy seabed close to an existing pipeline. We record the position of installed equipment so we can collect it at a later date.
Discharges (boat discharges, pipeline testing)	Impact to water quality	We will manage discharges to acceptable levels and follow the standard rules for what boats can discharge. We will select water treatment chemicals that are environmentally acceptable, and we will limit its use.
Air emissions	Impact to air quality, greenhouse gas emissions	We ensure engines and other equipment are looked after and low emission fuel will be used.
Disturbance to other boats	Exclude other users from activity area	We will communicate to other boats where we are and what we are doing. We mark the location of equipment on charts.

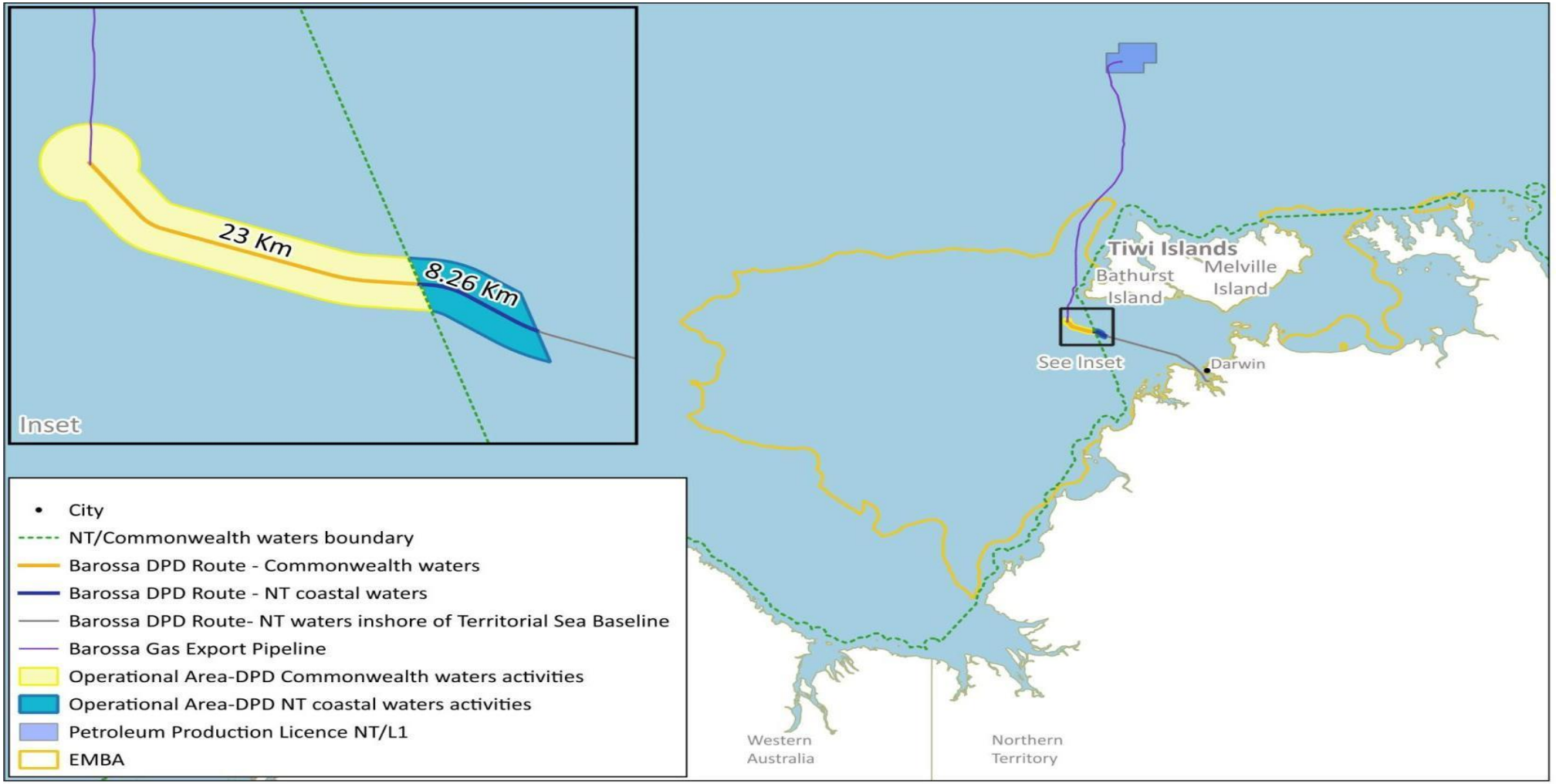
Santos

DPD risks

Unplanned events (Accidents)	Unplanned Impact	How we manage (the rules we follow)
Dropped objects	Impacts to water quality, disturbance to seabed and marine life	We follow strict procedures to stop objects dropping overboard and we pick up objects when it is safe to do so.
Disturbing marine animals	Disturbance (e.g. collisions) with marine life	We look out for marine life (e.g., whales, dolphins, turtles) and we slow down and move away from them where possible if they are too close. We follow rules that outline how we need to interact with
Invasive marine life	Impacts to other marine life and industry	We inspect the boats to ensure no invasive marine life before they arrive. We have plans and equipment in place on boats to prevent invasive marine species. The Federal government has strict rules we need to follow.
Chemical spill	Water quality impacts	We select chemicals that are friendly to the environment where possible and store them carefully. We have procedures for using and cleaning up chemicals.
Gas release (dry gas or nitrogen) - Bayu-Undan pipeline	Marine life impacts, other user impacts	We follow strict rules for lifting to prevent dropped objects. We have procedures in place to minimise loss of gas from Bayu-Undan pipeline.
Diesel spill	Water quality, impacts to habitats and marine life, protected areas, socio-economic and cultural values	We make sure all the boats are following the rules for preventing collisions. We let other boats know where we are and what we are doing. We follow strict procedures for refueling. We have plans and arranegments in place for responding to spills.

DPD Environment That May Be Affected – Diesel spill

Santos



Barossa DPD Route and EMBA in Commonwealth & NT waters

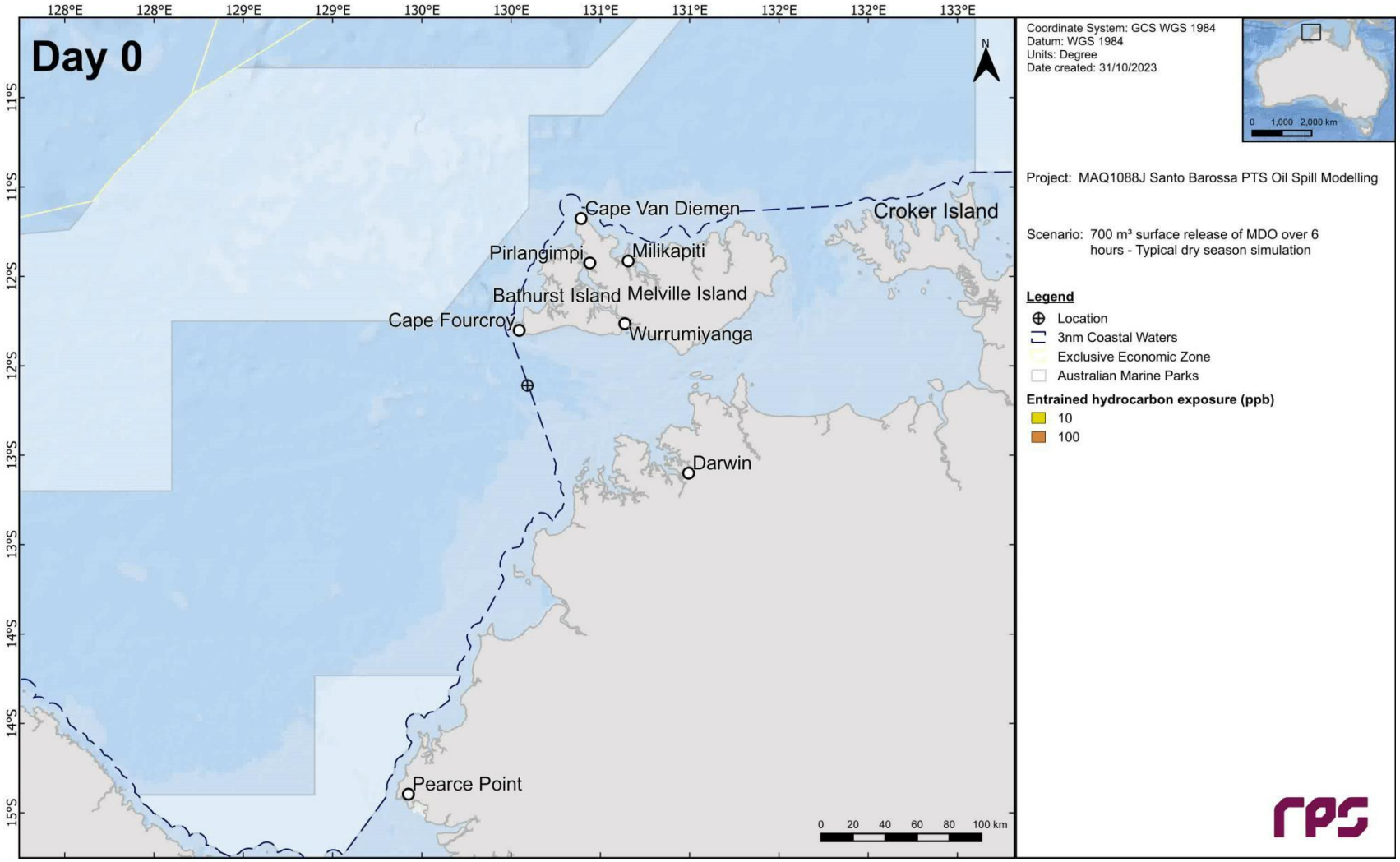
Spatial Reference Information
GDA 2020
ECS-007-10-GIS-28B Rev 2

N

0 40 80 120 160
Kilometres

DPD Diesel Spill Animation – typical dry season simulation

Santos



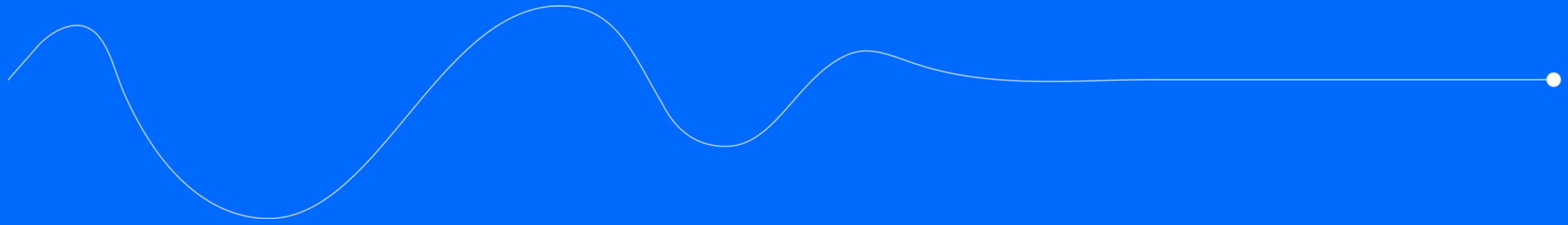
Santos

DPD QUESTIONS?

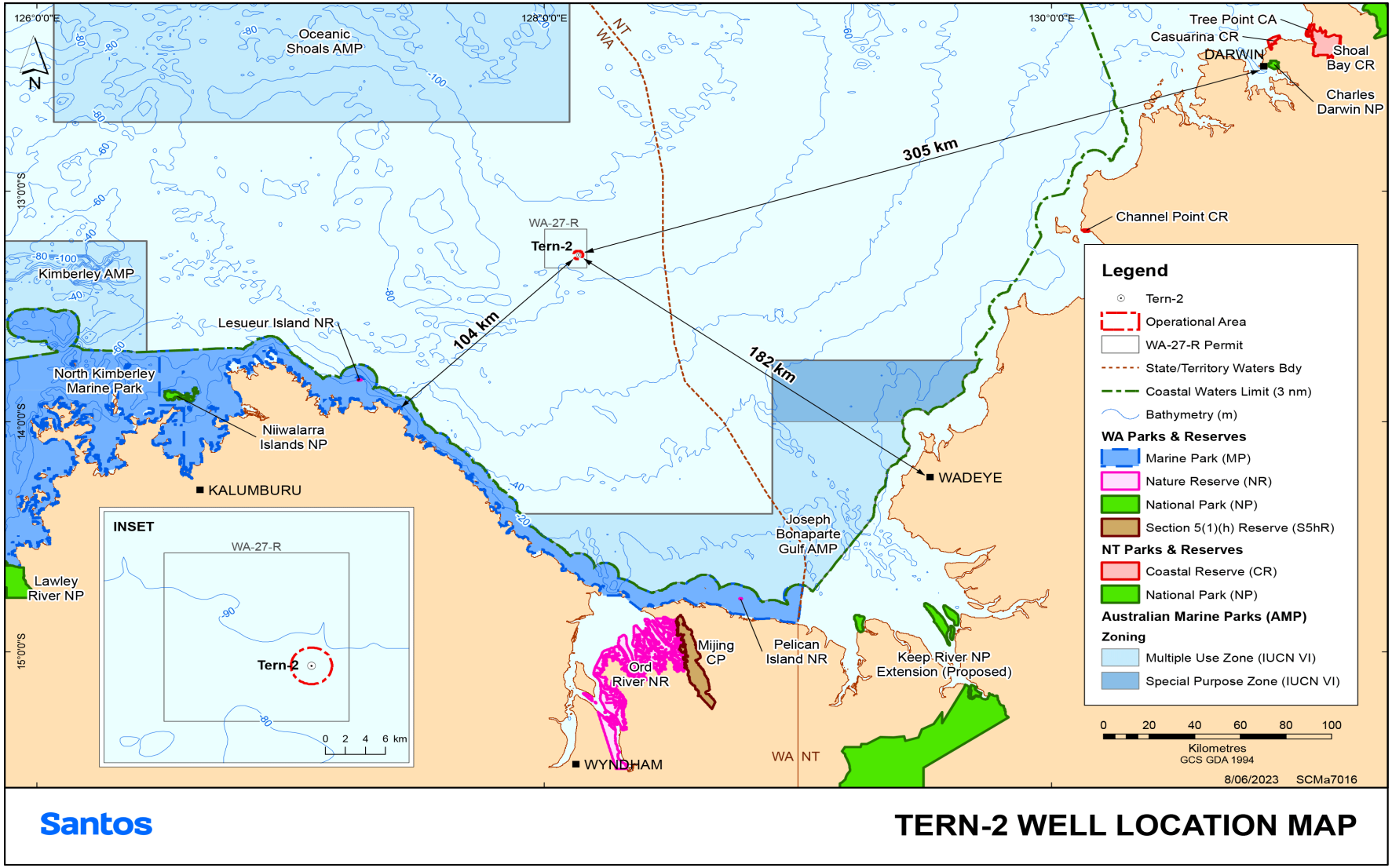
Santos

BONAPARTE BASIN CONSULTATION

TERN-2 PLUG AND ABANDONMENT



Tern-2 P&A - Location



Tern-2 P&A - Overview

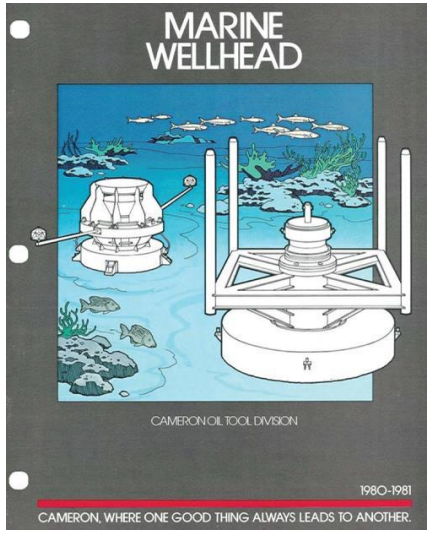
- Tern-2 is an appraisal well located within the Tern field of retention lease licence WA-27-R, approximately 300 km WSW of Darwin. The well was drilled in 1981 and 82. It was temporarily abandoned with cement barriers in January 1982.

- Key objectives of P&A activity:
  - Installing and verifying additional well barriers to supplement the existing system of well barriers.
  - Removing the wellhead and any structural evidence of the well from the seabed as best as practical to eliminate future hazards to the environment or other users of the area.

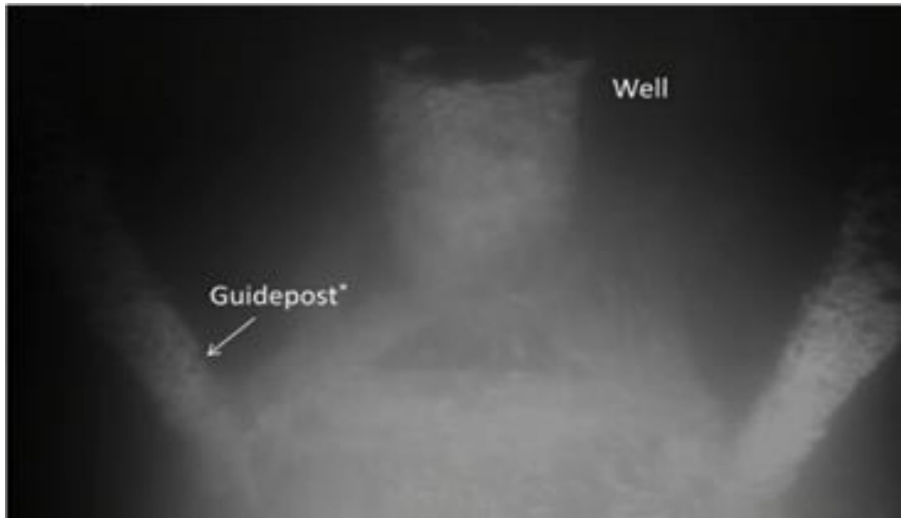
- Estimated activity duration:
  - ~10 days (Continuous operations, 24 hours per day, 7 days per week).
  - Up to 40 days in the event of unforeseen delays and poor metocean conditions.

- The Operational Area:
  - A circular area with a 2 km radius around the Tern-2 wellhead.
  - ~ 106 km from the closest shoreline
  - ~ 62 km southwest of Petrel-1 and ~ 9.8 km southeast of Tern-1 well.
  - Average water depth is ~ 83 m.

- The petroleum activities require the following vessels:
  - Light Well Intervention Vessel (LWIV)
  - Support vessel
  - Remotely Operated Vehicle (ROV)
  - Helicopters



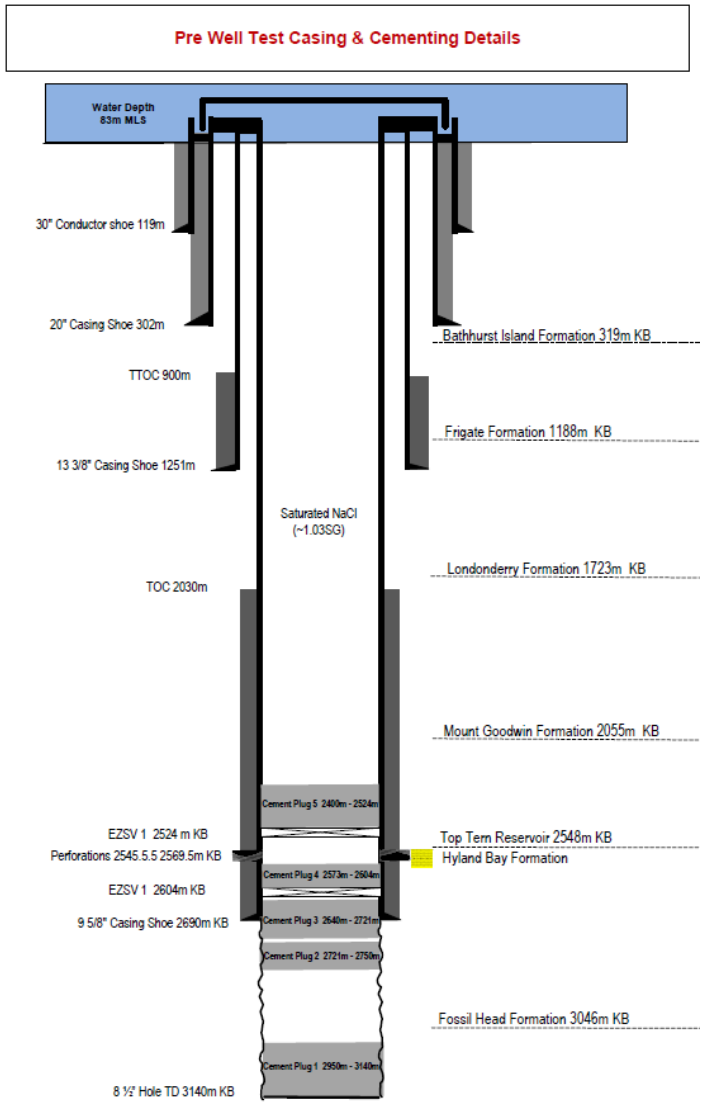
Example of the Tern-2 wellhead.



Example of wellhead at Tern-2 wellhead location.

Tern-2 P&A - Activity

- Utilising a Light Well Intervention Vessel for the following scope:
  - Clean and remove wellhead debris cap
  - Inspect and evaluate condition inside well
  - Using wireline, install additional P&A barriers into the well
  - Cut and remove wellhead
  - Contingency to place wellhead on seabed only if needed
  - Move wellhead to the vessel using ROV
  - If the wellhead is in poor condition and can't be removed it will be left on the seabed



Tern-2 wellhead schematic

Tern-2 P&A – Vessels & Vehicles

Example Light Well Intervention Vessel (LWIV)

Example Support Vessel

Example ROV

Example Helicopter

Tern-2 P&A - Impacts

Santos

Planned events	How we manage (the rules we follow)
Disturbance to other boats	We will communicate to other boats where we are and what we are doing. We mark the location of equipment on charts.
Seabed disturbance	We are putting equipment on a flat sandy seabed. We only put equipment in the approved location.
Light disturbance	We only use lights where needed for safe operations. We turn off lights when not needed.
Noise disturbance	We look out for marine life (e.g., whales, dolphins, turtles). Noise levels are not expected to impact at population level or have a significant impact on foraging behaviours of marine turtles.
Air emissions	We ensure engines and other equipment is looked after and fuel use and waste incineration standards are maintained.
Discharges	We will reduce discharges to only those necessary for operations and we follow the standard rules for what boats can discharge.
Wellhead left on seabed	We will leave the wellhead on the seabed only if it cannot be removed easily due to technical difficulties.
Oil spill response	We have plans and resources to be used if there is an accidental oil spill.

Tern-2 P&A - Risks

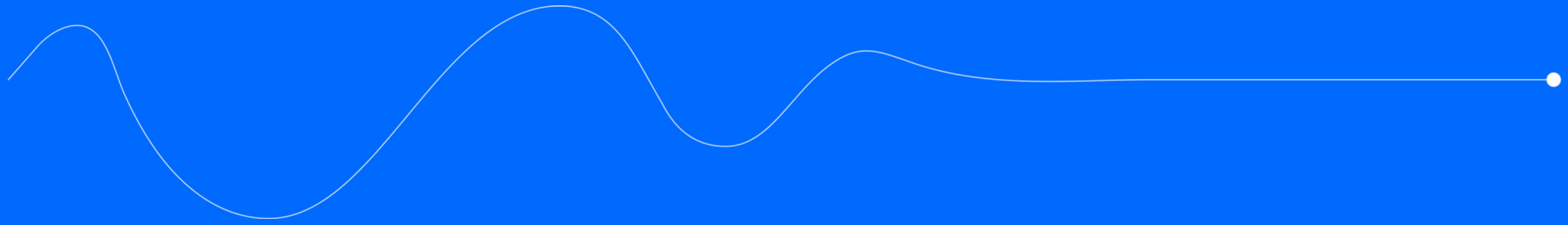
Santos

Unplanned events (Accidents)	How we manage (the rules we follow)
Diesel spill	We make sure all the boats are following the rules for preventing collisions. We let other boats know where we are and what we are doing. We will not refuel within the operational area.
Dropped objects	We follow strict procedures to stop objects dropping overboard and we pick up objects when it is safe to do so.
Disturbing marine animals	We look out for marine life (e.g., whales, dolphins, turtles) when transiting within and to and from the operational area and we slow down and move away from them where possible if they are too close.
Invasive marine life	We will use an anti-foulant system and follow strict procedures to avoid any introduction of invasive marine life.
Chemical spill	We select chemicals that are friendly to the environment where possible and store them carefully. We have procedures for using and cleaning up chemicals.
Disturbance to other boats	We let other boats know where we are and what we are doing. We will let other boats, fishing groups, and the government know if the wellhead cannot be removed and will be left on the seabed.

Santos

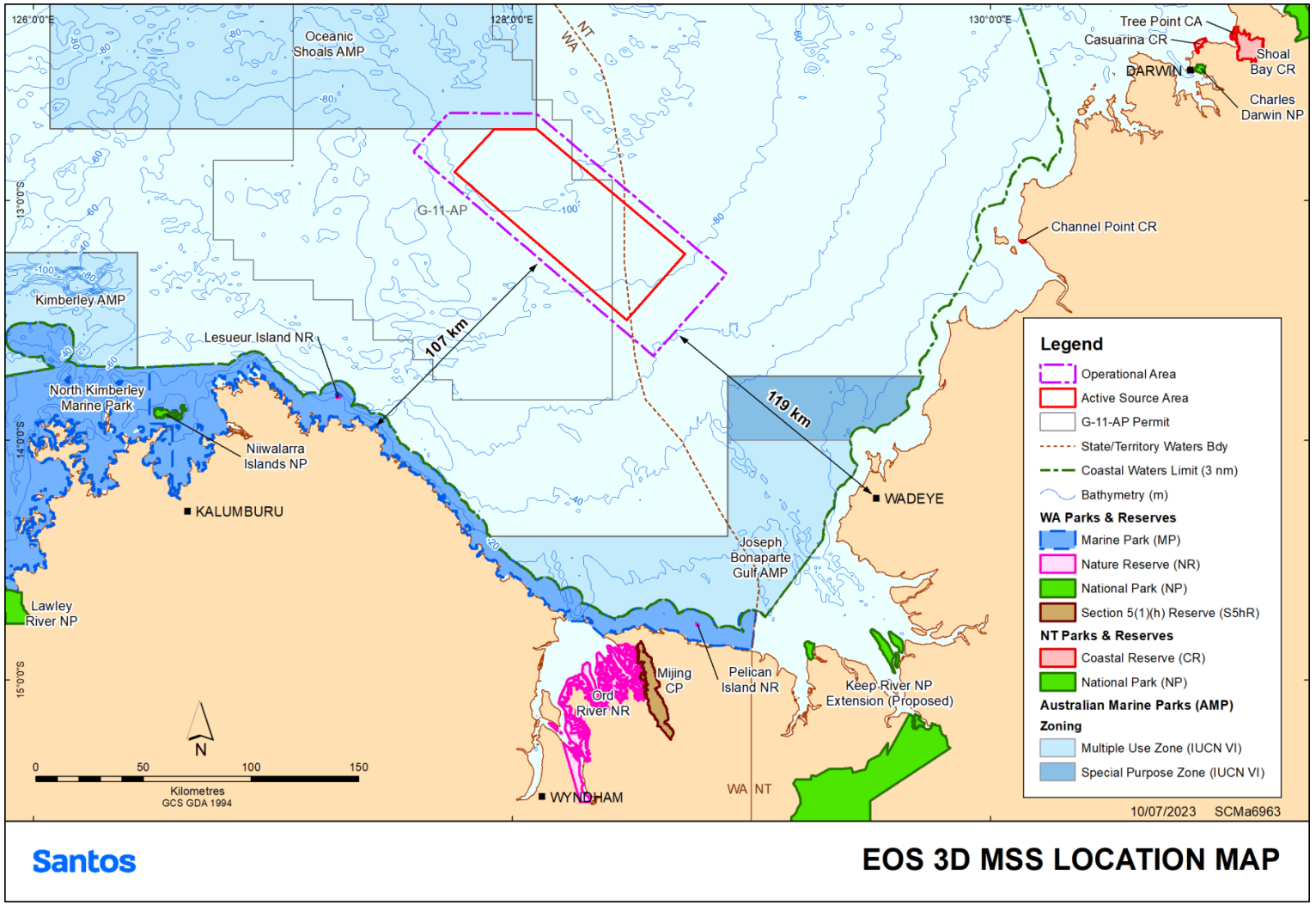
BONAPARTE BASIN CONSULTATION

EOS 3D MARINE SEISMIC SURVEY



WA & NT Environment Plan Consultation

Eos 3D MSS - Location



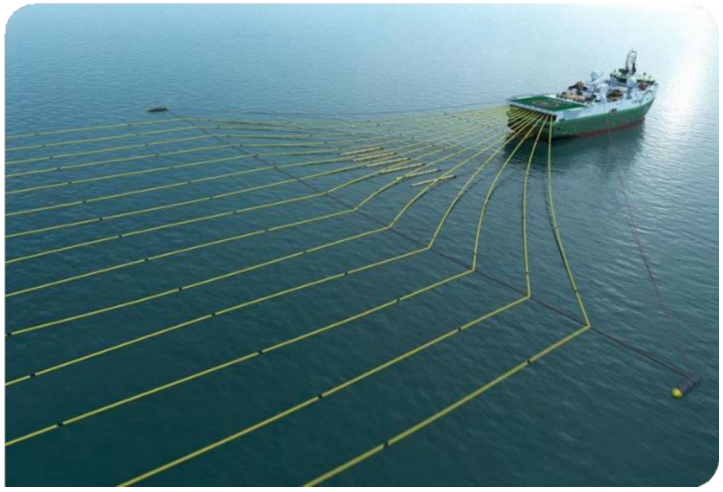
Eos 3D Marine Seismic Survey

What is a marine seismic survey?

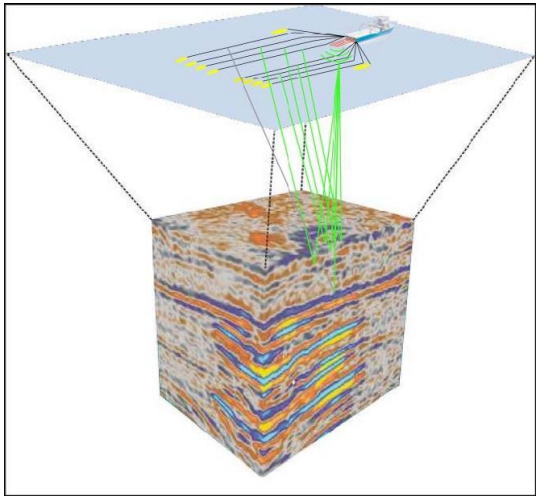
https://www.youtube.com/watch?v=T1yzHW5x1HE

Eos 3D MSS - Overview

- Santos plans to acquire a three-dimensional (3D) marine seismic survey (MSS) in Commonwealth waters in the Bonaparte Basin.
- The proposed activity is required to complete an appraisal of the carbon storage potential of Santos' greenhouse gas assessment (GHG) permit G-11-AP. The survey extends into GHG G-7-AP and overlaps petroleum permits WA-548-P and WA-6-R and surrounding waters in the Petrel Sub-Basin.
- Key objectives:
  - Facilitate future Carbon Dioxide (CO_2) injection activities by providing detailed structural and amplitude imaging of the reservoir/seal interface for each identified storage target to confirm suitability for injection and storage of CO_2.
- Timing:
  - 50 days, (42 days plus 8 days for contingency, e.g. weather, mechanical etc)
  - Continuous operations, 24 hours per day, 7 days per week.
- Operational Area:
  - Area within which the seismic survey vessel will operate during the normal conduct of the activity.
  - Includes the Active Source Area.
  - 60 to 115 m water depth.
- Active Source Area:
  - Area within which the seismic source will be operated to acquire the seismic data and achieve the geophysical objectives of the survey.
  - Area size: 4,028 km^2
  - 67 to 111 m water depth.
- Project vessels:
  - Seismic survey vessel
  - Up to two Support Vessels (one being a chase vessel)
  - Helicopters and drones

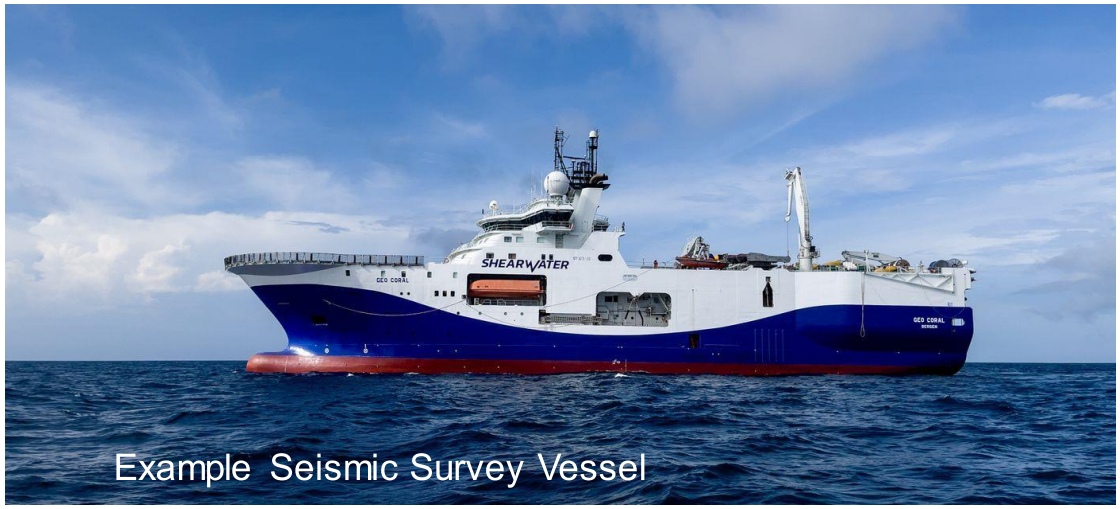


Example of a seismic array and Marine Seismic Vessel for 3D or 4D surveys



3D seismic survey, showing simplified configuration of seismic vessel and subsurface cube of data (Cameselle, 2020)

Eos 3D MSS – Vessels & Vehicles



Example Seismic Survey Vessel

Example Support Vessel

Example Chase Vessel

Example Helicopter

Eos 3D MSS - Impacts

Santos

Planned events	How we manage (the rules we follow)
Disturbance to commercial fishers	We will communicate to fishing boats where we are and what we are doing.
Disturbance to other boats	We will communicate to other boats where we are and what we are doing and provide notifications in advance of the survey starting.
Light disturbance	We only use lights where needed for safe operations. We turn off lights when not needed.
Noise disturbance	We look out for marine life (e.g., whales, dolphins, turtles) before the survey begins Animal spotters stay on the vessel during the survey and monitor. Soft start up- meaning the noise slowly gets louder giving marine animals time to move away from the sound.
Air emissions	We ensure engines and other equipment are looked after. Fuel use and waste incineration standards are maintained.
Discharges	We will follow the standard rules and procedures for what boats can discharge.
Impacts from other seismic surveys	We will communicate with other companies that may also be doing seismic surveys in the area and keep a large distance between other seismic vessels.

Eos 3D MSS - Risks

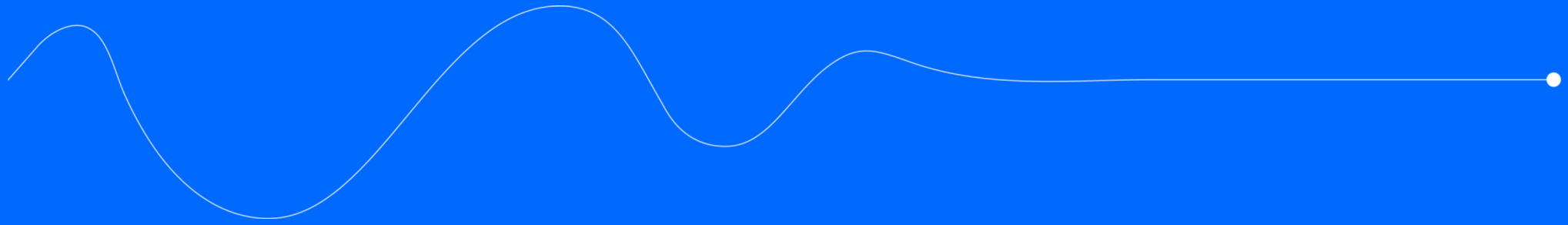
Santos

Unplanned events (Accidents)	How we manage (the rules we follow)
Diesel spill	We make sure all the boats are following the rules for preventing collisions. We let other boats know where we are and what we are doing. We follow strict procedures for refuelling.
Discharges	Where possible and safe to do so, we will recover any waste or equipment that accidentally falls overboard into the ocean.
Disturbing marine animals	We look out for marine life (e.g., whales, dolphins, turtles) and the support vessel will slow down and move away from them where possible if they are too close while the survey is taking place.
Invasive marine life	We will use an anti-foulant system and follow strict procedures to avoid any introduction of invasive marine life.
Chemical spill	We select chemicals that are friendly to the environment where possible and store them carefully. We have procedures for using and cleaning up chemicals.
Oil spill response	We have plans and resources to be used if there is an accidental oil spill.

Santos

BONAPARTE BASIN CONSULTATION

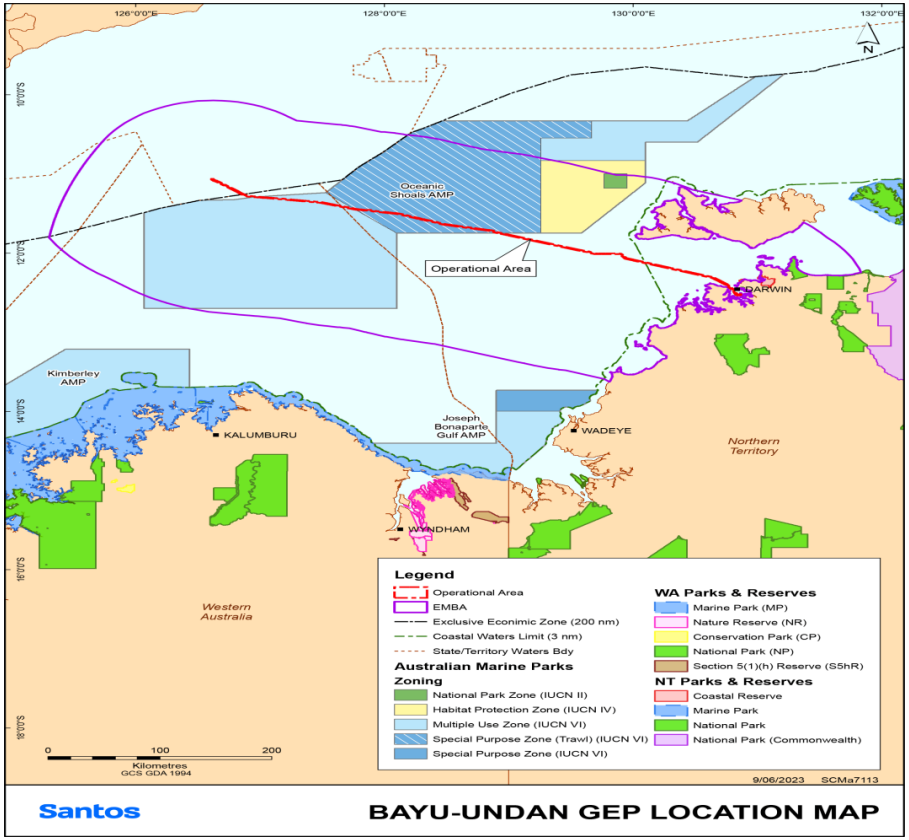
BAYU-UNDAN PIPELINE

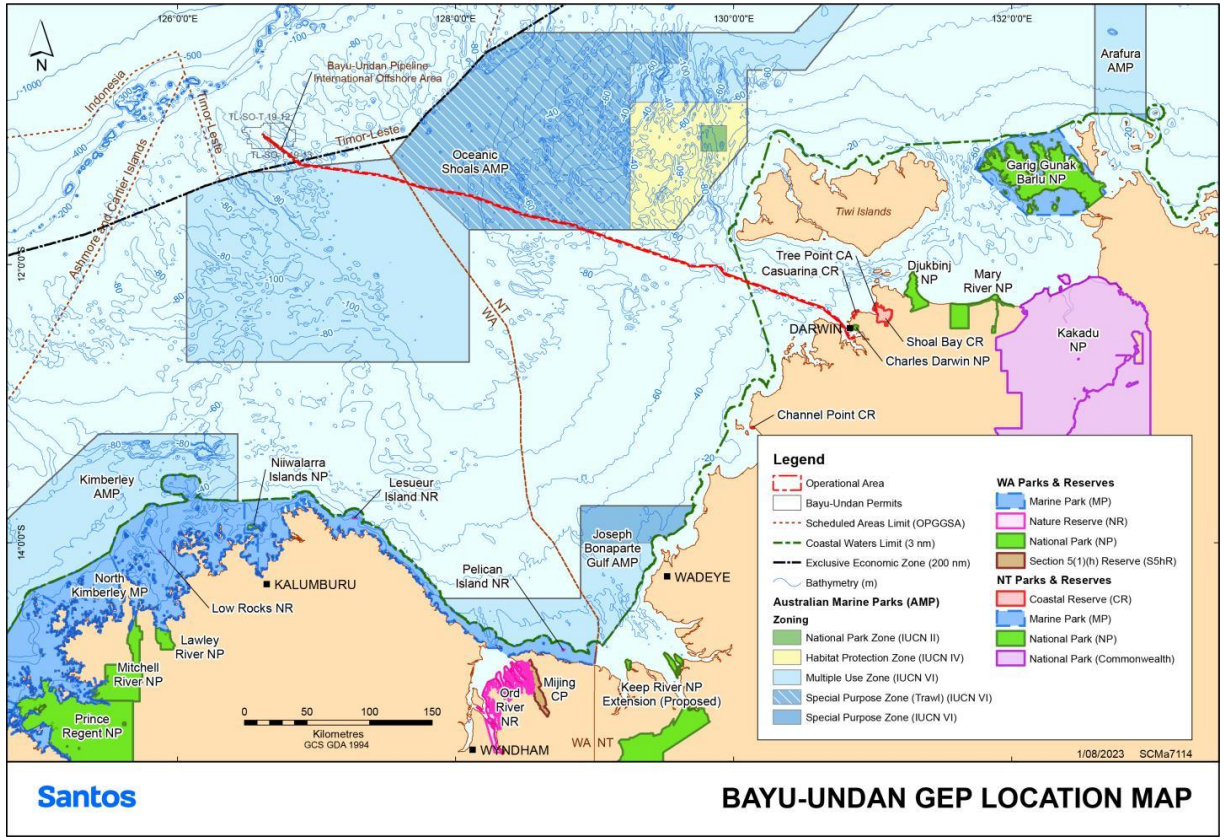


WA & NT Environment Plan Consultation

Bayu-Undan Gas Export Pipeline EP

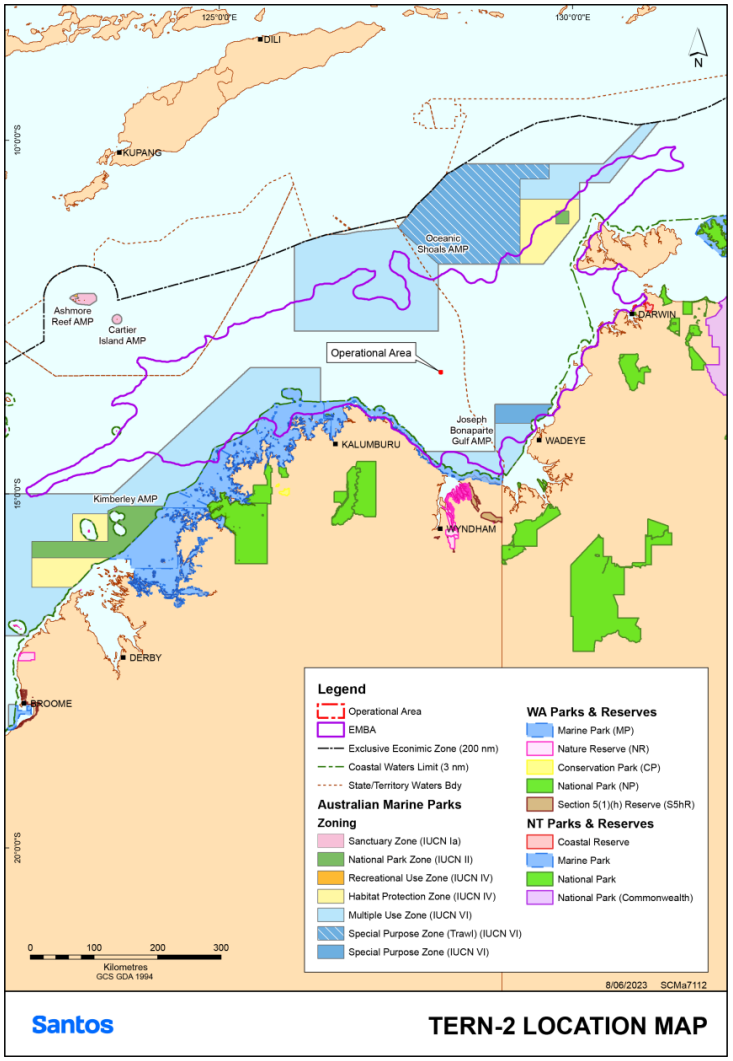
- Santos is the operator of the existing 502km Gas Export Pipeline.
- The pipeline transports dry natural gas from the Bayu-Undan Field (Timor-Leste waters) to the onshore Darwin liquefied natural gas (DLNG) plant.
- The pipeline has been operational since 2005.
- As the Field is approaching the end of life, the pipeline will transition from operations to a preservation state.
- The original EP for operations was accepted by NOPSEMA in 2019.
- The EP has been updated to include the final stages of operations (linepacking and back-feed), plus a preservation phase (gas-filled).





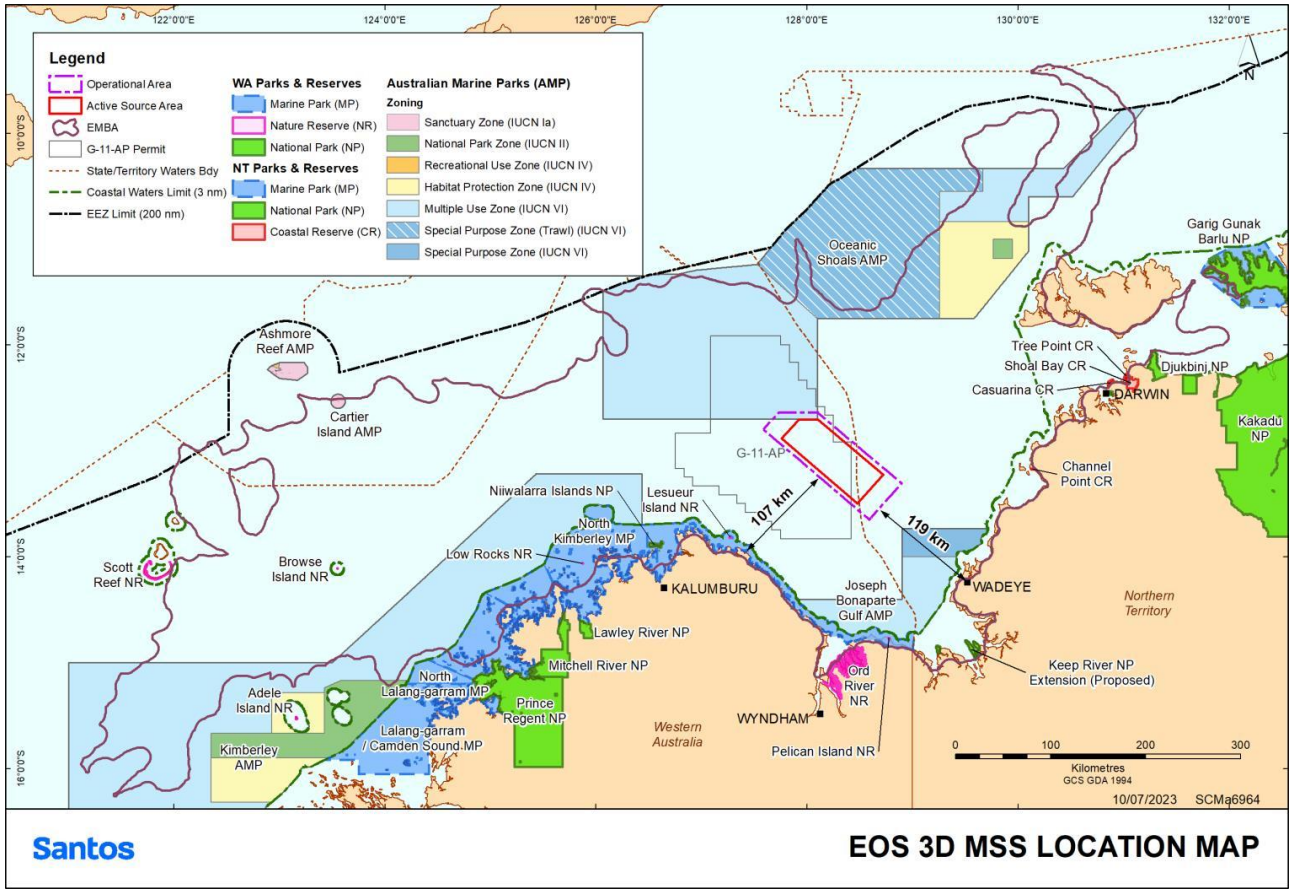
Santos

Spill Risk



Santos

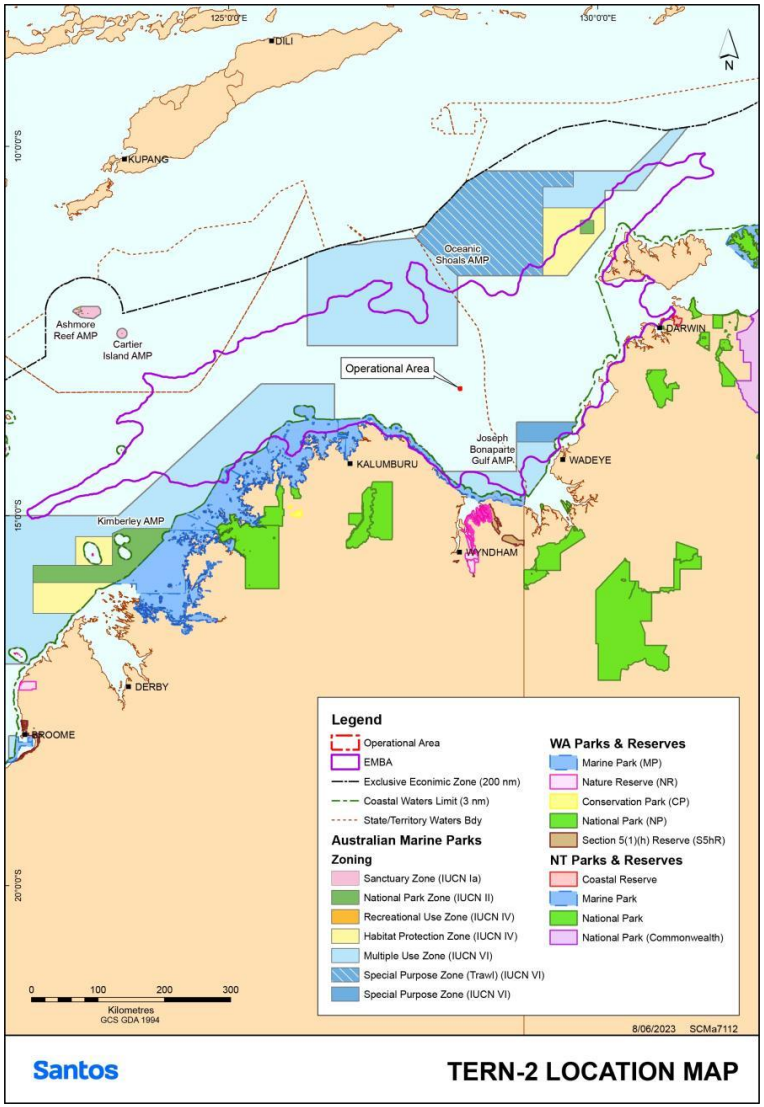
TERN-2 LOCATION MAP



Santos

EOS 3D MSS LOCATION MAP

Tern-2 P&A – Environment That May Be Affected



Feature	Public Information Review
Aboriginal Heritage	Aboriginal Heritage sites are present along the southern and eastern boundaries of the Environment That May Be Affected (EMBA).
Biologically Important Areas (BIAs)	The Operational Area includes BIAs for turtles only, the EMBA includes BIAs for dolphins, seabirds, sharks, whales and turtles.
Cultural Heritage	No known sites of shipwrecks, sunken aircraft or Aboriginal and Torres Strait Islander Underwater Cultural Heritage have been identified within the Operational Area. Within the EMBA the nearest shipwreck, the SEDCO Helen, is approximately 60 km northeast of the Operational Area located in depths of approximately 100 m .
Defence	Operational area overlaps practice and training areas that comprise the North Australian Exercise Area (NAZA) a maritime military zone administered by the Australian Defence Force, as well as restricted airspace.
Energy industry	Several offshore petroleum projects are in operation and there is exploration activity within the EMBA. The nearest platform is the ENI Blacktip Platform approximately 75 km to the southeast of the operational area.
Fishing	A number of Commonwealth, State and Territory fisheries management areas overlap the Operational Area and EMBA however, neither Commonwealth nor WA state-managed fisheries show activity within the Operational Area between 2010-2020.
	Traditional Australian Indigenous fishing activities are generally concentrated within 3 nm of the Northern Territory / Western Australian coastline.
	No interaction with recreational or charter boat fishers is anticipated given the remoteness of the Operational Area (~106 km from nearest coastline).
Key Ecological Features (KEFs)	The EMBA includes KEFs for the carbonate bank and terrace system of the Van Diemen Rise, the carbonate bank and terrace system of the Sahul Shelf, ancient coastline at 125m depth contour, continental slope Demersal Fish communities, the shelf break and slope of the Arafura Shelf, and the Pinnacles of the Bonaparte Basin.
Protected Areas (nearest Commonwealth and Territory)	In Commonwealth Waters the EMBA overlaps with the Oceanic Shoals Marine Park, Joseph Bonaparte Gulf AMP and the Kimberley AMP. The closest being the Oceanic Shoals AMP which is approximately 63 km north of the Operational Area.
	The North Kimberley State Marine Park is approximately 182 km west from the Operational Area and overlaps with the EMBA.
Shipping	The Operational Area does not overlap any shipping fairways, though is adjacent to vessel traffic. Vessel traffic from Wyndham may be present within the EMBA at periods of the year.
Telecommunications	The North West Cable System (NWCS) connects offshore oil and gas facilities in the Browse, Bonaparte and Carnarvon Basins to onshore locations and is approximately 140 km north-north-east of the Operational Area.
Tourism	Remoteness of the Operational Area and water depth limits opportunities for tourism. Tourism is likely within the EMBA.
Towns/Communities	Darwin is the nearest capital city and is approximately 300 km northeast from the Operational Area.

Eos 3D MSS - Activity

- The process of collecting seismic data is known as ‘acquisition’.
- Marine seismic surveys are carried out by specialised vessels that tow an array of acoustic sources (airguns) and receivers (hydrophones) across a defined acquisition area.
- The seismic survey vessel will tow a seismic source array (up to 3,500 in3) and up to 12 streamers, approximately 113 m apart, and will travel back and forth across the survey area in a “race track” pattern, lines separated by approximately 500-700m within an overall acquisition area.
- The streamer array will be approximately 8 km long and positioned 10 – 30 m below the ocean surface.
- Airguns work by rapidly releasing compressed air to form a bubble, which creates a pulse of sound. This sound energy is directed at the seafloor and penetrates into the various rock layers beneath.
- The reflected soundwaves are then captured by hydrophone receivers, which are towed behind the vessel on a series of cables known as 'streamers'.
- Support vessels will be on standby, one support vessel will be present at all times.
- 3 nm exclusion zone requested.
- Auscoast warning and/or Notice to Mariners will be issued prior to the start of the activity.
- The seismic survey vessel will display appropriate day shapes and lights to indicate it is under tow and is therefore restricted in it’s ability to manoeuvre, and the streamers will tow surface tail buoys fitted with radar reflectors.
- A visual and radar watch will be maintained on the bridge at all times.

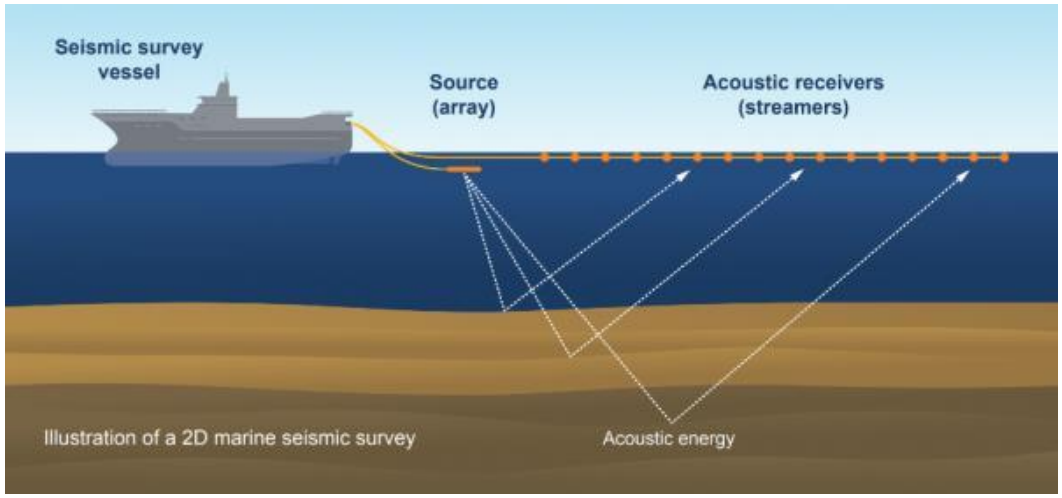
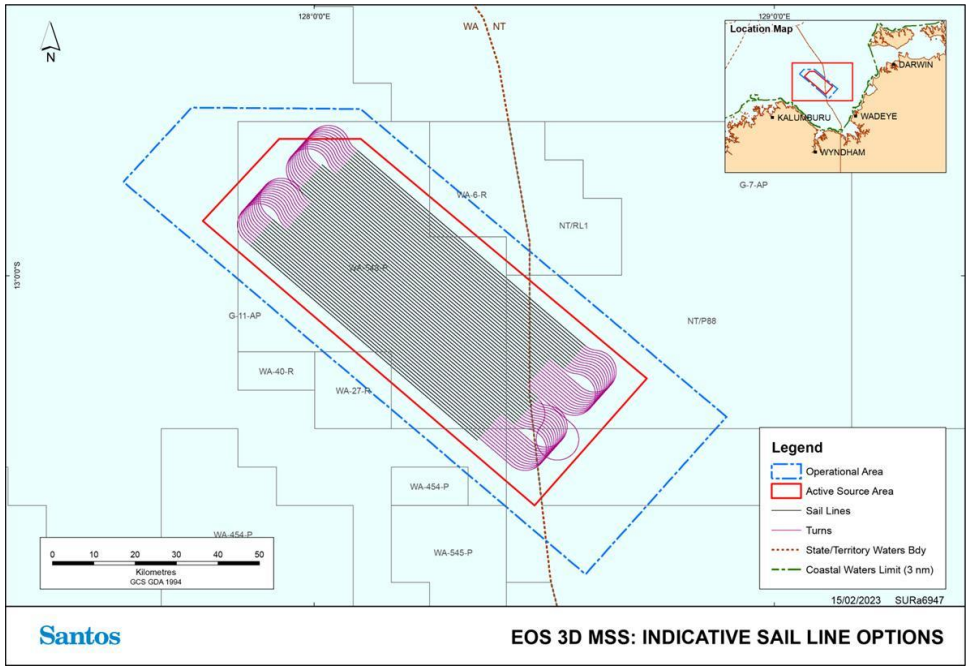


Diagram of a marine seismic survey (Source: NOPSEMA).



Eos 3D MSS – Environment That May Be Affected

Feature	Public Information Review
Aboriginal Heritage	Aboriginal Heritage sites are present along the coastline along the southern boundary of the EMBA.
Biologically Important Areas (BIAs)	The Operational Area includes BIAs for turtles.
Cultural Heritage	No known sites of shipwrecks, sunken aircraft or Aboriginal and Torres Strait Islander Underwater Cultural Heritage have been identified within the Operational Area. The nearest shipwreck, the SEDCO Helen, is approximately 11 km northeast of the Operational Area.
Defence	Operational area overlaps practice and training areas that comprise the North Australian Exercise Area (NAZA) a maritime military zone administered by the Australian Defence Force, as well as restricted airspace.
Energy Industry	Petroleum exploration and production activities have been undertaken within the EMBA and the Bonaparte Basin is an established hydrocarbon province with a number of commercial operations. Several exploration permits overlap the Operational Area with the closest production licence being the Eni Australia B.V. located 21 km south of the Operational Area.
Fishing	Five Commonwealth, thirteen Western Australia and ten Northern Territory fisheries overlap the EMBA, some of which are active in the Operational Area.
	Traditional Australian Indigenous fishing activities are generally concentrated within 3 nm of the Northern Territory / Weste rn Australian coastline.
	Fishing charter vessels may transit through the Operational Area and EMBA. Northern Prawn Fishery (NPF) fishing season (within the NPF licence area) is annually from August to November.
Key Ecological Features (KEFs)	The Operational Area overlaps one KEF for the Carbonate Bank and Terrace System of the Sahul Shelf.
Protected Areas (nearest Commonwealth and Territory)	The Operational Area overlaps the Oceanic Shoals Marine Park and four additional Australian Marine Parks overlap the EMBA. .
	Eighteen state/territory marine parks overlap the EMBA with the closest being the North Kimberley Marine Park located approximately 100 km south-west of the Operational Area.
Shipping	The Operational Area does not overlap any shipping fairways, however there is vessel traffic that passes through the northern end of the Operational Area. High vessel traffic to be expected from largest exporter of cattle out of Wyndham during Q3.
Telecommunications	The North West Cable System (NWCS) connects offshore oil and gas facilities in the Browse, Bonaparte and Carnarvon Basins to onshore locations and is approximately 125 km north-north- east of the Operational Area.
Tourism	Remoteness of the Operational Area and water depth limits opportunities for tourism. Tourism is likely within the EMBA.
Towns/Communities	Darwin is the nearest capital city and is approximately 230 km northeast from the Operational Area.
	Wadeye is the nearest community and is approximately 119 km southeast from the Operational Area.

Eos 3D MSS - Activity

- The process of collecting seismic data is known as ‘acquisition’.
- Marine seismic surveys are carried out by specialised vessels that tow an array of acoustic sources (airguns) and receivers (hydrophones) across a defined acquisition area.
- The seismic survey vessel will tow a seismic source array (up to 3,500 in3) and up to 12 streamers, approximately 113 m apart, and will travel back and forth across the survey area in a “race track” pattern, lines separated by approximately 500-700m within an overall acquisition area.
- The streamer array will be approximately 8 km long and positioned 10 – 30 m below the ocean surface.
- Airguns work by rapidly releasing compressed air to form a bubble, which creates a pulse of sound. This sound energy is directed at the seafloor and penetrates into the various rock layers beneath.
- The reflected soundwaves are then captured by hydrophone receivers, which are towed behind the vessel on a series of cables known as 'streamers'.
- Support vessels will be on standby, one support vessel will be present at all times.
- 3 nm exclusion zone requested.
- Auscoast warning and/or Notice to Mariners will be issued prior to the start of the activity.
- The seismic survey vessel will display appropriate day shapes and lights to indicate it is under tow and is therefore restricted in it’s ability to manoeuvre, and the streamers will tow surface tail buoys fitted with radar reflectors.
- A visual and radar watch will be maintained on the bridge at all times.

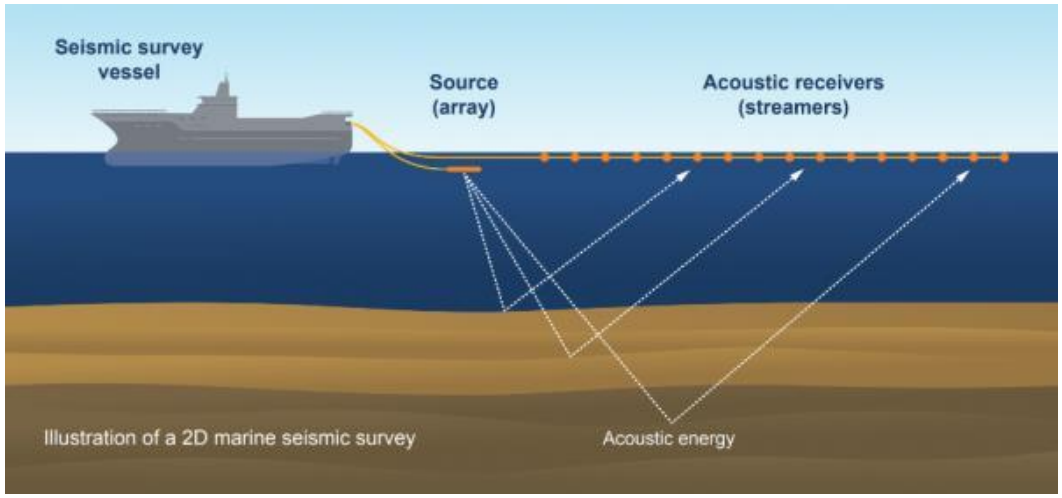
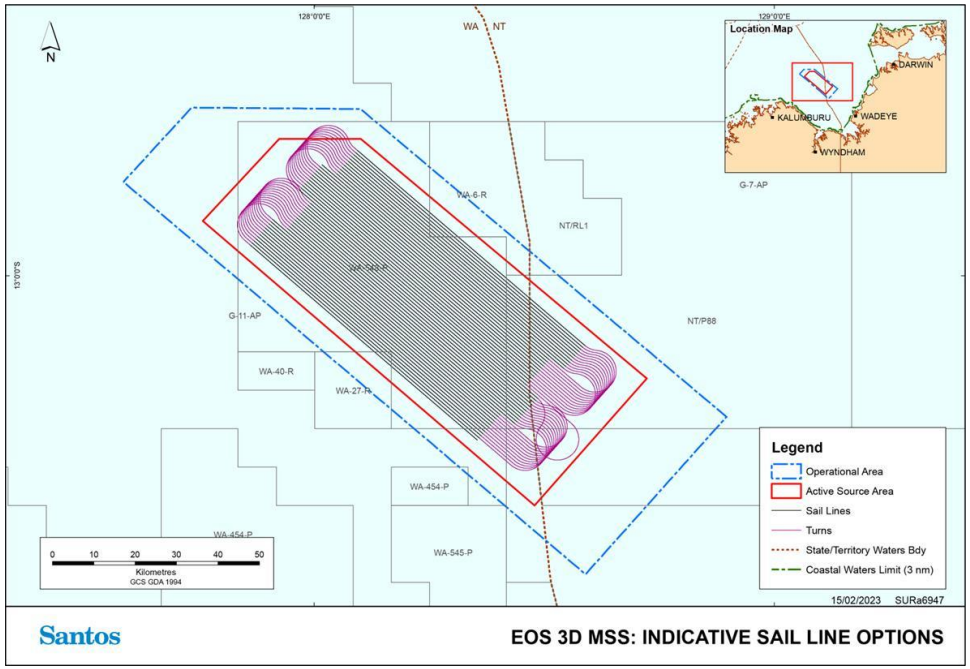


Diagram of a marine seismic survey (Source: NOPSEMA).



Eos 3D MSS – Commercial Fishers

Co-existence approach

- Minimise the extent of interruption by the seismic survey activities on commercial fishing operators' activities to the lowest practicable level.
- Mitigate the effects of the interruptions.
- Apply an equitable 'commercial fishers payment claim protocol'.

Commercial fishers payment claim protocol

- The survey will potentially impact commercial fishers whose fishing operations overlap with the seismic survey.
- Santos has a process to enable commercial fishers to lodge evidence-based payment claims for temporary loss of fish catch, displacement costs and equipment damage or loss directly caused by the seismic survey.
- Santos will also assess requests for administrative support to help fishers collate historical fishing data required for an evidence-based payment claim.
- The control measures identified within the draft Environment Plan, to outline how the potentially competing demands of commercial fishing operators and Santos' seismic survey may be managed, are consistent with those adopted for other Santos marine seismic surveys.

Commercial prawn and indicator fish species spawning	J	F	M	A	M	J	J	A	S	O	N	D	Source
Banana prawn spawning													AFMA 2020
Juvenile banana prawn migration													Longeran et al. 2002
Brown tiger prawn spawning													AFMA 2020
Grooved tiger prawn spawning													AFMA 2020
Blue endeavour prawn spawning													AFMA 2020
Red endeavour prawn spawning													AFMA 2020
Red emperor													DPIRD 2019
Goldband snapper													DPIRD 2019
Spanish mackerel (Kimberley stock)													DPIRD 2019

Key

Sensitivity/activity occurs

Extended peak spawning period

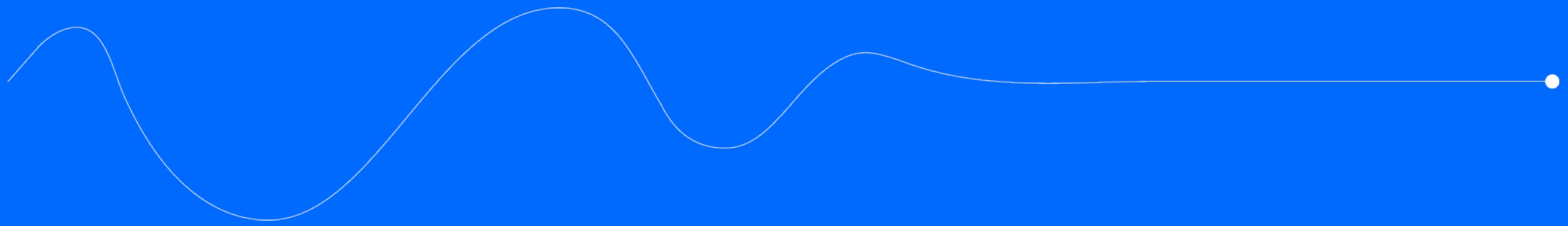
Peak spawning/migration period

*Extended peak spawning period – applies only to Goldband Snapper and Spanish Mackerel

Bonaparte Basin Consultation - ECNT 14.11.23

Santos

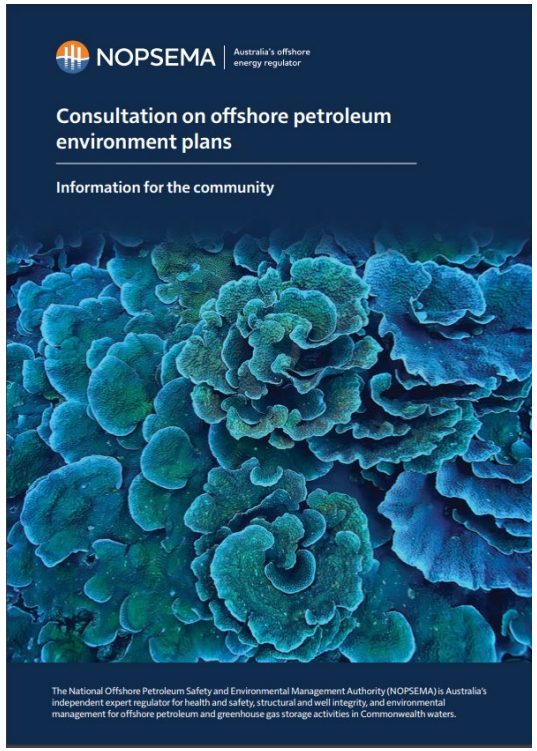
CONSULTATION – BONAPARTE BASIN



November 2023

Regulatory Consultation

Commonwealth waters – National Offshore Petroleum Safety and Environmental Management Authority



"In the course of preparing an Environment Plan, a titleholder must consult with relevant persons in accordance with Division 2.2A, Regulation 11A…

"The purpose of consultation under regulation 11A of the Environment Regulations is to ensure that authorities, persons or organisations that are potentially affected by activities are consulted and their input considered in the development of environment plans."

Guideline - Consultation in the course of preparing an environment plan, NOPSEMA

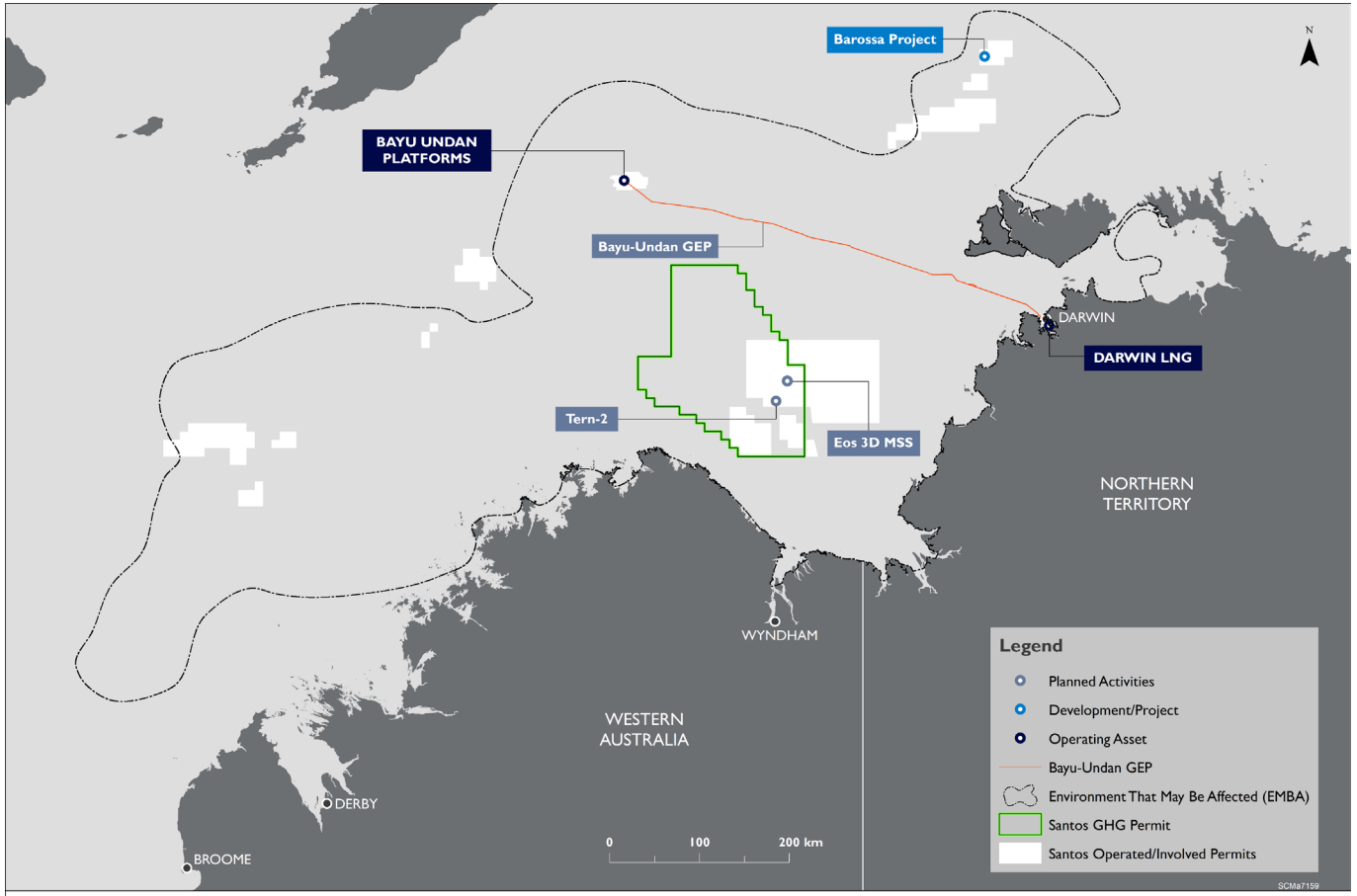
A **relevant person** is an authority, a person or an organisation whose functions, interests or activities may be affected by proposed activities.

Bonaparte Basin

Santos

- Santos is proposing to undertake activities Consultation for our Bonaparte Basin activities (outside of Barossa Gas Project activities) starts on **27 October 2023** and closes on **27 November 2023**.
- Proposed activities are:
  - Tern-2 Plug and Abandonment
  - Eos 3D Marine Seismic Survey
  - Bayu-Undan Gas Export Pipeline Operations

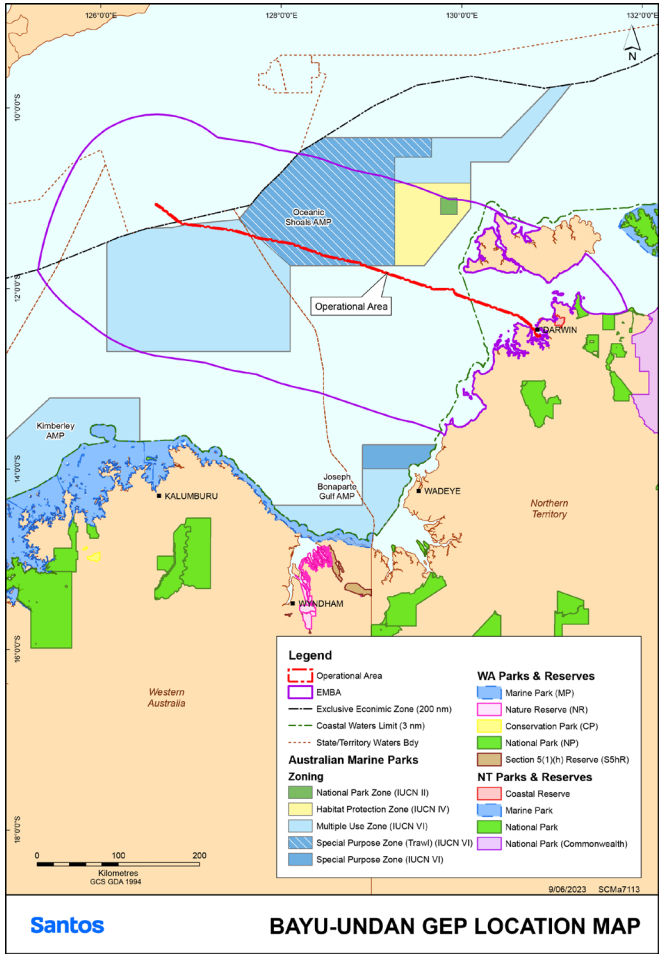
- **Email** – offshore.consultation@santos.com
- **Web** – www.Santos.com/offshoreconsultation
- **Phone** – 1800 267 600



Bayu-Undan Gas Export Pipeline EP

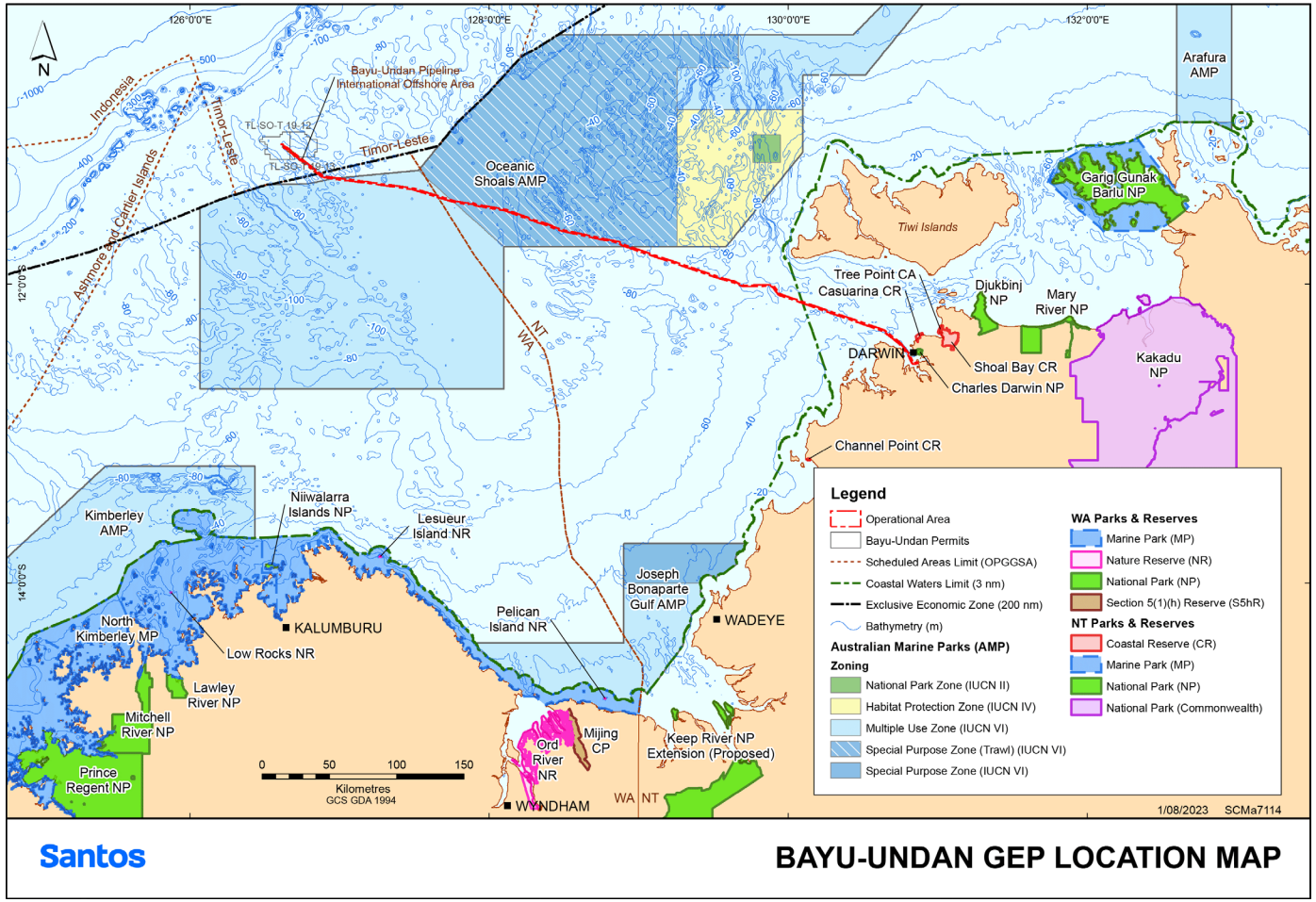
Santos

- Santos is the operator of the existing 502km Gas Export Pipeline.
- The pipeline transports dry natural gas from the Bayu-Undan Field (Timor-Leste waters) to the onshore Darwin liquefied natural gas (DLNG) plant.
- The pipeline has been operational since 2005.
- As the Field is approaching the end of life, the pipeline will transition from operations to a preservation state.
- The original EP for operations was accepted by NOPSEMA in 2019.
- The EP has been updated to include the final stages of operations (linepacking and back-feed), plus a preservation phase (gas-filled).



Santos

BAYU-UNDAN GEP LOCATION MAP



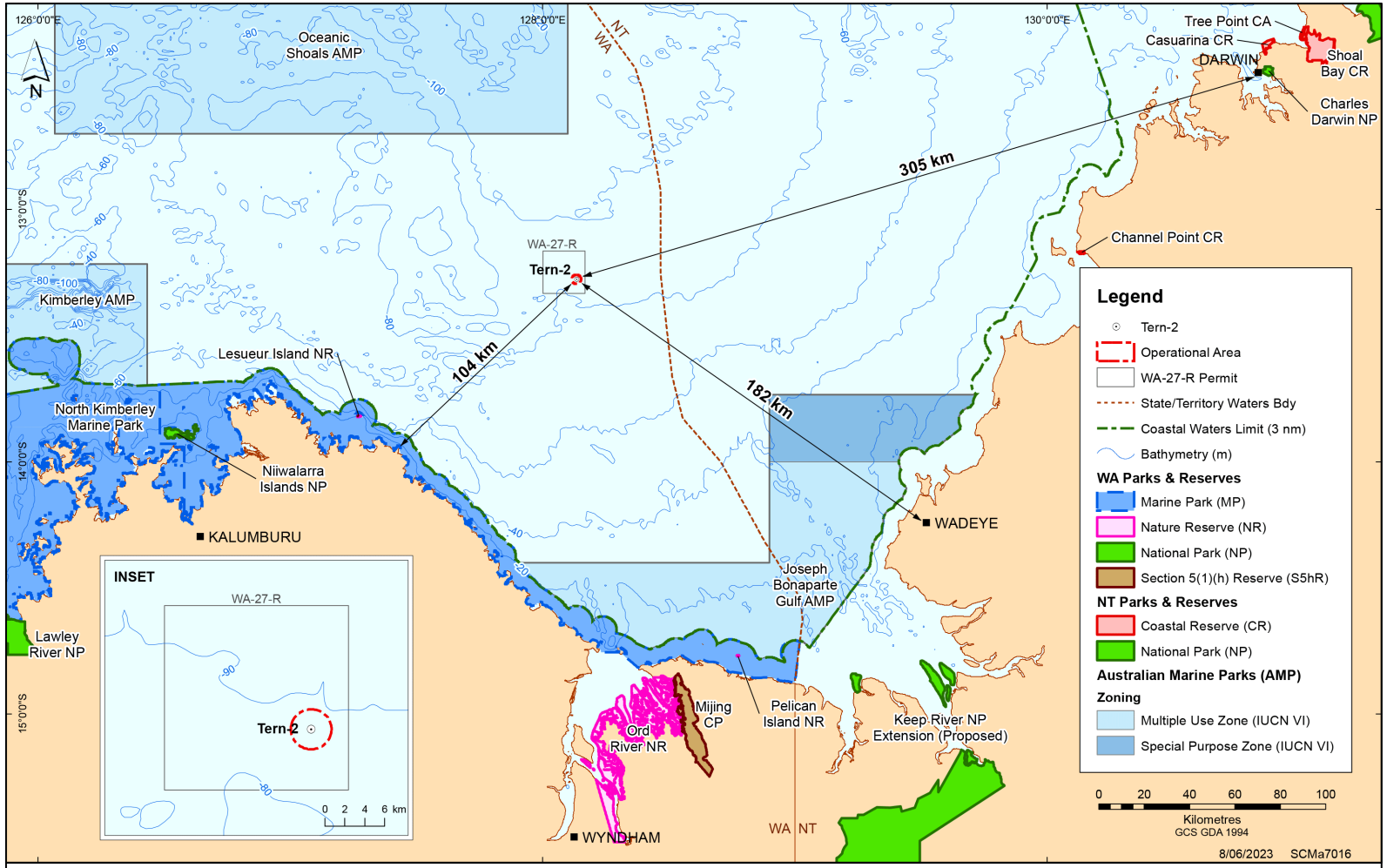
Santos

BAYU-UNDAN GEP LOCATION MAP

Santos

Tern-2 Plug and Abandonment

Santos



Santos

TERN-2 WELL LOCATION MAP

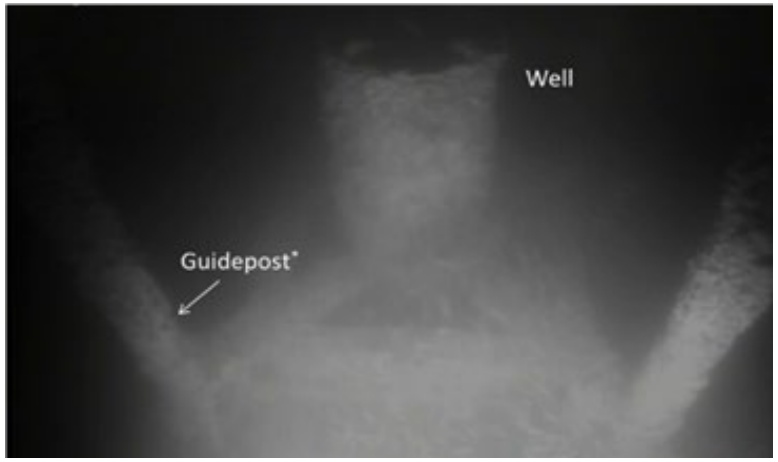
Wellhead	Title	Approx. Water Depth (m)	Coordinates (Datum/Projection: GDA 94 Zone 50)	
			Latitude	Longitude
Tern-2	WA-27-R	83	13° 16' 37.36" S	128° 08' 02.68" E

Tern-2 Plug and Abandonment

Santos

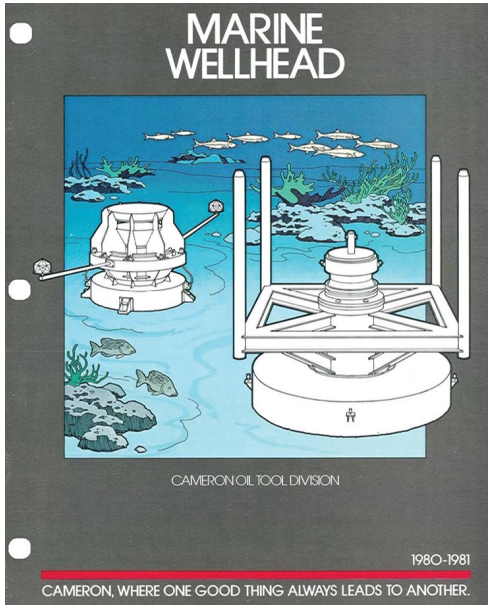
Activity overview:

- Install and verify additional well barriers to supplement the existing system of well barriers
- Operation Area is approximately 300 km WSW of Darwin, 106 km from the closest shoreline, 62 km southwest of Petrel-1 and 9.8 km southeast of Tern-1 well
- Operational Area is circular with a 2 km radius from the Tern-2 wellhead
- Removing the wellhead as best as practical to remove any structural evidence of the well from the seabed and eliminate future hazards to the environment or other users of the area



Timing

- Approximately 10 days (continuous operations, 24 hours per day, 7 days per week)
- Up to 40 days in the event of unforeseen delays and poor metocean conditions



Vessels:

- Light Well Intervention Vessel (LWIV)
- Support vessel
- Remotely Operated Vehicle (ROV)
- Helicopters

Eos 3D Marine Seismic Survey

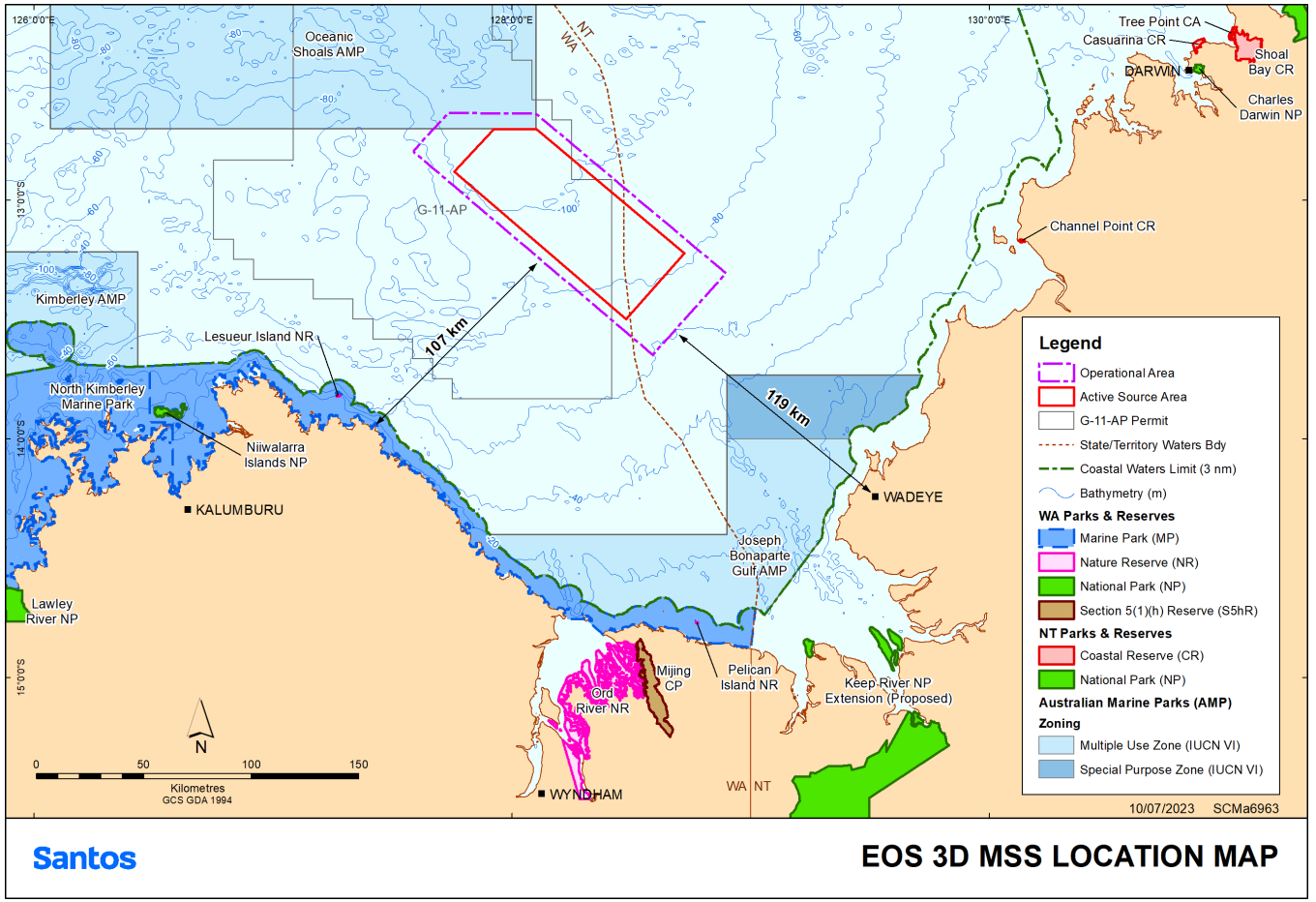
Santos

Activity Overview:

- Identify and image detailed subsea geological formations for the potential injection and storage of Carbon Dioxide (CO_2)
- Operational Area is approximately 107 km from the nearest coastline, and approximately 119 km from Wadeye in the Northern Territory
- Exclusion zone 3 nm (5.6 km) exclusion (safety) zone around the seismic vessel and trailing streamers
- Streamer length: Approximately 8 km
- Seismic streamer spread width: Approximately 1,350 m

Timing:

- From Q3 2024 with activity duration approximately 50 days, subject to activity schedule requirements, vessel availability and weather
- Time to traverse a single sail line: approx. 8 hrs and 30 mins.
- Line turns: 2-4 hrs
- Expected duration is a forecast and is subject to change based on vessel availability, adverse weather conditions or technical/equipment issues that may arise during the activity.

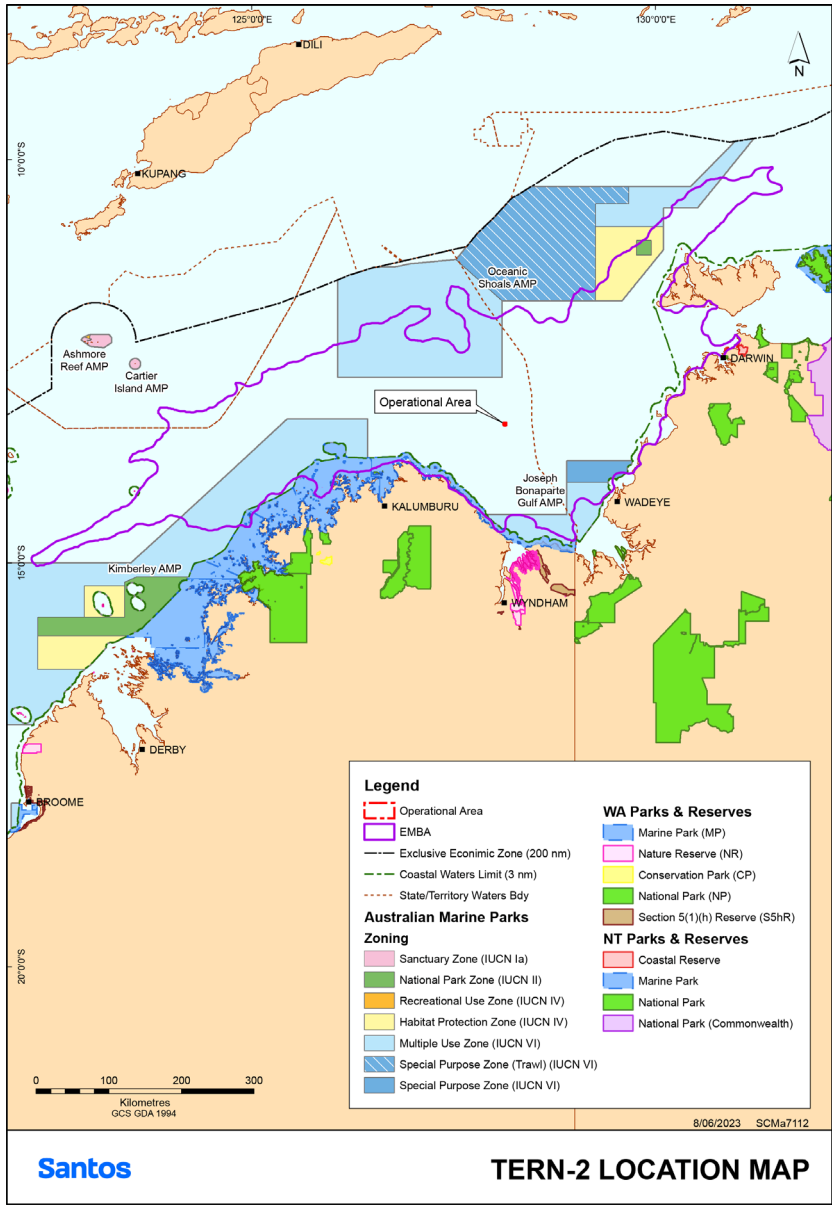


Vessels:

- One purpose built seismic survey vessel.
- Up to two dedicated support vessels (one being a chase vessel) will accompany the seismic survey vessel to provide logistical, safety and equipment management duties.
- Specific vessel details are unknown at this time.

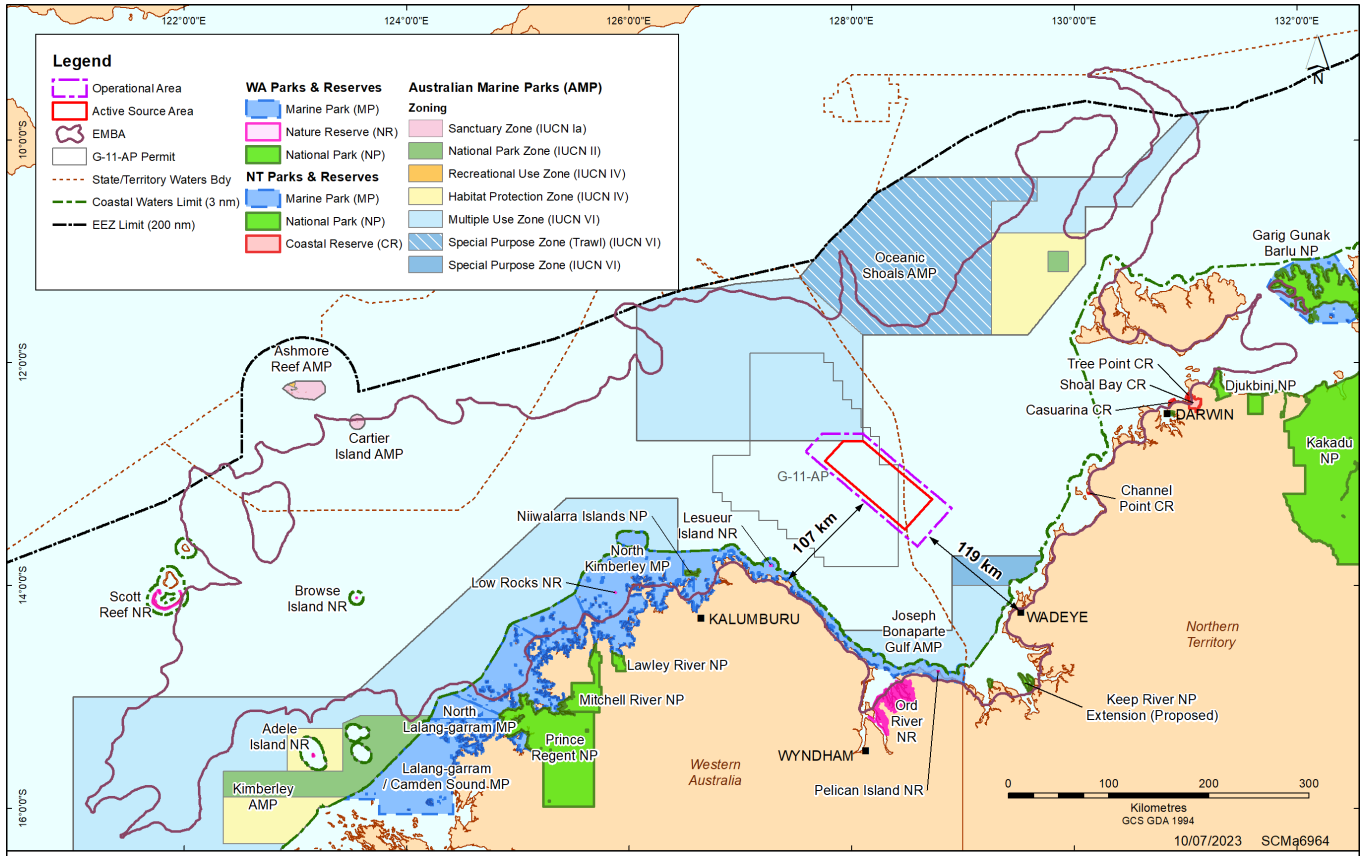
Spill Risk

Santos



Santos

TERN-2 LOCATION MAP



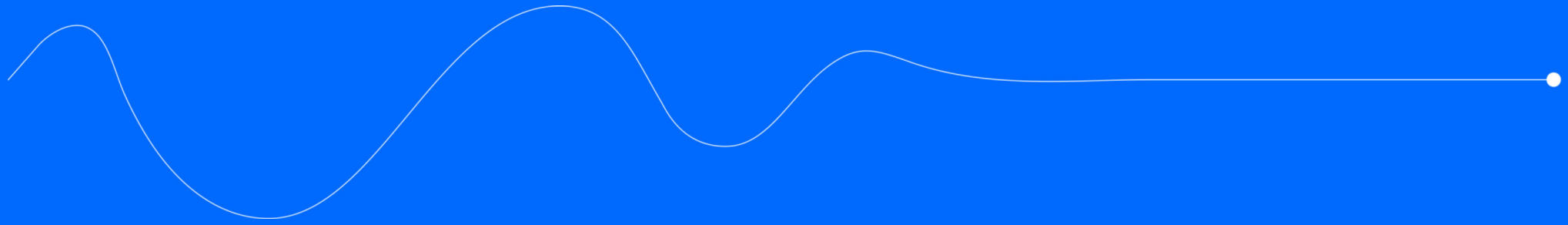
Santos

EOS 3D MSS LOCATION MAP

NT WA 11A Consultation_Tern 2 and Eos

Santos

NORTHERN TERRITORY & WESTERN AUSTRALIA PROJECT CONSULTATION SESSION



WA & NT Environment Plan Consultation

Presented by **Santos Team**

Acknowledgement of Country

Santos acknowledges the Traditional Owners of the land on which we meet today.

We pay our respects to Elders past, present and emerging.

Privacy Statement

Santos Ltd, Santos NA Barossa Pty Ltd and their related bodies corporate (together, we, our, us or Santos) collect personal information about you, such as your name and sensitive information about your indigenous heritage. We use this information to record your attendance at any meeting or other discussion with us, to provide you with information about our projects, to receive and respond to any feedback that you provide, to answer any questions you might have and for other purposes that we tell you about during your meeting or other discussion with us. Santos will handle any information that you provide in accordance with our Code of Conduct and our Confidentiality, IP and Privacy Procedure. You can ask us for a copy of this Privacy Notice or these other documents.

If you do not provide your personal information, we may not be able to identify you as the person who provided particular feedback or we may be unable to discuss any feedback you have provided with you further or respond to your questions. We may disclose your information to other companies within the Santos group, to third parties that help us run our business and to relevant government agencies and government departments.

Due to the global nature of our operations and business, your personal information may be accessed by or disclosed to Santos personnel outside Australia. We may also use overseas third parties to collect, transfer, store and handle your personal information. Some of the overseas countries that your personal information may be accessed from, disclosed or transmitted to or stored in include but are not limited to, Papua New Guinea and the United States of America.

You have a right to request a copy of any personal information that we hold about you, as well as a right to request that we correct any information that we hold about you that is inaccurate, out-of-date, incomplete, irrelevant or misleading. You can also make a complaint about how we have handled your personal information. Our Barossa Gas Project Consultation Privacy Policy explains in more detail how you can exercise these rights, including how we will respond to your access or correction request or to any privacy complaint that you make. This Privacy Policy is available on our website at www.santos.com/barossa/barossa-gas-project-consultation-privacy-policy, or you can contact us to request a copy be provided to you.

You can contact us by:

- posting a letter addressed to us at 60 Flinders Street, Adelaide, South Australia, 5000;
- telephoning us on +61 8 8116 5000; or
- sending us an email at offshore.consultation@santos.com and compliance@santos.com.

Santos

Welcome & Introductions

We are here today to share information about our company & operations and to listen to your questions about Santos & upcoming projects.

Peter Kirkpatrick *– General Manager, Darwin*

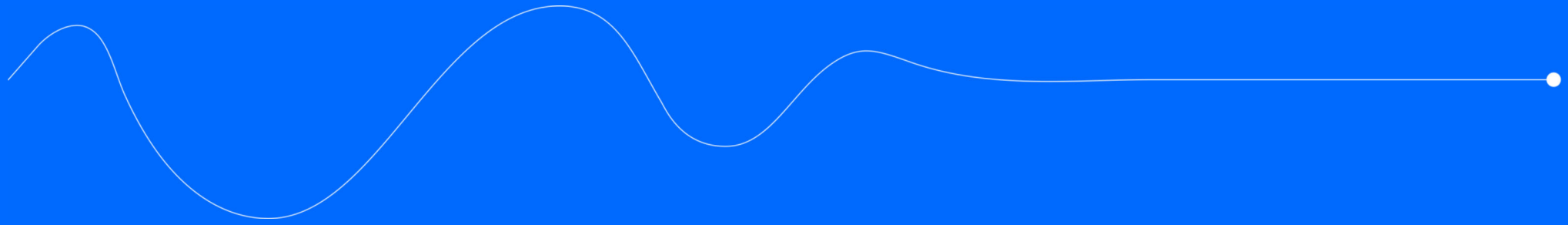
Tony Johnson *- Manager Consultation and Engagement, Offshore*

Lachlan MacArthur *– Senior Environmental Adviser*

Emma Haddon *– Senior Environmental Advisor*

Santos

SANTOS OPERATIONS & DARWIN LNG



WA & NT Environment Plan Consultation

Presented by **Barossa Team**

SANTOS - South Australia, Northern Territory Oil Search

Santos is a global energy company committed to increasingly cleaner energy and fuels production, with operations across Australia, Papua New Guinea, Timor-Leste and North America (Alaska).

At Santos, our commitment is to be a global leader in the transition to cleaner energy and clean fuels, by helping the world decarbonise to reach net-zero emissions in an affordable and sustainable way.

For more than 65 years, Santos has been working in partnership with local communities, providing local jobs and business opportunities, safely developing its natural gas resources, and powering industries and households.

Santos is one of Australia's biggest domestic gas suppliers and a leading LNG supplier in the Asia Pacific region.

We are committed to supplying critical fuels such as oil and gas in a more sustainable way through decarbonising projects, including the Moomba CCS Project, while we all transition to cleaner fuels.

Our business focus: Safe, reliable operations & Minimise our social and environmental impacts.

Darwin LNG Facility & Operations

Santos

- Located in Darwin at Wickham Point Darwin LNG (DLNG) is a single train liquefaction and storage facility that started production in 2006.
- The Bayu-Undan facility, which supplies gas to DLNG via 26-inch subsea pipeline, is located approximately 500 kilometers north-west of Darwin in the Timor Sea.
- The facility includes a central production Storage and Offloading vessel for condensate and LPG products and an unmanned wellhead platform.
- Approx 140 local Darwin people work at the LNG Facility.
- 100% Darwin residential Santos employee workforce.
- DLNG established the NT's first LNG Process Operator Traineeships in 2010.
  - ~10% of those who have completed identified as an Aboriginal or Torres Strait Islander.

The Oil and Gas lifecycle

Santos

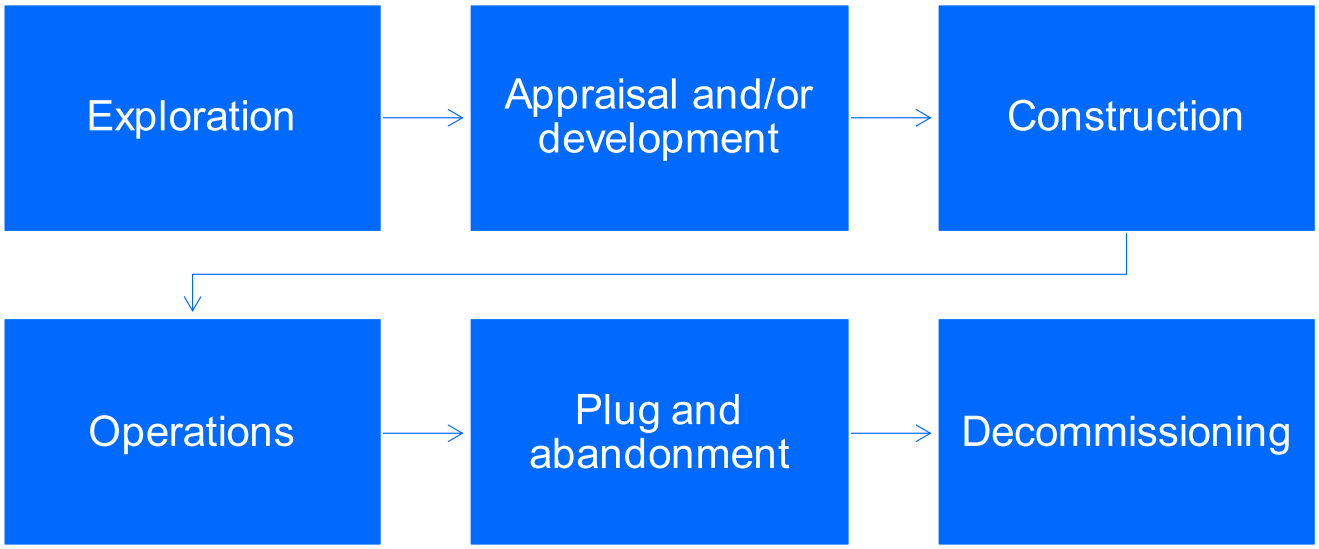
The oil and gas lifecycle involves the exploration, extraction, and use of these valuable resources.

It starts with searching for oil and gas deep underground using seismic surveys and drilling exploration wells, followed by the construction of infrastructure to extract and produce them.

Afterward, the products are transported to end-users.

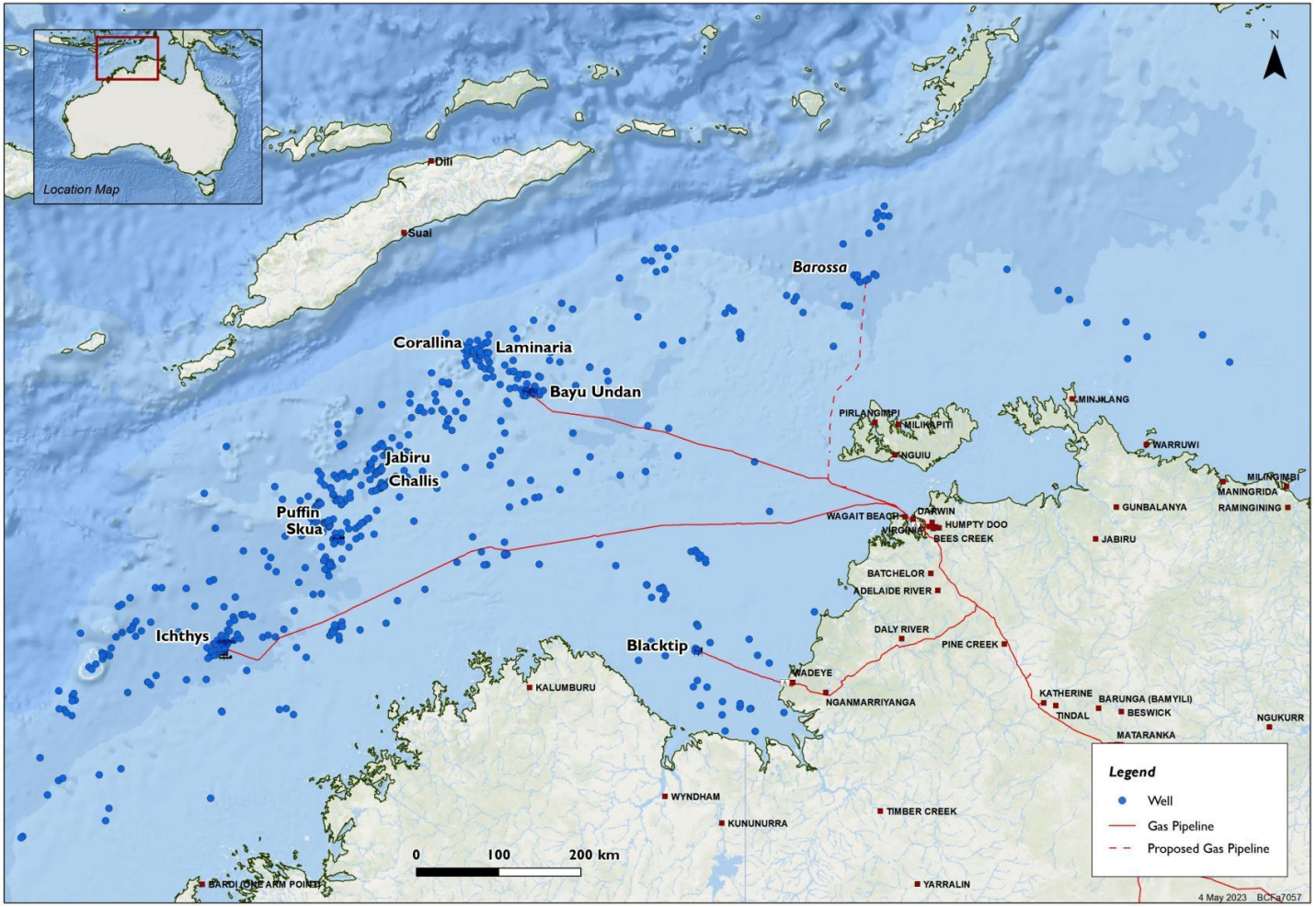
When the resources are depleted, there's a process to close down operations and ensure environmental compliance, called decommissioning.

Current Santos projects are at various stages of this lifecycle.



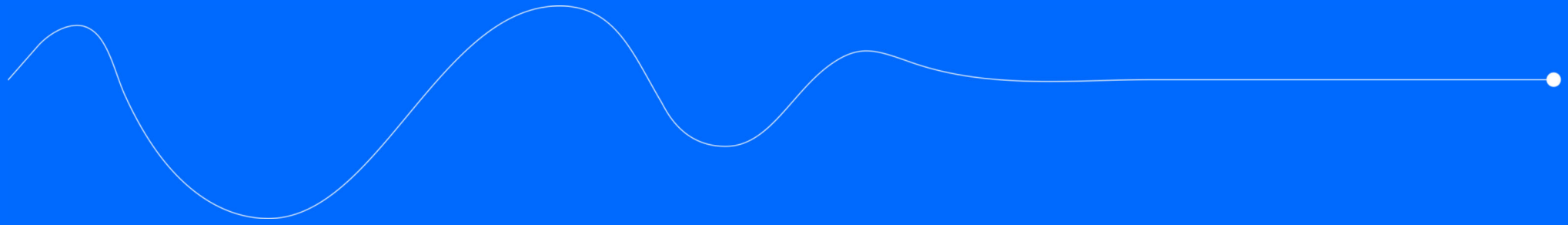
Wells Drilled by All Industry Since 1969

Santos



Santos

ENGAGEMENT & CONSULTATION EXPLAINED



Consultation for Environment Plans

Commonwealth waters – National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA)

"In the course of preparing an Environment Plan, a titleholder must consult with relevant persons in accordance with Division 2.2A, Regulation 11A…

"The purpose of consultation under regulation 11A of the Environment Regulations is to ensure that authorities, persons or organisations that are potentially affected by activities are consulted and their input considered in the development of environment plans."

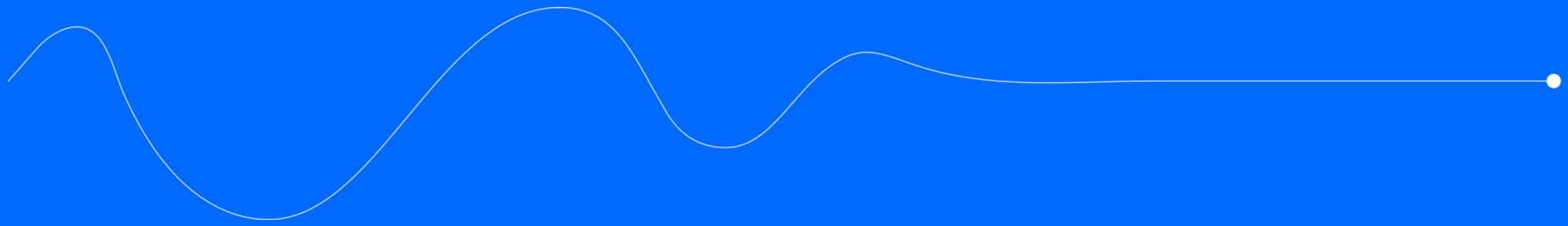
Guideline - Consultation in the course of preparing an environment plan, NOPSEMA

NOPSEMA

Information provided by relevant persons in consultation may also help titleholders **better understand the values and sensitivities of the environment** and inform the evaluation of the **potential impacts and risks** associated with the activity and **how to manage them** appropriately

Santos

BONAPARTE BASIN CONSULTATION

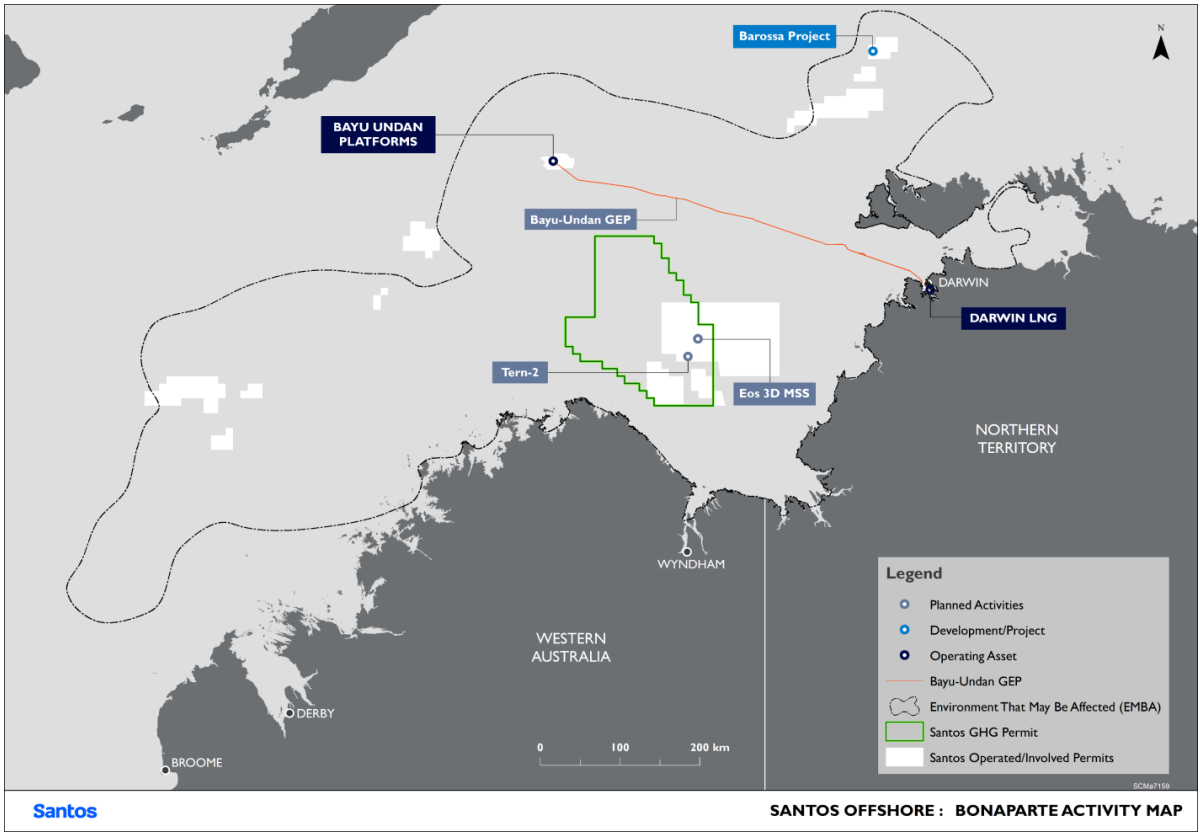


WA & NT Environment Plan Consultation

Bonaparte Basin

- Santos is proposing to undertake Consultation for our Bonaparte Basin activities (outside of Barossa Gas Project activities); starts on **27 October 2023** and closes on **27 November 2023**.
- Proposed activities are:
  - Tern-2 Plug and Abandonment (P&A)
  - Eos 3D Marine Seismic Survey

  Santos is also looking to place the Bayu-Undan Gas Export Pipeline into preservation at end of field life.

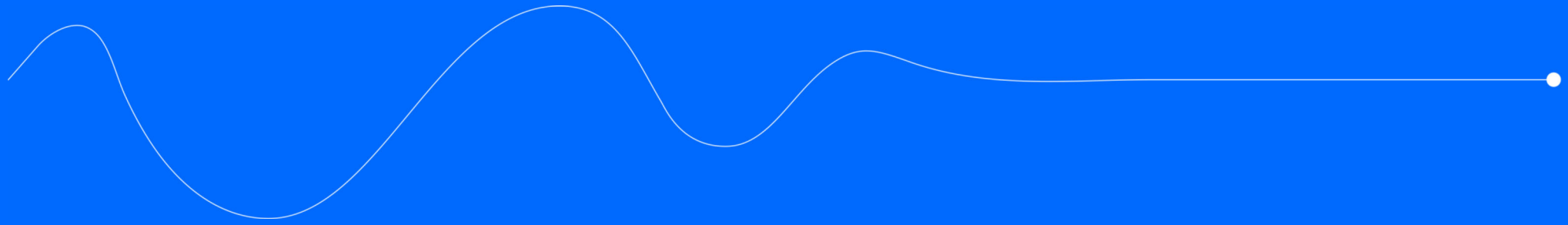


Oil Spill Modelling

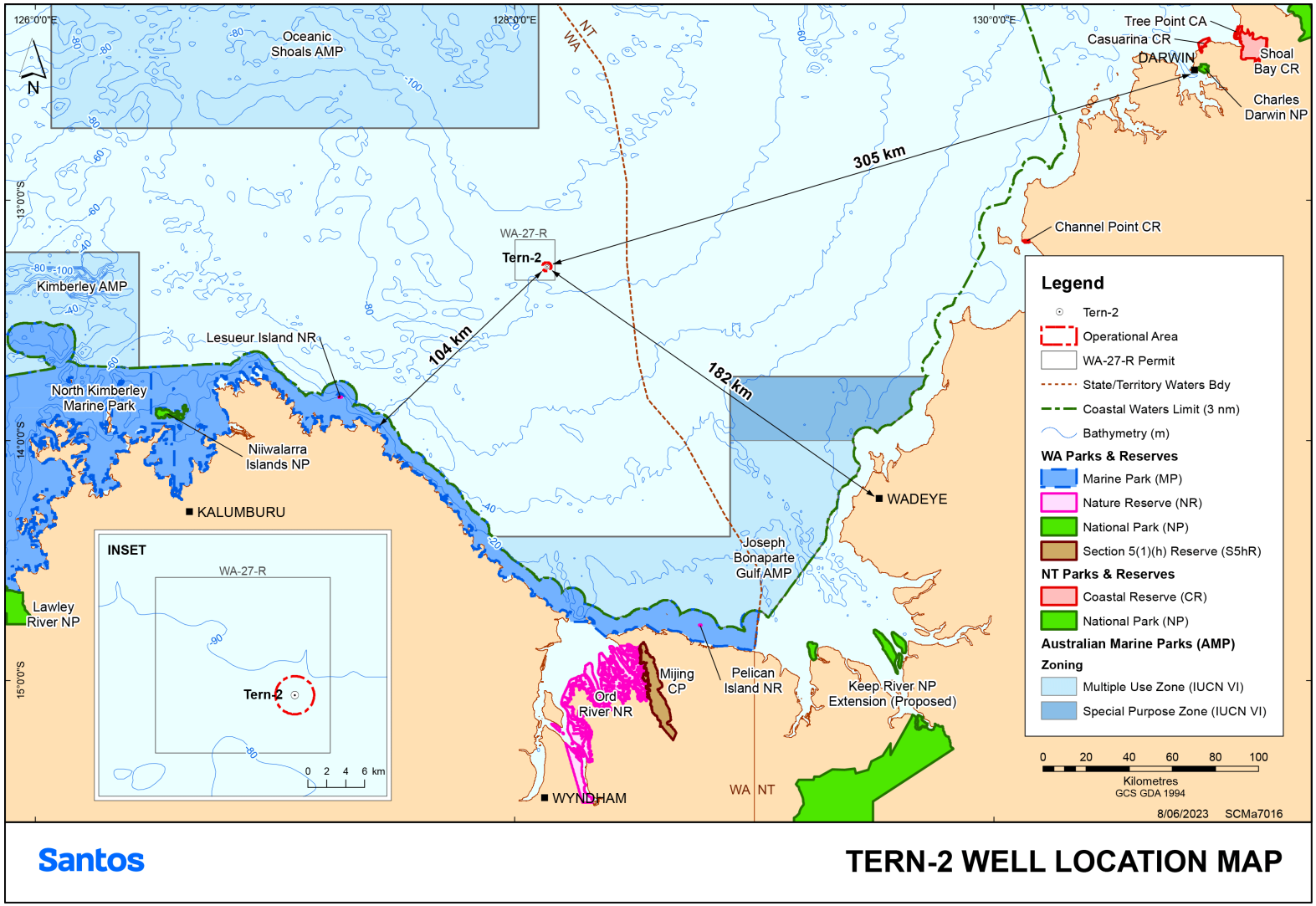
Santos

BONAPARTE BASIN CONSULTATION

TERN-2 PLUG AND ABANDONMENT



Tern-2 P&A - Location



Tern-2 P&A - Overview

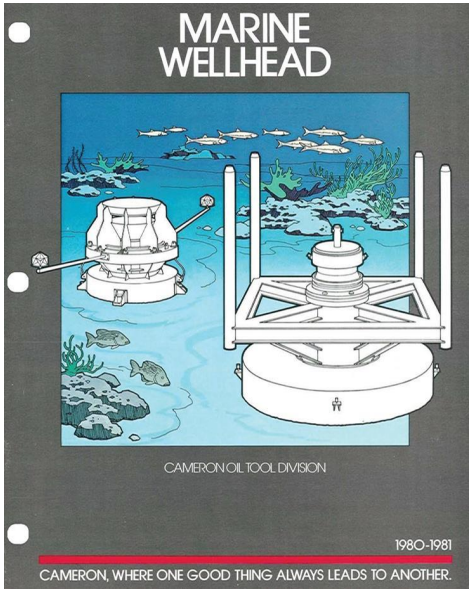
- Tern-2 is an appraisal well located approximately 300 km WSW of Darwin.
- The well was drilled in 1981 and 82.
- It was temporarily abandoned with cement barriers in January 1982.

- Key objectives of P&A activity:
  - Installing and verifying additional well barriers
  - Removing the wellhead and any infrastructure from the seabed as best as practical to eliminate future hazards to the environment or other users of the area.

- Estimated activity duration:
  - ~10 days (Continuous operations, 24 hours per day, 7 days per week).
  - Up to 40 days in the event of unforeseen delays and poor metocean conditions.

  The Operational Area:
  - A circular area with a 2 km radius around the Tern-2 wellhead.
  - ~ 106 km from the closest shoreline
  - Average water depth is ~ 83 m.

- The petroleum activities require the following vessels:
  - Light Well Intervention Vessel (LWIV)
  - Support vessel
  - Remotely Operated Vehicle (ROV)
  - Helicopters

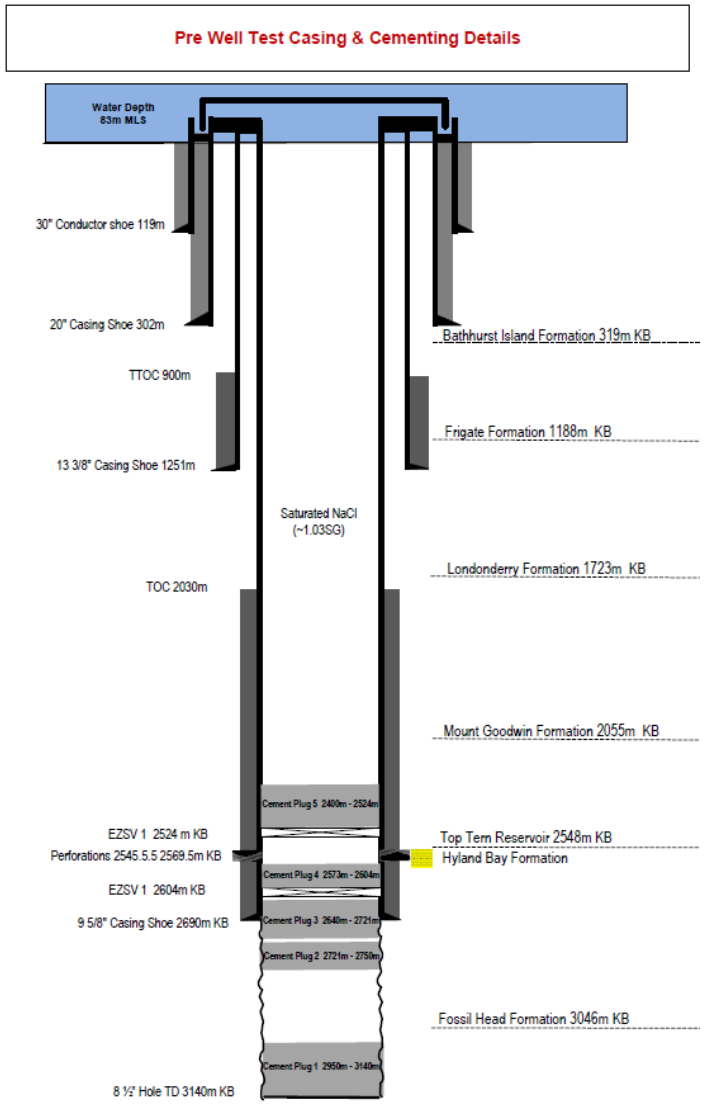


Example of the Tern-2 wellhead.

Example of wellhead at Tern-2 wellhead location.

Tern-2 P&A - Activity

- Utilising a Light Well Intervention Vessel for the following scope:
  - Clean and remove wellhead debris cap
  - Inspect and evaluate condition inside well
  - Using wireline, install additional P&A barriers into the well
  - Cut and remove wellhead
  - Contingency to place wellhead on seabed only if needed
  - Move wellhead to the vessel using ROV
  - If the wellhead is in poor condition and can't be removed it will be left on the seabed



Tern-2 wellhead schematic

Tern-2 P&A – Vessels & Vehicles

Example Light Well Intervention Vessel (LWIV)

Example Support Vessel

Example ROV

Example Helicopter

Tern-2 P&A - Impacts

Santos

Planned events	How we manage (the rules we follow)
Disturbance to other boats	We will communicate to other boats where we are and what we are doing. We mark the location of equipment on charts.
Seabed disturbance	We are putting equipment on a flat sandy seabed. We only put equipment in the approved location.
Light disturbance	We only use lights where needed for safe operations. We turn off lights when not needed.
Noise disturbance	We look out for marine life (e.g., whales, dolphins, turtles). Noise levels are not expected to impact at population level or have a significant impact on foraging behaviours of marine turtles.
Air emissions	We ensure engines and other equipment is looked after and fuel use and waste incineration standards are maintained.
Discharges	We will reduce discharges to only those necessary for operations and we follow the standard rules for what boats can discharge.
Wellhead left on seabed	We will leave the wellhead on the seabed only if it cannot be removed easily due to technical difficulties.
Oil spill response	We have plans and resources to be used if there is an accidental oil spill.

Tern-2 P&A - Risks

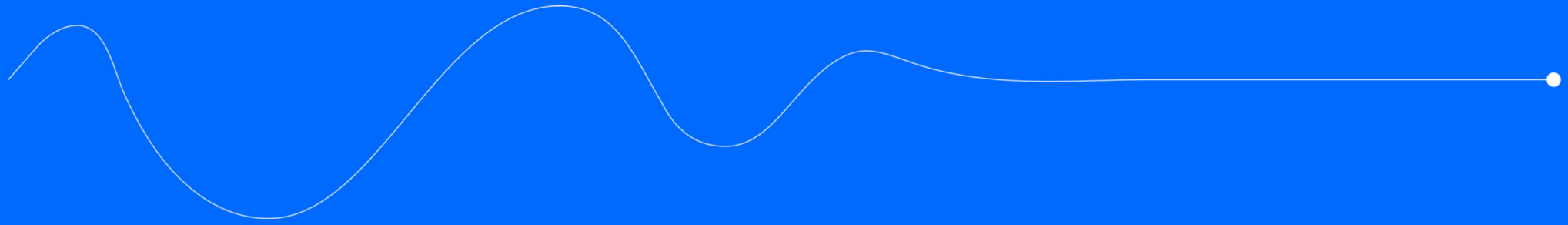
Santos

Unplanned events (Accidents)	How we manage (the rules we follow)
Diesel spill	We make sure all the boats are following the rules for preventing collisions. We let other boats know where we are and what we are doing. We will not refuel within the operational area.
Dropped objects	We follow strict procedures to stop objects dropping overboard and we pick up objects when it is safe to do so.
Disturbing marine animals	We look out for marine life (e.g., whales, dolphins, turtles) when transiting within and to and from the operational area and we slow down and move away from them where possible if they are too close.
Invasive marine life	We will use an anti-foulant system and follow strict procedures to avoid any introduction of invasive marine life.
Chemical spill	We select chemicals that are friendly to the environment where possible and store them carefully. We have procedures for using and cleaning up chemicals.
Disturbance to other boats	We let other boats know where we are and what we are doing. We will let other boats, fishing groups, and the government know if the wellhead cannot be removed and will be left on the seabed.

Santos

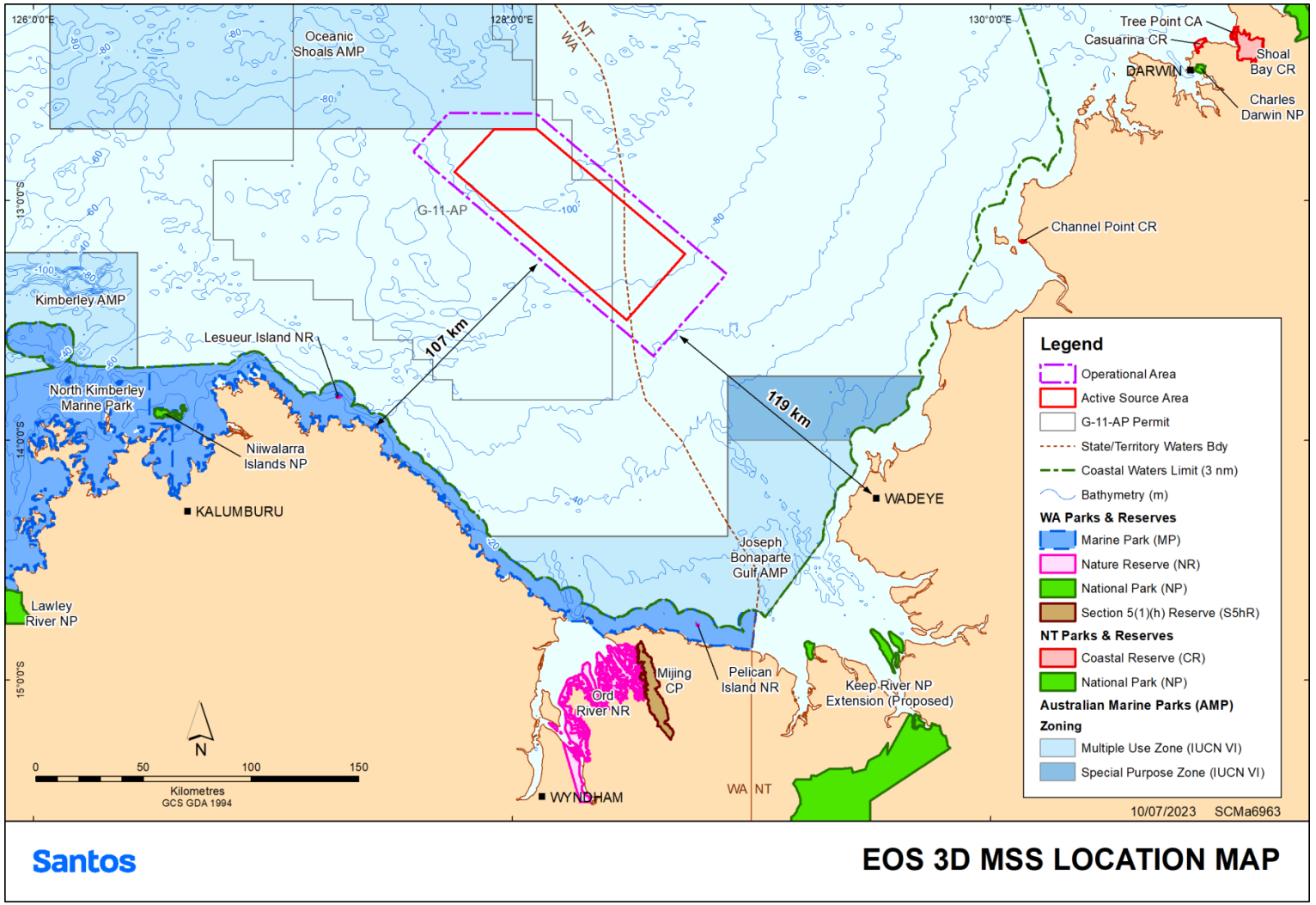
BONAPARTE BASIN CONSULTATION

EOS 3D MARINE SEISMIC SURVEY



WA & NT Environment Plan Consultation

Eos 3D MSS - Location



Eos 3D Marine Seismic Survey

What is a marine seismic survey?

Eos 3D MSS - Overview

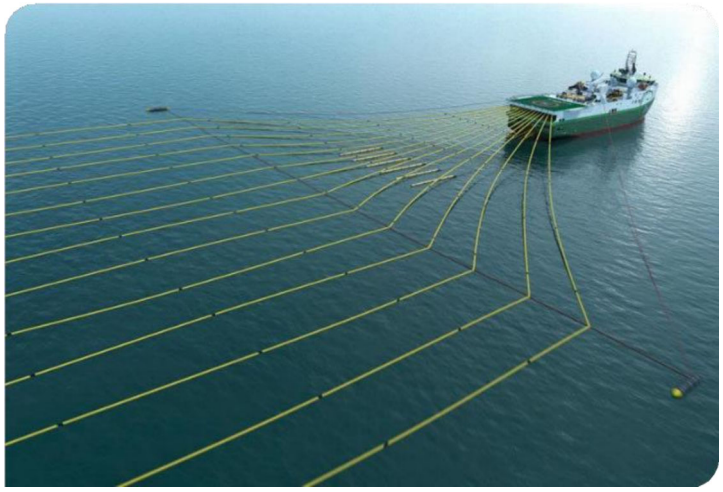
- Santos plans to acquire a three-dimensional (3D) marine seismic survey (MSS) in Commonwealth waters in the Bonaparte Basin.
- The proposed activity is required to complete an appraisal of the carbon storage potential of Santos' greenhouse gas assessment (GHG) permit

- Key objectives:
  - future Carbon Dioxide (CO_2) injection activities by providing details of geology for suitability of injection and storage of CO_2.
- Timing:
  - 50 days, (42 days plus 8 days for contingency, e.g. weather, mechanical etc)
  - Continuous operations, 24 hours per day, 7 days per week.

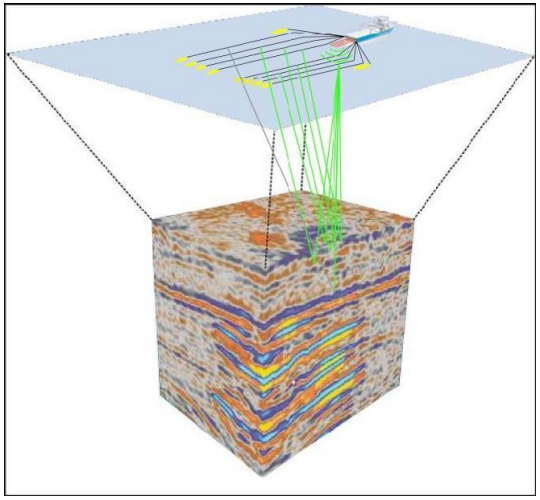
- Operational Area:
  - Area within which the seismic survey vessel will operate during the normal conduct of the activity.
  - 60 to 115 m water depth.

- Active Source Area:
  - Area size: 4,028 km^2
  - 67 to 111 m water depth.

- Project vessels:
  - Seismic survey vessel
  - Up to two Support Vessels (one being a chase vessel)
  - Helicopters and drones

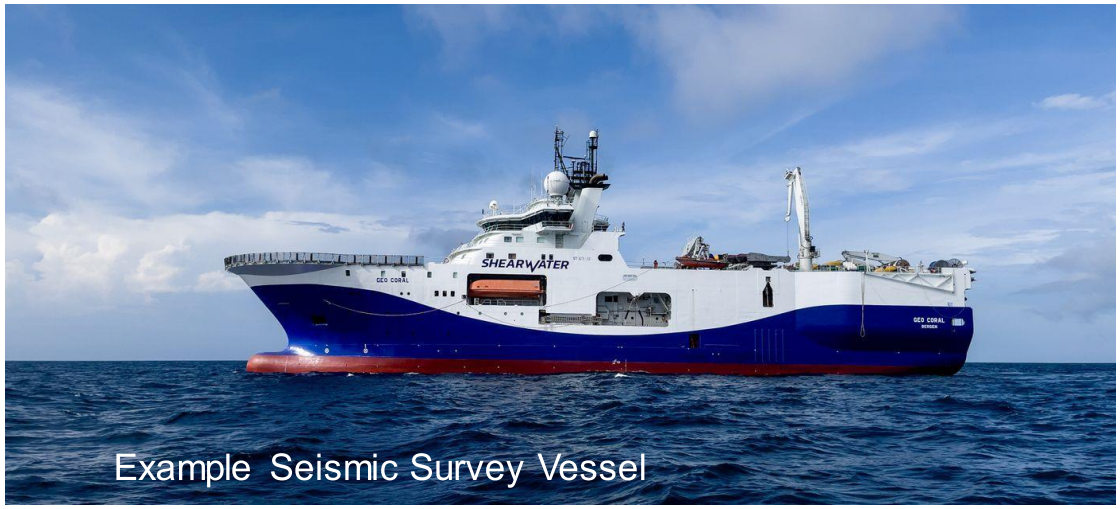


Example of a seismic array and Marine Seismic Vessel for 3D or 4D surveys



3D seismic survey, showing simplified configuration of seismic vessel and subsurface cube of data (Cameselle, 2020)

Eos 3D MSS – Vessels & Vehicles



Example Seismic Survey Vessel

Example Support Vessel

Example Chase Vessel

Example Helicopter

Eos 3D MSS - Impacts

Santos

Planned events	How we manage (the rules we follow)
Disturbance to commercial fishers	We will communicate to fishing boats where we are and what we are doing. We have a process to enable commercial fishers to lodge evidence-based payment claims for temporary loss of fish catch, displacement costs and equipment damage or loss directly caused by the seismic survey.
Disturbance to other boats	We will communicate to other boats where we are and what we are doing and provide notifications in advance of the survey starting.
Light disturbance	We only use lights where needed for safe operations. We turn off lights when not needed.
Noise disturbance	We look out for marine life (e.g., whales, dolphins, turtles) and the support vessel will slow down and move away from them where possible if they are too close while the survey is taking place.
Air emissions	We ensure engines and other equipment is looked after and fuel use and waste incineration standards are maintained.
Discharges	We will follow the standard rules and procedures for what boats can discharge.
Impacts from other seismic surveys	We will communicate with other companies that may also be doing seismic surveys in the area and keep a large distance between other seismic vessels.

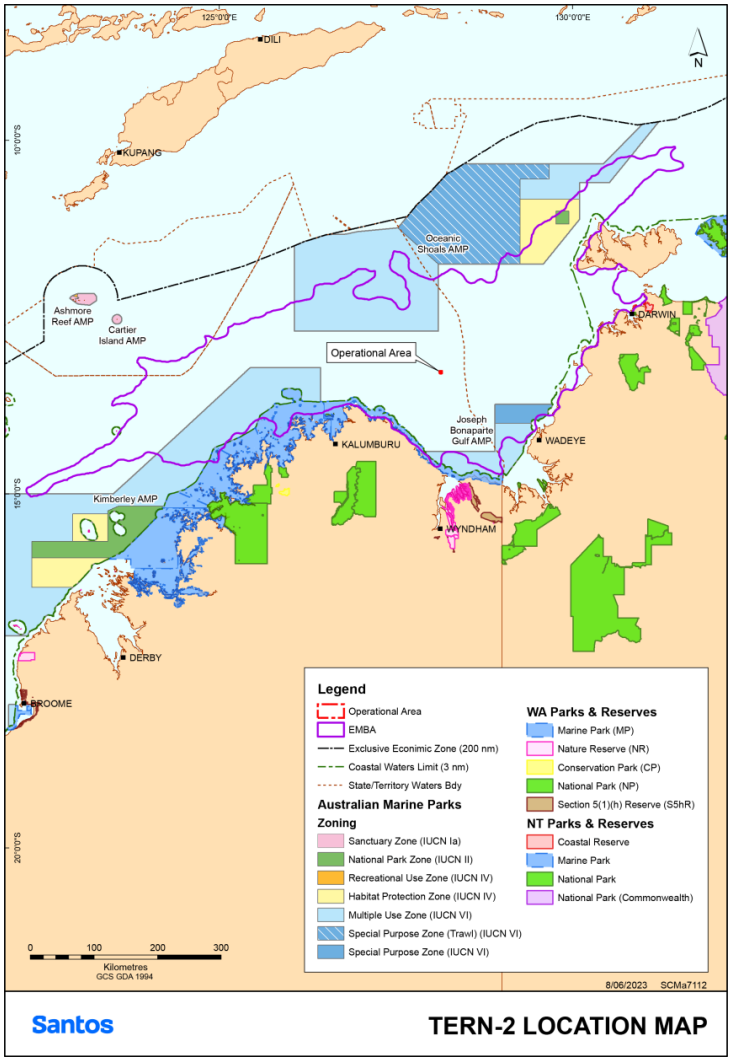
Eos 3D MSS - Risks

Santos

Unplanned events (Accidents)	How we manage (the rules we follow)
Diesel spill	We make sure all the boats are following the rules for preventing collisions. We let other boats know where we are and what we are doing. We follow strict procedures for refuelling.
Discharges	Where possible and safe to do so, we will recover any waste or equipment that accidentally falls overboard into the ocean.
Disturbing marine animals	We look out for marine life (e.g., whales, dolphins, turtles) and the support vessel will slow down and move away from them where possible if they are too close while the survey is taking place.
Invasive marine life	We will use an anti-foulant system and follow strict procedures to avoid any introduction of invasive marine life.
Chemical spill	We select chemicals that are friendly to the environment where possible and store them carefully. We have procedures for using and cleaning up chemicals.
Oil spill response	We have plans and resources to be used if there is an accidental oil spill.

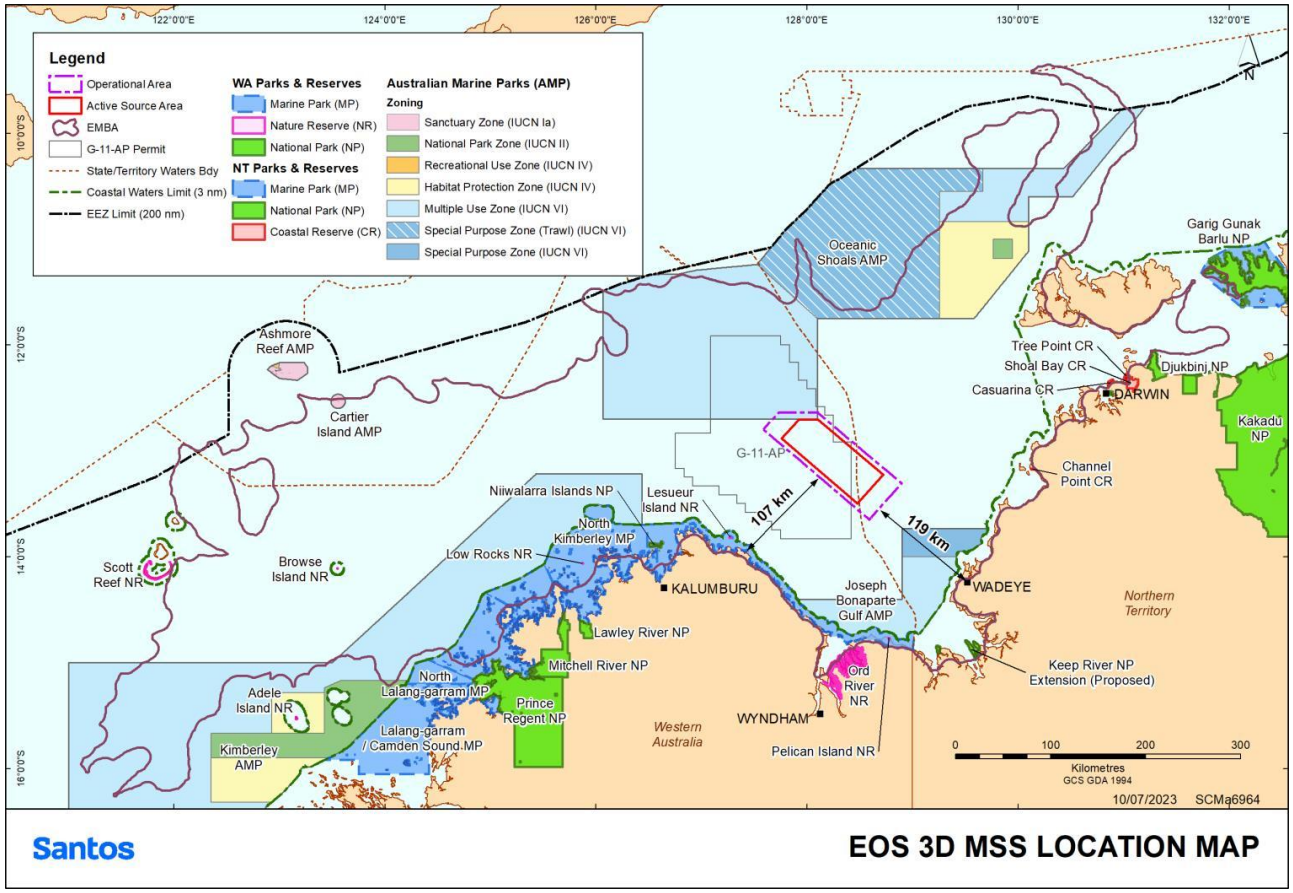
Santos

Spill Risk



Santos

TERN-2 LOCATION MAP

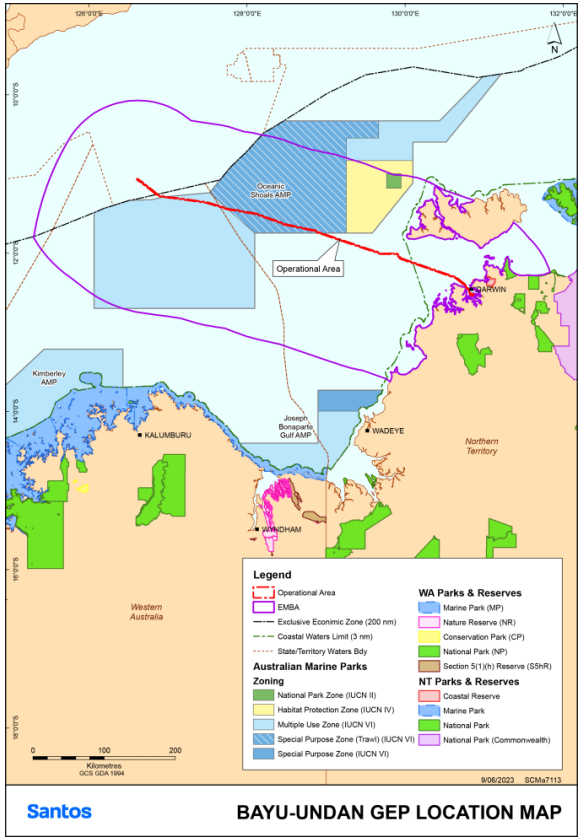


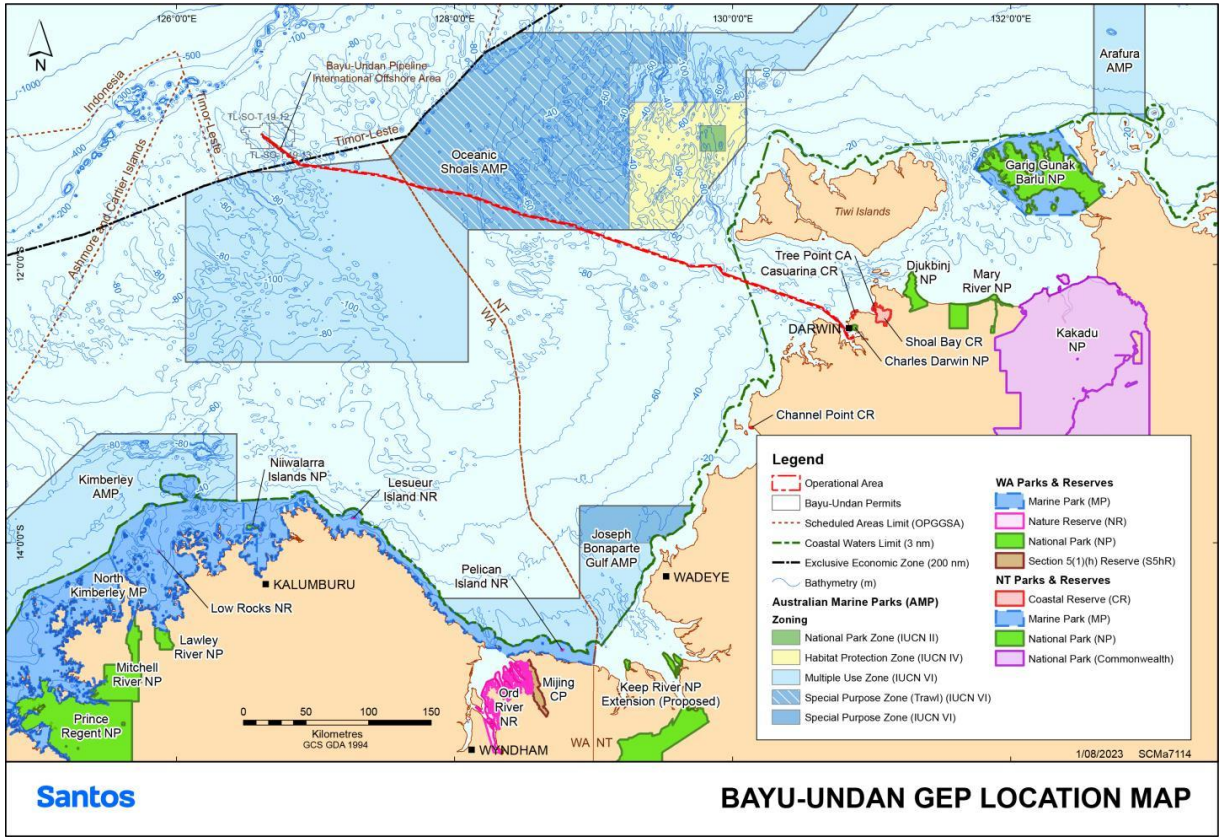
Santos

EOS 3D MSS LOCATION MAP

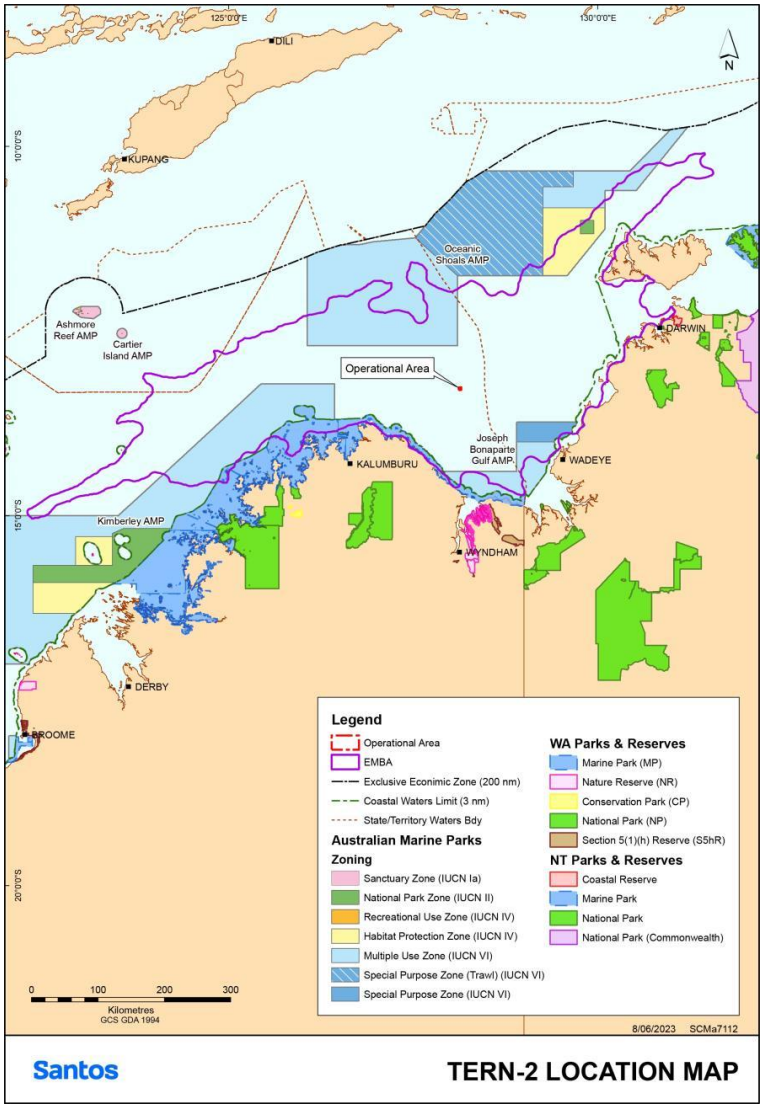
Bayu-Undan Gas Export Pipeline EP

- Santos is the operator of the existing 502km Gas Export Pipeline.
- The pipeline transports dry natural gas from the Bayu-Undan Field (Timor-Leste waters) to the onshore Darwin liquefied natural gas (DLNG) plant.
- The pipeline has been operational since 2005.
- As the Field is approaching the end of life, the pipeline will transition from operations to a preservation state.
- The original EP for operations was accepted by NOPSEMA in 2019.
- The EP has been updated to include the final stages of operations (linepacking and back-feed), plus a preservation phase (gas-filled).





Tern-2 P&A – Environment That May Be Affected



Feature	Public Information Review
Aboriginal Heritage	Aboriginal Heritage sites are present along the southern and eastern boundaries of the Environment That May Be Affected (EMBA).
Biologically Important Areas (BIAs)	The Operational Area includes BIAs for turtles only, the EMBA includes BIAs for dolphins, seabirds, sharks, whales and turtles.
Cultural Heritage	No known sites of shipwrecks, sunken aircraft or Aboriginal and Torres Strait Islander Underwater Cultural Heritage have been identified within the Operational Area. Within the EMBA the nearest shipwreck, the SEDCO Helen, is approximately 60 km northeast of the Operational Area located in depths of approximately 100 m .
Defence	Operational area overlaps practice and training areas that comprise the North Australian Exercise Area (NAZA) a maritime military zone administered by the Australian Defence Force, as well as restricted airspace.
Energy industry	Several offshore petroleum projects are in operation and there is exploration activity within the EMBA. The nearest platform is the ENI Blacktip Platform approximately 75 km to the southeast of the operational area.
Fishing	A number of Commonwealth, State and Territory fisheries management areas overlap the Operational Area and EMBA however, neither Commonwealth nor WA state-managed fisheries show activity within the Operational Area between 2010-2020.
	Traditional Australian Indigenous fishing activities are generally concentrated within 3 nm of the Northern Territory / Western Australian coastline.
	No interaction with recreational or charter boat fishers is anticipated given the remoteness of the Operational Area (~106 km from nearest coastline).
Key Ecological Features (KEFs)	The EMBA includes KEFs for the carbonate bank and terrace system of the Van Diemen Rise, the carbonate bank and terrace system of the Sahul Shelf, ancient coastline at 125m depth contour, continental slope Demersal Fish communities, the shelf break and slope of the Arafura Shelf, and the Pinnacles of the Bonaparte Basin.
Protected Areas (nearest Commonwealth and Territory)	In Commonwealth Waters the EMBA overlaps with the Oceanic Shoals Marine Park, Joseph Bonaparte Gulf AMP and the Kimberley AMP. The closest being the Oceanic Shoals AMP which is approximately 63 km north of the Operational Area.
	The North Kimberley State Marine Park is approximately 182 km west from the Operational Area and overlaps with the EMBA.
Shipping	The Operational Area does not overlap any shipping fairways, though is adjacent to vessel traffic. Vessel traffic from Wyndham may be present within the EMBA at periods of the year.
Telecommunications	The North West Cable System (NWCS) connects offshore oil and gas facilities in the Browse, Bonaparte and Carnarvon Basins to onshore locations and is approximately 140 km north-north-east of the Operational Area.
Tourism	Remoteness of the Operational Area and water depth limits opportunities for tourism. Tourism is likely within the EMBA.
Towns/Communities	Darwin is the nearest capital city and is approximately 300 km northeast from the Operational Area.

Eos 3D MSS - Activity

- The process of collecting seismic data is known as ‘acquisition’.
- Marine seismic surveys are carried out by specialised vessels that tow an array of acoustic sources (airguns) and receivers (hydrophones) across a defined acquisition area.
- The seismic survey vessel will tow a seismic source array (up to 3,500 in3) and up to 12 streamers, approximately 113 m apart, and will travel back and forth across the survey area in a “race track” pattern, lines separated by approximately 500-700m within an overall acquisition area.
- The streamer array will be approximately 8 km long and positioned 10 – 30 m below the ocean surface.
- Airguns work by rapidly releasing compressed air to form a bubble, which creates a pulse of sound. This sound energy is directed at the seafloor and penetrates into the various rock layers beneath.
- The reflected soundwaves are then captured by hydrophone receivers, which are towed behind the vessel on a series of cables known as 'streamers'.
- Support vessels will be on standby, one support vessel will be present at all times.
- 3 nm exclusion zone requested.
- Auscoast warning and/or Notice to Mariners will be issued prior to the start of the activity.
- The seismic survey vessel will display appropriate day shapes and lights to indicate it is under tow and is therefore restricted in it’s ability to manoeuvre, and the streamers will tow surface tail buoys fitted with radar reflectors.
- A visual and radar watch will be maintained on the bridge at all times.

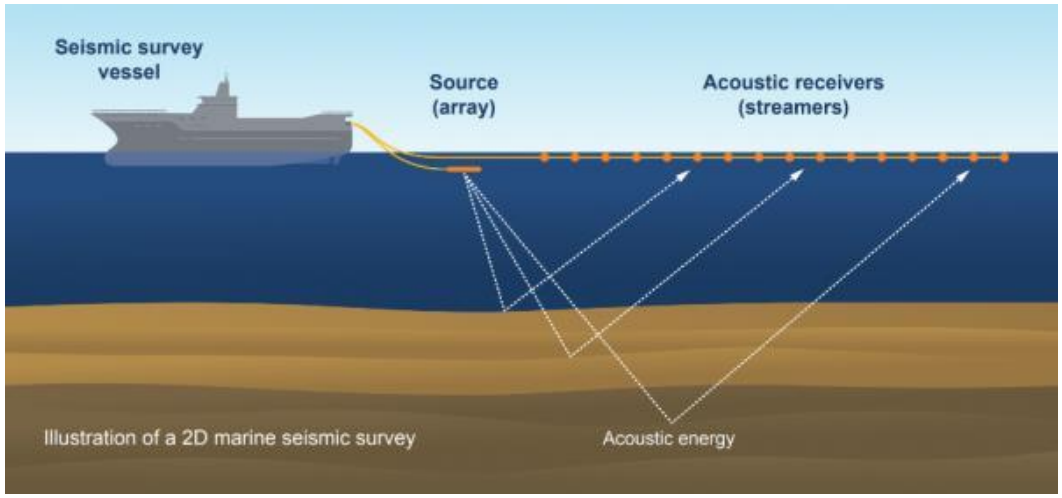
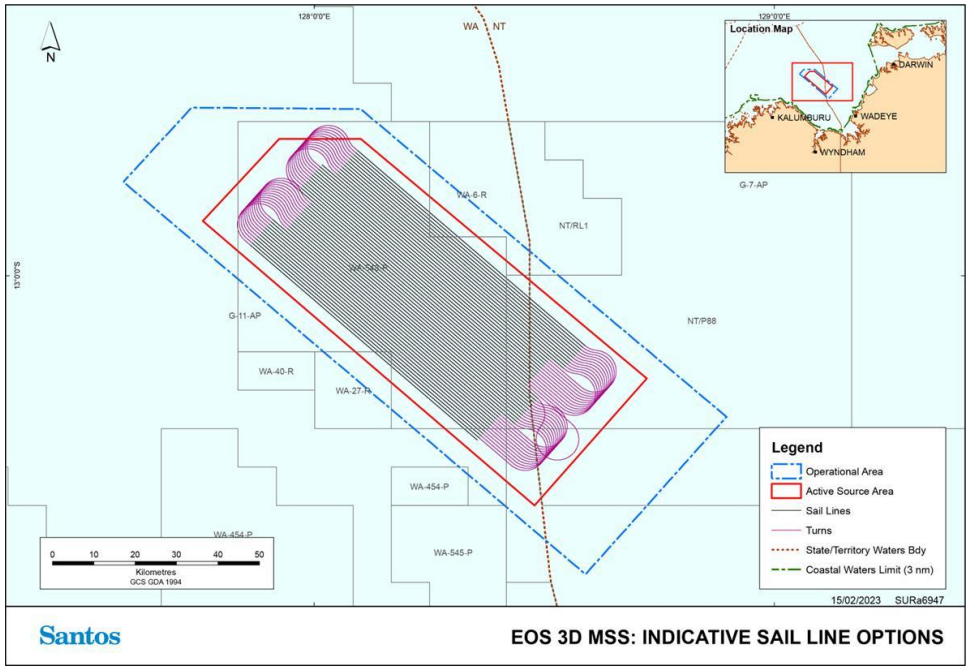


Diagram of a marine seismic survey (Source: NOPSEMA).



Eos 3D MSS – Environment That May Be Affected

Feature	Public Information Review
Aboriginal Heritage	Aboriginal Heritage sites are present along the coastline along the southern boundary of the EMBA.
Biologically Important Areas (BIAs)	The Operational Area includes BIAs for turtles.
Cultural Heritage	No known sites of shipwrecks, sunken aircraft or Aboriginal and Torres Strait Islander Underwater Cultural Heritage have been identified within the Operational Area. The nearest shipwreck, the SEDCO Helen, is approximately 11 km northeast of the Operational Area.
Defence	Operational area overlaps practice and training areas that comprise the North Australian Exercise Area (NAZA) a maritime military zone administered by the Australian Defence Force, as well as restricted airspace.
Energy Industry	Petroleum exploration and production activities have been undertaken within the EMBA and the Bonaparte Basin is an established hydrocarbon province with a number of commercial operations. Several exploration permits overlap the Operational Area with the closest production licence being the Eni Australia B.V. located 21 km south of the Operational Area.
Fishing	Five Commonwealth, thirteen Western Australia and ten Northern Territory fisheries overlap the EMBA, some of which are active in the Operational Area.
	Traditional Australian Indigenous fishing activities are generally concentrated within 3 nm of the Northern Territory / Weste rn Australian coastline.
	Fishing charter vessels may transit through the Operational Area and EMBA. Northern Prawn Fishery (NPF) fishing season (within the NPF licence area) is annually from August to November.
Key Ecological Features (KEFs)	The Operational Area overlaps one KEF for the Carbonate Bank and Terrace System of the Sahul Shelf.
Protected Areas (nearest Commonwealth and Territory)	The Operational Area overlaps the Oceanic Shoals Marine Park and four additional Australian Marine Parks overlap the EMBA. .
	Eighteen state/territory marine parks overlap the EMBA with the closest being the North Kimberley Marine Park located approximately 100 km south-west of the Operational Area.
Shipping	The Operational Area does not overlap any shipping fairways, however there is vessel traffic that passes through the northern end of the Operational Area. High vessel traffic to be expected from largest exporter of cattle out of Wyndham during Q3.
Telecommunications	The North West Cable System (NWCS) connects offshore oil and gas facilities in the Browse, Bonaparte and Carnarvon Basins to onshore locations and is approximately 125 km north-north- east of the Operational Area.
Tourism	Remoteness of the Operational Area and water depth limits opportunities for tourism. Tourism is likely within the EMBA.
Towns/Communities	Darwin is the nearest capital city and is approximately 230 km northeast from the Operational Area.
	Wadeye is the nearest community and is approximately 119 km southeast from the Operational Area.

Eos 3D MSS - Activity

- The process of collecting seismic data is known as ‘acquisition’.
- Marine seismic surveys are carried out by specialised vessels that tow an array of acoustic sources (airguns) and receivers (hydrophones) across a defined acquisition area.
- The seismic survey vessel will tow a seismic source array (up to 3,500 in3) and up to 12 streamers, approximately 113 m apart, and will travel back and forth across the survey area in a “race track” pattern, lines separated by approximately 500-700m within an overall acquisition area.
- The streamer array will be approximately 8 km long and positioned 10 – 30 m below the ocean surface.
- Airguns work by rapidly releasing compressed air to form a bubble, which creates a pulse of sound. This sound energy is directed at the seafloor and penetrates into the various rock layers beneath.
- The reflected soundwaves are then captured by hydrophone receivers, which are towed behind the vessel on a series of cables known as 'streamers'.
- Support vessels will be on standby, one support vessel will be present at all times.
- 3 nm exclusion zone requested.
- Auscoast warning and/or Notice to Mariners will be issued prior to the start of the activity.
- The seismic survey vessel will display appropriate day shapes and lights to indicate it is under tow and is therefore restricted in it’s ability to manoeuvre, and the streamers will tow surface tail buoys fitted with radar reflectors.
- A visual and radar watch will be maintained on the bridge at all times.

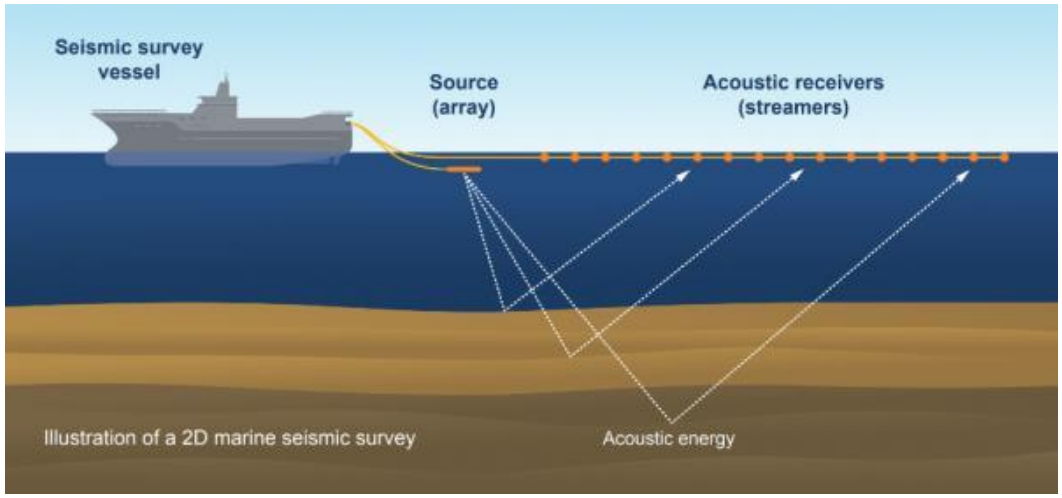
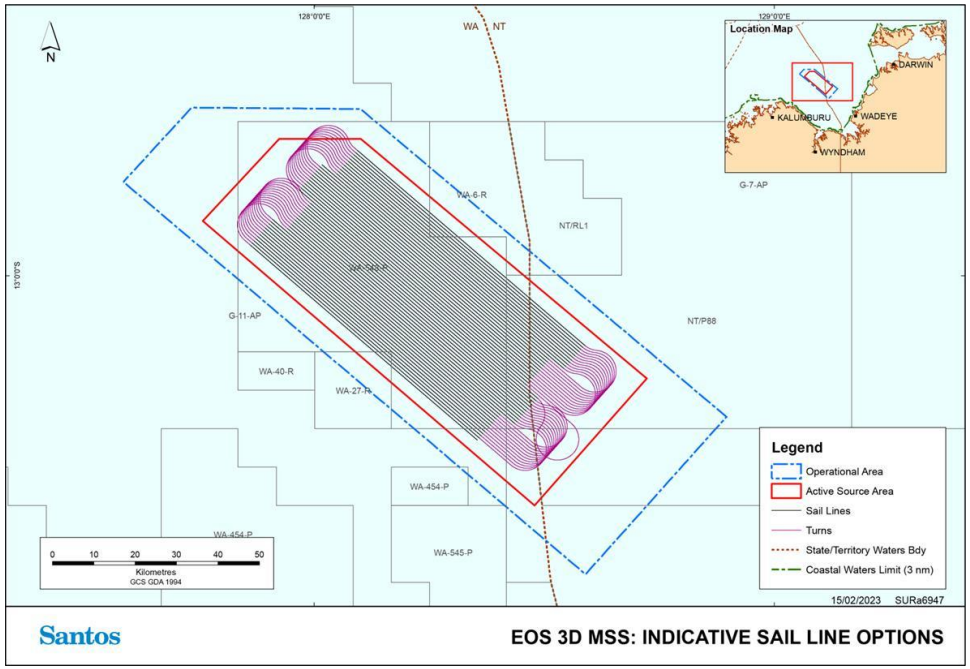


Diagram of a marine seismic survey (Source: NOPSEMA).



Eos 3D MSS – Commercial Fishers

Co-existence approach

- Minimise the extent of interruption by the seismic survey activities on commercial fishing operators' activities to the lowest practicable level.
- Mitigate the effects of the interruptions.
- Apply an equitable 'commercial fishers payment claim protocol'.

Commercial fishers payment claim protocol

- The survey will potentially impact commercial fishers whose fishing operations overlap with the seismic survey.
- Santos has a process to enable commercial fishers to lodge evidence-based payment claims for temporary loss of fish catch, displacement costs and equipment damage or loss directly caused by the seismic survey.
- Santos will also assess requests for administrative support to help fishers collate historical fishing data required for an evidence-based payment claim.
- The control measures identified within the draft Environment Plan, to outline how the potentially competing demands of commercial fishing operators and Santos' seismic survey may be managed, are consistent with those adopted for other Santos marine seismic surveys.

Commercial prawn and indicator fish species spawning	J	F	M	A	M	J	J	A	S	O	N	D	Source
Banana prawn spawning													AFMA 2020
Juvenile banana prawn migration													Longeran et al. 2002
Brown tiger prawn spawning													AFMA 2020
Grooved tiger prawn spawning													AFMA 2020
Blue endeavour prawn spawning													AFMA 2020
Red endeavour prawn spawning													AFMA 2020
Red emperor													DPIRD 2019
Goldband snapper													DPIRD 2019
Spanish mackerel (Kimberley stock)													DPIRD 2019

Key

Sensitivity/activity occurs

Extended peak spawning period

Peak spawning/migration period

*Extended peak spawning period – applies only to Goldband Snapper and Spanish Mackerel

Consultation effort 2025

(Relevant persons consultation cover pages are now included)

Campaign Email

From: Consultation, Santos <Offshore.consultation@santos.com>
Sent: Wednesday, 16 April 2025 10:50 AM
To: [redacted]
Cc: [redacted]
Subject: CONSULTATION ACTIVITY UPDATE | Eos 3D Marine Seismic Survey Environment Plan

Dear [redacted],

Santos is contacting you further to consultation activities previously undertaken for the proposed Eos 3D Marine Seismic Survey (MSS) in Commonwealth waters offshore Western Australia and Northern Territory.

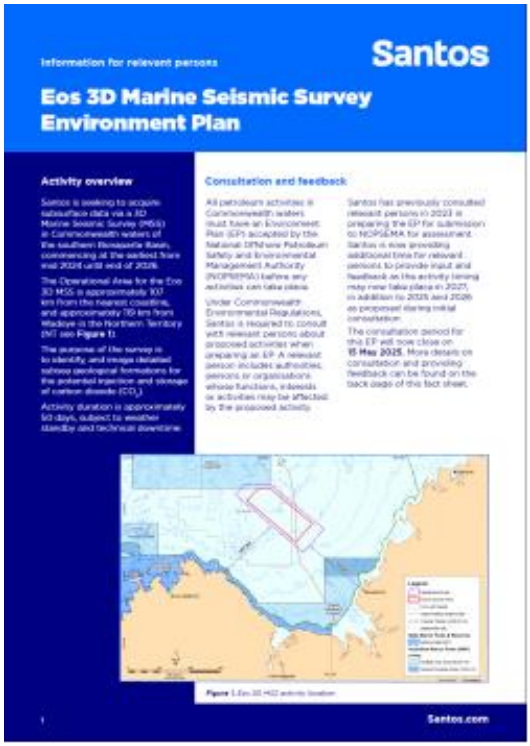
The Environment Plan (EP) for proposed activities is planned to be submitted in the coming months for assessment by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA).

Ahead of this submission, we advise that there has been an update to the proposed activity timing, with earliest activity commencement now being **Q1 2026**. However, the proposed activity may occur **anytime from EP acceptance by the Regulator to the end of December 2027**.

Proposed activities
The purpose of the Eos 3D MSS is to identify and image detailed subsea geological formations for the potential injection and storage of carbon dioxide (CO_2).

The survey Operational Area is approximately 107 km from the nearest coastline, and approximately 119 km from Wadeye in the Northern Territory.

The activity fact sheet previously provided has been updated to reflect the new proposed activity timing, noting that all other details regarding proposed activity scope, location and duration remain the same. **Click the image below** to link to our Consultation Hub, where the fact sheet is published.



Providing feedback
Consultation provides you with an opportunity to raise concerns, including objections or claims, about the potential impacts of the activity on your functions, interests or activities, to seek information about how you may be affected, and understand how Santos intends to manage the activity to ensure the associated impacts are as low as reasonably practicable and are acceptable.

Santos welcomes your feedback specific to the proposed activities described under the proposed EP by the close of business on **19 May 2025**.

You can provide feedback via return email or call us toll free on **1800 267 600**.

Please note that feedback previously received will be included in the EP unless otherwise requested.

Please also let us know if you would like any sensitive information to remain private. If requested, Santos will ensure your information remains confidential between us and NOPSEMA and will not be published or otherwise made publicly available. Santos will handle your information in accordance with our *Offshore Western Australia and Northern Territory Consultation Privacy Policy*.

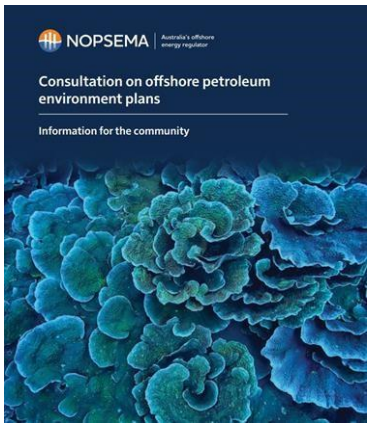
NOPSEMA public comment period
Importantly, exploration EPs assessed by NOPSEMA have a public comment period that provide an opportunity for community members to raise issues about environmental management matters that have not yet been considered in the EP for the proposed activity.

The Eos 3D MSS EP is an exploration EP and NOPSEMA will publish the EP on its website following an initial administrative check. Links will be provided on this site to online forms for community members to make comment.

Once the public comment period has closed, NOPSEMA will provide all community comments to Santos for consideration and response. Santos will then submit a final EP to NOPSEMA for formal assessment.

More information about this NOPSEMA public comment period can be found here.

Additional resources
NOPSEMA has published information that sets out titleholders' responsibilities for consultation, as well as opportunities for relevant persons to provide guidance for consultation expectations. **Click the image to read in full**.



We look forward to hearing from you soon and please let us know if you know of other authorities, persons or organisations we should consult.

Regards

Consultation Team

Santos

t: +61 1800 267 600 | e: offshore.consulation@santos.com

Santos.com | Follow us on LinkedIn, Facebook and Twitter

Santos acknowledges the Traditional Owners and Custodians of the lands on which we operate. We pay our respects to their Elders past, present and emerging.

Fact sheet

Information for relevant persons

Santos

Eos 3D Marine Seismic Survey Environment Plan

Activity overview

Santos is seeking to acquire subsurface data via a 3D Marine Seismic Survey (MSS) in Commonwealth waters of the southern Bonaparte Basin, commencing at the earliest from mid 2024 until end of 2026.

The Operational Area for the Eos 3D MSS is approximately 107 km from the nearest coastline, and approximately 119 km from Wadeye in the Northern Territory (NT see **Figure 1**).

The purpose of the survey is to identify, and image detailed subsea geological formations for the potential injection and storage of carbon dioxide (CO_2).

Activity duration is approximately 50 days, subject to weather standby and technical downtime.

Consultation and feedback

All petroleum activities in Commonwealth waters must have an Environment Plan (EP) accepted by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) before any activities can take place.

Under Commonwealth Environmental Regulations, Santos is required to consult with relevant persons about proposed activities when preparing an EP. A relevant person includes authorities, persons or organisations whose functions, interests or activities may be affected by the proposed activity.

Santos has previously consulted relevant persons in 2023 in preparing the EP for submission to NOPSEMA for assessment. Santos is now providing additional time for relevant persons to provide input and feedback as the activity timing may now take place in 2027, in addition to 2025 and 2026 as proposed during initial consultation.

The consultation period for this EP will now close on **19 May 2025.** More details on consultation and providing feedback can be found on the back page of this fact sheet.

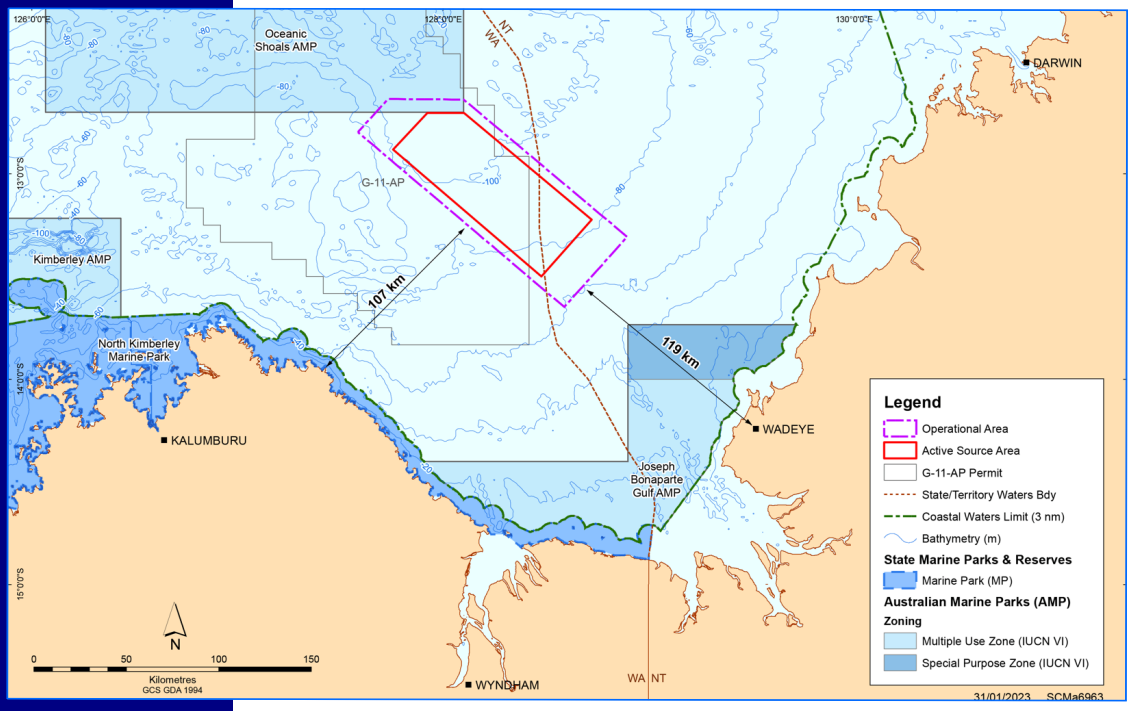


Figure 1. *Eos 3D MSS activity location*

Activity description

Activity details		
Timing	Earliest commencement of the activity is Q1 2026, however, activity may occur anytime from EP acceptance by NOPSEMA to end of December 2027.	
Duration	• Approximately 50 days to complete the activity. • The expected duration is a forecast and is subject to change based on adverse weather conditions or technical/equipment issues that may arise during the activity.	
Water depth	Operational Area 60 m to 115 m.	Active Source Area 67 m to 111 m.
Vessels	• Seismic survey vessel. • Up to two dedicated support vessels (one being a chase vessel) will accompany the seismic survey vessel to provide logistical, safety and equipment management duties. • Vessel details are unknown at this time.	
Aircraft	• Aircraft maybe used for crew changes, critical equipment supply, surveillance and emergency response uses. Aircraft includes helicopters and drones.	
Volume of seismic source	• Max. 3,050 cubic inches (in^3).	
Operating pressure	• 2,000 psi.	
Description of the natural environment	• The Operational Area is predominately characterised by a relatively flat and largely featureless seabed, predominantly sand with a proportion of silt and clay which gradually slopes from south to north.	
Exclusion zone	• 3 nm (5.6 km) exclusion (safety) zone around the seismic vessel and trailing streamers.	
Greenhouse gas assessment permit	• G-11-AP.	
Activity coordinates		
Operational Area	**Latitude**	**Longitude**
	12° 47′ 45.870″ S	127° 35′ 9.014″ E
	12° 38′ 5.216″ S	127° 44′ 2.253″ E
	12° 38′ 16.443″ S	128° 6′ 3.199″ E
	13° 18′ 22.214″ S	128° 53′ 45.423″ E
	13° 38′ 52.656″ S	128° 35′ 23.154″ E
Active source area	**Latitude**	**Longitude**
	12° 52′ 52.261″ S	127° 45′ 28.575″ E
	12° 42′ 9.215″ S	127° 55′ 28.219″ E
	12° 42′ 8.964″ S	128° 6′ 5.702″ E
	13° 13′ 21.492″ S	128° 43′ 23.459″ E
	13° 29′ 56.111″ S	128° 28′ 44.239″ E

Activity purpose and approvals

The Eos 3D MSS is required to meet Santos' work program obligations for GHG assessment permit G-11-AP.

GHG assessment permits allow titleholders to explore in the permit area for potential GHG storage formations and potential GHG injection sites in Commonwealth offshore areas. The primary purpose of the 3D MSS is to facilitate future CO_2 injection activities by providing detailed structural and amplitude imaging of the reservoir/seal interface for each identified storage target to confirm suitability for injection and storage of CO_2.

An EP is being prepared for the survey, which must demonstrate that the impacts and risks of the activity will be managed to a level as low as reasonably practicable and acceptable over the life of the activity. The EP will be submitted to NOPSEMA for acceptance in accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth)*.

About marine seismic surveys

The process of collecting seismic data is known as 'acquisition'. A marine seismic survey takes place along a series of pre-defined acquisition lines (normally several hundred metres apart) within an overall acquisition area.

Figure 2. Example of a seismic array and marine seismic vessel for 3D or 4D surveys.

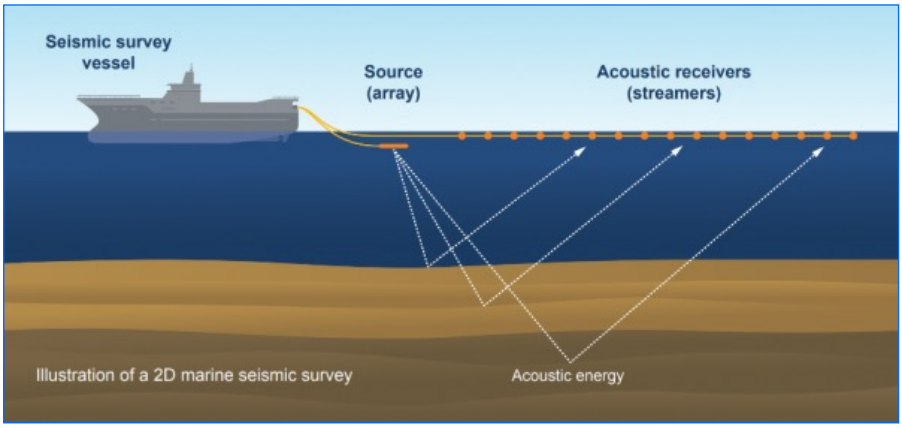


Figure 3. Illustration of a marine seismic survey (Source: NOPSEMA).

Marine seismic surveys are carried out by specialised vessels that tow an array of acoustic sources (airguns) and receivers (hydrophones) across a defined acquisition area. Airguns work by rapidly releasing compressed air to form a bubble, which creates a pulse of sound. This sound energy is directed at the seafloor and penetrates into the various rock layers beneath.

The reflected soundwaves are then captured by hydrophone receivers, which are towed behind the vessel on a series of cables known as 'streamers'.

Marine seismic surveys can be two, three, or four dimensional (2D, 3D, or 4D). 2D surveys tend to have a smaller sound source and a single streamer (see **Figure 3**) while 3D and 4D surveys use a larger sound source and multiple streamers (see **Figure 2**).

More information about marine seismic surveys can be found **here**.

Source: NOPSEMA

Defining the environment area for proposed activities

Santos has undertaken an assessment to define the environmental, social, economic and cultural aspects that may be affected by proposed activities.

To do this we have considered the totality of the area where activity impacts and risks may occur.

These areas are summarised in Table 1. The widest extent of these area is called the Environment that May Be Affected (EMBA), which for this activity is the outer boundary of worst-case marine diesel oil spill resulting from a vessel collision (see **Figure 4**).

Oil spill EMBAs are defined by overlaying a great number (usually hundreds) of individual, computer simulated, hypothetical oil spill events into a single map. Each simulation starts from the same location (release point), but each will be subject to a different set of wind and weather conditions derived from historical data. The use of advanced and sophisticated models enables us to present all the areas that could be affected.

While the EMBA represents the largest possible spatial extent that could be contacted by the worst-case spill events modelled, an actual spill event is more accurately represented by a single simulation run, resulting in a smaller spatial extent. Often one or more simulation runs are selected to be representative of the 'worst-case' based on the nature and scale of the Activity and the local environment.

However, both the EMBA (based on numerous possible spills) and the single representative worst-case oil spill are used for the environmental risk assessment and oil spill preparedness and response planning.

Please see the **NOPSEMA Spill Modelling Video** for more information on oil spill modelling and why it is required for the preparation of Environment Plans.

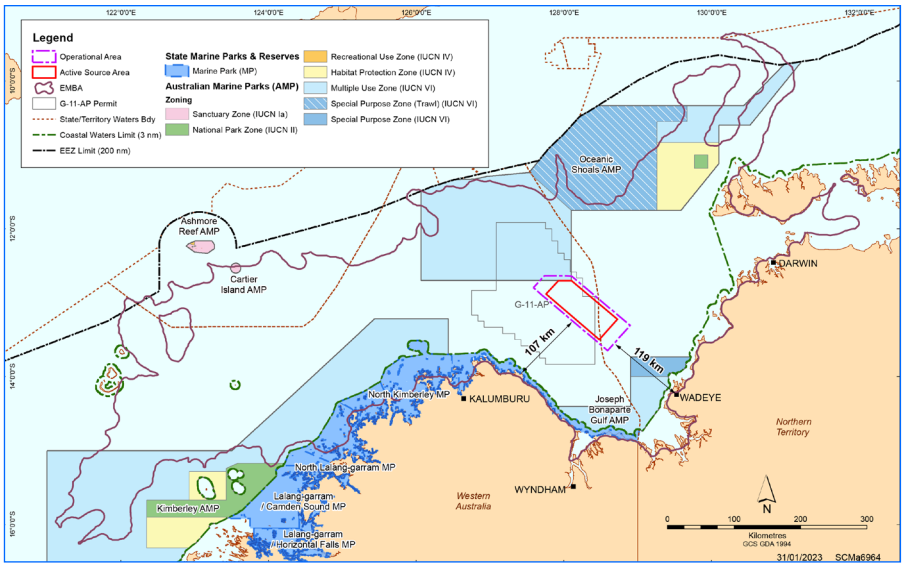


Figure 4. *Eos 3D MSS activity location & EMBA.*

Table 1. Environment area for proposed activities

Operational Area
The area in which the seismic vessel will operate, accounting for line turns with streamers deployed.
Active source area
The area in which the seismic vessel will operate to acquire the seismic data and achieve the geophysical objectives of the survey.
Environment that May Be Affected (EMBA)
The spatial extent of activity impacts (e.g. vessel presence, light, noise) and risk (e.g., hydrocarbon spill).

Santos has undertaken a review of publicly available information to identify environmental, social, economic and cultural features and/or values that may be affected by activity impacts and risks. The outcomes of this review are summarised in **Table 2**.

Table 2. Environmental, social, economic and cultural features

Feature	Description	Within Operational Area	Within EMBA	Public information review
Aboriginal heritage	Registered Aboriginal heritage sites protected under the: • *Aboriginal Torres Strait Islander Heritage Protection Act 1984 (Cwth).* • *Aboriginal Sacred Sites Act 1989.* • *Heritage Act 2011(NT).* • *Aboriginal Land Act 1978 (NT).* • *Aboriginal Cultural Heritage Act 2021 (WA).* • *Aboriginal Heritage Act 1972 (WA).*	No	Yes	Aboriginal Heritage sites are present along the southern eastern boundaries of the EMBA. Sea country interests may exist in the EMBA.
Biologically important areas	Biologically important areas (BIAs) are spatially defined areas where aggregations of individuals of a species are known to display biologically important behaviour such as breeding, foraging, resting or migration.	Yes	Yes	The Operational Area includes BIAs for turtles.
Cultural heritage	*Registered cultural sites under the:* • *Underwater Cultural Heritage Act 2018.*	No	Yes	No known sites of shipwrecks, sunken aircraft or Aboriginal and Torres Strait Islander Underwater Cultural Heritage have been identified within the Operational Area. The nearest shipwreck, the SEDCO Helen, is approximately 10 km northeast of the Operational Area.

Table 2. Environmental, social, economic and cultural features ... continued

Feature	Description	Within Operational Area	Within EMBA	Public information review
Defence	Designated defence activity areas.	Yes	Yes	Defence activities may take place within the Operational Area.
Fishing	Commercial fishing.	Yes	Yes	A number of Commonwealth, State and Territory fisheries overlap the EMBA, some of which are active in the Operational Area.
	Indigenous, subsistence or customary fishing.	No	Yes	Traditional Australian Indigenous fishing activities are generally concentrated within 3 nm of the Northern Territory / Western Australian coastline.
	Recreational fishing.	Yes	Yes	Fishing charter vessels may transit through the Operational Area and EMBA but fishing activities are considered unlikely in the Operational Area due to remoteness.
Key ecological features	Key ecological features (KEFs) are elements of the Commonwealth marine environment that are considered to be of regional importance for either a region's biodiversity or its ecosystem function and integrity.	Yes	Yes	The Operational Area overlaps one KEF for the carbonate bank and terrace system of the Sahul Shelf. KEFs are present in the EMBA.
Oil and gas operations	Petroleum operations.	Yes	Yes	Petroleum exploration and production activities have been undertaken within the EMBA and the Bonaparte Basin is an established hydrocarbon province with a number of commercial operations. Several exploration permits overlap the Operational Area with the closest production licence being the Eni Australia B.V. located 21 km south-east of the Operational Area.

Table 2. Environmental, social, economic and cultural features ... continued

Feature	Description	Within Operational Area	Within EMBA	Public information review
Protected areas (nearest Commonwealth and Territory)	Australian Marine Park (AMP).	Yes	Yes	The Operational Area overlaps the Oceanic Shoals AMP and five AMPs overlap the EMBA.
	Northern Territory Reserves.	No	Yes	The EMBA overlaps the Garig Gunak Barlu Marine Park (Cobourg Peninsula), located approximately 318 km north-east of the Operational Area, and several other Northern Territory Reserves. • Casuarina Coastal Reserve. • Channel Point Coastal Reserve. • Shoal Bay Coastal Reserve. • Tree Point Conservation Area. • Buffalo Creek Management Area. • Djukbinj National Park. • Keep River National Park.
	Western Australia Reserves.	No	Yes	The EMBA overlaps the North Kimberley Marine Park (NKMP), located approximately 105 km west of the Operational Area, and several other Western Australia Reserves including the Ord River Nature Reserve (Ramsar Site), located approximately 133 km south of the Operational Area. • Niiwalarra Islands National Park. • Browse Island Nature Reserve. • Lesueur Island Nature Reserve. • Low Rocks Nature Reserve. • Pelican Island Nature Reserve.

Table 2. Environmental, social, economic and cultural features ... continued

Feature	Description	Within Operational Area	Within EMBA	Public information review
Shipping	Shipping routes.	Yes	Yes	The Operational Area does not overlap any shipping fairways, however there is vessel traffic that passes through the northern end of the Operational Area.
Telecommunications	Subsea telecommunications cables.	No	Yes	The North West Cable System (NWCS) connects offshore oil and gas facilities in the Browse, Bonaparte and Carnarvon Basins to onshore locations and is approximately 125 km north-north- east of the Operational Area.
Tourism	Marine and coastal tourism.	No	Yes	Remoteness of the Operational Area and water depth limits opportunities for tourism. Tourism is likely within the EMBA.
Towns / communities	Darwin.	No	Yes	Darwin is the nearest capital city and is approximately 230 km northeast from the Operational Area.
	Wadeye.	No	Yes	Wadeye is the nearest community and is approximately 119 km southeast from the Operational Area.

We have summarised in Table 3 the potential environmental impacts and risks and associated management measures for the proposed activity. These aspects will be risk-assessed with the Environment Plan on a case-by-case basis.

Table 3. Activity impacts and risk management

Potential impacts – planned activities	
Acoustic disturbance to fauna	

Description of potential impacts
Potential impacts from noise emissions may occur in the operational area from the following sources:
• Seismic source array.
• Vessel operations (e.g. vessel engines, thrusters, propeller cavitation and operation of machinery and equipment).
• Helicopter activities relating to crew change requirements.
	Compliance with the following key management measures
	Marine fauna observations undertaken to minimise the disturbance to fauna caused by the Activity.
	• Implementation of EPBC Act Policy Statement 2.1 (Part A):
	  • Pre start-up visual observation.
	  • Soft start procedures.
	  • Start-up delay procedure.
	  • Operations procedure.
	  • Shut-down procedure.
	  • Night-time and low visibility procedures.
	• Adoption of EPBC Regulations (Part 8) for interacting with cetaceans.
	• Implementation of selected control options of EPBC Act Policy Statement 2.1 (Part B).
	  • Use of 2 Marine Fauna Observers (or 1 x MFO and 1 x SEA) on board the seismic survey vessel (Part B.1).
	  • Adaptive management measures for Omura's whales (Part B.6).
	• No operation of seismic source within the Carbonate Bank and Terrace Systems of the Sahul Shelf or the Pinnacles of the Bonaparte Basin KEFs.
	• No operation of the seismic source within the Active Source Area where impacts to the Australian snubfin dolphin foraging/resting/calving/breeding BIAs may occur.

Table 3. Activity impacts and risk management ... continued

	• Shutdown procedures for turtles in accordance with EPBC Act Policy Statements 2.1 (Part A). • No operation of the seismic source within the internesting BIA for flatback turtles during nesting season. • Night-time and low-visibility procedures for turtles consistent with EPBC Act Policy Statement 2.1 - Procedure A.3.6. • Seismic source validation. • Increased duration of pre-start visual observations conducted by MFO (Omura's whale is primary observation target however, all fauna to be observed).
Atmospheric emissions	
Description of potential impacts Potential impacts from atmospheric emissions may occur in the operational area from the following sources: • Vessel operations (e.g. vessel & aircraft engines, generators, mobile and fixed plant and equipment). • Vessel waste incinerator. • Vessel ozone-depleting substances (ODS) used in closed-system rechargeable refrigeration systems.	**Compliance with the following key management measures** • International Convention for the Prevention of Pollution from Ships (MARPOL) -compliant Marine diesel oil (MDO) will be used during activity. • Waste incineration managed in accordance MARPOL and Marine Orders as appropriate. • All vessel engines to be maintained in accordance with manufacturers specifications. • Air pollution prevention certification. • Ozone-depleting substance handling procedures.

Table 3. Activity impacts and risk management ... continued

Light emissions	
Description of potential impacts	**Compliance with the following key management measures**
Potential impacts from light emissions may occur in the operational area from the following sources: • Vessel operations (e.g. external navigation and safe operations lighting). • Vessel-based spot lighting (e.g. streamer deployment and retrieval procedures).	• Lighting will be used as required for safe work conditions and navigational purpose.
Planned operational discharges	
Description of potential impacts	**Compliance with the following key management measures**
• Planned discharges from the vessel in the operational area may include: • Sewage/greywater. • Food waste. • Brine. • Cooling water. • Deck drainage. • Oily water.	• Sewage treatment system. • Oily water treatment system. • General chemical management procedures. • Hazardous chemical management procedures. • Waste (garbage) management procedure. • Deck cleaning product selection procedure. • Clean up of oil/ lubricant spills to deck in accordance with vessel Shipboard Oil Pollution Emergency Plan (SOPEP).

Table 3. Activity impacts and risk management ... continued

Interaction with commercial fisheries	
Description of potential impacts Interaction with commercial fisheries may occur as a result of: • Vessel operations including the presence of any towed equipment (e.g. streamers).	**Compliance with the following key management measures** • Recreational fishing restrictions. • Navigation equipment and procedures. • Vessels fitted with AIS systems and radars, including AIS (virtual or installed) to mark the location of streamer tail buoys. • Exclusion (safety) zone established to reduce potential for collision or interference with other marine user activities. • Maritime Notices - Notices to Mariners (NTM) and AUSCOAST warnings. • Santos activity notifications (where requested). • Support vessel present and operational during the Activity. • Decision making and communications protocol implemented in the event that the seismic vessel and towed equipment are required to leave the Operational Area during the survey. • Concurrent operations planning with relevant commercial fishers. • Application of Santos Commercial Fishers Payment Claim Protocol. • Constant bridge watch. • Protocols for handling entangled fishing gear to be provided to seismic contractor.

Table 3. Activity impacts and risk management ... continued

Interaction with other marine users	
Description of potential impacts Interaction with commercial fisheries may occur as a result of: • Vessel operations including the presence of any towed equipment (e.g. streamers).	**Compliance with the following key management measures** • Navigation equipment and procedures. • Vessels fitted with AIS systems and radars, including AIS (virtual or installed) to mark the location of streamer tail buoys. • Exclusion (safety) zone established to reduce potential for collision or interference with other marine user activities. • Maritime Notices - Notices to Mariners (NTM) and AUSCOAST warnings. • Notices to Department of Defence (DoD). • Stakeholder consultation. • Support vessel present and operational during the Activity. • Constant bridge watch. • Santos decision making and communications protocol implemented in the event that the seismic vessel and towed equipment are required to leave the Operational Area during the survey. • Recreational fishing restrictions.
Cumulative and additive noise emissions impacts	
Description of potential impacts Potential impacts from successive seismic surveys can be classified as the following: • Cumulative impacts - Considered when the spatial footprint of impacts from previous seismic surveys (or other significant underwater sound producing activities) have occurred over the same area of activity. • Additive impacts - Result from other concurrent seismic surveys (or other significant underwater sound producing activities), where the effects may or may not overlap spatially, but when taken together have an additive or incremental effect on the same receptors.	**Compliance with the following key management measures** • Seismic source separation distance during concurrent surveys: minimum 40 km while operating. • Management of concurrent seismic surveys within commercial fisheries. • Identification and risk assessment of other concurrent petroleum activities within 20 km of the operating seismic source.

Table 3. Activity impacts and risk management ... continued

Potential risks - unplanned activities	
Marine diesel oil (MDO) release from vessel collision (surface)	
Description of potential risks Potential release of MDO may occur in the operational area from the following sources: • Vessel collision and fuel tank rupture.	**Compliance with the following key management measures** • MARPOL-compliant fuel oil (MDO) will be used during the activity. • Vessels fitted with AIS systems and radars (virtual or installed) to mark the location of seismic streamer tail buoys. • Exclusion (safety) zone established to reduce potential for collision or interference with other marine user activities. • Maritime Notices - Notices to Mariners (NTM) and AUSCOAST warnings. • Navigation equipment and procedures. • Support vessel in place during Activity to reduce potential for collision or interference with other marine users. • Constant bridge watch. • Restrictions on how small volumes of unused IFO and HFO must be stored on a vessel, including restricting volumes and limiting storage to tanks that do not have direct exposure to the marine environment. • Implementation of Oil Pollution Emergency Plan (OPEP). • Implementation of Vessel spill response plans (SOPEP/SMPEP). • Maximum volume of fuel stored in a single tank of vessels used for the Activity will not exceed 1,065 m^3.

Table 3. Activity impacts and risk management ... continued

Minor hydrocarbon release	
Description of potential risks Sources of risk from an accidental minor release of hydrocarbons may occur as a result of: • Vessel refuelling (e.g. fuel hose breaks, coupling failure, tank overfilling). • Vessel equipment and machinery failure (e.g. tank pipework failure or rupture, hydraulic hose failure, inadequate bunding and/or storage, insufficient fastening or inadequate handling, vessel thruster/propeller stern tube seal leak and/or mechanical damage).	**Compliance with the following key management measures** • MARPOL-compliant fuel oil (MDO) will be used during the activity. • Deck drainage control measures (such as scupper plugs) in areas where chemicals and hydrocarbons are stored and frequently handled. • General chemical management procedures. • Hazardous chemical management procedures. • Maritime dangerous goods code. • Bulk refuelling transfer procedures. • Implementation of Oil Pollution Emergency Plan (OPEP). • Implementation of Vessel spill response plans (SOPEP/SMPEP). • Bunkering / bunkering drill undertaken prior to the Activity.
Spill response operations	
Description of potential risks In the event of a hydrocarbon spill, response strategies will be implemented where possible to reduce environmental impacts to ALARP but may include: • Light, noise and atmospheric emissions. • Operational discharges and waste. • Physical presence and disturbance. • Disruption to other users of marine and coastal areas and townships. • Shoreline clean-up operations. • Oiled wildlife response operations.	**Compliance with the following key management measures** • In the event of a hydrocarbon spill, the Oil Pollution Emergency Plan (OPEP) requirements are implemented to mitigate environmental impacts.

Table 3. Activity impacts and risk management ... continued

Unplanned hazardous and non-hazardous discharges - liquid	
Description of potential impacts Sources of risk from an accidental release of hazardous and non-hazardous (non-hydrocarbon) liquids may occur as a result of: • Vessel equipment and machinery failure (e.g. tank pipework failure or rupture, hydraulic hose failure, inadequate bunding and/or storage, insufficient fastening or inadequate handling, vessel thruster/propeller stern tube seal leak and/or mechanical damage).	**Compliance with the following key management measures** • Equipment maintenance in accordance with preventative maintenance system (PMS). • Oily water treatment system. • General chemical management procedures. • Hazardous chemical management procedures. • Maritime dangerous goods code. • Dropped object prevention procedure. • Implementation of Vessel spill response plans (SOPEP/SMPEP).
Unplanned hazardous and non-hazardous discharges - solid	
Description of potential risks Sources of risk from an accidental release of hazardous and non-hazardous (non-hydrocarbon) solids may occur as a result of: • Overfull/uncovered bins on deck. • Incorrectly disposed items. • Spills during transfers of waste. • Loss of vessel and survey equipment (e.g. streamers, fenders). • Supply transfer from support vessel to survey vessel. Solid objects, such as those below, can be accidentally released to the marine environment, and potentially impact sensitive receptors: • Non-hazardous solid wastes, such as paper, plastics and packaging. • Hazardous sold wastes, such as batteries, fluorescent tubes, medical wastes, and aerosol cans.	**Compliance with the following key management measures** • Equipment maintenance in accordance with Preventative Maintenance System (PMS). • Streamers are fitted with streamer recovery devices (SRD). • Waste (garbage) management procedure. • Dropped object prevention procedure. • Streamer deployment / retrieval procedure. • Streamers have locating devices fitted. • Streamer tow depth constrained.

Table 3. Activity impacts and risk management ... continued

Marine fauna collisions	
Description of potential risks Marine fauna interactions may occur as a result of: • Vessel collision. • Equipment collision (e.g. streamers, seismic source).	**Compliance with the following key management measures** • Streamer deployment / retrieval procedure. • Use of a 'turtle friendly' tail buoy. • Implementation of *Environmental Protection and Biodiversity Regulations 2000* (Part 8) for interacting with cetaceans. • Implementation of control measures consistent with EPBC Act Policy Statement 2.1 (Part B): • Use of two Marine Fauna Observers (MFOs) (or 1 x MFO and 1 x SEA) on board the seismic survey vessel. At least one MFO will have previous experience on a seismic survey vessel as an MFO. • Constant bridge watch. • Marine fauna observations undertaken to minimise the disturbance to fauna caused by the Activity. • Whale shark interaction guideline for support vessel.
Introduction of invasive marine species (IMS)	
Description of potential risks Introduction of invasive marine species (IMS) may occur due to: • Biofouling on vessels and marine equipment (e.g. streamers, ballast water exchange). • External / internal niches (e.g. sea chests, seawater systems).	**Compliance with the following key management measures** • Anti-foulant system. • Aquatic Biosecurity Solution vessel check tool (applied to vessels), and immersible equipment clean. • Biosecurity risk management Plan. • Ballast water management plan.

Consultation

Consultation provides Santos with an opportunity to receive feedback from authorities, persons and organisations whose functions, interests or activities may be affected by proposed petroleum activities.

This feedback helps us to refine or change the management measures we are planning to address potential activity impacts and risks. Santos' objective for proposed activities is to reduce environmental impacts and risks to a level that is As Low As Reasonably Practicable (ALARP) and acceptable over the life of the activity.

Consultation also helps us to identify values and sensitivities where information is not publicly available, such as spiritual and cultural connection to land and sea country, as well as first-hand feedback on commercial and recreational fishing, tourism and local community activities and interests.

Providing feedback

You might be a relevant person if, for example, you have spiritual or cultural connections to land and sea country in accordance with Indigenous tradition that might be affected by our activity, if you otherwise carry out recreational or commercial fishing, tourism or other activities that might be affected by our proposed activity, or if you are part of a local community that might be affected by our proposed activity.

If you consider you may be a relevant person, please contact us by **19 May 2025** to allow Santos time to initiate consultation with you, so you can tell us how you would like to be consulted throughout this process or if you need additional information.

The merits of relevant person feedback provided through the consultation process will be considered during EP development, with a summary of responses summarised and included in the EP submitted to NOPSEMA for assessment. Please let us know if you would like your personal/organisational details or any part of your feedback to remain private and we will ensure this remains confidential to NOPSEMA.

More information about how community members can participate in environmental approvals for activities proposed in Commonwealth waters has been published in a **brochure** by NOPSEMA.

Contact

E: offshore.consultation@santos.com
T: 1800 267 600
santos.com/offshoreconsultation

NOPSEMA: Public comment period advertising efforts 2025

Santos

PUBLIC NOTICE: EOS 3D MARINE SEISMIC SURVEY (MSS)

PROPOSED EOS 3D MARINE SEISMIC SURVEY (MSS) ACTIVITY

Santos is proposing to undertake a 3D Marine Seismic Survey (MSS) to acquire subsurface data in Commonwealth waters of the southern Bonaparte Basin, in greenhouse gas assessment permit G-11-AP.

The proposed Operational Area (OA) for Eos MSS is located approximately 107 km from the nearest coastline, and approximately 119 km from Wadeye in the Northern Territory. The survey activity is estimated to take up to 50-days to complete and is planned to take place anytime from the date of EP acceptance by NOPSEMA until 31 December 2027. Information about proposed activities, including a summary of key activity impacts, risks and management measures is included in a Consultation Fact Sheet, which can be accessed by the Santos QR code included in this notice.

An environment plan (EP) for the activity has been prepared in accordance with the regulation administered by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) under the *Offshore Petroleum and Greenhouse Gas Storage Act 2006*.

A comment period is open until 7 September 2025 providing the public with an opportunity to submit a comment in relation to the EP. To submit a comment, visit the NOPSEMA website. Further information on this proposed activity can be found at the NOPSEMA QR code.

CONTACT INFORMATION

NOPSEMA

SANTOS

G-G's trans lobby patronage 'must end'

EXCLUSIVE

STEPHEN RICE
NSW EDITOR

Governor-General Sam Mostyn faces growing calls to abandon her patronage of the powerful LGBTIQ+ lobby group Equality Australia after it argued in the Federal Court against the right of biological women to have female-only spaces.

Ms Mostyn declined to answer multiple questions from The Australian about her patronage in the wake of Equality Australia's support for transgender woman Roxanne Tickle in her landmark discrimination case against Giggle app founder Sall Grover.

Groups from across the political spectrum, ranging from the conservative Family First Party to the progressive LGB Alliance, representing lesbians and gay men, have called for Ms Mostyn to resign as Equality Australia patron.

The advocacy group was granted amicus curiae (friend of the court) status in the Federal Court appeal specifically to argue against the long-established Lesbian Action Group, with Equality Australia chief executive and ex-Labor staffer Anna Brown citing the patronage of Ms Mostyn in her affidavit to intervene.

Former deputy prime minister John Anderson told The Australian: "I truly believe that the role of governors-general should involve impartiality, and patronage of lobby groups is something that I would think is actually quite troubling.

"That is particularly so when you've got other lobby groups like the Lesbian Action Group lined up on the other side."

Under the strict rules set out by the Office of the Official Secretary to the Governor-General, patronage must "pose no reputational risk to the office or governor-general" and the organisation must not promote the governor-general as patron or imply any endorsement of a position or action".

Ms Mostyn declined to answer any of 10 questions posed by The Australian about her patronage of Equality Australia, including whether the group represented "the things that unite Australia as a nation", one of the stated roles of the governor-general's community engagements.

Ms Mostyn also did not respond to queries about whether Equality Australia had consulted her, as required by the policy, on "activity that could be construed as fundraising, advocacy or any activity that could be considered beyond the publicly accepted role of the governor-general"?

Equality Australia was given friend of the court status in the Giggle v Tickle appeal to advocate that sex was not binary or biologically fixed at birth but simply "a way of classifying people along a scale between a man at one end and a woman at the other".

The organisation has been using an HIV/AIDS charity to collect tax-deductible donations after its own bid for Deductible Gift Recipient status was rejected by the Australian Charities and Not-for-Profits Commission and the Federal Court specifically because it was an advocacy group, not one that was providing benevolent relief

In a two-line statement, a spokesperson for the Office of the Official Secretary to the Governor-General said: "The Governor-General is patron of organisations that work in areas including sports, music and the arts, mental health, veterans' welfare, medical research and more.

"Request for patronage is only considered and accepted as an honorary position, and patronage does not include any involvement in an organisation's operations, endorsement of positions or responsibility for their activity."

The claim that the Governor-General has not endorsed Equality Australia activities appears to be at odds with Ms Mostyn's announcement of the role, in which she says that it is her "privilege ... as patron to support Equality Australia in bringing an end to discrimination and injustice".

In the statement and video, highlighted on Equality Australia's website, the Governor-General says: "I look forward to amplifying Equality Australia's mission to build an equal Australia that is fair and inclusive for all LGBTIQ+ people, their families and their communities."

MAIN PICTURE: GETTY IMAGES

Clockwise from main: Governor-General Sam Mostyn; Equality Australia chief executive Anna Brown; transgender woman Roxanne Tickle

Equality Australia CEO Ms Brown declares that: "Today we have our head of state proudly supporting the work we do to ensure LGBTIQ+ Australians are equal in the eyes of the law.

"We look forward to working with Her Excellency and drawing on her longstanding experience in tackling injustice and prejudice in the pursuit of creating the best possible Australia for us all."

On Wednesday, Ms Grover posted on social media platform X: "Sam Mostyn is connected to an organisation that is in direct opposition to the reality of what a woman is. She is supporting an organisation that is actively involved in removing women's rights. Whoops."

The LGB Alliance Australia told The Australian: "The Governor-General holds an office that must remain apolitical and neutral on contested matters. By serving as patron of a lobby group actively campaigning to change laws on issues that undermine sex-based rights, harm women, and erode protections for the LGB community, the Governor-General risks damaging public trust in the independence of the office and giving the appearance of taking sides in debates that demand impartial oversight."

Family First Party national director Lyle Shelton said Equality Australia's intervention in the Tickle v Giggle case is further evidence of its "political activism".

"Clearly, the Governor-General should not be patron of a political activist organisation, particularly one which lobbies for experimental and irreversible gender change treatments on children. As our head of state, the Governor-General must remain above politics," Mr Shelton said.

DIGITAL

Read the 10 questions the Governor-General didn't answer properly

THEAUSTRALIAN.COM.AU OR THE APP

Calls for Equity to repay trust cash

EXCLUSIVE

PAIGE TAYLOR
INDIGENOUS AFFAIRS CORRESPONDENT

A disgraced former bankrupt received the lion's share of money drained from an Aboriginal trust that was established to relieve poverty among Western Australia's 30,000 Noongar people.

The Australian's investigation into what happened to the Noongar Charitable Trust established that the biggest individual recipients of the Aboriginal trust money were non-Aboriginal people.

The WA ombudsman now claims professional trustees Equity must pay for allowing "imprudent" spending of the trust's money. Equity disagreed with this finding in a message to shareholders on Wednesday.

The matter appears headed for court.

Matthew Pavlinovich, a former bankrupt once named in state parliament among the "dirty dozen" of WA's finance broking scandal, received $12m of trust money during the six-year period when the trust's value fell from $38m to $19m.

That amount was paid to Mr Pavlinovich in two transactions when the South West Aboriginal Land and Sea Council purchased his former dancing horse theme park 40km northeast of Perth in March 2020. The property, El Caballo, was worth just $5.9m at the time, a report by the WA ombudsman Bevan Warner, tabled in state parliament on Tuesday, states.

Equity gave the green light for the purchase without an independent market valuation, Mr Warner writes. Mr Warner claims Equity breached its duties over the purchase of two parcels of land comprising El Caballo.

Mr Warner's report states that Equity authorised a further $1.5m in trust money after the El Caballo purchase, apparently for renovations so it could be used to accommodate Noongar people who were homeless, victims of domestic violence or elderly.

Mr Warner wrote in his report that an additional $180,000 in trust money was paid to Bruce Young, director of Spatial Property Group, for his role in the El Caballo deal. Mr Young had earlier stated in an email forwarded to Equity that the $12m asking price for El Caballo "represents excellent value", the report states. Mr Young also advised against an independent market, the report states.

Noongar researcher and lawyer Hannah McGlade, an advocate for Aboriginal women and children and an expert on effective domestic violence strategies, said El Caballo could never have worked as a shelter for victims of family violence.

"Nobody asked us, but if they had, we would have told them it is too far from essential services – it has no police nearby, no health services nearby and no public transport," Dr McGlade said.

She said Noongar people wanted to see consequences for decision-makers at the land council at the time. In his report, Mr Warner writes he will refer former office holders to the regulator, the Office of the Registrar of Indigenous Corporations.

The South West Aboriginal Land and Sea Council's current chief executive Vanessa Kickett is calling on Equity to pay $21m in reparations. Ms Kickett took over the job at the land council in 2023, two years after the purchase of El Caballo, and was not involved in decisions to spend trust money on real estate.

Santos

PUBLIC NOTICE:
EOS 3D MARINE SEISMIC SURVEY (MSS)

PROPOSED EOS 3D MARINE SEISMIC SURVEY (MSS) ACTIVITY

Santos is proposing to undertake a 3D Marine Seismic Survey (MSS) to acquire subsurface data in Commonwealth waters of the southern Bonaparte Basin, in greenhouse gas assessment permit G-11-AP.

The proposed Operational Area (OA) for Eos MSS is located approximately 107 km from the nearest coastline, and approximately 119 km from Wadeye in the Northern Territory. The survey activity is estimated to take up to 50-days to complete and is planned to take place anytime from the date of EP acceptance by NOPSEMA until 31 December 2027. Information about proposed activities, including a summary of key activity impacts, risks and management measures is included in a Consultation Fact Sheet, which can be accessed by the Santos QR code included in this notice.

An environment plan (EP) for the activity has been prepared in accordance with the regulation administered by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) under the *Offshore Petroleum and Greenhouse Gas Storage Act 2006*.

A comment period is open until 7 September 2025 providing the public with an opportunity to submit a comment in relation to the EP. To submit a comment, visit the NOPSEMA website. Further information on this proposed activity can be found at the NOPSEMA QR code.

CONTACT INFORMATION

NOPSEMA

SANTOS

Five-year-olds taught body parts may not match gender

Continued from Page 1

prescriptions for puberty blockers and cross-sex hormones for minors, amid a National Health and Medical Research Council review of the guidelines for care of trans and gender-diverse people under 18 with gender dysphoria. The review is expected to take four years.

Child psychiatrist Jillian Spencer said all other states were using a "full affirmation pathway" to treat children with gender distress. "And that pathway, firstly involves social transition, but then puberty blockers from the start of puberty, cross sex hormones from the age of 14, and girls can have a double mastectomy from the age of 15. Genital surgery is done on both sexes from the age of 18," she said.

Dr Spencer, who has been outspoken on the issue to the point of being stood down from her role at the Queensland Children's Hospital in 2023 after raising clinically grounded objections to the gender affirming model, said she was concerned by the "Respectful Relationships" curriculum.

"Because of the harms of medical interventions – like infertility, lack of sexual function, physical health problems and the risk of regret – we need to do what we can to assist children to feel comfortable in their body," she said. "I think it's wrong to introduce (the notion of being transgender) early. It just introduces confusion."

A Victorian government spokesperson said: "Whether you're gay or straight or transgender we'll always support you in Victoria.

"That's our record. Our schools will always support all students, and staff are trained to create the most supportive spaces.

"Transgender young people are 15 times more likely to attempt suicide than the general population, and we know that when young people are supported to affirm their gender identity we get better outcomes."

Psychiatrist Andrew Amos said "multiple" international reviews had revealed "without question" there was "no evidence that gender affirming care, as practised in Victoria and around Australia, reduces the risk of suicide in children and adolescents".

"There is reason to believe it may increase the risk, particularly by reducing the likelihood of diagnosing coexisting mental illnesses in children with gender dysphoria," Dr Amos said.

He said the "Stacey" case study was an example of "transgender ideology prioritising the rights of boys over the health and safety of girls." "The best example of that is the intrusion of boys into single sex girls' spaces, and that would include sporting teams, and bathrooms," Dr Amos said. "At older ages, it also includes protected spaces like rape crisis centres."

Libertarian Party MP David Limbrick, who last month hosted a forum featuring Dr Spencer, Dr Amos and the Parents of Children with Gender Distress spokeswoman, said it was "Orwellian" that an ideology "that destroys relationships between parents and kids and between parents and schools is underpinned by a curriculum called respectful relationships".

"I have spoken to several parents whose families have been torn apart by this ideology, and all of it was started and enabled in school, often in secret," Mr Limbrick said.

"Many parents are hearing horror stories and are now looking for ways to protect their families."

> Stacey is a transgender girl. She dresses like the other girls, plays with them and everything seems fine. But one day, Lara says Stacey should be in the boys' team at sports, not the girls' team. Ask, 'Is it true that Stacey would not be allowed to be in the girls' team with the other girls? What could Stacey do or say?' Responses might include, 'Yes I can play with the girls' team because I am a girl!' or 'Go and ask the teacher if you don't believe me. Our teacher says I belong in the girls team!'
>
> **A case study from Victoria's Respectful Relationships curriculum**

Indigenous school rates 'falling off a cliff'

EXCLUSIVE

JOANNA PANAGOPOULOS
EDUCATION REPORTER

Indigenous student attendance falls off a cliff between primary and high school, with experts urging the government to prioritise a "smooth" transition to improve engagement and outcomes.

Average school attendance rates for Aboriginal and Torres Strait Islander and non-Indigenous students remains stable throughout primary school, but declines massively for Indigenous students between Year 6 and Year 7 and each year after that, an analysis of national data by the University of Queensland shows. This decline is much less pronounced for non-Indigenous students. Study lead Azhar Potia described it as an "attendance cliff" for Indigenous students from the start of high school until Year 10 completion.

"It's a pattern that's consistent across all geographical locations, but more pronounced in schools in remote and very remote jurisdictions," Dr Potia, who now works at the University of the Sunshine Coast, said. "The attendance cliff is a notable symbol of inequity, and the data identifies a clear gap in national policy focus that must be addressed through policy and practice, led by First Nations people."

He said Indigenous students were more likely to move away from their communities and families to boarding schools, and did not always have someone embedded within the school that understood their cultural identity, making the transition to high school "difficult".

Research collaborator Tracy Woodroffe from Charles Darwin University, who worked as a teacher for 20 years before becoming a senior lecturer, wants Closing The Gap targets expanded to include a focus on the "crucial middle years of education".

"In the primary years, students have one teacher across a number of subjects. They get to know the students and student's family," she said. "That works better for Indigenous students ... that connectedness is really important."

Professor Karen Thorpe, an expert in child development at UQ's Queensland Brain Institute, also noted the "transition to secondary education is not a targeted priority" in Closing The Gap reforms.

"Addressing this oversight is imperative in creating equitable educational opportunities that improve engagement, attendance and outcomes for Aboriginal and Torres Strait Islander students," she said. "We need to smooth the way for positive transition from primary to secondary school for all students, but particularly those who identify as First Nations."

Multiple police officers attended the house on Lancewood St and closed the road following an incident in Rosebery on Friday. Picture: Stephanie Hanlon

Man stabs himself to death

Probe into tragic outcome of police search of Palmerston home

Thomas McLean, Katie Hall, Nathaniel Chambers and Stephanie Hanlon

A man is dead after stabbing himself in the chest "multiple times" with a knife during a police search at his Palmerston home.

NT Police said the death in custody occurred during the execution of a search warrant at the 62-year-old man's Lancewood St, Rosebery home about 7am on Friday.

Investigators from the Northern Territory Police Force's joint anti-child abuse task force, including detectives and Australian Federal Police members, were present.

NT Police Assistant Commissioner Travis Wurst speaks to media on Friday.

NT Police Assistant Commissioner Travis Wurst said as officers searched the home, the man "obtained access to a knife" and "struck himself multiple times in the chest", sustaining "serious injuries".

Mr Wurst said the man had not threatened officers with the knife at any time, however one officer sustained a cut to the hand while attempting to stop him hurting himself. Mr Wurst said officers also used a taser on the man in further attempt to stop him.

The man fell to the ground and NT Police provided him with first aid.

Paramedics from St John NT arrived shortly after, however the man died at the scene.

Mr Wurst said the man's wife was at the scene during the incident.

The death was declared as a death in custody.

Major crime investigators are investigating.

Mr Wurst said the coroner was "aware of our actions" and "we are investigating this on behalf of the coroner at this stage".

"Major crime have carriage of this particular matter, they will investigate, they will provide files to the coroner in due (time) because it's a death in custody and there will be a mandatory inquest into this matter," he said.

"This is a really serious and traumatic incident for both members present and the deceased person's wife ... welfare support has been provided to all."

This marks the third publicly recorded death in custody in the Northern Territory in 2025.

Mr Wurst said he "wasn't entirely sure" how many deaths in custody there had been this year, but he was "aware of three".

"There could be others; a death in custody is very generic term and encapsulates when people also die in prison as well, so there may well be more than three," he said.

Mr Wurst refused to comment on details surrounding the reason the search warrant was issued, saying they were "particularly sensitive" and "no further details can be provided at this time".

"The forensic pathologist is aware of this matter, but no autopsy has been completed at this stage," he said.

Mr Wurst said all circumstances as to how and why the death occurred would form part of the investigation.

"I'm aware that body-worn video was being (taken) by the officers who were present," he said. "That body-worn video has been captured by investigators will be used as part of what we consider as an investigative brief for this matter."

One resident – who spoke to this masthead on the condition of anonymity – said they had overheard "screaming" and "fighting" on the street on Thursday night.

Mr Wurst said he was "not aware of that having any relevance to this particular matter".

At the time of publication, Lancewood St remained closed as police continued to investigate.

Help is available – contact Lifeline 13 11 14 or Beyond Blue on 1300 22 4636.

Santos

PUBLIC NOTICE: EOS 3D MARINE SEISMIC SURVEY (MSS)

PROPOSED EOS 3D MARINE SEISMIC SURVEY (MSS) ACTIVITY

Santos is proposing to undertake a 3D Marine Seismic Survey (MSS) to acquire subsurface data in Commonwealth waters of the southern Bonaparte Basin, in greenhouse gas assessment permit G-11-AP.

The proposed Operational Area (OA) for Eos MSS is located approximately 107 km from the nearest coastline, and approximately 119 km from Wadeye in the Northern Territory. The survey activity is estimated to take up to 50-days to complete and is planned to take place anytime from the date of EP acceptance by NOPSEMA until 31 December 2027. Information about proposed activities, including a summary of key activity impacts, risks and management measures is included in a Consultation Fact Sheet, which can be accessed by the Santos QR code included in this notice.

An environment plan (EP) for the activity has been prepared in accordance with the regulation administered by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) under the *Offshore Petroleum and Greenhouse Gas Storage Act 2006*.

A comment period is open until 7 September 2025 providing the public with an opportunity to submit a comment in relation to the EP. To submit a comment, visit the NOPSEMA website. Further information on this proposed activity can be found at the NOPSEMA QR code.

CONTACT INFORMATION

NOPSEMA

SANTOS

V1 - NTNE01Z01MA

Picture: Jackson Flindell

HEALING THE 'CURSE' OF TIME

JESSICA EVENSEN

The West Australian PULSE

"Everyone was moving forward, but I was staying in this really dark place, and I just wanted time to stop for a bit."

So says Sara Tan, the proud recipient of The West Australian Pulse People's Choice Award 2025.

Tan's award-winning four-minute animation — titled Zinnia, a flower associated with endurance and memory — includes stunning vignettes of her life with her beloved cat, Mimi, and her feelings of immense grief after her passing.

"Mimi was the one constant in my life," Tan told The West.

"Whenever I came back from school she was there, and whenever I was studying she would always just sleep on my cap and accompany me.

"Even though she was a pet and couldn't use words, just being by my side communicated what a strong relationship we had together."

Mimi died of chronic kidney disease in 2019 when Tan was just 12 years old.

"It felt like time was always moving forward and time was a curse," the now 18-year-old said.

"But with this animation, I started exploring the idea that maybe I could move forward with time instead of just staying in one place."

Tan's remarkable animation took more than 500 hours to complete — handpainting each frame with acrylic and gouache (watercolour) paint. The budding artist also used Procreate, a digital painting app, to animate her extraordinary designs.

"I started with a storyboard and then I did a lot of sketches of scenes that I really wanted to keep in the animation," Tan said.

"I would do the background and then I would animate the actual subject, so I didn't need to repeatedly paint the background."

Tan said she used art as an outlet to process her pain and "make peace" with the loss of Mimi.

"It really healed my relationship with time and made me finally feel like my cat lived a happy life," she said.

East coast thugs pull strings in WA attacks

SHANNON HAMPTON

Police Commissioner Col Blanch has called for a crackdown on the sale of illicit tobacco and claimed police know who ordered shootings and firebombings targeting Perth smoke shops.

Mr Blanch said the violence had been ordered by "organised crime elemenes" from the east coast linked to so-called tobacco wars in cities like Melbourne who are now replicating those same standover and extortion tactics to dominate the market in Perth.

Over the past week, there has been a spate of shootings and firebombings targeting tobacco stores in Cannington, Huntingdale and Ballajura.

Mr Blanch said WA Police were "on top of it". "In fact, we know the crew who are behind it from the east coast," he told 6PR.

"One of the challenges for police, it's been in organised crime for a little while now, is encrypted applications and anonymising applications and bitcoin payments.

"A lot of the people who are contracted to conduct the shootings or the firebombings are actually contracted over the dark web or through anonymising applications and often they don't know each other.

"So working through the organised crime network and finding the linkages is challenging, not impossible, but challenging for law enforcement.

"But we've got a pretty good handle on who. So it's not about identification, we're in the mode now in getting enough evidence to prove that it was actually that person that tasked those attacks, so we can then prosecute.

"But we're already executing search warrants, we're searching houses, we're seizing devices and we are making good progress."

Mr Blanch called for tougher penalties for people caught selling illicit tobacco — including shutting down stores.

"I think the country is experiencing a new way of organised crime operating by doing this tactic through illicit tobacco sales, and I think consistently we can come up with some legal strategies to really prevent the sale in the first place," he said.

"They are not allowed to do it today, but I think the penalties and the consequences of doing it need to be far greater, because at the moment, it's quite a lucrative business where these shops can earn thousands and thousands of dollars.

"So, a small fine is not really going to be a deterrent. So we really have to change the game up."

Mr Blanch said the Cook Government had been looking at what could be done to introduce laws to clamp down on illicit sales.

"I think our Government have been always been very good at introducing pretty tough laws ... what I would ask is that we are able to do that very rapidly," he said.

"Don't make it a bureaucratic process, make it happen really fast because I think there has to be severe consequences for those shops that think it's OK."

Santos

PUBLIC NOTICE: EOS 3D MARINE SEISMIC SURVEY (MSS)

PROPOSED EOS 3D MARINE SEISMIC SURVEY (MSS) ACTIVITY

Santos is proposing to undertake a 3D Marine Seismic Survey (MSS) to acquire subsurface data in Commonwealth waters of the southern Bonaparte Basin, in greenhouse gas assessment permit G-11-AP.

The proposed Operational Area (OA) for Eos MSS is located approximately 107 km from the nearest coastline, and approximately 119 km from Wadeye in the Northern Territory. The survey activity is estimated to take up to 50-days to complete and is planned to take place anytime from the date of EP acceptance by NOPSEMA until 31 December 2027. Information about proposed activities, including a summary of key activity impacts, risks and management measures is included in a Consultation Fact Sheet, which can be accessed by the Santos QR code included in this notice.

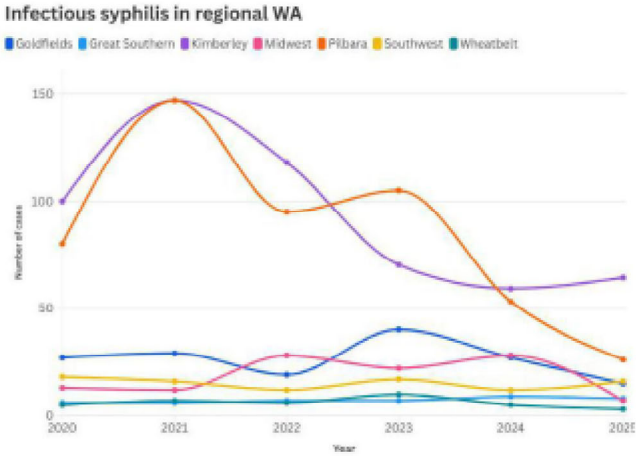
An environment plan (EP) for the activity has been prepared in accordance with the regulation administered by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) under the *Offshore Petroleum and Greenhouse Gas Storage Act 2006*.

A comment period is open until 7 September 2025 providing the public with an opportunity to submit a comment in relation to the EP. To submit a comment, visit the NOPSEMA website. Further information on this proposed activity can be found at the NOPSEMA QR code.

CONTACT INFORMATION

NOPSEMA SANTOS

Concerns for babies as syphilis cases soar



LAURA NEWELL

Syphilis cases in the Kimberley have already rocketed above last year's figures despite there being another four months of the year to go.

WA Department of Health figures reveal that the Kimberley has seen 64 cases so far this year compared to 59 in 2024, making it the regional area hardest hit by the sexually transmitted disease.

It comes as syphilis was declared a Communicable Disease Incident of National Significance earlier this month by Australia's chief medical officer, Michael Kidd.

Across Australia, as of August 6, there have already been 8546 cases of infectious syphilis recorded and 11 cases of congenital syphilis, leading to the death of four infants.

Last year, cases of infectious syphilis totalled 5968 with 10 congenital cases and four infant deaths. "Declaring a CDINS will bring together national efforts to co-ordinate an enhanced national response," Dr Kidd said.

"I am very concerned about the ongoing impact of syphilis on public health.

"Syphilis is preventable, and is easy to treat if found early. Testing and treatment are simple and accessible."

In WA the only region that has a higher incidence of infectious syphilis than the Kimberley is metro Perth with a whopping 342 cases so far this year.

The Pilbara sits in third place with 36 cases. Last year, the region notched up a total of 58.

Symptoms vary at each stage of the virus but often take the form of painless sores, or rash on the body, palms or soles of the feet.

Many people do not show symptoms but can still pass the infection on to their sexual partners.

Syphilis can cause serious complications if not treated and if women contract it during pregnancy it can be passed onto the baby, leading to congenital syphilis.

Statewide, there have been three recorded cases of congenital syphilis so far this year — one in the Pilbara, one in the Goldfields and one in metro Perth.

In 2024, Aboriginal and Torres Strait Islander Australians had infectious syphilis rates seven times higher than non-Indigenous Australians.

Since 2016, more than half of all congenital syphilis cases have occurred in First Nations babies.

One in three affected infants have died.

The Australian College of Rural and Remote Medicine, the peak organisation for rural, remote and First Nations health care, said the declaration of syphilis as a CDINS was a sobering reminder of health inequities facing the communities it serves.

In the Kimberley so far this year, 61 of the people with infectious syphilis were Aboriginal. Just three were classed as "non-Aboriginal". In the Pilbara the split was 22 to four.

ACRRM president Rod Martin said that the crisis reflected long-standing gaps in access to timely testing, treatment, and antenatal care, despite syphilis being entirely preventable and treatable.

"Every one of those deaths is a tragedy," he said.

"We know syphilis often presents without symptoms, but with early testing and treatment, congenital syphilis is entirely preventable."

Dr Martin urged all Australians who are sexually active, especially those planning for a baby, to get a sexual health check.

"Testing is simple, treatment is effective, and awareness is essential to preventing serious outcomes — including a perinatal death rate of up to 30 per cent."

Glimpse of Galati raises eyebrows

CAIN ANDREWS

Spudshed boss Tony Galati has revealed he's looking north for the next frontier of his grocery empire, with the Pilbara and Kimberley both on the radar.

Speaking to the Broome Advertiser on Thursday, Mr Galati said the idea of bringing the cut-price supermarket chain to Broome was more than just talk.

"Well, look out — you never know what might happen around the corner," he said. "We are looking into it. We've been looking. I was up here a couple of years ago, looking into it. I think you'll probably see us up there in the future."

It comes after the popular business identity was spotted strolling the aisles of Karratha supermarkets this week, quietly sizing up the local grocery scene.

He told Pilbara News he's "seriously considering" a move into Karratha — his most remote venture yet — but said freight costs, site availability and staffing remained big hurdles.

"I'd love to open a store here," he said. "But things like freight, location and staff are big challenges. If they want us up here, we'll come."

Tony Galati holding up his wares at a Spudshed supermarket.

Teenage girls accused of robbery & stealing a car

CAIN ANDREWS

Broome Detectives are calling for public help after an alleged aggravated robbery in the early hours of Friday, August 15.

Police say a silver Hyundai Venue was stolen from a property on Carnarvon Street at about 12.45am.

The victim ran to another member of the public for help and investigators are keen to identify and speak with that person.

Police say a short time later, officers tried to stop the car on Reid Road in Cable Beach.

It's alleged the vehicle failed to stop and was later abandoned.

Two 13-year-old girls were arrested soon after.

One girl has been charged with aggravated robbery and stealing a motor vehicle.

The other faces the same charges, plus possession of cannabis.

Anyone with information, or dashcam, mobile phone or CCTV footage should contact Crime Stoppers on 1800 333 000, or crimestopperswa.com.au.

Santos

PUBLIC NOTICE: EOS 3D MARINE SEISMIC SURVEY (MSS)

PROPOSED EOS 3D MARINE SEISMIC SURVEY (MSS) ACTIVITY

Santos is proposing to undertake a 3D Marine Seismic Survey (MSS) to acquire subsurface data in Commonwealth waters of the southern Bonaparte Basin, in greenhouse gas assessment permit G-11-AP.

The proposed Operational Area (OA) for Eos MSS is located approximately 107 km from the nearest coastline, and approximately 119 km from Wadeye in the Northern Territory. The survey activity is estimated to take up to 50-days to complete and is planned to take place anytime from the date of EP acceptance by NOPSEMA until 31 December 2027. Information about proposed activities, including a summary of key activity impacts, risks and management measures is included in a Consultation Fact Sheet, which can be accessed by the Santos QR code included in this notice.

An environment plan (EP) for the activity has been prepared in accordance with the regulation administered by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) under the *Offshore Petroleum and Greenhouse Gas Storage Act 2006*.

A comment period is open until 7 September 2025 providing the public with an opportunity to submit a comment in relation to the EP. To submit a comment, visit the NOPSEMA website. Further information on this proposed activity can be found at the NOPSEMA QR code.

CONTACT INFORMATION

NOPSEMA SANTOS

Appendix F Santos risk matrix and consequence table

Santos Risk Matrix

Santos

Consequence							
Safety		**Negligible Harm** + No bodily damage or minimal harm or impairment (hours to days)	**Minor Harm** + Short term impairment (days to weeks)	**Moderate Harm** + Temporary disablement or medium-term impairment (weeks to months)	**Severe Harm** + Long term/life altering disablement or impairment	**Single Fatality OR Critical Life Threatening Injuries**	**Multiple Fatalities**
Environment		+ No impact to Environmental Value (EV).	+ Small-scale impact to EV(s) of conservation significance + Potential surface or groundwater impact.	+ Moderate-scale impact to EV(s) of conservation significance + Localised surface or groundwater impact.	+ Large-scale impact to EV(s) of conservation significance + Moderate-scale surface water impact; + Localised impact to groundwater with potential or known beneficial use.	+ Extensive population or community scale impact to EV(s) of conservation significance + Extensive impact to other EV(s).	+ Irreversible impact to EV(s).
Community & Reputation		+ No actual or potential community criticism + Details remain within Santos sites and/or offices	+ Minor level local community criticism (< week) + No reputation impact	+ Local community criticism (> week) or one-day community protest + Local company reputation impacted	+ State-level community criticism or protest over multiple days/locations + State-based company reputation impacted + Very short-term share price impact (< week)	+ National community criticism or large scale protest + Company reputation and approvals impacted + Shareholder intervention or short-term share price impact (< month)	+ Sustained national community criticism or widespread protest + Industry reputation and approvals impacted + Changes at executive/board level or long-term share price impact (> month)
Financial (A$)		< $100k	$100k to $1m	$1m to $10m	$10m to $100m	$100m to $500m	> $500m
Workforce		+ Will require some staff attention over several days. + No actual or potential impact to culture	+ Will require several days local management time. + Minor impact to employee engagement and limited staff turnover	+ Will require head office staff and take several weeks of site management time. + Moderate impact to employee engagement and staff turnover above industry average with some key roles	+ Will require several weeks of senior management time + Impact to employee engagement (< 6 months), moderate turnover of key roles and no succession	+ Will require several months of senior management time + Impact to employee engagement (< 18 months), high staff turnover and attraction issues	+ Will require more than a year of senior management involvement and operations severely disrupted + Impact to employee engagement (> 18 months), significant key role turnover and attraction issues
Compliance		+ Non-conformance with legislation, instruments (e.g. tenure licence) or contract + No regulatory or punitive action	+ Minor breach of legislation, instruments or contract + Notification/report to; request for information by; and/or administrative/ warning notice from the regulator + LOCI Tier 3 or non-hydrocarbon releases notifiable to the regulator	+ Limited number of minor breaches of legislation, instruments or contract + Statutory notice from the regulator + LOCI Tier 2 or non-hydrocarbon releases immediately reportable to the regulator	+ Systemic minor breaches (or one moderate breach) of legislation, instruments or contract + Company charged with an offence with minor penalty/fine + LOCI Tier 1 or cumulative regulator notification of non-hydrocarbon releases	+ Systemic moderate breaches (OR single material breach) of legislation, instruments or contract + Company charged with an offence with moderate penalty/fine	+ Material breaches of legislation, instruments or contract + Company or officers charged with an offence with material penalty/fine, or loss of tenure/operatorship
		I	**II**	**III**	**IV**	**V**	**VI**
Likelihood							
ALMOST CERTAIN (< 4 monthly) Occurs frequently	f	Low	Medium	High	Very High	Very High	Very High
LIKELY (4 monthly - 1 yearly) Could occur within the annual plan	e	Low	Medium	High	High	Very High	Very High
OCCASIONAL (1 - 3 yearly) Could occur within the 3-year plan	d	Low	Low	Medium	High	High	Very High
POSSIBLE (3 - 10 yearly) Could occur within the 10-year, long term plan	c	Very Low	Low	Low	Medium	High	Very High
UNLIKELY (10 - 30 yearly) Not expected to occur; known to have occurred elsewhere	b	Very Low	Very Low	Low	Low	Medium	High
REMOTE (30 - 100 yearly) Requires exceptional circumstances and is unlikely even in the long term	a	Very Low	Very Low	Very Low	Low	Medium	Medium

Explanatory Notes / Definitions

1 Not all elements within a consequence category require achievement; any single element within a category is sufficient.
2 For non-operated assessments use impacts to Santos or net quantities. For operated assessments use impacts to the entire joint venture or gross quantities.
3 Environment:
3.1 Environmental Values (EVs) includes flora & fauna species (terrestrial & aquatic), populations & habitats, vegetation, water resources (surface water, groundwater & marine), soils & landforms.
3.2 The assessment depends upon the nature of the receiving environment. Therefore, not all elements under each category will be applicable.
3.3 A conservation significant value is subject to legal protection through regulation or has been identified as a priority by government in terms of special protection or management.
3.4 The Environment category does not capture non-compliance with regulatory requirements or external reporting triggers. These should be assessed under the Compliance category.
3.5 For Environmental costs (including short-term clean up, Environmental Incident Response costs, penalties & fines, total/lifecycle rehabilitation, monitoring and remediation/disposal) use financial consequence.
4 Community & Reputation:
4.1 Definition of community criticism includes criticism by one or more individuals in person, public forums, traditional media or social media.
5 Financial:
5.1 Calculate current financial consequences using Free Cash Flow (FCF).
5.2 Calculate future or multi-year financial consequences using Net Present Value (NPV).
6 Compliance:
6.1 For Compliance costs (including contract breaches, fines, penalties, legal fees, etc.) use financial consequence.
6.2 Community criticism, protest and reputation impacts associated with Compliance assessment should use the Community & Reputation category.

Residual/Current Risk Level	Risk Acceptance / Tolerance
Very High	CEO Direct Report
High	CEO Direct Report
Medium (with Fatality Consequence)	VP/General Manager
Medium (all other risks)	Manager
Low	Team Leader / Supervisor
Very Low	Any Person (ALARP/SFAIRP)

Consequence Level		I	II	III	IV	V	VI
Acceptability		Acceptable	Acceptable	Unacceptable	Unacceptable	Unacceptable	Unacceptable
Severity Description		**Negligible** ***No impact or negligible impact***	**Minor** ***Detectable but insignificant change to local population, industry or ecosystem factors. Localised effect***	**Moderate** ***Significant impact to local population, industry or ecosystem factors***	**Major** ***Major long-term effect on local population, industry or ecosystem factors***	**Severe** ***Complete loss of local population, industry or ecosystem factors AND/OR extensive regional impacts with slow recovery***	**Critical** ***Irreversible impact to regional population, industry or ecosystem factors***
Environmental Receptors	Fauna In particular, EPBC Act listed threatened/migratory fauna or *WA Biodiversity Conservation Act 2016* specially protected fauna	Short term behavioural impacts only to small proportion of local population and not during critical lifecycle activity; No decrease in local population size; No reduction in area of occupancy of species; No loss/disruption of habitat critical to survival of a species; No disruption to the breeding cycle of any individual; No introduction of disease likely to cause a detectable population decline.	Detectable but insignificant decrease in local population size; Insignificant reduction in area of occupancy of species; Insignificant loss/disruption of habitat critical to survival of a species; Insignificant disruption to the breeding cycle of local population.	Significant decrease in local population size but no threat to overall population viability; Significant behavioural disruption to local population; Significant disruption to the breeding cycle of a local population; Significant reduction in area of occupancy of species; Significant loss of habitat critical to survival of a species; Modify, destroy, remove, isolate or decrease availability of quality of habitat to the extent that a significant decline in local population is likely; Introduce disease likely to cause a significant population decline.	Long term decrease in local population size and threat to local population viability; Major disruption to the breeding cycle of local population; Major reduction in area of occupancy of species; Fragmentation of existing population; Major loss of habitat critical to survival of a species; Modify, destroy, remove, isolate or decrease availability of quality of habitat to the extent that a long term decline in local population is likely; Introduce disease likely to cause a long term population decline.	Complete loss of local population; Complete loss of habitat critical to survival of local population; Wide spread (regional) decline in population size or habitat critical to regional population.	Complete loss of regional population; Complete loss of habitat critical to survival of regional population.
	Physical Environment/Habitat Includes: air quality; water quality; benthic habitat (biotic/abiotic), particularly habitats that are rare or unique; habitat that represents a Key Ecological Feature[1]; habitat within a protected area; habitats that include benthic primary producers[2] and/or epi-fauna[3]	No or negligible reduction in physical environment/habitat area/function.	Detectable but localised and insignificant loss of area/function of physical environment/habitat. Rapid recovery evident within approximately two years (two season recovery).	Significant loss of area and/or function of local physical environment/habitat. Recovery over medium term (2–10 years)	Major, large-scale loss of area and/or function of physical environment/local habitat. Slow recovery over decades.	Extensive destruction of local physical environment/habitat with no recovery; Long term (decades) and wide spread loss of area or function of primary producers on a regional scale.	Complete destruction of regional physical environment/habitat with no recovery. Complete loss of area or function of primary producers on a regional scale.
	Threatened ecological communities (EPBC Act listed ecological communities)	No decline in threatened ecological community population size, diversity or function; No reduction in area of threatened ecological community; No introduction of disease likely to cause decline in threatened ecological community population size, diversity or function.	Detectable but insignificant decline in threatened ecological community population size, diversity or function; Insignificant reduction in area of threatened ecological community.	Significant decline in threatened ecological community population size, diversity or function; Significant reduction in area of threatened ecological community; Introduction of disease likely to cause significant decline in threatened ecological community population size, diversity or function.	Major, long term decline in threatened ecological community population size, diversity or function; Major reduction in area of threatened ecological community; Fragmentation of threatened ecological community; Introduce disease likely to cause long term decline in threatened	Extensive, long term decline in threatened ecological community population size, diversity or function; Complete loss of threatened ecological community.	Complete loss of threatened ecological community with no recovery.

[1] As defined by the Department of Agriculture, Water and Environment
[2] Benthic photosynthetic organisms such as seagrass, algae, hard corals and mangroves
[3] Fauna attached to the substrate including sponges, soft corals and crinoids.

Consequence Level		I	II	III	IV	V	VI
Acceptability		Acceptable	Acceptable	Unacceptable	Unacceptable	Unacceptable	Unacceptable
Severity Description		**Negligible** ***No impact or negligible impact***	**Minor** ***Detectable but insignificant change to local population, industry or ecosystem factors. Localised effect***	**Moderate** ***Significant impact to local population, industry or ecosystem factors***	**Major** ***Major long-term effect on local population, industry or ecosystem factors***	**Severe** ***Complete loss of local population, industry or ecosystem factors AND/OR extensive regional impacts with slow recovery***	**Critical** ***Irreversible impact to regional population, industry or ecosystem factors***
					ecological community population size, diversity or function.		
	Protected Areas Includes: World Heritage Properties; Ramsar wetlands; Commonwealth/National Heritage Areas; Land/Marine Conservation Reserves.	No or negligible impact on protected area values; No decline in species population within protected area; No or negligible alteration, modification, obscuring or diminishing of protected area values.*	Detectable but insignificant impact on one of more of protected area's values. Detectable but insignificant decline in species population within protected area. Detectable but insignificant alteration, modification, obscuring or diminishing of protected area values.*	Significant impact on one of more of protected area's values; Significant decrease in population within protected area; Significant alteration, modification, obscuring or diminishing of protected area values.	Major long_term effect on one of more of protected area's values; Long-term decrease in species population contained within protected area and threat to that population's viability; Major alteration, modification, obscuring or diminishing of protected area values.	Extensive loss of one or more of protected area's values; Extensive loss of species population contained within protected area.	Complete loss of one or more of protected area's values with no recovery; Complete loss of species population contained within protected area with no recovery.
	Socio-economic receptors Includes: fisheries (commercial and recreational); tourism; oil and gas; defence; commercial shipping.	No or negligible loss of value of the local industry; No or negligible reduction in key natural features or populations supporting the activity.	Detectable but insignificant short-term loss of value of the local industry. Detectable but insignificant reduction in key natural features or population supporting the local activity.	Significant loss of value of the local industry; Significant medium term reduction of key natural features or populations supporting the local activity.	Major long-term loss of value of the local industry and threat to viability; Major reduction of key natural features or populations supporting the local activity.	Shutdown of local industry or widespread major damage to regional industry; Extensive loss of key natural features or populations supporting the local industry.	Permanent shutdown of local or regional industry; Permanent loss of key natural features or populations supporting the local or regional industry.

Appendix G Eos 3D MSS acoustic modelling

Santos Eos 3D Marine Seismic Survey

Acoustic Modelling for Assessing Marine Fauna Sound Exposures

JASCO Applied Sciences (Australia) Pty Ltd

20 April 2023

Submitted to:

Vanessa Smith
Santos Limited
Contract 3269076

Authors:

Victoria E. Warren
Matthew W. Koessler

P001733-001
Document 03021
Version 2.0

JASCO APPLIED SCIENCES

Suggested citation:

Warren, V.E., and M. W. Koessler. 2023. Santos Eos 3D Marine Seismic Survey: Acoustic Modelling for Assessing Marine Fauna Sound Exposures. Document 03021, Version 2.0. Technical report by JASCO Applied Sciences for Santos Limited.

The results presented herein are relevant within the specific context described in this report. They could be misinterpreted if not considered in the light of all the information contained in this report. Accordingly, if information from this report is used in documents released to the public or to regulatory bodies, such documents must clearly cite the original report, which shall be made readily available to the recipients in integral and unedited form.

Contents

Executive Summary 1
1. Introduction 4
2. Modelling Scenarios 5
2.1. Sensitive receivers 6
3. Noise Effect Criteria 8
3.1. Marine Mammals 9
3.2. Fish, Fish Eggs, and Fish Larvae 9
3.3. Sea Turtles 10
3.4. Invertebrates 11
3.4.1. Benthic Invertebrates (Crustaceans and Bivalves) 11
3.4.2. Plankton 12
3.5. Human Health Assessment Threshold 12
4. Methods 14
4.1. Acoustic Source Model 14
4.2. Environmental Parameters 14
4.3. Sound Propagation Models 14
4.4. Geometry and Modelled Regions 15
4.5. Accumulated SEL 15
5. Results 17
5.1. Acoustic Source Levels and Directivity 17
5.2. Per-Pulse Sound Fields 17
5.2.1. Tabulated Results 18
5.2.2. Sound Field Maps and Graphs 21
5.3. Multiple Pulse Sound Fields 28
5.3.1. Tabulated Results 28
5.3.2. Sound Level Contour Map 30
6. Discussion 31
6.1. Overview and Source Levels 31
6.2. Per-Pulse Sound Fields 31
6.3. Multiple Pulse Sound Fields 32
6.4. Summary 32
Glossary 35
Literature Cited 44
Appendix A. Acoustic Metrics A-1
Appendix B. Acoustic Source Model B-1
Appendix C. Sound Propagation Models C-1

Appendix D. Methods and Parameters D-1
Appendix E. Model Validation Information E-1
Appendix F. Additional Results F-1

Figures

Figure 1. Overview of the modelled sites, acquisition lines, and features for the Santos Eos 3D Marine Seismic Survey area. 6
Figure 2. Overview of sensitive receiver locations (1–5) in relation to the proposed Santos Eos 3D Marine Seismic Survey area (refer Table 6). 7
Figure 3. *Site 1, tow azimuth 131°, SPL*: Sound level contour map of unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response thresholds for marine mammals, turtles and human health. 21
Figure 4. *Site 2, tow azimuth 131°, SPL*: Sound level contour map of unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response thresholds for marine mammals, turtles and human health. 22
Figure 5. *Site 3, tow azimuth 131°, SPL*: Sound level contour map of unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response thresholds for marine mammals, turtles and human health. 22
Figure 6. *Site 4, tow azimuth 131°, SPL*: Sound level contour map of unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response thresholds for marine mammals, turtles and human health. 23
Figure 7. *Site 5, tow azimuth 131°, SPL*: Sound level contour map of unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response thresholds for marine mammals, turtles and human health. 23
Figure 8. *Site 6, tow azimuth 131°, SPL*: Sound level contour map of unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response thresholds for marine mammals, turtles and human health. 24
Figure 9. *Site 1, tow azimuth 131°, SPL*: Sound level contours in vertical slice of the sound field 25
Figure 10. *Site 2, tow azimuth 131°, SPL*: Sound level contours in vertical slice of the sound field 25
Figure 11. *Site 3, tow azimuth 131°, SPL*: Sound level contours in vertical slice of the sound field 26
Figure 12. *Site 4, tow azimuth 131°, SPL*: Sound level contours in vertical slice of the sound field 26
Figure 13. *Site 5, tow azimuth 131°, SPL*: Sound level contours in vertical slice of the sound field 27
Figure 14. *Site 6, tow azimuth 131°, SPL*: Sound level contours in vertical slice of the sound field 27
Figure 15. Sound level contour map of unweighted maximum-over-depth SEL_{24h} results for Scenario 1, along with isopleths for cetaceans, turtles and fish. 30

Figure A-1. Decidecade frequency bands (vertical lines) shown on a linear frequency scale and a logarithmic scale. A-3
Figure A-2. Sound pressure spectral density levels and the corresponding decidecade band sound pressure levels of example ambient noise shown on a logarithmic frequency scale. A-3
Figure A-3. Auditory weighting functions for functional marine mammal hearing groups as recommended by Southall et al. (2019). A-6
Figure B-1. Layout of the modelled 3050 in^3 seismic source. Tow depth is 8 m. The labels indicate the firing volume (in cubic inches) for each airgun. Also see Table B-1. ..... B-2
Figure B-2. Predicted source level details for the 3050 in^3 array at 8 m towed depth. B-4
Figure B-3. Directionality of the predicted horizontal source levels for the 3050 in^3 seismic source, 5 Hz to 2 kHz. B-5
Figure C-1. The N×2-D and maximum-over-depth modelling approach used by MONM. C-1
Figure D-1. Sample areas ensonified to an arbitrary sound level with R_{max} and $R_{95\%}$ ranges shown for two scenarios. D-1
Figure D-2. *Site 2, 3050 in^3 seismic source*: Range-and-depth-dependent conversion offsets for converting sound exposure level (SEL) to sound pressure level (SPL) for seismic pulses. D-2

Figure D-3. *Site 3, 3050 in³ seismic source*: Range-and-depth-dependent conversion offsets for converting sound exposure level (SEL) to sound pressure level (SPL) for seismic pulses. D-3
Figure D-4. *Site 6, 3050 in³ seismic source*: Range-and-depth-dependent conversion offsets for converting sound exposure level (SEL) to sound pressure level (SPL) for seismic pulses. D-3
Figure D-5. Bathymetry map of the modelling area for the Santos Eos 3D Marine Seismic Survey.... D-4
Figure D-6. The sound speed profile (June) used for the modelling D-5
Figure F-1. *Site 1, tow azimuth 131º, SEL:* Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps. F-1
Figure F-2. *Site 2, tow azimuth 131º, SEL:* Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps. F-2
Figure F-3. *Site 3, tow azimuth 131º, SEL:* Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps. F-2
Figure F-4. *Site 4, tow azimuth 131º, SEL:* Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps. F-3
Figure F-5. *Site 5, tow azimuth 131º, SEL:* Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps. F-3
Figure F-6. *Site 6, tow azimuth 131º, SEL:* Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps. F-4

Tables

Table 1. Maximum (R_{max}) horizontal distances (in km) from modelled sites or scenarios to behavioural response thresholds and temporary threshold shift (TTS) and permanent threshold shift (PTS) for marine mammals 2
Table 2. Maximum (R_{max}) horizontal distances (in km) from modelled sites or scenarios to behavioural response thresholds and temporary threshold shift (TTS) and permanent threshold shift (PTS) for sea turtles 2
Table 3. Summary of maximum fish, fish eggs, and larvae injury and temporary threshold shift (TTS) onset distances for single impulse and 24 hour sound level exposure (SEL_{24h}) modelled scenarios 3
Table 4. Location details for the single impulse modelled sites. 5
Table 5. Parameters for modelled scenario 5
Table 6. Location details for the sensitive receiver sites. 7
Table 7. Unweighted sound pressure level (SPL), 24 h sound exposure level (SEL_{24h}), and peak pressure (PK) thresholds for acoustic effects on marine mammals. 9
Table 8. Criteria for seismic noise exposure for fish, adapted from Popper et al. (2014). 10
Table 9. Acoustic effects of impulsive noise on sea turtles: Unweighted sound pressure level (SPL), 24 hour sound exposure level (SEL_{24h}), and peak pressure (PK) thresholds 11
Table 10. Far-field source level specifications for 3050 in³ sources 17
Table 11. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) from the seismic source to modelled maximum-over-depth and maximum-over-azimuth unweighted per-pulse sound exposure level (SEL) isopleths from the modelled single impulse sites, with the water depth indicated. 18
Table 12. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) from the seismic source to modelled maximum-over-depth and maximum-over-azimuth per-pulse sound pressure level (SPL) isopleths from the modelled single impulse sites, with the water depth indicated. 19
Table 13. Maximum (R_{max}) horizontal distances (in km) from the seismic source to modelled maximum-over-depth peak pressure level (PK) thresholds based on Southall et al. (2019) for marine mammals, and Popper et al. (2014) for fish and Finneran et al. (2017) for sea turtles, at the modelled single impulse sites, with the water depth indicated. 19

Table 14. Maximum (R_{max}) horizontal distances (in m) from the seismic source to modelled seafloor (receiver located 50 cm above seafloor) peak pressure level thresholds (PK) at three water depths (83 m, 96.5 m and 110 m) within the Active Source Zone. 20
Table 15. Maximum (R_{max}) horizontal distances (in m) from the seismic source to modelled seafloor (receiver located 5 cm above seafloor) peak-peak pressure levels (PK-PK) at three water depths (83 m, 96.5 m and 110 m) within the Active Source Area. Results included in relation to benthic invertebrates (Section 3.4). 20
Table 16. Maximum-over-depth received sound levels (SPL) at the sensitive receivers outlined in Section 2.1, along with the distance between the receiver and the closest modelled site 21
Table 17. Maximum-over-depth distances (in km) to frequency-weighted 24 hour sound exposure level (SEL_{24h}) based permanent threshold shift (PTS) and temporary threshold shift (TTS) for marine mammals (Southall et al. 2019) and sea turtles (Finneran et al. 2017) using the 3050 in^3 array. 28
Table 18. Distances to 24 hour sound exposure level (SEL_{24h}) based fish criteria in the water column and at the seafloor for the 3050 in^3 seismic source. 29
Table 19. Maximum-over-depth received sound levels at the sensitive receivers outlined in Section 2.1. SEL_{24h} values for Receivers 1 and 2 are weighted for HF-cetaceans, and Receiver 3 is weighted for turtles (refer Appendix A.4). 29
Table 20. Maximum (R_{max}) horizontal distances (in km) from modelled sites or scenarios to behavioural response thresholds and temporary threshold shift (TTS) and permanent threshold shift (PTS) for marine mammals 33
Table 21. Maximum (R_{max}) horizontal distances (in km) from modelled sites or scenarios to behavioural response thresholds and temporary threshold shift (TTS) and permanent threshold shift (PTS) for sea turtles 33
Table 22. Summary of maximum fish, fish eggs, and larvae injury and temporary threshold shift (TTS) onset distances for single impulse and 24 hour sound level exposure (SEL_{24h}) modelled scenarios 34

Table A-1. Parameters for the auditory weighting functions as recommended by Southall et al. (2019). A-6
Table B-1. Layout of the modelled 3050 in^3 seismic source. Tow depth is 8 m. Firing pressure for all guns was 2000 psi. Also see Figure B-1. ..... B-3
Table D-1. Geoacoustic profile for all modelling sites. D-5

Executive Summary

JASCO Applied Sciences (JASCO) performed a numerical modelling study of underwater sound levels from the planned Santos Eos 3D Marine Seismic Survey (MSS) to assist in understanding the potential acoustic impact on key regional receptors including marine mammals, sea turtles, fish benthic invertebrates, plankton, sponges, coral, and human divers. The modelling considered an airgun array with a total volume 3050 in^3, towed at 8 m depth in a triple source configuration behind a single vessel.

A specialised airgun array source model was used to predict the acoustic signature of the seismic source, and complementary underwater acoustic propagation models were used in conjunction with the array signature to estimate sound levels considering site-specific environmental influences. Single-impulse sound fields were predicted at six sites within the Active Source Area, with water depths between 83 and 110 m. An accumulated sound exposure field was predicted for a representative scenario for likely survey operations over 24 hours.

The modelling methodology considered source directivity and range-dependent environmental properties likely to be encountered within the survey area. Estimated underwater acoustic levels are presented as sound pressure levels (SPL, L_p), zero-to-peak pressure levels (PK, L_{pk}), peak-to-peak pressure levels (PK-PK; $L_{pk\text{-}pk}$), and either single-impulse (i.e., per-pulse) or accumulated sound exposure levels (SEL, L_E) as appropriate for different noise effect criteria. A conservative sound speed profile that would be most supportive of sound propagation conditions for the period of the survey was defined and applied to all modelling.

The analysis considered the distances away from the seismic source at which several effects criteria or relevant sound levels were reached. The results are summarised below for the representative single-impulse sites and accumulated SEL scenarios.

Marine mammals

Table 1 summarises the distances to criteria for marine mammals. These maximum distances are associated with the broadside aspect of the array.

- The maximum distance where the NOAA (2019) marine mammal behavioural response criterion of 160 dB re 1 µPa (SPL) for impulsive noise could be exceeded was 11 km.
- The results for marine mammal permanent threshold shift (PTS) and temporary threshold shift (TTS) criteria from Southall et al. (2019) allows for two metrics (PK and SEL_{24h}). The longest distance associated with either metric is required to be applied for assessment. Table 1 summarises the maximum distances for PTS and TTS, along with the relevant metric associated with the maximum distance.
- The SEL_{24h} is a cumulative metric that reflects the dosimetric impact of noise levels within 24 hours based on the assumption that an animal is consistently exposed to such noise levels at a fixed position. The SEL_{24h} radii were generally larger than those for peak pressure criteria, but they represent an unlikely worst-case scenario. More realistically, marine mammals would not stay in the same location for 24 hours. Therefore, a reported radius for SEL_{24h} criteria does not mean that marine fauna travelling within this radius of the source will be injured, but rather that an animal could be exposed to the sound level associated with injury (either PTS or TTS) if it remained within the ensonified area for 24 hours.

Table 1. Maximum (R_{max}) horizontal distances (in km) from modelled sites or scenarios to behavioural response thresholds and temporary threshold shift (TTS) and permanent threshold shift (PTS) for marine mammals

Hearing group	Modelled distance to effect threshold (R_{max}) (km)		
	Behavioural response[1]	Impairment: TTS[2]	Impairment: PTS[2]
LF cetaceans	11.0	80.7 (SEL_{24h})	5.28 (SEL_{24h})
HF cetaceans		0.10 (SEL_{24h})	–
VHF cetaceans		0.75 (SEL_{24h})	0.37 (PK)
Sirenians		0.10 (SEL_{24h})	–

Noise exposure criteria: [1] NOAA (2019) and [2] Southall et al. (2019)
A dash indicates the threshold was not reached within the limits of the modelling resolution (20 m).

Sea turtles

Table 2 summarises the distances to criteria for sea turtles.

- The PK turtle injury criteria of 232 dB re 1 µPa for PTS and 226 dB re 1 µPa for TTS from Finneran et al. (2017) was not exceeded at a distance longer than 20 m from the acoustic centre of the source.
- The maximum distance to the SEL_{24h} metric was 100 m for PTS onset and 3.24 km for TTS onset (Finneran et al. 2017). As is the case with marine mammals, a reported radius for SEL_{24h} criteria does not mean that turtles travelling within this radius of the source will be injured, but rather that an animal could be exposed to the sound level associated with either PTS or TTS if it remained within the ensonified area for 24 hours.
- The behavioural response criteria of turtles (166 dB re 1 µPa (SPL) and the 175 dB re 1 µPa (SPL) threshold for behavioural disturbance (McCauley et al. 2000) could be exceeded at distances of 6.12 km and 2.26 km, respectively.

Table 2. Maximum (R_{max}) horizontal distances (in km) from modelled sites or scenarios to behavioural response thresholds and temporary threshold shift (TTS) and permanent threshold shift (PTS) for sea turtles

Hearing group	Modelled distance to effect threshold (R_{max})			
	Behavioural response[1]	Behavioural disturbance[1]	Impairment: TTS[2]	Impairment: PTS[2]
Sea Turtles	6.12	2.26	3.24	0.10

Noise exposure criteria: [1] McCauley et al. (2000), and [2] Finneran et al. (2017)

Fish, fish eggs, and fish larvae

This modelling study assessed the ranges at the seafloor and in the water column for quantitative criteria based on Popper et al. (2014) and considered both PK and SEL_{24h} metrics associated with mortality and potential mortal injury as well as impairment in the following groups:

- Fish without a swim bladder (also appropriate for sharks in the absence of other information)
- Fish with a swim bladder that do not use it for hearing
- Fish that use their swim bladders for hearing
- Fish eggs and fish larvae

Table 22 summarises the distances to injury criteria for fish, fish eggs, and fish larvae along with the relevant metric. Seafloor sound levels were assessed for three different water depths within the Operation Area (83, 96.5 and 110 m).

Table 3. Summary of maximum fish, fish eggs, and larvae injury and temporary threshold shift (TTS) onset distances for single impulse and 24 hour sound level exposure (SEL_{24h}) modelled scenarios

Relevant hearing group	Effect criteria	Water column		Seafloor	
		Metric associated with longest distance to criteria	R_{max} (km)	Metric associated with longest distance to criteria	R_{max} (km)
Fish: No swim bladder	Recoverable injury	SEL_{24h}	0.10	PK	0.08
	TTS	SEL_{24h}	7.11	SEL_{24h}	6.40
Fish: Swim bladder not involved in hearing and Swim bladder involved in hearing	Recoverable injury	PK	0.17	PK	0.20
	TTS	SEL_{24h}	7.11	SEL_{24h}	6.40
Fish eggs, and larvae	Injury	SEL_{24h}	0.10	SEL_{24h}	*

Benthic invertebrates, Sponges, Coral, and Plankton

To assist with assessing the potential effects on these receptors, the following results were determined:

- Crustaceans: The sound level of 202 dB re 1 µPa PK-PK from Payne et al. (2008) which is representative of no effects, was considered for seafloor sound levels; the sound level was reached at ranges between 512 and 673 m depending on the modelled site.
- Sponges and coral: The PK sound level at the seafloor directly underneath the seismic source was estimated at three representative water depths and compared to the sound level of 226 dB re 1 µPa PK at which sponges and corals are not visibly affected (Heyward et al. 2018); the threshold was not reached.

Divers

An SPL human health assessment of 145 dB re 1 µPa (SPL; L_p) derived from Parvin (2005) was considered for people swimming and diving and the sound level was reached at ranges between 30.9 and 47.8 km in the broadside direction depending on the modelled site.

1. Introduction

JASCO Applied Sciences (JASCO) performed a numerical estimation study of underwater sound levels associated with the planned Santos Eos 3-D Marine Seismic Survey (MSS) to assist in understanding the potential acoustic effect on receptors including marine mammals, fish, sea turtles, benthic invertebrates, plankton, sponges, corals, and human divers. The proposed seismic survey is shown in Figure 1.

The modelling study considered a 3050 in^3 seismic source in a triple array with 75 m cross-line separation. JASCO's specialised Airgun Array Source Model (AASM) was used to predict the acoustic signature and spectra for the seismic source. AASM accounts for individual airgun volumes, airgun bubble interactions, and array geometry to yield accurate source predictions.

Complementary underwater acoustic propagation models were used in conjunction with the array signature to estimate sound levels considering site-specific environmental influences. Single-impulse sound fields were predicted at six sites within the Active Source Area, and accumulated sound exposure fields were predicted for one representative scenario for likely survey operations over 24 h. A conservative sound speed profile that would be most supportive of sound propagation conditions for the potential survey period was defined and applied throughout.

The modelling methodology considered source directivity and range-dependent environmental properties. Estimated underwater acoustic levels are presented as sound pressure levels (SPL, L_p), zero-to-peak pressure levels (PK, L_{pk}), peak-to-peak pressure levels (PK-PK; $L_{pk\text{-}pk}$), and either single-impulse (i.e., per-pulse) or accumulated sound exposure levels (SEL, L_E) as appropriate for different noise effect criteria.

Section 2 provides more detail about the modelling scenario and single impulse sites. Section 3 explains the metrics used to represent underwater acoustic fields and the impact criteria considered. Section 4 details the methodology for predicting the source levels and modelling the sound propagation, including the specifications of the seismic source and all environmental parameters the propagation models require. Section 5 presents the results, which are then discussed and summarised in Section 6.

2. Modelling Scenarios

Six single impulse sites and one acquisition scenario were modelled considering a 3050 in^3 seismic source. The locations of the modelled sites are provided in Table 4, and the acquisition scenario is detailed in Table 5, with all sites and acquisition lines shown in Figure 1. The modelling assumed that a survey vessel sailed along survey lines at ~4.5 knots, towed three 3050 in^2 arrays in a triple source configuration, with an impulse interval (inter-pulse interval) of 8.33 m and an array separation of 75 m. The single impulse sites and accumulated SEL scenario were selected based on a proposed survey plan where the survey lines run at 311/131°.

The locations of the six selected impulse sites are considered representative of the range of water depths that will be covered during the Santos Eos 3D MSS and were also selected for their proximity to sensitive receivers (Section 2.1). In addition to sound levels in the water column, seafloor sound levels were assessed at three different representative depths within the Active Source Area (83, 96.5, and 110 m).

One 24 hour scenario was modelled, termed Scenario 1 (Table 5). For modelling purposes, the seismic source was assumed not to operate during line turns. Scenario 1 accounted for 17,088 impulses during the 17.08 h period of acquisition (excluding turns), henceforth referred to as 24 h.

Table 4. Location details for the single impulse modelled sites.

Site	Latitude (S)	Longitude (E)	MGA[1] Zone 52		Water depth (m)
			X (m)	Y (m)	
1	12° 55' 33.83"	127° 52' 12.34"	377428	8570770	100
2	12° 58' 02.54"	127° 55' 05.23"	382658	8566224	102
3	13° 08' 04.55"	128° 06' 46.11"	403840	8547810	95
4	13° 20' 45.95"	128° 21' 34.72"	430655	8524501	84
5	12° 48' 58.28"	128° 02' 01.94"	395151	8582995	110
6	13° 08' 01.28"	128° 25' 16.94"	437286	8548008	83

1 Map Grid of Australia (MGA)

Table 5. Parameters for modelled scenario

Scenario	Source volume (in^3)	Tow depth (m)	Tow direction (°)	Source configuration	Impulse interval (m)	Discharged impulses
1	3050	8	131 & 311	Triple	8.33	17,088

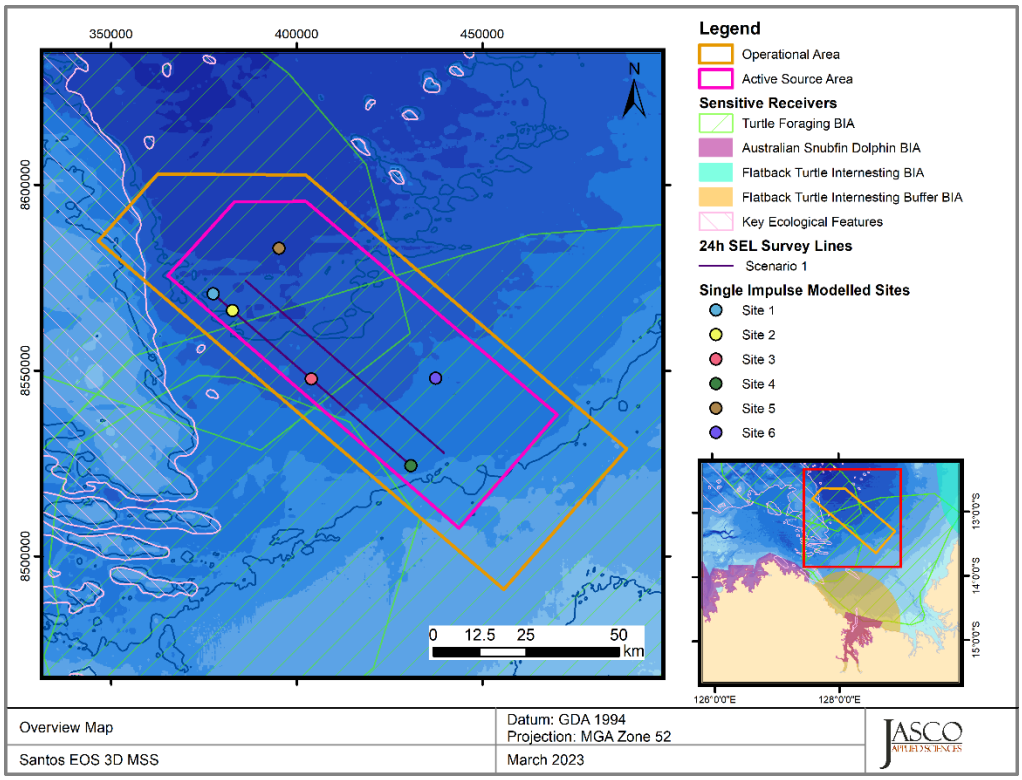


Figure 1. Overview of the modelled sites, acquisition lines, and features for the Santos Eos 3D Marine Seismic Survey area. Sensitive receiver locations are also shown for reference, and these are summarised in Section 2.1.

2.1. Sensitive receivers

The proposed seismic survey lies within foraging Biologically Important Areas (BIAs) for green and olive ridley turtles (Figure 2). In addition, Australian snubfin dolphin BIAs and a flatback turtle inter-nesting buffer BIA are located nearby in nearshore waters. The Key Ecological Features (KEFs) of the 'Pinnacles of the Bonaparte Basin' and the 'Carbonate bank and terrace system of the Sahul Shelf' are close to, or within, the Operational Area of the survey. The closest points of the BIAs and KEFs to the proposed seismic survey have been numbered 1–5 and are summarised in Table 6; acoustic source levels at these receiver locations have been calculated specifically (Section 5.2.1.3). Finally, per-pulse and 24 hour sound exposure thresholds for dugongs (sirenians) have also been considered, as it is possible that these marine mammals could be found in the area.

Table 6. Location details for the sensitive receiver sites.

Receiver ID	Sensitive receiver	Species Group(s)	Latitude (S)	Longitude (E)	MGA[1] Zone 52		Closest modelled site
					X (m)	Y (m)	
1	Australian snubfin dolphin BIA	High Frequency Cetacean	13° 57' 08.60"	127° 31' 30.59"	340683	8457045	3
2	Australian snubfin dolphin BIA	High Frequency Cetacean	14° 34' 08.65"	128° 06' 32.80"	404030	8389148	4
3	Flatback turtle internesting buffer BIA	Turtle	13° 58' 34.16"	128° 26' 56.40"	440490	8454842	4
4	Pinnacles of the Bonaparte Basin KEF	Fish and Benthic Invertebrates	13° 03' 31.86"	127° 50' 16.39"	374001	8556067	2
5	Carbonate bank and terrace system of the Sahul Shelf KEF	Fish and Benthic Invertebrates	12° 51' 28.75"	127° 42' 05.28"	359095	8578214	1

[1] Map Grid of Australia (MGA)

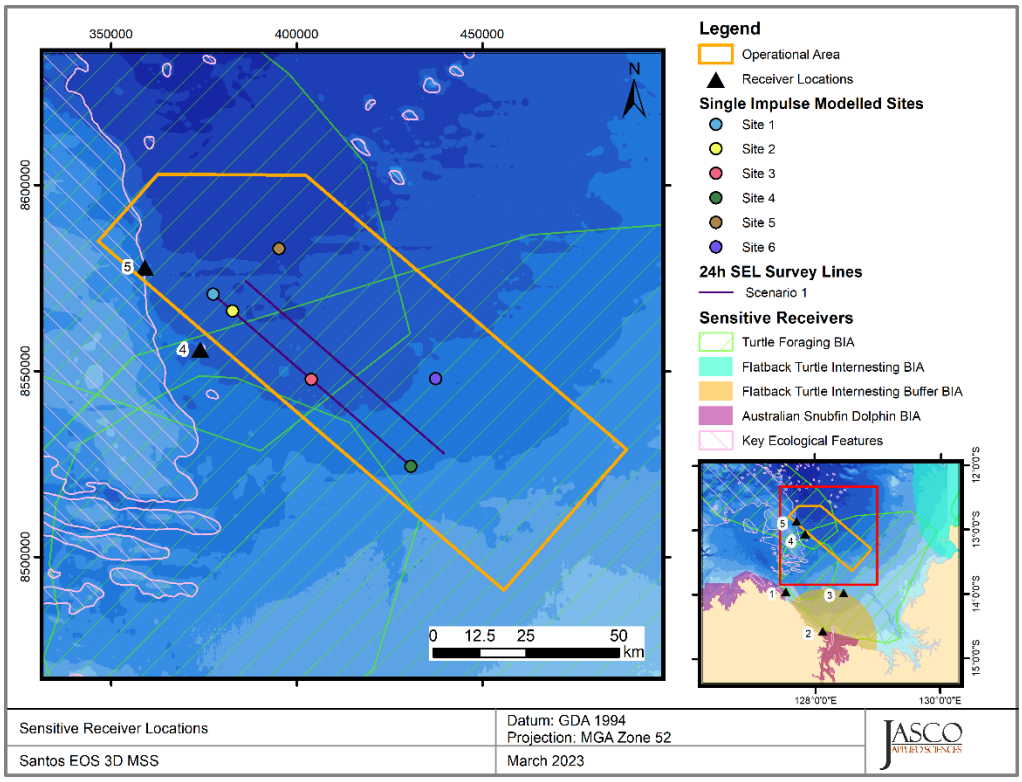


Figure 2. Overview of sensitive receiver locations (1–5) in relation to the proposed Santos Eos 3D Marine Seismic Survey area (refer Table 6).

3. Noise Effect Criteria

The perceived loudness of sound, especially impulsive noise such as from seismic airguns, is not generally proportional to the instantaneous acoustic pressure. Rather, perceived loudness depends on the pulse rise-time and duration and the frequency content. Several sound level metrics, such as PK, SPL, and SEL, are commonly used to evaluate noise and its effects on marine life (Appendix A). The period of accumulation associated with SEL is defined, with this report referencing either a "per pulse" assessment or over 24 h. The acoustic metrics in this report reflect the updated ANSI and ISO standards for acoustic terminology, ANSI-ASA (S1.1-2013) and ISO/DIS 18405 (2017).

Whether acoustic exposure levels might injure or disturb marine mammals is an active research topic. Since 2007, several expert groups have investigated an SEL-based assessment approach for injury, with a handful of key papers published on the topic. The number of studies that investigated the level of disturbance to marine animals by underwater noise has also increased substantially.

We chose the following noise criteria for this study because they include standard thresholds and thresholds suggested by the best available science (see Sections 3.1–3.4 and Appendix A):

- Peak pressure levels (PK; L_{pk}) and frequency-weighted accumulated sound exposure levels (SEL; $L_{E,24h}$) from Southall et al. (2019) for the onset of Permanent Threshold Shift (PTS) and Temporary Threshold Shift (TTS) in marine mammals.
- Marine mammal behavioural threshold based on the current US National Oceanic and Atmospheric Administration (NOAA 2019) criterion for marine mammals of 160 dB re 1 µPa (SPL; L_p) for impulsive sound sources.
- Sound exposure guidelines for fish, fish eggs and larvae (used as a surrogate for plankton), and turtles (Popper et al. 2014).
- Peak pressure levels (PK; L_{pk}) and frequency-weighted accumulated sound exposure levels (SEL; $L_{E,24h}$) from Finneran et al. (2017) for the onset of permanent threshold shift (PTS) and temporary threshold shift (TTS) in turtles.
- Sea turtle behavioural response threshold of 166 dB re 1 µPa (SPL; L_p) (McCauley et al. 2000), along with a sound level associated with behavioural disturbance 175 dB re 1 µPa (SPL; L_p) (McCauley et al. 2000).
- Peak-peak pressure levels (PK-PK; $L_{pk\text{-}pk}$) at the seafloor to help assess effects of noise on crustaceans through comparing to results in Day et al. (2016a), Day et al. (2019), Day et al. (2016b), Day et al. (2017) and Payne et al. (2008).
- A sound level of 226 dB re 1 µPa (PK; L_{pk}) reported by Heyward et al. (2018) to correspond to no visible damage or stress in corals.
- An SPL human health assessment threshold of 145 dB re 1 µPa (SPL; L_p) for sound exposure to people swimming and diving derived from Parvin (2005), and considering Ainslie (2008).

Additionally, to assess the size of the low-power zone required under the Australian Environment Protection and Biodiversity Conservation (EPBC) Act Policy Statement 2.1, Department of the Environment, Water, Heritage and the Arts (DEWHA 2008), the distance to an unweighted per-pulse SEL of 160 dB re 1 µPa^2·s (L_E) is reported.

The following subsections expand on the thresholds and sound levels for marine mammals, fish, sea turtles, fish eggs, fish larvae, benthic invertebrates, and human divers.

3.1. Marine Mammals

There are two categories of auditory threshold shifts or hearing loss: permanent threshold shift (PTS), a physical injury to an animal's hearing organs; and Temporary Threshold Shift (TTS), a temporary reduction in an animal's hearing sensitivity as the result of receptor hair cells in the cochlea becoming fatigued.

To help assess the potential for the possible injury and hearing sensitivity changes in marine mammals, this report applies the criteria recommended by Southall et al. (2019), considering both PTS and TTS. These criteria, along with the applied behavioural criteria (NOAA 2019), are summarised in Table 7, with descriptions included in Appendix A.3.1 (auditory impairment) and Appendix A.3.2 (behavioural response), with frequency weighting explained in Appendix A.4. Whilst the recently published Southall et al. (2021) provides recommendations and discusses nuances of assessing behavioural response, the authors do not recommend new numerical thresholds for onset of behavioural responses for marine mammals.

Table 7. Unweighted sound pressure level (SPL), 24 h sound exposure level (SEL_{24h}), and peak pressure (PK) thresholds for acoustic effects on marine mammals.

Hearing group	NOAA (2019)	Southall et al. (2019)			
	Behaviour	PTS onset thresholds[1] (received level)		TTS onset thresholds[1] (received level)	
	SPL (L_p; dB re 1 µPa)	Weighted SEL (L_E; dB re 1 µPa^2 s)	PK (L_{pk}; dB re 1 µPa)	Weighted SEL (L_E; dB re 1 µPa^2 s)	PK (L_{pk}; dB re 1 µPa)
Low-frequency cetaceans	160	183	219	168	213
High-frequency cetaceans		185	230	170	224
Very-high-frequency cetaceans		155	202	140	196
Sirenians		190	226	175	220

[1] Dual metric acoustic thresholds for impulsive sounds: Use whichever results in the largest isopleth for calculating PTS and TTS onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds should also be considered.
L_p-denotes sound pressure level period and has a reference value of 1 µPa.
L_{pk}, flat–peak sound pressure is flat weighted or unweighted and has a reference value of 1 µPa.
L_E - denotes cumulative sound exposure over a 24 h assessment period and has a reference value of 1 µPa^{2}s.
Subscripts indicate the designated marine mammal auditory weighting.

3.2. Fish, Fish Eggs, and Fish Larvae

In 2006, the Working Group on the Effects of Sound on Fish and Turtles was formed to continue developing noise exposure criteria for fish and turtles, work begun by a panel convened by NOAA two years earlier. The resulting guidelines included specific thresholds for different levels of effects and for different groups of species (Popper et al. 2014). These guidelines defined quantitative thresholds for three types of immediate effects:

- Mortality, including injury leading to death.
- Recoverable injury, including injuries unlikely to result in mortality, such as hair cell damage and minor haematoma.
- TTS.

Masking and behavioural effects can be assessed qualitatively, by assessing relative risk rather than by specific sound level thresholds. However, as these depend upon activity-based subjective ranges, these effects are not addressed in this report and are included in Table 8 for completeness only. Because the presence or absence of a swim bladder has a role in hearing, fish's susceptibility to injury from noise exposure varies depending on the species and the presence and possible role of a swim bladder in hearing. Thus, different thresholds were proposed for fish without a swim bladder (also appropriate for sharks and applied to whale sharks in the absence of other information), fish with a swim bladder not used for hearing, and fish that use their swim bladders for hearing. Turtles, fish eggs, and fish larvae are considered separately. Table 8 lists relevant effects thresholds from Popper et al. (2014).

The SEL metric integrates noise intensity over some period of exposure. Because the period of integration for regulatory assessments is not well defined for sounds that do not have a clear start or end time, or for very long-lasting exposures, it is required to define a time. Popper et al. (2014) recommend applying a standard period, where this is either defined as a justified fixed period or the duration of the activity; however, Popper et al. (2014) also included caveats about how long the fish will be exposed because they can move (or remain in location) and so can the source. Popper et al. (2014) summarises that in all TTS studies considered, fish that showed TTS recovered to normal hearing levels within 18–24 hours. Due to this, a period of accumulation of 24 hours has been applied in this study for SEL, which is similar to that applied for marine mammals in NMFS (2016, 2018) and Southall et al. (2019).

Table 8. Criteria for seismic noise exposure for fish, adapted from Popper et al. (2014).

Type of animal	Mortality and Potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
Fish: No swim bladder (particle motion detection)	>219 dB SEL_{24h} or >213 dB PK	>216 dB SEL_{24h} or >213 dB PK	>>186 dB SEL_{24h}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: Swim bladder not involved in hearing (particle motion detection)	210 dB SEL_{24h} or >207 dB PK	203 dB SEL_{24h} or >207 dB PK	>>186 dB SEL_{24h}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: Swim bladder involved in hearing (primarily pressure detection)	207 dB SEL_{24h} or >207 dB PK	203 dB SEL_{24h} or >207 dB PK	186 dB SEL_{24h}	(N) Low (I) Low (F) Moderate	(N) High (I) High (F) Moderate
Fish eggs and fish larvae (relevant to plankton)	>210 dB SEL_{24h} or >207 dB PK	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low

Peak sound level (PK) dB re 1 µPa; SEL_{24h} dB re 1µPa^2·s. All criteria are presented as sound pressure, even for fish without swim bladders, since no data for particle motion exist. Relative risk (high, moderate, or low) is given for animals at three distances from the source defined in relative terms as near (N), intermediate (I), and far (F).

3.3. Sea Turtles

There is a paucity of data regarding responses of turtles to acoustic exposure, and no studies of hearing loss due to exposure to loud sounds. Popper et al. (2014) suggested thresholds for onset of mortal injury (including PTS) and mortality for sea turtles and, in absence of taxon-specific information, adopted the levels for fish that do not hear well (suggesting that this likely would be conservative for sea turtles).

Finneran et al. (2017) presented revised thresholds for sea turtle injury and hearing impairment (TTS and PTS). Their rationale is that sea turtles have best sensitivity at low frequencies and are known to

have poor auditory sensitivity (Bartol and Ketten 2006, Dow Piniak et al. 2012). Accordingly, TTS and PTS thresholds for turtles are likely more similar to those of fishes than to marine mammals (Popper et al. 2014).

McCauley et al. (2000) observed the behavioural response of caged sea turtles—green (*Chelonia mydas*) and loggerhead (*Caretta caretta*)—to an approaching seismic airgun. For received levels above 166 dB re 1 µPa (SPL), the sea turtles increased their swimming activity, and above 175 dB re 1 µPa they began to behave erratically, which was interpreted as an agitated state. The 166 dB re 1 µPa level has been used as the threshold level for a behavioural response by NMFS and applied in the Arctic Programmatic Environment Impact Statement (PEIS) (NSF 2011). In addition the 175 dB re 1 µPa level from McCauley et al. (2000) is recommended as a criterion for behavioural disturbance. The Recovery Plan for Marine Turtles in Australia (Department of the Environment and Energy et al. 2017) acknowledges the 166 dB re 1 µPa SPL reported by McCauley et al. (2000) as the level that may result in a behavioural response by marine turtles. These thresholds are shown in Table 9.

Table 9. Acoustic effects of impulsive noise on sea turtles: Unweighted sound pressure level (SPL), 24 hour sound exposure level (SEL_{24h}), and peak pressure (PK) thresholds

Effect type	Criterion	SPL (L_p; dB re 1 µPa)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	PK (L_{pk}; dB re 1 µPa)
Behavioural response	McCauley et al. (2000)	166	NA	
Behavioural disturbance		175		
PTS onset thresholds[1] (received level)	Finneran et al. (2017)	NA	204	232
TTS onset thresholds[1] (received level)			189	226

[1] Dual metric acoustic thresholds for impulsive sounds: Use whichever results in the largest isopleth for calculating PTS and TTS onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds should also be considered.

L_p denotes sound pressure level period and has a reference value of 1 µPa.

$L_{pk,flat}$ denotes peak sound pressure is flat weighted or unweighted and has a reference value of 1 µPa.

L_E denotes cumulative sound exposure over a 24 h assessment period and has a reference value of 1 µPa²s.

3.4. Invertebrates

3.4.1. Benthic Invertebrates (Crustaceans and Bivalves)

Research is ongoing into the relationship between sound and its effects on crustaceans, including the relevant metrics for both effect and impact. Available literature suggests particle motion, rather than sound pressure, is a more important factor for crustacean and bivalve hearing. Water depth and seismic source size are related to the particle motion levels at the seafloor, with larger arrays and shallower water being related to higher particle motion levels, more likely relevant to effects on crustaceans and bivalves.

At the seafloor interface, crustaceans and bivalves are subject to particle motion stimuli from several acoustic or acoustically-induced waves. These include the particle motion associated with an impinging sound pressure wave in the water column (the incident, reflected, and transmitted portions), substrate acoustic waves, and interface waves of the Scholte type. However, it is unclear which aspect(s) of these waves is/are most relevant to the animals, either when they normally sense the environment or their physiological responses to loud sounds, so there is not enough information to establish similar criteria and thresholds as done for marine mammals and fish. Including recent research, such as Day et al. (2016b), current literature does not clearly define an appropriate metric or

identify relevant levels (pressure or particle motion) for an assessment. This includes the consideration of what particle motion levels lead to a behavioural response, or mortality. Therefore, at this stage, we cannot propose authoritative thresholds to inform the impact assessment. As there are no specific criteria, here we compare modelled levels with pressure metrics presented in literature to assist the assessment.

The pressure and acceleration examples provided in Day et al. (2016a) indicate that the acceleration and pressure signals occurred simultaneously, which was interpreted as an indication that the waterborne sounds were responsible for the accelerations measured by the geophones. For clarity, it is important to distinguish that the acceleration from waterborne sound energy is *not* ground roll, which Day et al. (2016a) correctly define as the sound that propagates along the interface at a speed lower than the shear wave speed of the sediment. However, the report subsequently uses ground roll for all further discussions of particle acceleration. While Day et al. (2016a) discuss that they chose the simplest measure of ground roll, it should have been referring to as 'the acceleration from waterborne sound energy', or 'waterborne acceleration' for short.

For crustaceans, a PK-PK sound level of 202 dB re 1 µPa (Payne et al. 2008) is considered to be associated with no effect. Pk-Pk sound levels exceeding 202 dB re 1 µPa are therefore assessed here. Additionally for context related to different levels of potential impairment, the PK-PK sound levels of 209-212 dB re 1 µPa determined by Day et al. (2016b) to affect crustaceans, and 213 dB re 1 µPa from Day et al. (2019), are also included.

For bivalves, PK-PK sound levels of 212, and 213 dB re 1 µPa are presented to allow comparison to the maximum sound levels measured in Day et al. (2016a) and Day et al. (2017) for scallops and pearl shell oyster at which behavioural and physiological effects occurred.

3.4.2. Plankton

To assess effects on plankton, there are only a few studies to base threshold criteria on. Popper et al. (2014) cites many of the references and studies on potential impacts of noise emissions on fish eggs and larvae prior to 2014. Results presented in Day et al. (2016b) for embryonic lobsters and Fields et al. (2019) for copepods align with those presented in Popper et al. (2014), which is that mortality and sub-lethal injury are limited to within tens of metres of seismic sources. Additionally, the Popper et al. (2014) criteria (Table 8), are extrapolated from simulated pile driving signals which have a more rapid rise time and greater potential for trauma than pulses from a seismic source.

Other research, such as McCauley et al. (2017), has indicated the potential for effects at longer range and at levels of 178 dB PK-PK, however, Fields et al. (2019) noted that it was difficult to reconcile the high mortality reported by McCauley et al. (2017) with the low mortalities reported in the greater previous body of earlier research and their experiment. They recommended further research into whether it is the sound pulse itself (i.e. the energy, peak pressures, or particle acceleration), the (turbulent) fluid flow occurring more slowly (i.e. not related to the sound pulse), or other effects such as the bubble cloud that which might cause higher mortality near the seismic source.

3.5. Human Health Assessment Threshold

Underwater, the human ear is about 20 dB less sensitive than it is in air at low frequencies (20 Hz), increasing to 40 dB at mid–frequencies (less than 1 kHz), and increasing to 70–80 dB less sensitive at higher frequencies (Parvin 1998). Divers who wear neoprene hoods have even higher hearing thresholds (lower sensitivity) above 500 Hz because the hood material absorbs high–frequency sounds (Sims et al. 1999). Exposure studies related to divers have typically focused on military sonar exposure, with little information on seismic surveys, and as such care is required when considering

thresholds for recreational divers and swimmers, particularly for impulsive sounds such as seismic surveys (Ainslie 2008).

The auditory threshold of hearing under water was lowest at 1 kHz (70 dB re 1 µPa SPL) and increased for lower and higher frequencies to around 120 dB re 1 µPa at 20 Hz and at 20 kHz (Parvin 1998). Fothergill et al. (2000) and Fothergill et al. (2001) conducted controlled acoustic exposure experiments on military divers under fully controlled conditions at a US Ocean Simulation Facility and an US Open water test facility; in all tests, the diver were covered with soft or hard shell dive suits and their position and distance relative to sound source, signal characteristics and received levels were controlled and documented (Pestorius et al. 2009). A total of 89 male Navy divers were exposed to pure tone signals and sweeps between 160–320 Hz at SPLs up to 160 dB re 1 µPa. The divers were exposed to these sounds over 100 seconds at depths from 10 to 40 metres. The divers rated the sounds on a severity scale. For frequencies between 100 and 500 Hz, at a received SPL of 130 dB re 1 µPa, divers and swimmers detected body vibration. None of the divers tested rated levels of 140 dB re 1 µPa as “very severe”; however, at 157 dB re 1 µPa, sound was rated as “very severe” 19 % of the time. No physiological damage was observed at the highest levels tested: 160 dB re 1 µPa (Fothergill et al. 2001). In a subsequent study, recreational divers were exposed to tonal signals or 30 Hz sweeps at frequencies between 100 and 500 Hz at received levels of 130–157 dB re 1 µPa (Pestorius et al. 2009). Each exposure lasted for 7 s. Nine female and 17 male scuba divers were tested, all wearing full body neoprene wetsuits. Diver aversion and perception of body vibration were used as test parameters. The results showed no sex–specific differences. The results differed as a function of frequency – while test results showed a strong overall variation between subjects, signals at 100 Hz elicited the strongest aversion in all tests and even at 148 dB a few diver ratings indicated extreme aversion. Due to this and the strong variation between test subjects, the following exposure limit for both military and recreational divers was suggested as a conservative measure: For frequencies between 100 and 500 Hz, the maximum SPL should be 145 dB re 1 µPa over a maximum continuous exposure of 100 seconds or with a maximum duty cycle of 20 % and a maximum daily cumulative total of 3 h. The trading relation between the maximum SPL and duration was 4 dB per doubling of duration (e.g., 141 dB SPL for a 200 second exposure) (Pestorius et al. 2009).

Considering only frequencies between 100 and 500 Hz, Parvin (2005) suggested 145 dB re 1 µPa as a safety criterion for recreational divers and swimmers. Seismic impulses are broadband sources, and therefore, to be precautionary, the 145 dB re 1 µPa SPL suggested by Fothergill et al. (2001) and Parvin (2005) has been applied in this study as a broadband SPL and as a human health assessment threshold for recreational divers and swimmers. This does not imply that this level is associated with the onset of injury.

4. Methods

4.1. Acoustic Source Model

The pressure signature of the individual airguns and the composite decidecade bands point-source equivalent directional levels (i.e., source levels) of the four seismic sources were modelled with JASCO's Airgun Array Source Model (AASM). Although AASM accounts for notional pressure signatures of each seismic source with respect to the effects of surface-reflected signals on bubble oscillations and inter-bubble interactions, the surface-reflected signal (known as surface ghost) is not included in the far-field source signatures. The acoustic propagation models account for those surface reflections, which are a property of the propagating medium rather than the source.

AASM considers:

- Array layout.
- Volume, tow depth, and firing pressure of each airgun.
- Interactions between different airguns in the array.

All seismic sources considered were modelled over AASM's full frequency range, up to 25 kHz. Appendix B.1 details this model.

4.2. Environmental Parameters

The specifications of the environmental parameters used in the propagation models are described in detail in Appendix D. A single sound speed profile for June was considered in this modelling study; this was identified as the seasonal period that was likely to result in the farthest propagation (Appendix D.3.2) due to the presence of a slightly upward refracting sound speed profile.

Seabed sediments in the operational area were modelled as a single seabed type. The seabed was modelled as unconsolidated sediment transitioning to more compact and cemented sediments deeper below the seafloor, see Table D-1.

4.3. Sound Propagation Models

Three sound propagation models were used to predict the acoustic field around the seismic source:

- Combined range-dependent parabolic equation and Gaussian beam acoustic ray-trace model (MONM-BELLHOP, 5 Hz to 25 kHz).
- Full Waveform Range-dependent Acoustic Model (FWRAM, 5 to 1024 Hz).
- Wavenumber integration model (VSTACK, 5 to 1024 Hz).

The models were used in combination to characterise the acoustic fields at short and long ranges in terms of SEL, SPL, PK, and PK-PK. Appendix C provides further detailed information about each model.

MONM-BELLHOP was used to calculate SEL of a 360° area around each source location. FWRAM was used to model synthetic seismic pulses and to calculate water column PK and PK-PK levels. FWRAM was also used to generate a generalised SEL to SPL conversion function for the considered modelled sites. The conversion function was applied to predicted per-pulse SEL results from MONM-BELLHOP to estimate SPL values.

VSTACK was used to calculate close range PK, PK-PK, and particle motion levels along transects at the seafloor along the endfire and broadside directions of the seismic source at three water depths, 83, 96.5, and 110 m.

4.4. Geometry and Modelled Regions

To assess sound levels with MONM-BELLHOP, the sound field modelling calculated propagation losses up to distances of 100 km from the source in each cardinal direction, with a horizontal separation of 20 m between receiver points along the modelled radials. The sound fields were modelled with a horizontal angular resolution of $\Delta\theta = 2.5°$ for a total of N = 144 radial planes. The single-impulse sound fields were modelled within a 100 × 100 km box area. Receiver depths were chosen to span the entire water column, from 2 m to a maximum of 150 m, with step sizes that increased with depth. To supplement the MONM results, high-frequency propagation loss was modelled using BELLHOP for frequencies from 1.25 to 25 kHz. The MONM and BELLHOP results were combined to produce results for the full frequency range of interest.

FWRAM was run to 100 km with a 20 m receiver range step, which increases with distance from the source along four radials (fore and aft endfire, and port and starboard broadside). This was done to compute SEL-to-SPL conversions (Appendix D.2) but also to quantify water column PK and PK-PK.

The maximum modelled range for VSTACK was 1000 m, and a variable receiver range increment that increased away from the source was used, which increased from 10 to 25 m. Received levels were computed for receiver depths at 5 and 50 cm above the seafloor.

4.5. Accumulated SEL

During a seismic survey, new sound energy is introduced into an environment with each pulse from the seismic source. While some impact criteria are based on the per-pulse energy released, others, such as the marine mammal and fish SEL criteria used in this report (Section 3), account for the total acoustic energy marine fauna is subjected to over a specified duration. The duration is defined in this report as 24 hours. An accurate assessment of the accumulated sound energy depends not only on the parameters of each seismic impulse but also on the number of impulses delivered in a duration and the relative positions of the impulses.

When there are many seismic impulses, it becomes computationally prohibitive to perform sound propagation modelling for every single event. When the distance between the consecutive seismic impulses is small enough, such that the environmental parameters that influence sound propagation are virtually the same for many impulse points. The acoustic fields can, be modelled for a subset of seismic pulses and estimated at several adjacent ones. After sound fields from representative impulse locations are calculated, they are adjusted to account for the source position for nearby impulses.

Estimating the cumulative sound field with the described approach is not as precise as modelling sound propagation at every impulse location, small-scale, site-specific sound propagation features tend to blur and become less relevant when sound fields from adjacent impulses are summed. Larger scale sound propagation features, primarily dependent on water depth, dominate the cumulative field. The accuracy of the present method acceptably reflects those large-scale features, thus providing a meaningful estimate of a wide area SEL field in a computationally feasible framework.

To produce the map of accumulated received sound level distributions and calculate distances to specified sound level thresholds, the maximum-over-depth and seafloor levels were calculated at each sampling point within the modelled region. The radial grids of maximum-over-depth and seafloor sound levels for each impulse were then resampled (by linear triangulation) to produce a regular Cartesian grid. The sound field grids from all impulses were summed (see Equation A-5) to produce

the cumulative sound field grid with cell sizes of 20 m. The contours and threshold ranges were calculated from these flat Cartesian projections of the modelled acoustic fields.

The unweighted (fish) and frequency-weighted SEL_{24h} results were rendered as contour maps, including contours that focus on the relevant criteria-based thresholds. Only contours at ranges larger than the nearfield of the seismic source were rendered.

5. Results

5.1. Acoustic Source Levels and Directivity

AASM (Section B.1) was used to predict the horizontal and vertical overpressure signatures and corresponding power spectrum levels for the seismic source, with results provided in Appendix B.2 along with the horizontal directivity plots for the selected source.

Table 10 shows the PK and per-pulse SEL source levels in the horizontal-plane broadside (perpendicular to the tow direction), endfire (along the tow direction), and vertical directions for the modelled array signature (a 3050 in^3 seismic source). The vertical source level that accounts for the "surface ghost" (the out of phase reflected pulse from the water surface) is also presented to make it easier to compare the output of other seismic source models.

Figure B-2 in Appendix B.2 shows the broadside, endfire, and vertical overpressure signature and corresponding power spectrum levels for the source. The signature consists of a strong primary peak, related to the initial release of high-pressure air, followed by a series of pulses associated with bubble oscillations. Most energy was produced at frequencies below 500 Hz. Frequency-dependent peaks and nulls in the spectrum result from interference among airguns in the source and correspond with the volumes and relative locations of the airguns to each other.

Table 10. Far-field source level specifications for 3050 in^3 sources, for an 8 m tow depth. Source levels are for a point-like acoustic source with equivalent far-field acoustic output in the specified direction. Sound level metrics are per-pulse and unweighted.

Direction	Peak source pressure level ($L_{S,pk}$; dB re 1 µPa m)	Per-pulse source SEL ($L_{S,E}$; dB 1 μPa^2m^2s)	
		10-2000 Hz	2000-25000 Hz
Broadside	248.3	224.4	185.6
Endfire	247.7	224.8	188.2
Vertical	258.2	230.7	196.5
Vertical (surface affected source level)	258.2	233.0	199.5

5.2. Per-Pulse Sound Fields

This section presents the per-pulse sound fields in terms of maximum-over-depth SPL, SEL, PK, and seafloor PK and PK-PK. The different metrics are presented for the following reasons:

- SPL sound fields were used to determine the distances to marine mammal and turtle behavioural thresholds and the human health assessment threshold (see Sections 3, 3.1 and 3.3).
- Per-pulse SEL sound fields are used as inputs into the 24 h SEL scenario and to provide context for the range to 160 dB re 1 $\mu Pa^2 \cdot s$, relevant for the EPBC Act Policy Statement 2.1 (DEWHA 2008).
- PK metrics within the water column are relevant to thresholds and guidelines for marine mammals, sea turtles, fish, fish eggs and larvae (as well as plankton; Sections 3.1-3.3).
- PK metrics at the seafloor are relevant to guidelines for fish, fish eggs and larvae (Section 3.2) and the sound level for effects on corals and sponges.

- PK-PK metrics at the seafloor are relevant to sound levels used in the assessment of effect on benthic invertebrates (Section 3.4.1).

The maximum and 95% distances to per-pulse SEL and SPL metrics are presented in Table 11 and Table 12. The SPL sound fields, and distances to relevant isopleths can be visualised on the contour maps presented in Figures 3–8 and Appendix F.1. The SPL sound fields are also presented as vertical slices for selected sites along the endfire and broadside directions out to 13 km, with the airgun array in the centre (Figures 9–14).

Maximum distances to maximum-over-depth water column PK thresholds were calculated for all six single impulse sites, Sites 1 to 6, and are presented in Table 13. Seafloor sound levels were assessed at three different representative depths within the Active Source Area (83, 96.5, and 110 m) and Tables 14 and 15 present the PK and PK-PK results.

Section 5.2.1.3 presents the modelled received sound levels for each of the five sensitive receivers identified in Section 2.1.

5.2.1. Tabulated Results

5.2.1.1. Entire Water Column

Table 11. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) from the seismic source to modelled maximum-over-depth and maximum-over-azimuth unweighted per-pulse sound exposure level (SEL) isopleths from the modelled single impulse sites, with the water depth indicated.

Per-pulse SEL (L_E; dB re 1 µPa²·s)	Site 1 (100 m)		Site 2 (102 m)		Site 3 (95 m)		Site 4 (84 m)		Site 5 (110 m)		Site 6 (83 m)	
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
190	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
180	0.23	0.22	0.23	0.22	0.26	0.20	0.27	0.24	0.20	0.19	0.27	0.23
170	1.05	0.89	1.01	0.88	1.08	0.86	1.11	0.93	1.01	0.89	1.15	0.95
160[1]	4.65	3.71	4.77	3.73	4.48	3.55	4.36	3.63	4.22	3.51	4.71	3.77
150	11.9	9.83	12.0	9.74	12.7	9.82	12.2	9.57	12.2	9.43	12.7	10.1
140	29.3	23.6	28.8	23.5	30.6	23.7	31.2	24.2	27.7	22.5	32.3	26.3
130	77.4	60.6	83.2	63.9	92.3	72.6	102.6	78.9	75.7	60.2	113.2	82.7

[1] Low power zone assessment criteria DEWHA (2008).

Table 12. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) from the seismic source to modelled maximum-over-depth and maximum-over-azimuth per-pulse sound pressure level (SPL) isopleths from the modelled single impulse sites, with the water depth indicated.

SPL (L_p; dB re 1 µPa)	Site 1 (100 m)		Site 2 (102 m)		Site 3 (95 m)		Site 4 (84 m)		Site 5 (110 m)		Site 6 (83 m)	
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
200	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
190	0.20	0.18	0.19	0.17	0.20	0.18	0.21	0.19	0.18	0.17	0.21	0.20
180	0.88	0.80	0.89	0.79	0.87	0.80	0.94	0.82	0.88	0.81	0.96	0.78
175[1]	1.96	1.74	2.01	1.73	2.14	1.66	2.12	1.77	1.84	1.66	2.26	1.82
170	3.81	3.07	3.86	3.09	4.08	3.24	4.18	3.24	3.45	2.93	3.99	3.31
166[2]	5.99	4.72	6.12	4.75	5.85	4.74	5.55	4.63	5.37	4.42	5.95	4.80
160[3]	9.74	8.01	9.70	7.97	10.4	8.30	10.4	8.06	9.75	7.78	11.0	8.63
150	25.8	20.5	25.1	20.1	26.8	21.0	27.1	20.9	24.0	19.4	27.9	22.8
145[4]	39.7	31.9	41.4	33.2	43.9	34.3	46.7	36.4	39.9	30.9	47.8	38.6
140	68.6	53.0	71.1	55.2	81.5	64.0	88.2	68.3	71.3	55.4	97.4	71.8

[1] Threshold for turtle behavioural disturbance from impulsive noise (McCauley et al. 2000).
[2] Threshold for turtle behavioural response to impulsive noise (McCauley et al. 2000, NSF 2011).
[3] Marine mammal behavioural threshold for impulsive sound sources (NOAA 2019).
[4] Human health assessment threshold derived from Parvin (2005).

Table 13. Maximum (R_{max}) horizontal distances (in km) from the seismic source to modelled maximum-over-depth peak pressure level (PK) thresholds based on Southall et al. (2019) for marine mammals, and Popper et al. (2014) for fish and Finneran et al. (2017) for sea turtles, at the modelled single impulse sites, with the water depth indicated.

Hearing group	PK threshold (L_{pk}; dB re 1 µPa)	Distance R_{max} (km)					
		Site 1 (100 m)	Site 2 (102 m)	Site 3 (95 m)	Site 4 (84 m)	Site 5 (110 m)	Site 6 (83 m)
Low-frequency cetaceans (PTS)	219	0.04	0.04	0.04	0.04	0.04	0.04
Low-frequency cetaceans (TTS)	213	0.07	0.07	0.07	0.07	0.07	0.07
High-frequency cetaceans (PTS)	230	–	–	–	–	–	–
High-frequency cetaceans (TTS)	224	–	–	–	–	–	–
Very-high-frequency cetaceans (PTS)	202	0.36	0.36	0.37	0.36	0.36	0.36
Very-high-frequency cetaceans (TTS)	196	0.70	0.70	0.69	0.73	0.70	0.73
Sirenians (PTS)	226	–	–	–	–	–	–
Sirenians (TTS)	220	0.03	0.03	0.03	0.03	0.03	0.03
Sea Turtles (PTS)	232	–	–	–	–	–	–
Sea Turtles (TTS)	226	–	–	–	–	–	–
Fish: No swim bladder (also applied to sharks)	213	0.07	0.07	0.07	0.07	0.07	0.07
Fish: Swim bladder not involved in hearing, Swim bladder involved in hearing Fish eggs, and larvae	207	0.17	0.17	0.15	0.15	0.17	0.15

A dash indicates the threshold is not reached within the limits of the modelling resolution (20 m).

5.2.1.2. Seafloor

Ranges presented at the seafloor (50 cm above the interface) provided in Tables 14 and 15 are different to those for the maximum-over-depth modelling results presented in Table 13. This is because the model used for the water column results, calculated using FWRAM (Appendix C.2) do not represent the maximum sound levels at the seafloor close to the array. This is because FWRAM is based on a wide-angle parabolic equation (PE) algorithm which is valid to only approximately 70° down angle from the horizontal, and while it provides accurate predictions in the horizontal direction, it cannot predict sound levels directly under the array. The VSTACK model (Appendix C.3) is used to determine the levels at the seafloor directly under the array, and due to seafloor interactions, these can be greater than those elsewhere in the water column.

Table 14. Maximum (R_{max}) horizontal distances (in m) from the seismic source to modelled seafloor (receiver located 50 cm above seafloor) peak pressure level thresholds (PK) at three water depths (83 m, 96.5 m and 110 m) within the Active Source Zone.

Hearing group/animal type	PK threshold (L_{pk}; dB re 1 µPa)	Distance R_{max} (m)		
		83 m	96.5 m	110 m
Sponges and corals[1]	226	*	*	*
Fish: No swim bladder (also applied to sharks)	213	76	70	69
Fish: Swim bladder not involved in hearing, Swim bladder involved in hearing Fish eggs, and larvae	207	200	192	186

[1] Heyward et al. (2018)
An asterisk indicates that the sound level was not reached.

Table 15. Maximum (R_{max}) horizontal distances (in m) from the seismic source to modelled seafloor (receiver located 5 cm above seafloor) peak-peak pressure levels (PK-PK) at three water depths (83 m, 96.5 m and 110 m) within the Active Source Area. Results included in relation to benthic invertebrates (Section 3.4).

PK-PK ($L_{pk\text{-}pk}$; dB re 1 µPa)	Distance R_{max} (m)		
	83 m	96.5 m	110 m
213[1,2,3]	162	166	169
212[2,3]	187	182	190
210[1,2]	270	253	241
209[1,2]	300	289	290
202[4]	673	512	538

[1] Day et al. (2019), negative effects on lobster
[2] Day et al. (2016a), negative effects on lobster and scallops
[3] Day et al. (2017), negative effects on scallops
[4] Payne et al. (2008), sub-lethal effects on lobster

5.2.1.3. Sound Levels at Sensitive Receivers

The received per-pulse SPL sound levels at the sensitive receiver sites identified in Section 2.1 are provided in Table 16. The distance between Receiver 2, Australian snubfin dolphin BIA, and Site 4 (the closest single impulse modelling site) is 138 km. The level provided for Receiver 2 in Table 16 is the level at 70 km along the azimuth from modelling Site 4 to Receiver 2; the actual received level at Receiver 2 will therefore be less than this value.

Table 16. Maximum-over-depth received sound levels (SPL) at the sensitive receivers outlined in Section 2.1, along with the distance between the receiver and the closest modelled site.

Receiver ID	Sensitive receiver	SPL (L_p; dB re 1 µPa)	Distance between receiver and closest site (km)
1	Australian snubfin dolphin BIA	134.5	110
2	Australian snubfin dolphin BIA	< 131.0	138
3	Flatback turtle inter-nesting buffer BIA	129.8	70
4	Pinnacles of the Bonaparte Basin KEF	156.3	13
5	Carbonate bank and terrace system of the Sahul Shelf KEF	148.7	20

5.2.2. Sound Field Maps and Graphs

5.2.2.1. Sound Level Contour Maps

Sound level contour maps of SPL are included in this section for a tow azimuth of 131°, which generally resulted in larger maximum over depth sound fields than a tow azimuth of 311°.

Per-pulse SEL maps for a tow azimuth of 131° can be found in Appendix F.1 (corresponding results for a tow azimuth of 311° are not presented as these were generally smaller).

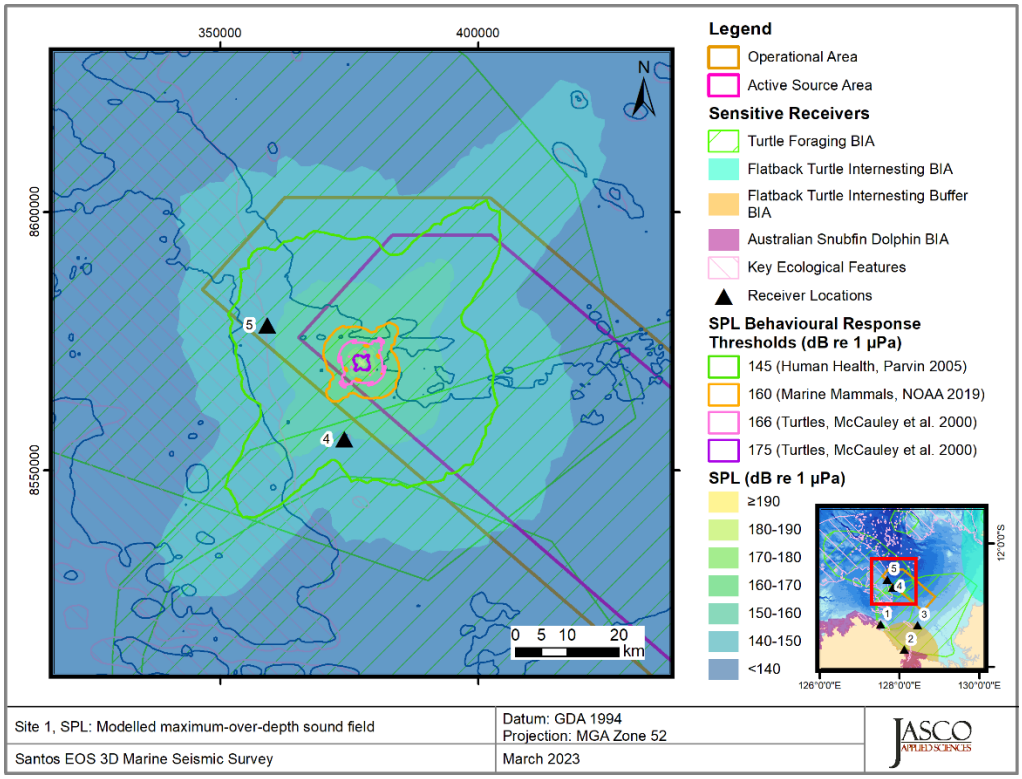


Figure 3. *Site 1, tow azimuth 131°, SPL*: Sound level contour map of unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response thresholds for marine mammals, turtles and human health.

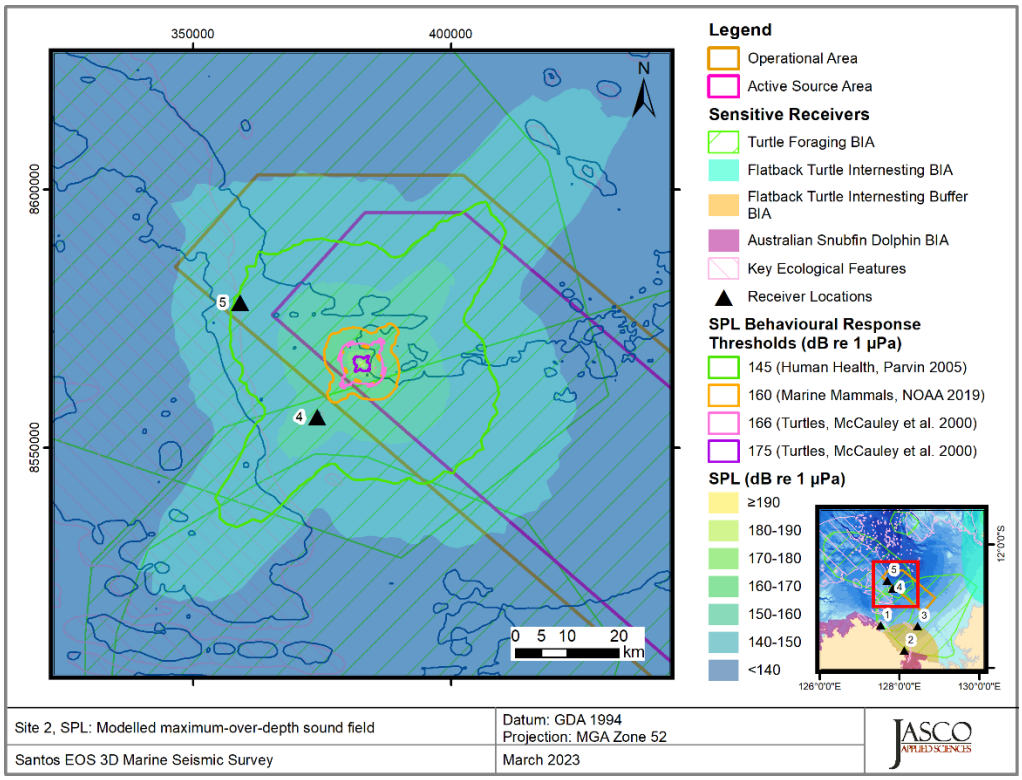


Figure 4. *Site 2, tow azimuth 131°, SPL*: Sound level contour map of unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response thresholds for marine mammals, turtles and human health.

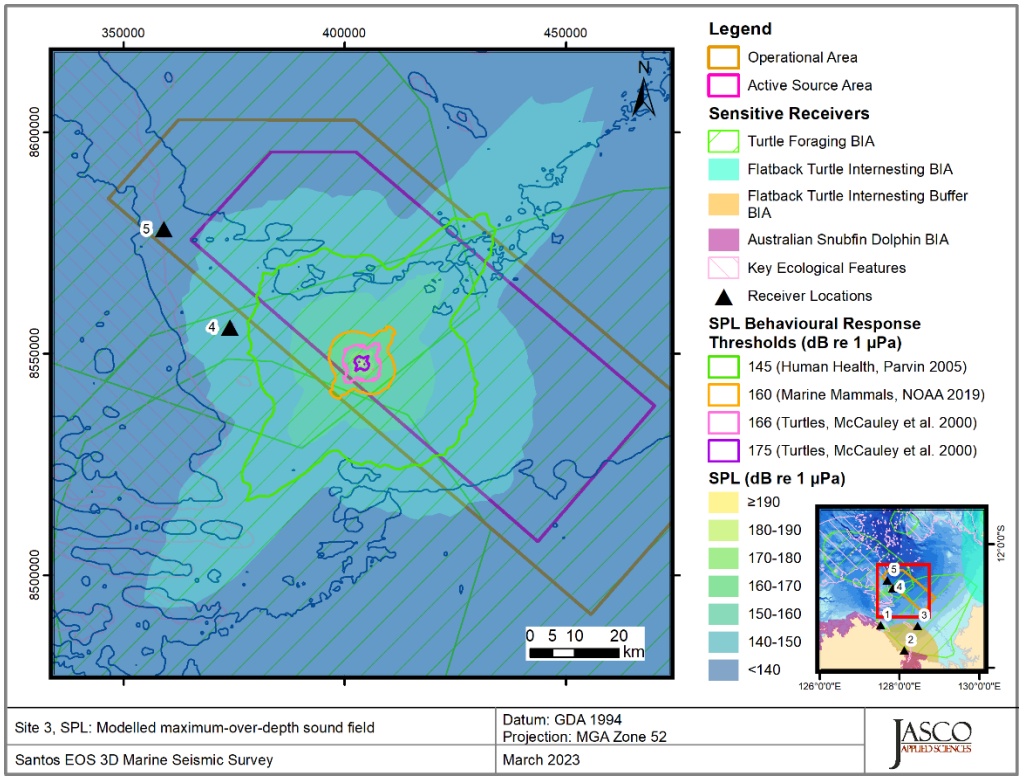


Figure 5. *Site 3, tow azimuth 131°, SPL*: Sound level contour map of unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response thresholds for marine mammals, turtles and human health.

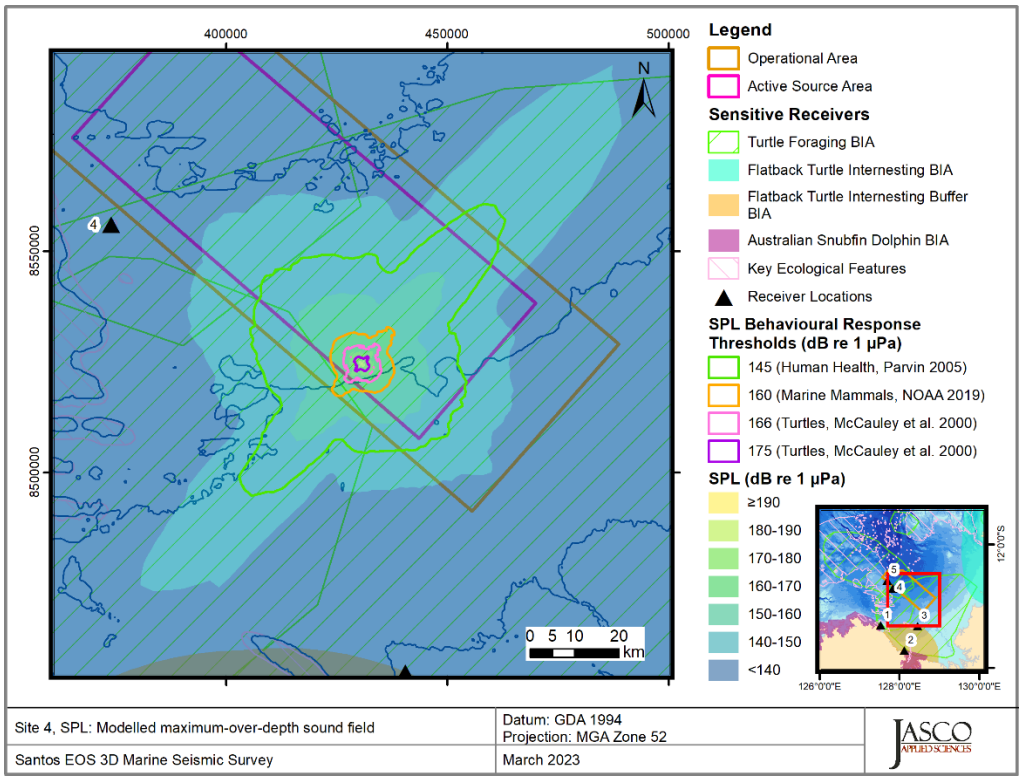


Figure 6. *Site 4, tow azimuth 131°, SPL*: Sound level contour map of unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response thresholds for marine mammals, turtles and human health.

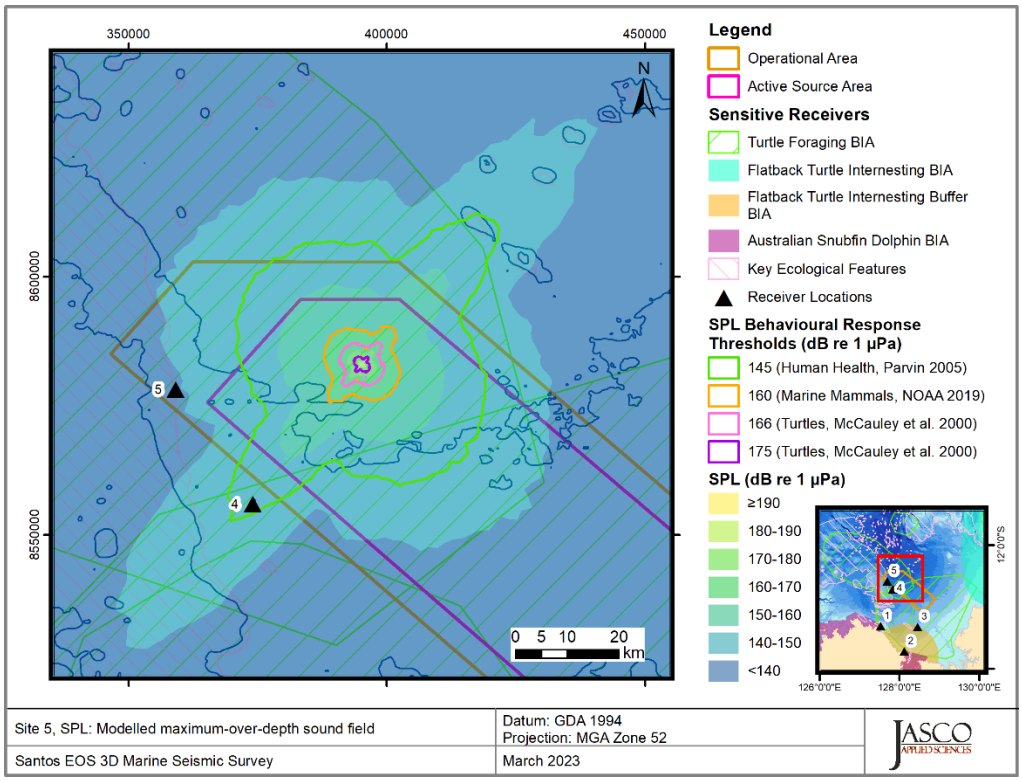


Figure 7. *Site 5, tow azimuth 131°, SPL*: Sound level contour map of unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response thresholds for marine mammals, turtles and human health.

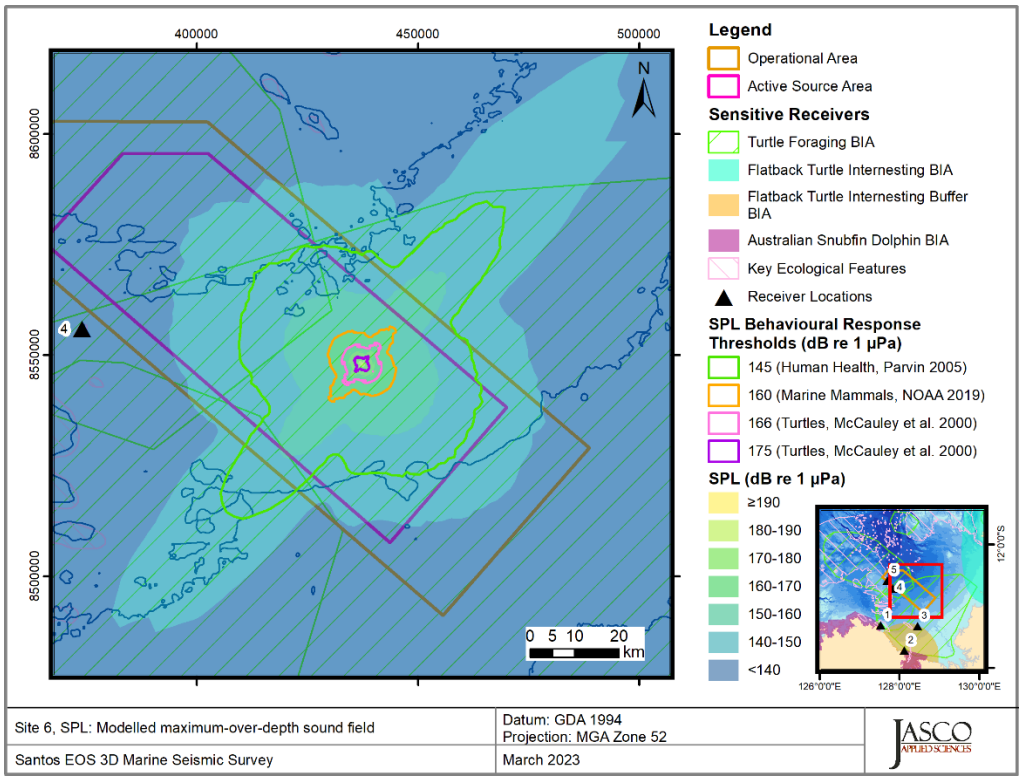


Figure 8. *Site 6, tow azimuth 131°, SPL*: Sound level contour map of unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response thresholds for marine mammals, turtles and human health.

5.2.2.1. Vertical Slices of Modelled Sound Fields

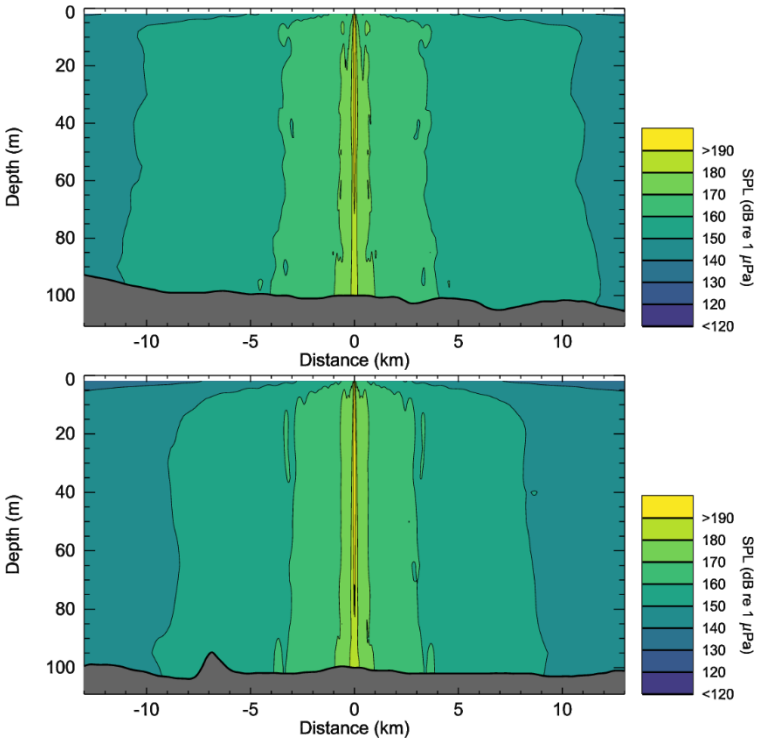


Figure 9. *Site 1, tow azimuth 131°, SPL*: Sound level contours in vertical slice of the sound field, perpendicular to (41°, broadside, top) and along the tow direction (131°, endfire, bottom). The positive distance direction in each slice is 90° clockwise from the tow azimuth for broadside, and the tow azimuth for the endfire slice.

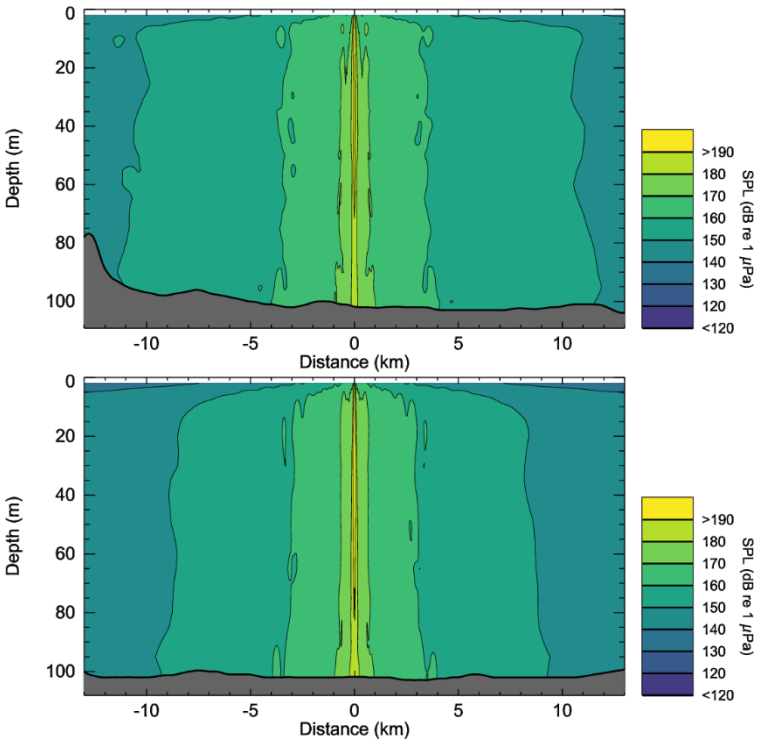


Figure 10. *Site 2, tow azimuth 131°, SPL*: Sound level contours in vertical slice of the sound field, perpendicular to (41°, broadside, top) and along the tow direction (131°, endfire, bottom). The positive distance direction in each slice is 90° clockwise from the tow azimuth for broadside, and the tow azimuth for the endfire slice.

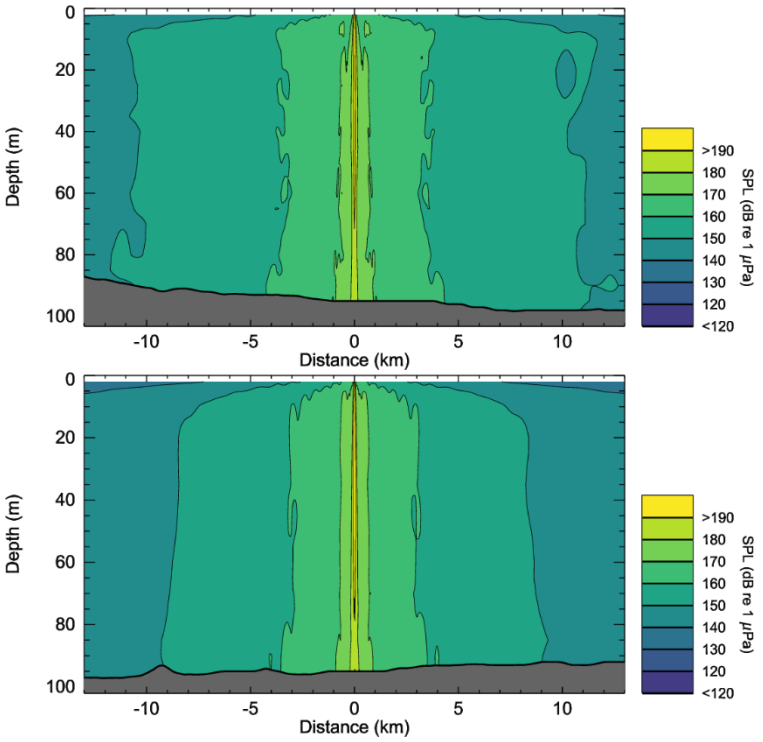


Figure 11. *Site 3, tow azimuth 131°, SPL*: Sound level contours in vertical slice of the sound field, perpendicular to (41°, broadside, top) and along the tow direction (131°, endfire, bottom). The positive distance direction in each slice is 90° clockwise from the tow azimuth for broadside, and the tow azimuth for the endfire slice.

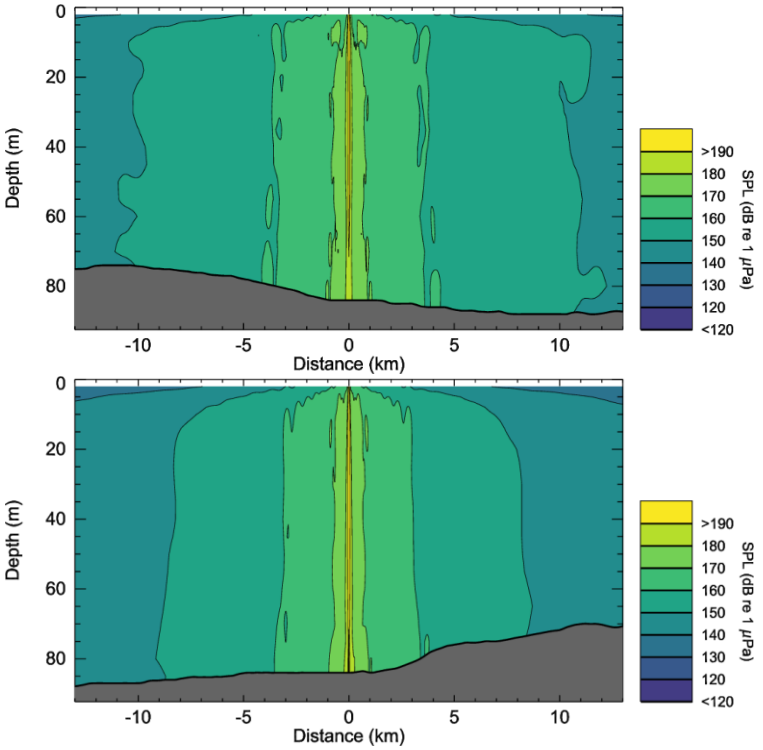


Figure 12. *Site 4, tow azimuth 131°, SPL*: Sound level contours in vertical slice of the sound field, perpendicular to (41°, broadside, top) and along the tow direction (131°, endfire, bottom). The positive distance direction in each slice is 90° clockwise from the tow azimuth for broadside, and the tow azimuth for the endfire slice.

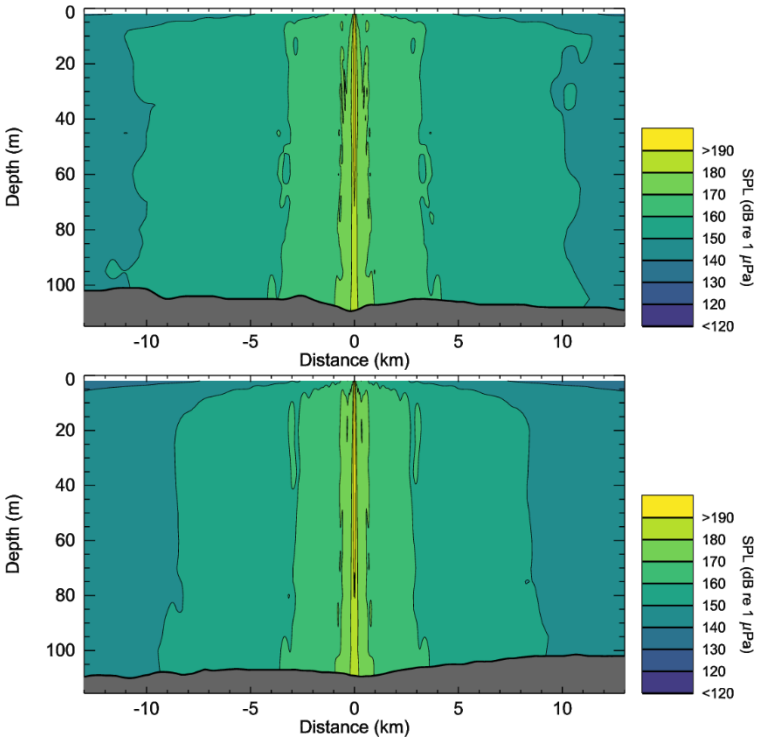


Figure 13. *Site 5, tow azimuth 131°, SPL*: Sound level contours in vertical slice of the sound field, perpendicular to (41°, broadside, top) and along the tow direction (131°, endfire, bottom). The positive distance direction in each slice is 90° clockwise from the tow azimuth for broadside, and the tow azimuth for the endfire slice.

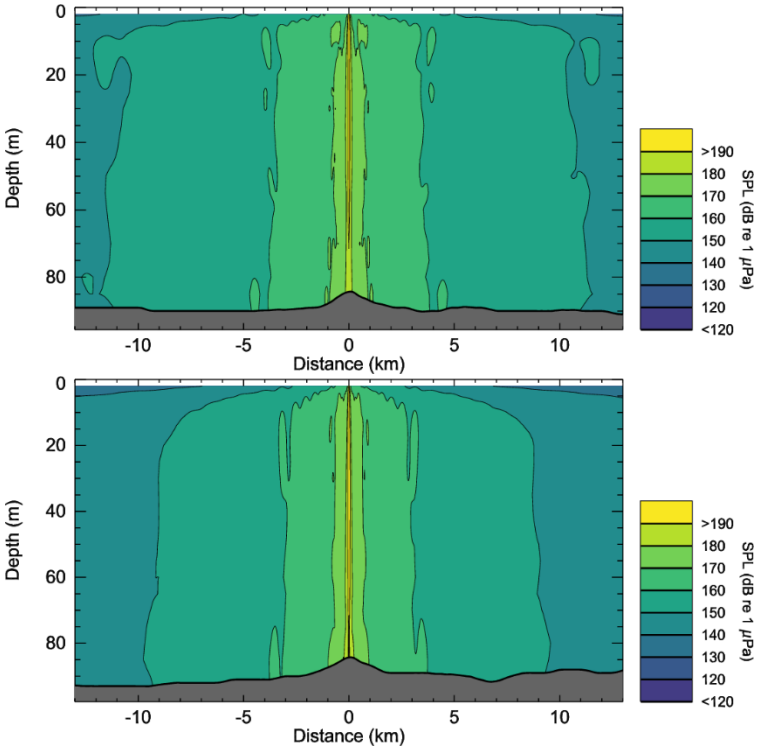


Figure 14. *Site 6, tow azimuth 131°, SPL*: Sound level contours in vertical slice of the sound field, perpendicular to (41°, broadside, top) and along the tow direction (131°, endfire, bottom). The positive distance direction in each slice is 90° clockwise from the tow azimuth for broadside, and the tow azimuth for the endfire slice.

5.3. Multiple Pulse Sound Fields

This section presents the sound fields in terms of SEL accumulated over 24 h of survey, for the modelled scenario (Section 2). Frequency-weighted SEL_{24h} sound fields were used to estimate the maximum and 95% distances (R_{max} and $R_{95\%;}$ calculated as detailed in Appendix D.1) to marine mammals and turtle PTS and TTS thresholds (listed in Table 17), and to estimate maximum distance and the area to injury and TTS guidelines for fish (Table 18).

The SEL_{24h} sound fields are presented as a contour map in Figure 15 for the modelled scenario. The figure presents the unweighted SEL_{24h} in 10 dB steps, as well as the isopleths corresponding to thresholds or guidelines for which R_{max} is greater than 20 m.

Section 5.3.1.1 presents the modelled received sound levels for each of the five sensitive receivers identified in Section 2.1.

5.3.1. Tabulated Results

Table 17. Maximum-over-depth distances (in km) to frequency-weighted 24 hour sound exposure level (SEL_{24h}) based permanent threshold shift (PTS) and temporary threshold shift (TTS) for marine mammals (Southall et al. 2019) and sea turtles (Finneran et al. 2017) using the 3050 in^3 array. Maximum extents are in the broadside direction.

Hearing group	Threshold for SEL_{24h} ($L_{E,24h}$; dB re 1 $\mu Pa^2 \cdot s$)	Scenario 1	
		R_{max} (km)	Area (km^2)
PTS			
Low-frequency cetaceans	183	5.28	1275
High-frequency cetaceans	185	-	-
Very-high-frequency cetaceans	155	0.10	4.88
Sea turtles	204	0.10	4.88
Sirenians	190	-	-
TTS			
Low-frequency cetaceans	168	80.7	12338
High-frequency cetaceans	170	0.10	3.54
Very-high-frequency cetaceans	140	0.75	180
Sea turtles	189	3.24	689
Sirenians	175	0.10	3.74

A dash indicates the threshold was not reached within the limits of the modelling resolution (20 m).

Table 18. Distances to 24 hour sound exposure level (SEL_{24h}) based fish criteria in the water column and at the seafloor for the 3050 in^3 seismic source.

Marine fauna group	Threshold for SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	Scenario 1			
		Maximum-over-depth		Seafloor	
		R_{max} (km)	Area (km²)	R_{max} (km)	Area (km²)
Mortality and potential mortal injury					
I	219	0.10	4.15	*	*
II, fish eggs and fish larvae	210	0.10	4.88	*	*
III	207	0.10	4.88	*	*
Fish recoverable injury					
I	216	0.10	4.88	*	*
II, III	203	0.12	30.3	0.10	19.2
Fish temporary threshold shift (TTS)					
I, II, III	186	7.11	1616	6.40	1515

Fish I-No swim bladder;
Fish II-Swim bladder not involved with hearing;
Fish III-Swim bladder involved with hearing.
An asterisk indicates that the threshold was not reached.

5.3.1.1. Sound Levels at Sensitive Receivers

Table 19. Maximum-over-depth received sound levels at the sensitive receivers outlined in Section 2.1. SEL_{24h} values for Receivers 1 and 2 are weighted for HF-cetaceans, and Receiver 3 is weighted for turtles (refer Appendix A.4).

Receiver ID	Sensitive receiver	Species Group(s)	SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)
1	Australian snubfin dolphin BIA	High Frequency Cetacean	120.3 (weighted)
2	Australian snubfin dolphin BIA	High Frequency Cetacean	< 119.5 (weighted)
3	Flatback turtle internesting buffer BIA	Turtle	154.8 (weighted)
4	Pinnacles of the Bonaparte Basin KEF	Fish and Benthic Invertebrates	180.5 (unweighted)
5	Carbonate bank and terrace system of the Sahul Shelf KEF	Fish and Benthic Invertebrates	173.7 (unweighted)

5.3.2. Sound Level Contour Map

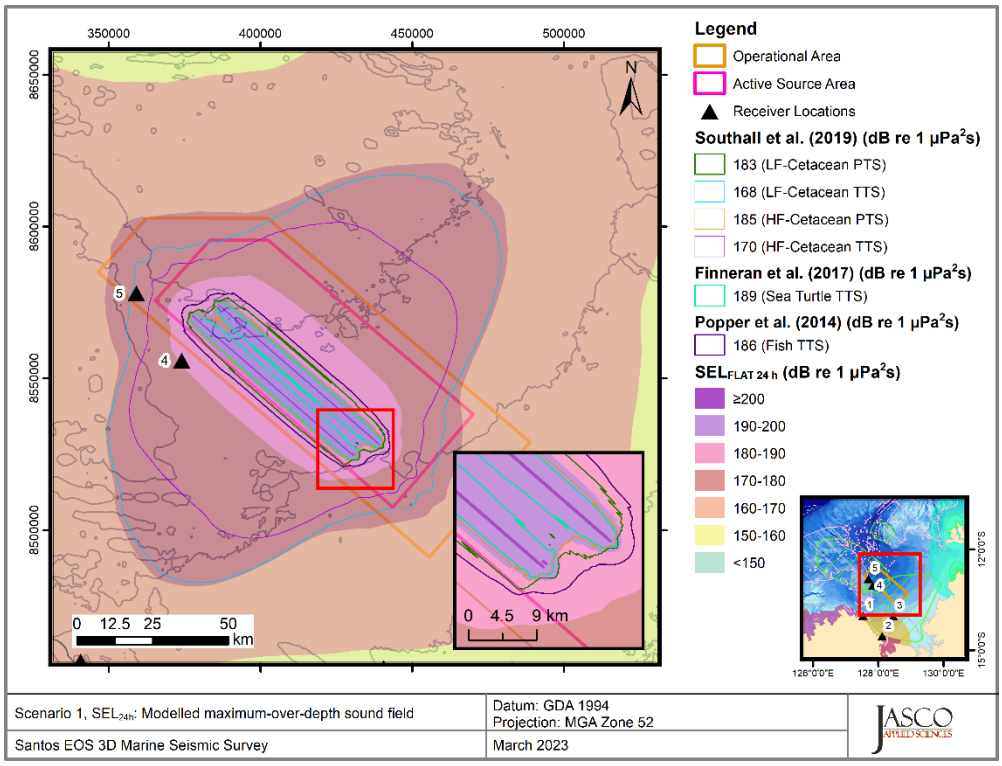


Figure 15. Sound level contour map of unweighted maximum-over-depth SEL_{24h} results for Scenario 1, along with isopleths for cetaceans, turtles and fish. Thresholds omitted here were not reached or not large enough to display graphically. Refer to Tables 17 and 18 for threshold distances.

6. Discussion

6.1. Overview and Source Levels

This modelling study predicted underwater sound levels associated with the planned Santos Eos 3D Marine Seismic Survey. The underwater sound field was modelled for a 3050 in^3 seismic source (Appendix B.2). Modelling accounted for site-specific bathymetric variations (Appendix D.3.1) and local geoacoustic properties (Appendix D.3.3).

An analysis of seasonal sound speed profiles indicated that June was the month most likely to be the most conducive to sound propagation due to the presence of an upward refracting layer near the sea surface; as such it was selected as part of a conservative approach to estimating distances to received sound level thresholds (Appendix D.3.2). When sound waves interact with the seabed, some of their energy is reflected, whilst some is transmitted and attenuated. The presence of the upward refracting layer has the potential refract energy away from the seabed to trap sound at higher frequencies that would otherwise dissipate more rapidly with range due to propagation, absorption, and seabed losses.

The overall broadband (10-25000 Hz) unweighted per-pulse SEL source level of the 3050 in^3 seismic source operating at 8 m depth was 224.4 dB 1 μPa^2m^2s in the broadside direction and 224.8 dB 1 μPa^2m^2s in the endfire direction. The peak pressure levels were 248.3 and 247.7 dB re 1 µPa m, respectively (Table 10).

6.2. Per-Pulse Sound Fields

The six modelled single impulse sites encompassed water depths from 83 to 110 m across one defined geological area with a single representative water column profile.

The modelled 3050 in^3 array had a pronounced broadside directivity pattern in the source level decidecade bands between ~125 to 250 Hz (Appendix B.2), which caused a noticeable axial bulge in the modelled acoustic footprints. This, in combination with deeper water depths in a north-westerly direction resulted in generally larger effect radii during tow azimuths of 131°, compared to tow azimuths of 311°. Furthermore, at all single impulse sites the distances to identified isopleths were greater in the broadside direction (NE-SW) than in the endfire direction (NW-SE), which is apparent in all contour maps in Section 5.2.2.1.

Most acoustic energy from a seismic source is output at lower frequencies, in the tens to hundreds of hertz. In shallow waters, the long wavelengths of very low frequency sounds are unable to propagate in the water column and energy is lost to the seabed. The low frequencies that are below the cut-off frequency , which can be calculated based on the water depth, water column sound speed profile (Appendix D.3.2) and seabed sound speed (Appendix D.3.3) (Jensen et al. 2011), cannot propagate to long distance in the water column. In the present study area, the water depth ranges from 83 m to 110 m, which corresponds to very low cut-off frequencies of approximately 10 to 14 Hz. Furthermore, in water depths around 100 m, frequencies of 200-800 Hz are able to propagate optimally (Jensen et al. 2011). Accordingly, the frequencies produced by the seismic source will likely propagate well in the study area considered here.

The distances to PK and PK-PK based criteria (Section 3.2 and 3.4) for fish, benthic crustaceans and bivalves and planktons at the seafloor generally decreased with increasing water depth (Tables 14 and 15). However, distances to these criteria did not always consistently change with increasing depth as any correlation between water depth and threshold distance is related to complex patterns of surface and seabed reflections that affect sound propagation in shallow water Since the threshold distances for these metrics are relatively small, and the water depths at the modelled sites span the water

depths within the survey area, we expect the threshold distances to be representative of the range of distances for all source locations within the region.

The proposed survey area lies within the foraging BIAs for green and olive ridley turtles. Accordingly, there is the potential for foraging turtles to experience sound levels above behavioural response and disturbance thresholds.

The received SPLs at all five identified sensitive receivers were below the quantitative behavioural response/disturbance thresholds for marine mammals and turtles. Corresponding thresholds for fish are qualitative and therefore are not addressed here. As has been noted, the distances to criteria for benthic invertebrates are small (less than 700 m), therefore these criteria are not exceeded at the sensitive receiver sites, which are located at least 13 km from the nearest seismic impulse site.

6.3. Multiple Pulse Sound Fields

The accumulated SEL over 24 hours of seismic source operation was modelled considering a representative scenario with a realistic acquisition pattern for the Santos Eos 3D Marine Seismic Survey. The modelling predicted the accumulation of sound energy, considering the change in location and the azimuth of the source at each pulse point, which was used to assess possible injury in marine mammals and the SEL_{24h} based fish and marine mammal criteria.

The footprints and range maxima for all accumulated SEL thresholds within the survey area are primarily influenced by the high levels in the broadside direction and the gradually variations in bathymetry as discussed above.

As the proposed seismic survey area lies within the foraging BIAs for green and olive ridley turtles there is the potential for foraging turtles to experience sound levels above TTS and PTS thresholds. However, the received SEL_{24h} at all five identified sensitive receivers were below their respective TTS and PTS thresholds for marine mammals, turtles and fish.

6.4. Summary

This section presents a summary of the distances to the noise effect criteria applied in this study (Section 3) as relevant to the impact assessment. The effect criteria for impairment of marine mammals, fish and sea turtles use dual metrics (PK and SEL_{24h}), and the longest distance associated with either metric is required to be applied. The longest distance is presented in this summary.

The SEL_{24h} is a cumulative metric that reflects the dosimetric effect of noise levels within 24 h based on the assumption that an animal is consistently exposed to such noise levels at a fixed position. Where the corresponding SEL_{24h} radii are larger than those for peak pressure criteria, they often represent an unlikely worst-case scenario. More realistically, marine mammals, fish and sea turtles would not stay in the same location for 24 hours, but rather a shorter period, depending upon their behaviour and the proximity and movements of the source. Therefore, a reported radius for SEL_{24h} criteria does not mean that marine fauna travelling within this radius of the source will be impaired, but rather that an animal could be exposed to the sound level associated with impairment (either PTS or TTS) if it remained within the ensonified area for 24 h.

Marine mammals

Table 20 summarises the distances to criteria for marine mammals, note that these distances are associated with the broadside aspect of the array.

Table 20. Maximum (R_{max}) horizontal distances (in km) from modelled sites or scenarios to behavioural response thresholds and temporary threshold shift (TTS) and permanent threshold shift (PTS) for marine mammals (SPL levels from Table 12, PK values from Table 13, and SEL_{24h} values from Table 17).

Hearing group	Modelled distance to effect threshold (R_{max})		
	Behavioural response[1]	Impairment: TTS[2]	Impairment: PTS[2]
LF cetaceans	11.0	80.7 (SEL_{24h})	5.28 (SEL_{24h})
HF cetaceans		0.10 (SEL_{24h})	–
VHF cetaceans		0.75 (SEL_{24h})	0.37 (PK)
Sirenians		0.10 (SEL_{24h})	–

Noise exposure criteria: [1] NOAA (2019) and [2] Southall et al. (2019)
A dash indicates the threshold was not reached within the limits of the modelling resolution (20 m).

Sea turtles

- The behavioural response criteria of turtles (166 dB re 1 µPa (SPL)) and the 175 dB re 1 µPa (SPL) threshold for behavioural disturbance (McCauley et al. 2000) could be exceeded at distances of 6.12 km and 2.26 km, respectively.

Table 21 summarises the distances to criteria for sea turtles.

- The PK turtle injury criteria of 232 dB re 1 µPa for PTS and 226 dB re 1 µPa for TTS from Finneran et al. (2017) was not exceeded at a distance longer than 20 m from the acoustic centre of the source.
- The maximum distance to the SEL_{24h} metric was 100 m for PTS onset and 3.24 km for TTS onset (Finneran et al. 2017). As is the case with marine mammals, a reported radius for SEL_{24h} criteria does not mean that turtles travelling within this radius of the source will be injured, but rather that an animal could be exposed to the sound level associated with either PTS or TTS if it remained within the ensonified area for 24 hours.
- The behavioural response criteria of turtles (166 dB re 1 µPa (SPL)) and the 175 dB re 1 µPa (SPL) threshold for behavioural disturbance (McCauley et al. 2000) could be exceeded at distances of 6.12 km and 2.26 km, respectively.

Table 21. Maximum (R_{max}) horizontal distances (in km) from modelled sites or scenarios to behavioural response thresholds and temporary threshold shift (TTS) and permanent threshold shift (PTS) for sea turtles (SPL values from Table 12, PK values from Table 13Table 13 and SEL_{24h} values from Table 17).

Hearing group	Modelled distance to effect threshold (R_{max})			
	Behavioural response[1]	Behavioural disturbance[1]	Impairment: TTS[2]	Impairment: PTS[2]
Sea Turtles	6.12	2.26	3.24	0.10

Noise exposure criteria: [1] McCauley et al. (2000), and [2] Finneran et al. (2017)

Fish, fish eggs, and fish larvae

This modelling study assessed the ranges at the seafloor and in the water column for quantitative criteria based on Popper et al. (2014) and considered both PK and SEL_{24h} metrics associated with mortality and potential mortal injury as well as impairment in the following groups:

- Fish without a swim bladder (also appropriate for sharks in the absence of other information)
- Fish with a swim bladder that do not use it for hearing

- Fish that use their swim bladders for hearing
- Fish eggs and fish larvae

Table 22 summarises the distances to injury criteria for fish, fish eggs, and fish larvae along with the relevant metric and its location in this report. Seafloor sound levels were assessed for three different water depths within the Operation Area (83, 96.5 and 110 m).

Table 22. Summary of maximum fish, fish eggs, and larvae injury and temporary threshold shift (TTS) onset distances for single impulse and 24 hour sound level exposure (SEL_{24h}) modelled scenarios (PK values from Tables 13 and 14 and SEL_{24h} values from Table 18).

Relevant hearing group	Effect criteria	Water column		Seafloor	
		Metric associated with longest distance to criteria	R_{max} (km)	Metric associated with longest distance to criteria	R_{max} (km)
Fish: No swim bladder	Recoverable injury	SEL_{24h}	0.10	PK	0.08
	TTS	SEL_{24h}	7.11	SEL_{24h}	6.40
Fish: Swim bladder not involved in hearing and Swim bladder involved in hearing	Recoverable injury	PK	0.17	PK	0.20
	TTS	SEL_{24h}	7.11	SEL_{24h}	6.40
Fish eggs, and larvae	Injury	SEL_{24h}	0.10	SEL_{24h}	*

Benthic invertebrates, Sponges, Coral, and Plankton

To assist with assessing the potential effects on these receptors, the following results were determined:

- Crustaceans: The sound level of 202 dB re 1 µPa PK-PK from Payne et al. (2008) which is representative of no effects, was considered for seafloor sound levels; the sound level was reached at ranges between 512 and 673 m depending on the modelled site.
- Sponges and coral: The PK sound level at the seafloor directly underneath the seismic source was estimated at three representative water depths and compared to the sound level of 226 dB re 1 µPa PK at which sponges and corals are not visibly affected (Heyward et al. 2018); the threshold was not reached.

Divers

An SPL human health assessment of 145 dB re 1 µPa (SPL; L_p) derived from Parvin (2005) was considered for people swimming and diving and the sound level was reached at ranges between 30.9 and 47.8 km in the broadside direction depending on the modelled site.

Glossary

Unless otherwise stated in an entry, these definitions are consistent with ISO 18405 (2017).

1/3-octave

One third of an octave. *Note*: A 1/3-octave is approximately equal to one decidecade (1/3 oct ≈ 1.003 ddec).

90 % energy time window

The time interval over which the cumulative energy rises from 5 to 95 % of the total pulse energy. This interval contains 90 % of the total pulse energy. Used to compute the 90 % sound pressure level. Unit: second (s). Symbol: T_{90}.

90 % sound pressure level (90 % SPL)

The sound pressure level calculated over the 90 % energy time window of a pulse. Unit: decibel (dB).

absorption

The conversion of sound energy to heat energy. Specifically, the reduction of sound pressure amplitude due to particle motion energy converting to heat in the propagation medium.

acoustic self-noise

Sound at a receiver caused by the deployment, operation, or recovery of a specified receiver, and its associated platform (ISO 18405:2017).

ambient sound

Sound that would be present in the absence of a specified activity (ISO 18405:2017). It is usually a composite of sound from many sources near and far, e.g., shipping vessels, seismic activity, precipitation, sea ice movement, wave action, and biological activity.

attenuation

The gradual loss of acoustic energy from absorption and scattering as sound propagates through a medium. Attenuation depends on frequency—higher frequency sounds are attenuated faster than lower frequency sounds.

audiogram

A graph or table of hearing threshold as a function of frequency that describes the hearing sensitivity of an animal over its hearing range.

auditory frequency weighting

The process of applying an auditory frequency-weighting function. An example for marine mammals are the auditory frequency-weighting functions published by Southall et al. (2007).

auditory frequency-weighting function

Frequency-weighting function describing a compensatory approach accounting for a species' (or functional hearing group's) frequency-specific hearing sensitivity.

azimuth

A horizontal angle relative to a reference direction, which is often magnetic north or the direction of travel. In navigation it is also known as bearing.

background noise

Combination of ambient sound, acoustic self-noise, and, where applicable, sonar reverberation (ISO 18405:2017) that is detected, measured, or recorded with a signal.

bandwidth

A range within a continuous band of frequencies. Unit: hertz (Hz).

broadband level

The total level measured over a specified frequency range. If the frequency range is unspecified, the term refers to the entire measured frequency range.

broadside direction

Perpendicular to the travel direction of a source. Compare with endfire direction.

cetacean

Member of the order Cetacea. Cetaceans are aquatic mammals and include whales, dolphins, and porpoises.

compressional wave

A mechanical vibration wave in which the direction of particle motion is parallel to the direction of propagation. Also called a longitudinal wave. In seismology/geophysics, it's called a primary wave or P-wave. Shear waves in the seabed can be converted to compressional waves in water at the water-seabed interface.

conductivity-temperature-depth (CTD)

Measurement data of the ocean's conductivity, temperature, and depth; used to compute sound speed profiles and salinity.

decade

Logarithmic frequency interval whose upper bound is ten times larger than its lower bound (ISO 80000-3:2006). For example, one decade up from 1000 Hz is 10,000 Hz, and one decade down is 100 Hz.

decibel (dB)

Unit of level used to express the ratio of one value of a power quantity to another on a logarithmic scale. Especially suited to quantify variables with a large dynamic range.

decidecade

One tenth of a decade. Approximately equal to one third of an octave (1 ddec ≈ 0.3322 oct), and for this reason sometimes referred to as a 1/3-octave.

decidecade band

Frequency band whose bandwidth is one decidecade. *Note*: The bandwidth of a decidecade band increases with increasing centre frequency.

delphinid

Member of the family of oceanic dolphins (Delphinidae), composed of approximately 35 extant species, including dolphins, porpoises, and killer whales.

endfire direction

Aligned with the travel direction of a source. Compare with broadside direction.

energy source level

A property of a sound source equal to the sound exposure level measured in the far field plus the propagation loss from the acoustic centre of the source to the receiver position. Unit: decibel (dB). Reference value: 1 μPa^2 m^2 s.

energy spectral density

Ratio of energy (time-integrated square of a specified field variable) to bandwidth in a specified frequency band from f_1 to f_2. In equation form, the energy spectral density E_f is given by: $E_f = 2\int_{f_1}^{f_2} |X(f)|^2 \, \mathrm{d}f / (f_2 - f_1)$ where $X(f)$ is the Fourier transform of the field variable $x(t)$: $X(f) = \int_{-\infty}^{+\infty} x(t) \exp(-2\pi i f t) \, \mathrm{d}t$

The field variable $x(t)$ is a scalar quantity, such as sound pressure. It can also be the magnitude or a specified component of a vector quantity such as sound particle displacement, velocity, or acceleration. The unit of energy spectral density depends on the nature of x, as follows:

- If x = sound pressure: Pa^2 s/Hz
- If x = sound particle displacement: m^2 s/Hz
- If x = sound particle velocity: (m/s)^2 s/Hz
- If x = sound particle acceleration: (m/s^2)^2 s/Hz

Note: The factor of two on the right side of the equation for E_f is needed to express a spectrum that is symmetric about f = 0, in terms of positive frequencies only. See entry 3.1.3.9 of ISO 18405 (2017).

energy spectral density level

The level ($L_{E,f}$) of the energy spectral density (E_f) in a stated frequency band and time window. Defined as: $L_{E,f} = 10\log_{10}(E_f/E_{f,0})$. Unit: decibel (dB). As with energy spectral density, energy spectral density level can be expressed in terms of various field variables (e.g., sound pressure, sound particle displacement). The reference value ($E_{f,0}$) for energy spectral density level depends on the nature of the field variable.

energy spectral density source level

A property of a sound source equal to the energy spectral density level of the sound pressure measured in the far field plus the propagation loss from the acoustic centre of the source to the receiver position. Unit: decibel (dB). Reference value: 1 μPa^2 m^2 s/Hz.

ensonified

Exposed to sound.

equal-loudness-level contour

Curve that shows, as a function of frequency, the sound pressure level required to produce a given loudness for a listener having normal hearing, listening to a specified kind of sound in a specified manner (ANSI S1.1-2013).

far field

The zone where, to an observer, sound originating from an array of sources (or a spatially distributed source) appears to radiate from a single point.

Fourier transform, Fourier synthesis

A mathematical technique which, although it has varied applications, is referenced in a physical data acquisition context as a method used in the process of deriving a spectrum estimate from time-series data (or the reverse process, termed the inverse Fourier transform). A computationally efficient numerical algorithm for computing the Fourier transform is known as the fast Fourier transform (FFT).

frequency

The rate of oscillation of a periodic function measured in cycles per unit time. The reciprocal of the period. Unit: hertz (Hz). Symbol: *f*. 1 Hz is equal to 1 cycle per second.

frequency weighting

The process of applying a frequency-weighting function.

frequency-weighting function

The squared magnitude of the sound pressure transfer function (ISO 18405:2017). For sound of a given frequency, the frequency-weighting function is the ratio of output power to input power of a specified filter, sometimes expressed in decibels. Examples include the following:

- *Auditory frequency-weighting function*: compensatory frequency-weighting function accounting for a species' (or functional hearing group's) frequency-specific hearing sensitivity.
- *System frequency-weighting function*: frequency-weighting function describing the sensitivity of an acoustic recording system, which typically consists of a hydrophone, one or more amplifiers, and an analog-to-digital converter.

functional hearing group

Category of animal species when classified according to their hearing sensitivity, hearing anatomy, and susceptibility to sound. For marine mammals, initial groupings were proposed by Southall et al. (2007), and revised groupings are developed as new research/data becomes available. Revised groupings proposed by Southall et al. (2019) include low-frequency cetaceans, high-frequency cetaceans, very high-frequency cetaceans, phocid carnivores in water, other carnivores in water, and sirenians. See auditory frequency-weighting functions, which are often applied to these groups. Example hearing groups for fish include species for which the swim bladder is involved in hearing, species for which the swim bladder is not involved in hearing, and species without a swim bladder (Popper et al. 2014).

geoacoustic

Relating to the acoustic properties of the seabed.

hearing threshold

For a given species or functional hearing group, the sound level for a given signal that is barely audible (i.e., that would be barely audible for a given individual in the presence of specified **background noise** during a specific percentage of experimental trials).

hertz (Hz)

Unit of frequency defined as one cycle per second. Often expressed in multiples such as kilohertz (1 kHz = 1000 Hz).

high-frequency (HF) cetaceans

See functional hearing group. *Note*: The mid- and high-frequency cetaceans groups proposed by Southall et al. (2007) were renamed high- and very-high-frequency cetaceans, respectively, by Southall et al. (2019).

hydrophone

An underwater sound pressure transducer. A passive electronic device for recording or listening to underwater sound.

hydrostatic pressure

The pressure at any given depth in a static liquid that is the result of the weight of the liquid acting on a unit area at that depth, plus any pressure acting on the surface of the liquid. Unit: pascal (Pa).

intermittent sound

A sound whose level abruptly drops below the **background noise** level multiple times during an observation period.

impulsive sound

Qualitative term meaning sounds that are typically transient, brief (less than 1 s), broadband, with rapid rise time and rapid decay. They can occur in repetition or as a single event. Sources of impulsive sound include, among others, explosives, seismic airguns, and impact pile drivers.

isopleth

A line drawn on a map through all points having the same value of some specified quantity (e.g., sound pressure level isopleth).

knot (kn)

Unit of vessel speed equal to 1 nautical mile per hour.

level

A measure of a quantity expressed as the logarithm of the ratio of the quantity to a specified reference value of that quantity. For example, a value of sound pressure level with reference to 1 μPa^2 can be written in the form *x* dB re 1 μPa^2.

low-frequency (LF) cetaceans

See functional hearing group.

masking

Obscuring of sounds of interest by other sounds at similar frequencies.

median

The 50th percentile of a statistical distribution.

mid-frequency (MF) cetaceans

See functional hearing group. *Note*: The mid-frequency cetaceans group proposed by Southall et al. (2007) was renamed high-frequency cetaceans by Southall et al. (2019).

M-weighting

A set of auditory frequency-weighting functions proposed by Southall et al. (2007).

mysticete

Member of the Mysticeti, a suborder of cetaceans. Also known as baleen whales, mysticetes have baleen plates (rather than teeth) that they use to filter food from water (or from sediment as for grey whales). This group includes rorquals (Balaenopteridae, such as blue, fin, humpback, and minke whales), right and bowhead whales (Balaenidae), and grey whales (*Eschrichtius robustus*).

_N_ percent exceedance level

The sound level exceeded _N_ % of the time during a specified time interval. See also percentile level.

non-impulsive sound

Sound that is not an impulsive sound.

octave

The interval between a sound and another sound with double or half the frequency. For example, one octave above 200 Hz is 400 Hz, and one octave below 200 Hz is 100 Hz.

odontocete

Member of Odontoceti, a suborder of cetaceans. These whales, dolphins, and porpoises have teeth (rather than baleen plates). Their skulls are mostly asymmetric, an adaptation for their echolocation. This group includes sperm whales, killer whales, belugas, narwhals, dolphins, and porpoises.

parabolic equation method

A computationally efficient solution to the acoustic wave equation that is used to model propagation loss. The parabolic equation approximation omits effects of backscattered sound (which are negligible for most ocean-acoustic propagation problems), simplifying the computation of propagation loss.

particle acceleration, particle displacement, particle motion, particle velocity

See sound particle acceleration, sound particle displacement, sound particle motion, sound particle velocity.

peak sound pressure level (PK), zero-to-peak sound pressure level

The level (L_{pk}) of the squared maximum magnitude of the sound pressure (p_{pk}^2) in a stated frequency band and time window. Defined as $L_{\mathrm{pk}} = 10log_{10}(p_{\mathrm{pk}}^2/p_0^2) = 20log_{10}(p_{pk}/p_0)$. Unit: decibel (dB). Reference value (p_0^2) for sound in water: 1 μPa^2.

peak-to-peak sound pressure

The difference between the maximum and minimum sound pressure over a specified frequency band and time window. Unit: pascal (Pa).

percentile level

The sound level not exceeded _N_ % of the time during a specified time interval. The _N_th percentile level is equal to the (100−_N_) % exceedance level. See also N percent exceedance level.

permanent threshold shift (PTS)

An irreversible loss of hearing sensitivity caused by excessive noise exposure. Considered auditory injury. Compare with temporary threshold shift.

point source

A source that radiates sound as if from a single point.

power spectral density

Generic term, formally defined as power in a unit frequency band. Unit: watt per hertz (W/Hz). The term is sometimes loosely used to refer to the spectral density of other parameters such as squared sound pressure. Ratio of energy spectral density, E_f, to time duration, Δt, in a specified temporal observation window. In equation form, the power spectral density P_f is given by $P_f = E_f/\Delta t$. Power

spectral density can be expressed in terms of various field variables (e.g., sound pressure, sound particle displacement).

power spectral density level

The level ($L_{P,f}$) of the power spectral density (P_f) in a stated frequency band and time window. Defined as: $L_{P,f} = 10log_{10}(P_f/P_{f,0})$. Unit: decibel (dB).

As with power spectral density, power spectral density level can be expressed in terms of various field variables (e.g., sound pressure, sound particle displacement). The reference value ($P_{f,0}$) for power spectral density level depends on the nature of the field variable.

power spectral density source level

A property of a sound source equal to the power spectral density level of the sound pressure measured in the far field plus the propagation loss from the acoustic centre of the source to the receiver position. Unit: decibel (dB). Reference value: 1 µPa^2 m^2/Hz.

propagation loss (PL)

Difference between a source level (SL) and the level at a specified location, $\mathrm{PL}(x) = \mathrm{SL} - L(x)$. Unit: decibel (dB). See also transmission loss.

received level

The level of a given field variable measured (or that would be measured) at a given location.

reference value

Standard value of a quantity used for calculating underwater sound level. The reference value depends on the quantity for which the level is being calculated:

Quantity	Reference value
Sound pressure	p_0^2 = 1 µPa^2 or p_0 = 1 µPa
Sound exposure	E_0 = 1 µPa^2 s
Sound particle displacement	δ_0^2 = 1 pm^2
Sound particle velocity	u_0^2 = 1 nm^2/s^2
Sound particle acceleration	a_0^2 = 1 µm^2/s^4

shear wave

A mechanical vibration wave in which the direction of particle motion is perpendicular to the direction of propagation. Also called a secondary wave or S-wave. Shear waves propagate only in solid media, such as sediments or rock. Shear waves in the seabed can be converted to compressional waves in water at the water-seabed interface.

sound

A time-varying disturbance in the pressure, stress, or material displacement of a medium propagated by local compression and expansion of the medium. In common meaning, a form of energy that propagates through media (e.g., water, air, ground) as pressure waves.

sound exposure

Time integral of squared sound pressure over a stated time interval in a stated frequency band. The time interval can be a specified time duration (e.g., 24 h) or from start to end of a specified event (e.g., a pile strike, an airgun pulse, a construction operation). Unit: pascal squared second (Pa^2 s). Symbol: E.

sound exposure level (SEL)

The level (L_E) of the sound exposure (E) in a stated frequency band and time window: $L_E = 10\log_{10}(E/E_0)$ (ISO 18405:2017). Unit: decibel (dB). Reference value (E_0) for sound in water: 1 μPa^2 s.

sound exposure spectral density

Distribution as a function of frequency of the time-integrated squared sound pressure per unit bandwidth of a sound having a continuous spectrum (ISO 18405:2017). Unit: pascal squared second per hertz (Pa^2 s/Hz).

sound field

Region containing sound waves.

sound intensity

Product of the sound pressure and the sound particle velocity (ISO 18405:2017). The magnitude of the sound intensity is the sound energy flowing through a unit area perpendicular to the direction of propagation per unit time. Unit: watt per metre squared (W/m^2). Symbol: I.

sound particle acceleration

The rate of change of sound particle velocity. Unit: metre per second squared (m/s^2). Symbol: a.

sound particle motion

Movement caused by the action of sound of the smallest volume of a medium that represents its mean physical properties. Important for determining effects of underwater noise on fishes and invertebrates because their hearing organs sense particle motion rather than sound pressure.

sound particle displacement

Displacement of a material element caused by the action of sound, where a material element is the smallest element of the medium that represents the medium's mean density (ISO 18405:2017). Unit: metre (m). Symbol: δ.

sound particle velocity

The velocity of a particle in a material moving back and forth in the direction of the pressure wave. Unit: metre per second (m/s). Symbol: u.

sound pressure

The contribution to total pressure caused by the action of sound (ISO 18405:2017). Unit: pascal (Pa). Symbol: p.

sound pressure level (SPL), rms sound pressure level

The level (L_p) of the time-mean-square sound pressure (p^2_{rms}) in a stated frequency band and time window: $L_p = 10\log_{10}(p^2_{\mathrm{rms}}/p_0^2) = 20\log_{10}(p_{rms}/p_0)$, where rms is the abbreviation for root-mean-square. Unit: decibel (dB). Reference value (p_0^2) for sound in water: 1 μPa^2. SPL can also be expressed in terms of the root-mean-square (rms) with a reference value of p_0 = 1 μPa. The two definitions are equivalent.

sound speed profile

The speed of sound in the water column as a function of depth below the water surface.

source level (SL)

A property of a sound source equal to the sound pressure level measured in the far field plus the propagation loss from the acoustic centre of the source to the receiver position. Unit: decibel (dB). Reference value: 1 $\mu Pa^2\,m^2$.

spectrum

Distribution of acoustic signal content over frequency, where the signal's content is represented by its power, energy, mean-square sound pressure, or sound exposure.

surface duct

The upper portion of a water column within which the gradient of the sound speed profile causes sound to refract upward and therefore reflect repeatedly off the surface resulting in relatively long-range sound propagation with little loss.

temporary threshold shift (TTS)

Reversible loss of hearing sensitivity caused by noise exposure. Compare with permanent threshold shift.

transmission loss (TL)

The difference between a specified level at one location and that at a different location: $\mathrm{TL}(x_1,x_2) = L(x_1) - L(x_2)$ (ISO 18405:2017). Unit: decibel (dB). See also propagation loss.

unweighted

Term indicating that no frequency-weighting function is applied.

very high-frequency (VHF) cetaceans

See functional hearing group.

wavelength

Distance over which a wave completes one cycle of oscillation. Unit: metre (m). Symbol: λ.

Literature Cited

[ANSI] American National Standards Institute and [ASA] Acoustical Society of America. S1.1-2013. *American National Standard: Acoustical Terminology*. NY, USA. https://webstore.ansi.org/Standards/ASA/ANSIASAS12013.

[DEWHA] Department of the Environment, Water, Heritage, and the Arts (Australia). 2008. *EPBC Act Policy Statement 2.1 - Interaction Between Offshore Seismic Exploration and Whales*. 14 p. http://www.environment.gov.au/resource/epbc-act-policy-statement-21-interaction-between-offshore-seismic-exploration-and-whales.

[HESS] High Energy Seismic Survey. 1999. *High Energy Seismic Survey Review Process and Interim Operational Guidelines for Marine Surveys Offshore Southern California*. Prepared for the California State Lands Commission and the United States Minerals Management Service Pacific Outer Continental Shelf Region by the High Energy Seismic Survey Team, Camarillo, CA, USA. 98 p. https://ntrl.ntis.gov/NTRL/dashboard/searchResults/titleDetail/PB2001100103.xhtml.

[ISO] International Organization for Standardization. 2006. *ISO 80000-3:2006 Quantities and units – Part 3: Space and time*. https://www.iso.org/standard/31888.html.

[ISO] International Organization for Standardization. 2017. *ISO 18405:2017. Underwater acoustics – Terminology*. Geneva. https://www.iso.org/standard/62406.html.

[NMFS] National Marine Fisheries Service (US). 1998. *Acoustic Criteria Workshop*. Dr. Roger Gentry and Dr. Jeanette Thomas Co-Chairs.

[NMFS] National Marine Fisheries Service (US). 2016. *Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts*. US Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-55. 178 p.

[NMFS] National Marine Fisheries Service (US). 2018. *2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts*. US Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-59. 167 p. https://media.fisheries.noaa.gov/dam-migration/tech_memo_acoustic_guidance_(20)_(pdf)_508.pdf.

[NOAA] National Oceanic and Atmospheric Administration (US). 2013. *Draft guidance for assessing the effects of anthropogenic sound on marine mammals: Acoustic threshold levels for onset of permanent and temporary threshold shifts*. National Oceanic and Atmospheric Administration, US Department of Commerce, and NMFS Office of Protected Resources, Silver Spring, MD, USA. 76 p.

[NOAA] National Oceanic and Atmospheric Administration (US). 2015. *Draft guidance for assessing the effects of anthropogenic sound on marine mammal hearing: Underwater acoustic threshold levels for onset of permanent and temporary threshold shifts*. NMFS Office of Protected Resources, Silver Spring, MD, USA. 180 p.

[NOAA] National Oceanic and Atmospheric Administration (US). 2016. *Document Containing Proposed Changes to the NOAA Draft Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Threshold Levels for Onset of Permanent and Temporary Threshold Shifts*. National Oceanic and Atmospheric Administration and US Department of Commerce. 24 p.

[NOAA] National Oceanic and Atmospheric Administration (US). 2018. Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to Marine Site Characterization Surveys off of Delaware. *Federal Register* 83(65): 14417-14443. https://www.federalregister.gov/d/2018-12225.

[NOAA] National Oceanic and Atmospheric Administration (US). 2019. *ESA Section 7 Consultation Tools for Marine Mammals on the West Coast* (web page), 27 Sep 2019. https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/esa-section-7-consultation-tools-marine-mammals-west.

[NSF] National Science Foundation (US), Geological Survey (US), and [NOAA] National Oceanic and Atmospheric Administration (US). 2011. *Final Programmatic Environmental Impact Statement/Overseas. Environmental Impact Statement for Marine Seismic Research Funded by the National Science Foundation or Conducted by the US Geological Survey*. National Science Foundation, Arlington, VA, USA. https://www.nsf.gov/geo/oce/envcomp/usgs-nsf-marine-seismic-research/nsf-usgs-final-eis-oeis_3june2011.pdf.

[ONR] Office of Naval Research. 1998. *ONR Workshop on the Effect of Anthropogenic Noise in the Marine Environment*. Dr. R. Gisiner, Chair.

Aerts, L.A.M., M. Blees, S.B. Blackwell, C.R. Greene, Jr., K.H. Kim, D.E. Hannay, and M.E. Austin. 2008. *Marine mammal monitoring and mitigation during BP Liberty OBC seismic survey in Foggy Island Bay, Beaufort Sea, July-August 2008: 90-day report*. Document P1011-1. Report by LGL Alaska Research Associates Inc., LGL Ltd., Greeneridge Sciences Inc., and JASCO Applied Sciences for BP Exploration Alaska. 199 p. ftp://ftp.library.noaa.gov/noaa_documents.lib/NMFS/Auke%20Bay/AukeBayScans/Removable%20Disk/P1011-1.pdf.

Ainslie, M.A. 2008. *Review of Published Safety Thresholds for Human Divers Exposed to Underwater Sound (Veilige maximale geluidsniveaus voor duikers-beoordeling van publicaties)*. Report TNO-DV-2007-A598. DTIC Document, TNO Defence Security and Safety, The Hague (Netherlands). 17 p. http://www.dtic.mil/dtic/tr/fulltext/u2/a485758.pdf

ANSI S1.1-2013. R2013. *American National Standard Acoustical Terminology*. American National Standards Institute, NY, USA.

Austin, M.E. and G.A. Warner. 2012. *Sound Source Acoustic Measurements for Apache's 2012 Cook Inlet Seismic Survey*. Version 2.0. Technical report by JASCO Applied Sciences for Fairweather LLC and Apache Corporation.

Austin, M.E. and L. Bailey. 2013. *Sound Source Verification: TGS Chukchi Sea Seismic Survey Program 2013*. Document 00706, Version 1.0. Technical report by JASCO Applied Sciences for TGS-NOPEC Geophysical Company.

Austin, M.E., A. McCrodan, and J.L. Wladichuk. 2013. Underwater Sound Measurements. *In* Reider, H.J., L.N. Bisson, M.E. Austin, A. McCrodan, J.L. Wladichuk, C.M. Reiser, K.B. Matthews, J.R. Brandon, K. Leonard*, et al.* (eds.). *Marine mammal monitoring and mitigation during Shell's activities in the Chukchi Sea, July–September 2013: 90-Day Report*. Report Number P1272D–2. Technical report by LGL Alaska Research Associates Inc., Anchorage, AK, USA and JASCO Applied Sciences, Victoria, BC, Canada for Shell Gulf of Mexico, Houston, TX, USA, National Marine Fisheries Service, and US Fish and Wildlife Services. 198 pp, plus appendices. http://www.nmfs.noaa.gov/pr/pdfs/permits/shell_chukchi_openwater_90dayreport.pdf.

Austin, M.E. 2014. Underwater noise emissions from drillships in the Arctic. *In*: Papadakis, J.S. and L. Bjørnø (eds.). *UA2014 - 2nd International Conference and Exhibition on Underwater Acoustics*. 22-27 Jun 2014, Rhodes, Greece. pp. 257-263.

Austin, M.E., H. Yurk, and R. Mills. 2015. *Acoustic Measurements and Animal Exclusion Zone Distance Verification for Furie's 2015 Kitchen Light Pile Driving Operations in Cook Inlet*. Version 2.0. Technical report by JASCO Applied Sciences for Jacobs LLC and Furie Alaska.

Austin, M.E. and Z. Li. 2016. *Marine Mammal Monitoring and Mitigation During Exploratory Drilling by Shell in the Alaskan Chukchi Sea, July–October 2015: Draft 90-day report*. *In*: Ireland, D.S. and L.N. Bisson (eds.). Underwater Sound Measurements. LGL Rep. P1363D. Report from LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Applied Sciences Ltd. For Shell Gulf of Mexico Inc, National Marine Fisheries Service, and US Fish and Wildlife Service. 188 pp + appendices.

Bartol, S.M. and D.R. Ketten. 2006. *Turtle and tuna hearing*. *In*: Swimmer, Y. and R. Brill (eds.). Sea turtle and pelagic fish sensory biology: Developing techniques to reduce sea turtle bycatch in longline fisheries. Volume December 2006. NOAA Technical Memorandum NMFS-PIFSC-7. 98-103 p. http://www.sefsc.noaa.gov/turtles/TM_NMFS_PIFSC_7_Swimmer_Brill.pdf#page=108.

Beaman, R.J. 2018. *High-resolution depth model for Northern Australia - 30 m*. Geoscience Australia, Canberra. http://pid.geoscience.gov.au/dataset/ga/121620.

Buckingham, M.J. 2005. Compressional and shear wave properties of marine sediments: Comparisons between theory and data. *Journal of the Acoustical Society of America* 117: 137-152. https://doi.org/10.1121/1.1810231.

Carnes, M.R. 2009. *Description and Evaluation of GDEM-V 3.0*. US Naval Research Laboratory, Stennis Space Center, MS. NRL Memorandum Report 7330-09-9165. 21 p. https://apps.dtic.mil/dtic/tr/fulltext/u2/a494306.pdf.

Collins, M.D. 1993. A split-step Padé solution for the parabolic equation method. *Journal of the Acoustical Society of America* 93(4): 1736-1742. https://doi.org/10.1121/1.406739.

Collins, M.D., R.J. Cederberg, D.B. King, and S. Chin-Bing. 1996. Comparison of algorithms for solving parabolic wave equations. *Journal of the Acoustical Society of America* 100(1): 178-182. https://doi.org/10.1121/1.415921.

Coppens, A.B. 1981. Simple equations for the speed of sound in Neptunian waters. *Journal of the Acoustical Society of America* 69(3): 862-863. https://doi.org/10.1121/1.382038.

Day, R.D., R.D. McCauley, Q.P. Fitzgibbon, K. Hartmann, J.M. Semmens, and Institute for Marine and Antarctic Studies. 2016a. *Assessing the Impact of Marine Seismic Surveys on Southeast Australian Scallop and Lobster Fisheries*. Impacts of Marine Seismic Surveys on Scallop and Lobster Fisheries. Fisheries Ressearch & Development Corporation. FRDC Project No 2012/008, University of Tasmania, Hobart. 159 p.

Day, R.D., R.D. McCauley, Q.P. Fitzgibbon, and J.M. Semmens. 2016b. Seismic air gun exposure during early-stage embryonic development does not negatively affect spiny lobster *Jasus edwardsii larvae* (Decapoda:Palinuridae). *Scientific Reports* 6: 1-9. https://doi.org/10.1038/srep22723.

Day, R.D., R.D. McCauley, Q.P. Fitzgibbon, K. Hartmann, and J.M. Semmens. 2017. Exposure to seismic air gun signals causes physiological harm and alters behavior in the scallop *Pecten fumatus*. *Proceedings of the National Academy of Sciences of the United States of America* 114(40): E8537-E8546. https://doi.org/10.1073/pnas.1700564114.

Day, R.D., R.D. McCauley, Q.P. Fitzgibbon, K. Hartmann, and J.M. Semmens. 2019. Seismic air guns damage rock lobster mechanosensory organs and impair righting reflex. *Proceedings of the Royal Society B* 286(1907). https://doi.org/10.1098/rspb.2019.1424.

Department of the Environment and Energy, NSW Government, and Queensland Government. 2017. *Recovery Plan for Marine Turtles in Australia*. https://www.environment.gov.au/marine/publications/recovery-plan-marine-turtles-australia-2017.

Dow Piniak, W.E., S.A. Eckert, C.A. Harms, and E.M. Stringer. 2012. *Underwater hearing sensitivity of the leatherback sea turtle (Dermochelys coriacea): Assessing the potential effect of anthropogenic noise*. US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2012-00156. 35 p.

Dragoset, W.H. 1984. A comprehensive method for evaluating the design of airguns and airgun arrays. *16th Annual Offshore Technology Conference* Volume 3, 7–9 May 1984. OTC 4747, Houston, TX, USA. pp. 75–84. https://doi.org/10.4043/4783-MS.

Ellison, W.T. and P.J. Stein. 1999. *SURTASS LFA High Frequency Marine Mammal Monitoring (HF/M3) Sonar: Sustem Description and Test & Evaluation*. Under US Navy Contract N66604-98-D-5725. http://www.surtass-lfa-eis.com/wp-content/uploads/2018/02/HF-M3-Ellison-Report-2-4a.pdf.

Ellison, W.T. and A.S. Frankel. 2012. A common sense approach to source metrics. *In* Popper, A.N. and A.D. Hawkins (eds.). *The Effects of Noise on Aquatic Life*. Volume 730. Springer, New York. pp. 433-438. https://doi.org/10.1007/978-1-4419-7311-5_98.

Fields, D.M., N.O. Handegard, J. Dalen, C. Eichner, K. Malde, Ø. Karlsen, A.B. Skiftesvik, C.M.F. Durif, and H.I. Browman. 2019. Airgun blasts used in marine seismic surveys have limited effects on mortality, and no sublethal effects on behaviour or gene expression, in the copepod *Calanus finmarchicus*. *ICES Journal of Marine Science* 76(7): 2033–2044. https://doi.org/10.1093/icesjms/fsz126.

Finneran, J.J. and C.E. Schlundt. 2010. Frequency-dependent and longitudinal changes in noise-induced hearing loss in a bottlenose dolphin (*Tursiops truncatus*). *Journal of the Acoustical Society of America* 128(2): 567-570. https://doi.org/10.1121/1.3458814.

Finneran, J.J. and A.K. Jenkins. 2012. *Criteria and thresholds for U.S. Navy acoustic and explosive effects analysis*. SPAWAR Systems Center Pacific, San Diego, CA, USA. 64 p.

Finneran, J.J. 2015. *Auditory weighting functions and TTS/PTS exposure functions for cetaceans and marine carnivores*. Technical report by SSC Pacific, San Diego, CA, USA.

Finneran, J.J. 2016. *Auditory weighting functions and TTS/PTS exposure functions for marine mammals exposed to underwater noise*. Technical Report for Space and Naval Warfare Systems Center Pacific, San Diego, CA, USA. 49 p. https://apps.dtic.mil/dtic/tr/fulltext/u2/1026445.pdf.

Finneran, J.J., E.E. Henderson, D.S. Houser, K. Jenkins, S. Kotecki, and J. Mulsow. 2017. *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)*. Technical report by Space and Naval Warfare Systems Center Pacific (SSC Pacific). 183 p. https://nwtteis.com/portals/nwtteis/files/technical_reports/Criteria_and_Thresholds_for_U.S._Navy_Acoustic_and_Explosive_Effects_Analysis_June2017.pdf.

Fisher, F.H. and V.P. Simmons. 1977. Sound absorption in sea water. *Journal of the Acoustical Society of America* 62(3): 558-564. https://doi.org/10.1121/1.381574.

Fothergill, D.M., J.R. Sims, and M.D. Curley. 2001. Recreational SCUBA divers' aversion to low frequency underwater sound. *Undersea and Hyperbaric Medicine* 28(1): 9-18.

Funk, D.W., D.E. Hannay, D.S. Ireland, R. Rodrigues, and W.R. Koski. 2008. *Marine mammal monitoring and mitigation during open water seismic exploration by Shell Offshore Inc. in the Chukchi and Beaufort Seas, July–November 2007: 90-day report*. LGL Report P969-1. Prepared by LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Research Ltd. for Shell Offshore Inc., National Marine Fisheries Service (US), and US Fish and Wildlife Service. 218 p. http://www-static.shell.com/static/usa/downloads/alaska/shell2007_90-d_final.pdf.

Hannay, D.E. and R. Racca. 2005. *Acoustic Model Validation*. Document 0000-S-90-04-T-7006-00-E, Revision 02, Version 1.3. Technical report by JASCO Research Ltd. for Sakhalin Energy Investment Company Ltd. 34 p.

Heap, A.D. 2009. *Marine Sediments (MARS) Database* (webpage). Commonwealth of Australia (Geoscience Australia), Creative Commons Attribution 4.0 International Licence. http://www.ga.gov.au/metadata-gateway/metadata/record/gcat_69869.

Heyward, A., J. Colquhoun, E. Cripps, D. McCorry, M. Stowar, B. Radford, K. Miller, I. Miller, and C. Battershill. 2018. No evidence of damage to the soft tissue or skeletal integrity of mesophotic corals exposed to a 3D marine seismic survey. *Marine Pollution Bulletin* 129(1): 8-13. https://doi.org/10.1016/j.marpolbul.2018.01.057.

Ireland, D.S., R. Rodrigues, D.W. Funk, W.R. Koski, and D.E. Hannay. 2009. *Marine mammal monitoring and mitigation during open water seismic exploration by Shell Offshore Inc. in the Chukchi and Beaufort Seas, July–October 2008: 90-Day Report*. Document P1049-1. 277 p.

Jensen, F.B., W.A. Kuperman, M.B. Porter, and H. Schmidt. 2011. *Computational Ocean Acoustics*. 2nd edition. AIP Series in Modern Acoustics and Signal Processing. AIP Press - Springer, New York. 794 p. https://doi.org/10.1007/978-1-4419-8678-8.

Landrø, M. 1992. Modeling of GI gun signatures. *Geophysical Prospecting* 40(7): 721–747. https://doi.org/10.1111/j.1365-2478.1992.tb00549.x.

Laws, R.M., L. Hatton, and M. Haartsen. 1990. Computer modelling of clustered airguns. *First Break* 8(9): 331–338. https://doi.org/10.3997/1365-2397.1990017.

Lucke, K., U. Siebert, P.A. Lepper, and M.-A. Blanchet. 2009. Temporary shift in masked hearing thresholds in a harbor porpoise (*Phocoena phocoena*) after exposure to seismic airgun stimuli. *Journal of the Acoustical Society of America* 125(6): 4060-4070. https://doi.org/10.1121/1.3117443.

Lurton, X. 2002. *An Introduction to Underwater Acoustics: Principles and Applications*. Springer, Chichester, UK. 347 p.

MacGillivray, A.O. and N.R. Chapman. 2012. Modeling underwater sound propagation from an airgun array using the parabolic equation method. *Canadian Acoustics* 40(1): 19-25. https://jcaa.caa-aca.ca/index.php/jcaa/article/view/2502/2251.

MacGillivray, A.O. 2018. Underwater noise from pile driving of conductor casing at a deep-water oil platform. *Journal of the Acoustical Society of America* 143(1): 450-459. https://doi.org/10.1121/1.5021554.

Malme, C.I., P.R. Miles, C.W. Clark, P.L. Tyack, and J.E. Bird. 1984. *Investigations of the Potential Effects of Underwater Noise from Petroleum Industry Activities on Migrating Gray Whale Behavior. Phase II: January 1984 Migration*. Report 5586. Report by Bolt Beranek and Newman Inc. for the US Department of the Interior, Minerals Management Service, Cambridge, MA, USA. https://www.boem.gov/sites/default/files/boem-newsroom/Library/Publications/1983/rpt5586.pdf.

Martin, S.B., K. Bröker, M.-N.R. Matthews, J.T. MacDonnell, and L. Bailey. 2015. Comparison of measured and modeled air-gun array sound levels in Baffin Bay, West Greenland. *OceanNoise 2015*. 11-15 May 2015, Barcelona, Spain.

Martin, S.B. and A.N. Popper. 2016. Short- and long-term monitoring of underwater sound levels in the Hudson River (New York, USA). *Journal of the Acoustical Society of America* 139(4): 1886-1897. https://doi.org/10.1121/1.4944876.

Martin, S.B., J.T. MacDonnell, and K. Bröker. 2017a. Cumulative sound exposure levels—Insights from seismic survey measurements. *Journal of the Acoustical Society of America* 141(5): 3603-3603. https://doi.org/10.1121/1.4987709.

Martin, S.B., M.-N.R. Matthews, J.T. MacDonnell, and K. Bröker. 2017b. Characteristics of seismic survey pulses and the ambient soundscape in Baffin Bay and Melville Bay, West Greenland. *Journal of the Acoustical Society of America* 142(6): 3331-3346. https://doi.org/10.1121/1.5014049.

Matthews, M.-N.R. and A.O. MacGillivray. 2013. Comparing modeled and measured sound levels from a seismic survey in the Canadian Beaufort Sea. *Proceedings of Meetings on Acoustics* 19(1): 1-8. https://doi.org/10.1121/1.4800553.

Mattsson, A. and M. Jenkerson. 2008. Single Airgun and Cluster Measurement Project. *Joint Industry Programme (JIP) on Exploration and Production Sound and Marine Life Proramme Review*. 28-30 Oct 2008. International Association of Oil and Gas Producers, Houston, TX, USA.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.-N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch, et al. 2000. *Marine seismic surveys: Analysis and propagation of air-gun signals; and effects of air-gun exposure on humpback whales, sea turtles, fishes and squid*. Report R99-15. Prepared for Australian Petroleum Production Exploration Association by Centre for Maine Science and Technology, Western Australia. 198 p. https://cmst.curtin.edu.au/wp-content/uploads/sites/4/2016/05/McCauley-et-al-Seismic-effects-2000.pdf.

McCauley, R.D., R.D. Day, K.M. Swadling, Q.P. Fitzgibbon, R.A. Watson, and J.M. Semmens. 2017. Widely used marine seismic survey air gun operations negatively impact zooplankton. *Nature Ecology & Evolution* 1(7): 1-8. https://doi.org/10.1038/s41559-017-0195.

McCrodan, A., C.R. McPherson, and D.E. Hannay. 2011. *Sound Source Characterization (SSC) Measurements for Apache's 2011 Cook Inlet 2D Technology Test*. Version 3.0. Technical report by JASCO Applied Sciences for Fairweather LLC and Apache Corporation. 51 p.

McPherson, C.R. and G.A. Warner. 2012. *Sound Sources Characterization for the 2012 Simpson Lagoon OBC Seismic Survey 90-Day Report*. Document 00443, Version 2.0. Technical report by JASCO Applied Sciences for BP Exploration (Alaska) Inc.

McPherson, C.R., A.O. MacGillivray, and E. Hagar. 2018. Validation of airgun array modelled source signatures. *Joint Meeting 176th Meeting Acoustical Society of America and 2018 Acoustics Week in Canada Canadian Acoustical Association*. 5–9 Nov 2018. Accepted Abstract, Victoria, BC, Canada.

McPherson, C.R. and S.B. Martin. 2018. *Characterisation of Polarcus 2380 in^3 Airgun Array*. Document 001599, Version 1.0. Technical report by JASCO Applied Sciences for Polarcus Asia Pacific Pte Ltd.

Nedwell, J.R. and A.W. Turnpenny. 1998. The use of a generic frequency weighting scale in estimating environmental effect. *Workshop on Seismics and Marine Mammals*. 23–25 Jun 1998, London, UK.

Nedwell, J.R., A.W. Turnpenny, J. Lovell, S.J. Parvin, R. Workman, J.A.L. Spinks, and D. Howell. 2007. *A validation of the dB$_{ht}$ as a measure of the behavioural and auditory effects of underwater noise*. Document 534R1231 Report by Subacoustech Ltd. for Chevron Ltd, TotalFinaElf Exploration UK PLC, Department of Business, Enterprise and Regulatory Reform, Shell UK Exploration and Production Ltd, The Industry

Technology Facilitator, Joint Nature Conservation Committee, and The UK Ministry of Defence. 74 p. https://tethys.pnnl.gov/sites/default/files/publications/Nedwell-et-al-2007.pdf.

O'Neill, C., D. Leary, and A. McCrodan. 2010. Sound Source Verification. (Chapter 3) *In* Blees, M.K., K.G. Hartin, D.S. Ireland, and D.E. Hannay (eds.). *Marine mammal monitoring and mitigation during open water seismic exploration by Statoil USA E&P Inc. in the Chukchi Sea, August-October 2010: 90-day report*. LGL Report P1119. Prepared by LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Applied Sciences Ltd. for Statoil USA E&P Inc., National Marine Fisheries Service (US), and US Fish and Wildlife Service. pp. 1-34.

Parvin, S.J. 1998. The effects of low frequency underwater sound on divers. *Undersea Defence Technology*. Wembley, UK. pp. 227-232.

Parvin, S.J. 2005. *Limits for underwater noise exposure of human divers and swimmers [presentation]*. Subacoustech. Presented at the National Physics Laboratory Seminar on Underwater Acoustics, Teddington, UK. http://www.subacoustech.com/wp-content/uploads/NPLDiverNoisePresentation.pdf.

Payne, J.F., C. Andrews, L. Fancey, D. White, and J. Christian. 2008. *Potential Effects of Seismic Energy on Fish and Shellfish: An Update since 2003*. Report 2008/060. Canadian Science Advisory Secretariat. 22 p. https://waves-vagues.dfo-mpo.gc.ca/Library/335123.pdf.

Payne, R. and D. Webb. 1971. Orientation by means of long range acoustic signaling in baleen whales. *Annals of the New York Academy of Sciences* 188: 110-141. https://doi.org/10.1111/j.1749-6632.1971.tb13093.x.

Pestorius, F.M., E.A. Cudahy, and D.M. Fothergill. 2009. Evolution of navy diver exposure standards for deterministic underwater sound in the 100-500 Hz band. *Meetings on Acoustics*. Volume 8(070002), 26-30 Oct 2009. Journal of the Acoustical Society of America, San Antonio, TX. https://doi.org/10.1121/1.3280165.

Popper, A.N., A.D. Hawkins, R.R. Fay, D.A. Mann, S. Bartol, T.J. Carlson, S. Coombs, W.T. Ellison, R.L. Gentry, et al. 2014. *Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI*. ASA S3/SC1.4 TR-2014. SpringerBriefs in Oceanography. ASA Press and Springer. https://doi.org/10.1007/978-3-319-06659-2.

Porter, M.B. and Y.C. Liu. 1994. Finite-element ray tracing. *In*: Lee, D. and M.H. Schultz (eds.). *International Conference on Theoretical and Computational Acoustics*. Volume 2. World Scientific Publishing Co. pp. 947-956.

Racca, R., A.N. Rutenko, K. Bröker, and M.E. Austin. 2012a. A line in the water - design and enactment of a closed loop, model based sound level boundary estimation strategy for mitigation of behavioural impacts from a seismic survey. *11th European Conference on Underwater Acoustics*. Volume 34(3), Edinburgh, UK.

Racca, R., A.N. Rutenko, K. Bröker, and G. Gailey. 2012b. Model based sound level estimation and in-field adjustment for real-time mitigation of behavioural impacts from a seismic survey and post-event evaluation of sound exposure for individual whales. *In*: McMinn, T. (ed.). *Acoustics 2012*. Fremantle, Australia. http://www.acoustics.asn.au/conference_proceedings/AAS2012/papers/p92.pdf.

Racca, R., M.E. Austin, A.N. Rutenko, and K. Bröker. 2015. Monitoring the gray whale sound exposure mitigation zone and estimating acoustic transmission during a 4-D seismic survey, Sakhalin Island, Russia. *Endangered Species Research* 29(2): 131-146. https://doi.org/10.3354/esr00703.

Sims, J.R., D.M. Fothergill, and M.D. Curley. 1999. *Effects of a neoprene wetsuit hood on low-frequency underwater hearing thresholds*. *The Journal of the Acoustical Society of America*. Volume 105(2). 2, pp. 1298-1298. https://asa.scitation.org/doi/abs/10.1121/1.426183.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene, Jr., D. Kastak, D.R. Ketten, J.H. Miller, et al. 2007. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. *Aquatic Mammals* 33(4): 411-521. https://doi.org/10.1578/AM.33.4.2007.411.

Southall, B.L., D.P. Nowaceck, P.J.O. Miller, and P.L. Tyack. 2016. Experimental field studies to measure behavioral responses of cetaceans to sonar. *Endangered Species Research* 31: 293-315. https://doi.org/10.3354/esr00764.

Southall, B.L., J.J. Finneran, C.J. Reichmuth, P.E. Nachtigall, D.R. Ketten, A.E. Bowles, W.T. Ellison, D.P. Nowacek, and P.L. Tyack. 2019. Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. *Aquatic Mammals* 45(2): 125-232. https://doi.org/10.1578/AM.45.2.2019.125.

Southall, B.L., D.P. Nowacek, A.E. Bowles, V. Senigaglia, L. Bejder, and P.L. Tyack. 2021. Marine Mammal Noise Exposure Criteria: Assessing the Severity of Marine Mammal Behavioral Responses to Human Noise. *Aquatic Mammals* 47(5): 421-464. https://doi.org/10.1578/AM.47.5.2021.421.

Teague, W.J., M.J. Carron, and P.J. Hogan. 1990. A comparison between the Generalized Digital Environmental Model and Levitus climatologies. *Journal of Geophysical Research* 95(C5): 7167-7183. https://doi.org/10.1029/JC095iC05p07167.

Warner, G.A., C. Erbe, and D.E. Hannay. 2010. Underwater Sound Measurements. (Chapter 3) *In* Reiser, C.M., D. Funk, R. Rodrigues, and D.E. Hannay (eds.). *Marine Mammal Monitoring and Mitigation during Open Water Shallow Hazards and Site Clearance Surveys by Shell Offshore Inc. in the Alaskan Chukchi Sea, July-October 2009: 90-Day Report*. LGL Report P1112-1. Report by LGL Alaska Research Associates Inc. and JASCO Applied Sciences for Shell Offshore Inc., National Marine Fisheries Service (US), and Fish and Wildlife Service (US). pp. 1-54.

Warner, G.A., M.E. Austin, and A.O. MacGillivray. 2017. Hydroacoustic measurements and modeling of pile driving operations in Ketchikan, Alaska [Abstract]. *Journal of the Acoustical Society of America* 141(5): 3992. https://doi.org/10.1121/1.4989141.

Wood, J.D., B.L. Southall, and D.J. Tollit. 2012. *PG&E offshore 3-D Seismic Survey Project Environmental Impact Report–Marine Mammal Technical Draft Report*. Report by SMRU Ltd. 121 p. https://www.coastal.ca.gov/energy/seismic/mm-technical-report-EIR.pdf.

Zhang, Z.Y. and C.T. Tindle. 1995. Improved equivalent fluid approximations for a low shear speed ocean bottom. *Journal of the Acoustical Society of America* 98(6): 3391-3396. https://doi.org/10.1121/1.413789.

Ziolkowski, A.M. 1970. A method for calculating the output pressure waveform from an air gun. *Geophysical Journal International* 21(2): 137-161. https://doi.org/10.1111/j.1365-246X.1970.tb01773.x.

Zykov, M.M. and J.T. MacDonnell. 2013. *Sound Source Characterizations for the Collaborative Baseline Survey Offshore Massachusetts Final Report: Side Scan Sonar, Sub-Bottom Profiler, and the R/V Small Research Vessel experimental*. Document 00413, Version 2.0. Technical report by JASCO Applied Sciences for Fugro GeoServices, Inc. and the (US) Bureau of Ocean Energy Management.

Appendix A. Acoustic Metrics

A.1. Pressure Related Acoustic Metrics

Underwater sound pressure amplitude is measured in decibels (dB) relative to a fixed reference pressure of p_0 = 1 µPa. Because the perceived loudness of sound, especially pulsed sound such as from seismic airguns, pile driving, and sonar, is not generally proportional to the instantaneous acoustic pressure, several sound level metrics are commonly used to evaluate sound and its effects on marine life. Here we provide specific definitions of relevant metrics used in the accompanying report. Where possible, we follow the American National Standard Institute and International Organization for Standardization definitions and symbols for sound metrics (e.g., ISO 2017, ANSI R2013), but these standards are not always consistent.

The zero-to-peak sound pressure, or peak sound pressure (PK or $L_{p,pk}$; dB re 1 µPa), is the decibel level of the maximum instantaneous acoustic pressure in a stated frequency band attained by an acoustic pressure signal, $\mathrm{p(t)}$:

$$L_{p,\mathrm{pk}} = 10\log_{10}\frac{\max|p^2(t)|}{p_0^2} = 20\log_{10}\frac{\max|p(t)|}{p_0} \quad \text{(A-1)}$$

PK is often included as a criterion for assessing whether a sound is potentially injurious; however, because it does not account for the duration of an acoustic event, it is generally a poor indicator of perceived loudness.

The peak-to-peak sound pressure (PK-PK or $L_{p,pk\text{-}pk}$; dB re 1 µPa) is the difference between the maximum and minimum instantaneous sound pressure, possibly filtered in a stated frequency band, attained by an impulsive sound, $\mathrm{p(t)}$:

$$L_{p,\mathrm{pk\text{-}pk}} = 10\log_{10}\frac{[\max(p(t)) - \min(p(t))]^2}{p_0^2} \quad \text{(A-2)}$$

The sound pressure level (SPL or L_p; dB re 1 µPa) is the root-mean-square (rms) pressure level in a stated frequency band over a specified time window (T; s). It is important to note that SPL always refers to an rms pressure level and therefore not instantaneous pressure:

$$L_p = 10\log_{10}\left(\frac{1}{T}\int_T g(t)\,p^2(t)\,dt \Big/ p_0^2\right) \quad \text{(A-3)}$$

where $\mathrm{g(t)}$ is an optional time weighting function. In many cases, the start time of the integration is marched forward in small time steps to produce a time-varying SPL function. For short acoustic events, such as sonar pulses and marine mammal vocalizations, it is important to choose an appropriate time window that matches the duration of the signal. For in-air studies, when evaluating the perceived loudness of sounds with rapid amplitude variations in time, the time weighting function $\mathrm{g(t)}$ is often set to a decaying exponential function that emphasizes more recent pressure signals. This function mimics the leaky integration nature of mammalian hearing. For example, human-based fast time-weighted SPL ($L_{p,fast}$) applies an exponential function with time constant 125 ms. A related simpler approach used in underwater acoustics sets $\mathrm{g(t)}$ to a boxcar (unity amplitude) function of width 125 ms; the results can be referred to as $L_{p,boxcar\ 125ms}$. Another approach, historically used to evaluate SPL of impulsive signals underwater, defines $\mathrm{g(t)}$ as a boxcar function with edges set to the times corresponding to 5% and 95% of the cumulative square pressure function encompassing the duration of an impulsive acoustic event. This calculation is applied individually to each impulse signal, and the results are referred to as 90% SPL ($L_{p,90\%}$).

The sound exposure level (SEL or L_E; dB re 1 µPa²·s) is the time-integral of the squared acoustic pressure over a duration (T):

$$L_E = 10 \log_{10} \left(\int_T p^2(t)\, dt \Big/ T_0 p_0^2 \right) \quad \text{(A-4)}$$

where T_0 is a reference time interval of 1 s. SEL continues to increase with time when non-zero pressure signals are present. It is a dose-type measurement, so the integration time applied must be carefully considered for its relevance to impact to the exposed recipients.

SEL can be calculated over a fixed duration, such as the time of a single event or a period with multiple acoustic events. When applied to pulsed sounds, SEL can be calculated by summing the SEL of the N individual pulses. For a fixed duration, the square pressure is integrated over the duration of interest. For multiple events, the SEL can be computed by summing (in linear units) the SEL of the N individual events:

$$L_{E,N} = 10 \log_{10} \sum_{i=1}^{N} 10^{\frac{L_{E,i}}{10}} \quad \text{(A-5)}$$

If applied, the frequency weighting of an acoustic event should be specified, as in the case of weighted SEL (e.g., $L_{E,LF,24h}$; see Appendix A.4) or auditory-weighted SPL ($L_{p,ht}$). The use of fast, slow, or impulse exponential-time-averaging or other time-related characteristics should also be specified.

A.2. Decidecade Band Analysis

The distribution of a sound's power with frequency is described by the sound's spectrum. The sound spectrum can be split into a series of adjacent frequency bands. Splitting a spectrum into 1 Hz wide bands, called passbands, yields the power spectral density of the sound. This splitting of the spectrum into passbands of a constant width of 1 Hz, however, does not represent how animals perceive sound.

Because animals perceive exponential increases in frequency rather than linear increases, analysing a sound spectrum with passbands that increase exponentially in size better approximates real-world scenarios. In underwater acoustics, a spectrum is commonly split into decidecade bands, which are one tenth of a decade wide. They are approximately one third of an octave (base 2) wide and are therefore often referred to as 1/3-octave-bands. Each octave represents a doubling in sound frequency. The centre frequency of the ith band, $f_c(i)$, is defined as:

$$f_c(i) = 10^{\frac{i}{10}} \text{ kHz} \quad \text{(A-6)}$$

and the low (f_{lo}) and high (f_{hi}) frequency limits of the ith decade band are defined as:

$$f_{lo,i} = 10^{\frac{-1}{20}} f_c(i) \quad \text{and} \quad f_{hi,i} = 10^{\frac{1}{20}} f_c(i) \quad \text{(A-7)}$$

The decidecade bands become wider with increasing frequency, and on a logarithmic scale the bands appear equally spaced (Figure A-1). The acoustic modelling spans from band 7 (f_c (7) = 5 Hz) to band 44 ($f_c(44)$ = 25 kHz).

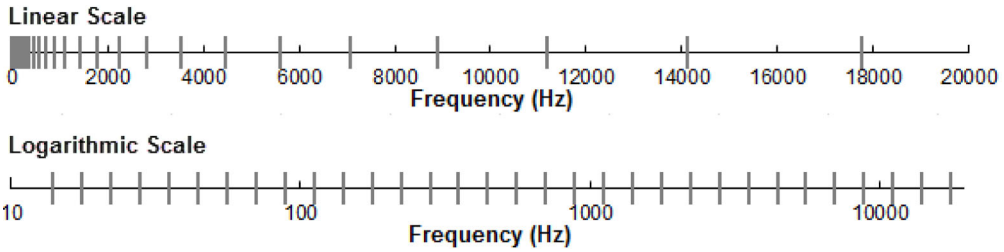


Figure A-1. Decidecade frequency bands (vertical lines) shown on a linear frequency scale and a logarithmic scale.

The sound pressure level in the ith band ($L_{p,i}$) is computed from the spectrum $S(f)$ between $f_{\mathrm{lo},i}$ and $f_{\mathrm{hi},i}$:

$$L_{p,i} = 10 \log_{10} \int_{f_{\mathrm{lo},i}}^{f_{\mathrm{hi},i}} S(f)\, df \tag{A-8}$$

Summing the sound pressure level of all the bands yields the broadband sound pressure level:

$$\text{Broadband SPL} = 10 \log_{10} \sum_{i} 10^{\frac{L_{p,i}}{10}} \tag{A-9}$$

Figure A-2 shows an example of how the decidecade band sound pressure levels compare to the sound pressure spectral density levels of an ambient noise signal. Because the decidecade bands are wider with increasing frequency, the decidecade band SPL is higher than the spectral levels at higher frequencies. Acoustic modelling of decidecade bands requires less computation time than 1 Hz bands and still resolves the frequency-dependence of the sound source and the propagation environment.

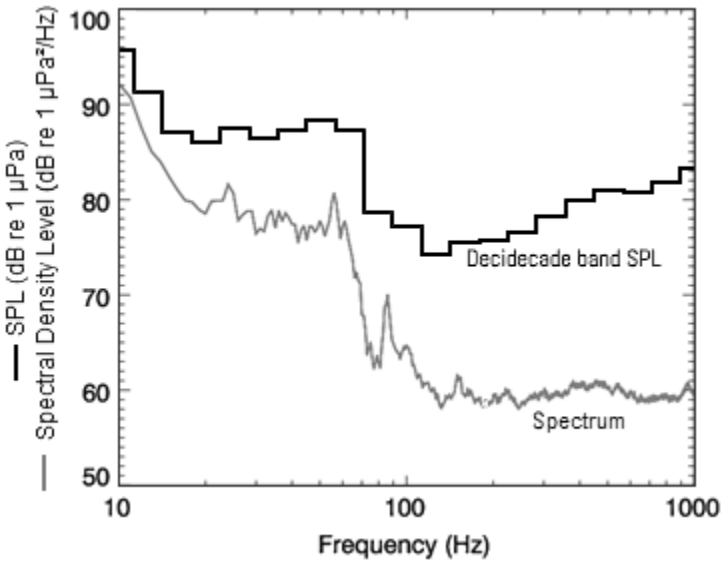


Figure A-2. Sound pressure spectral density levels and the corresponding decidecade band sound pressure levels of example ambient noise shown on a logarithmic frequency scale.

A.3. Marine Mammal Impact Criteria

It has been long recognised that marine mammals can be adversely affected by underwater anthropogenic noise. For example, Payne and Webb (1971) suggested that communication distances of fin whales are reduced by shipping sounds. Subsequently, similar concerns arose regarding effects of other underwater noise sources and the possibility that impulsive sources—primarily airguns used in seismic surveys—could cause auditory injury. This led to a series of workshops held in the late 1990s, conducted to address acoustic mitigation requirements for seismic surveys and other underwater noise sources (NMFS 1998, ONR 1998, Nedwell and Turnpenny 1998, HESS 1999, Ellison and Stein 1999). In the years since these early workshops, a variety of thresholds have been proposed for both injury and disturbance. The following sections summarize the recent development of thresholds; however, this field remains an active research topic.

A.3.1. Injury

In recognition of shortcomings of the SPL-only based injury criteria, in 2005 NMFS sponsored the Noise Criteria Group to review literature on marine mammal hearing to propose new noise exposure criteria. Some members of this expert group published a landmark paper (Southall et al. 2007) that suggested assessment methods similar to those applied for humans. The resulting recommendations introduced dual acoustic injury criteria for impulsive sounds that included peak pressure level thresholds and SEL_{24h} thresholds, where the subscripted 24h refers to the accumulation period for calculating SEL. The peak pressure level criterion is not frequency weighted whereas the SEL_{24h} is frequency weighted according to one of four marine mammal species hearing groups: low-, mid- and high-frequency cetaceans (LF, MF, and HF cetaceans, respectively) and Pinnipeds in Water (PINN). These weighting functions are referred to as M-weighting filters (analogous to the A-weighting filter for human; Appendix A.4). The SEL_{24h} thresholds were obtained by extrapolating measurements of onset levels of Temporary Threshold Shift (TTS) in belugas by the amount of TTS required to produce Permanent Threshold Shift (PTS) in chinchillas. The Southall et al. (2007) recommendations do not specify an exchange rate, which suggests that the thresholds are the same regardless of the duration of exposure (i.e., it implies a 3 dB exchange rate).

Wood et al. (2012) refined Southall et al.'s (2007) thresholds, suggesting lower injury values for LF and HF cetaceans while retaining the filter shapes. Their revised thresholds were based on TTS-onset levels in harbour porpoises from Lucke et al. (2009), which led to a revised impulsive sound PTS threshold for HF cetaceans of 179 dB re 1 $\mu Pa^2 \cdot s$. Because there were no data available for baleen whales, Wood et al. (2012) based their recommendations for LF cetaceans on results obtained from MF cetacean studies. In particular they referenced Finneran and Schlundt (2010) research, which found mid-frequency cetaceans are more sensitive to non-impulsive sound exposure than Southall et al. (2007) assumed. Wood et al. (2012) thus recommended a more conservative TTS-onset level for LF cetaceans of 192 dB re 1 $\mu Pa^2 \cdot s$.

As of present an optimal approach is not apparent. There is consensus in the research community that an SEL-based method is preferable either separately or in addition to an SPL-based approach to assess the potential for injuries. In August 2016, after substantial public and expert input into three draft versions and based largely on the above-mentioned literature (NOAA 2013, 2015, 2016), NMFS finalised technical guidance for assessing the effect of anthropogenic sound on marine mammal hearing (NMFS 2016). The guidance describes injury criteria with new thresholds and frequency weighting functions for the five hearing groups described by Finneran and Jenkins (2012). The latest revision to this work was published in 2018; with the criteria defined in NMFS (2018). Southall et al. (2019) revisited the interim criteria published in 2007. All noise exposure criteria in NMFS (2018) and Southall et al. (2019) are identical (for impulsive and non-impulsive sounds); however, the mid- and high-frequency cetaceans groups from NMFS (2018) were renamed high- and very high-frequency

cetaceans, respectively, in Southall et al. (2019). The latest criteria from Southall et al. (2019) is applied in this report.

A.3.2. Behavioural response

Numerous studies on marine mammal behavioural responses to sound exposure have not resulted in consensus in the scientific community regarding the appropriate metric for assessing behavioural reactions. However, it is recognised that the context in which the sound is received affects the nature and extent of responses to a stimulus (Southall et al. 2007, Ellison and Frankel 2012, Southall et al. 2016).

For impulsive noise, NMFS currently uses step function thresholds of 160 dB re 1 µPa SPL (unweighted) to assess and regulate noise-induced behavioural impacts for marine mammals (NOAA 2018, NOAA 2019). The threshold for impulsive sound is derived from the High-Energy Seismic Survey (HESS) panel (HESS 1999) report that, in turn, is based on the responses of migrating mysticete whales to airgun sounds (Malme et al. 1984). The HESS team recognised that behavioural responses to sound may occur at lower levels, but significant responses were only likely to occur above a SPL of 140 dB re 1 µPa. Southall et al. (2007) found varying responses for most marine mammals between a SPL of 140 and 180 dB re 1 µPa, consistent with the HESS (1999) report, but lack of convergence in the data prevented them from suggesting explicit step functions.

A.4. Marine Mammal Frequency Weighting

The potential for noise to affect animals depends on how well the animals can hear it. Noises are less likely to disturb or injure an animal if they are at frequencies that the animal cannot hear well. An exception occurs when the sound pressure is so high that it can physically injure an animal by non-auditory means (i.e., barotrauma). For sound levels below such extremes, the importance of sound components at particular frequencies can be scaled by frequency weighting relevant to an animal's sensitivity to those frequencies (Nedwell and Turnpenny 1998, Nedwell et al. 2007).

A.4.1. Marine Mammal Frequency Weighting Functions

In 2015, a US Navy technical report by Finneran (2015) recommended new auditory weighting functions. The overall shape of the auditory weighting functions is similar to human A-weighting functions, which follows the sensitivity of the human ear at low sound levels. The new frequency-weighting function is expressed as:

$$G(f) = K + 10\log_{10}\left[\left(\frac{(f/f_{lo})^{2a}}{\left[1+(f/f_{lo})^{2}\right]^{a}\left[1+(f/f_{hi})^{2}\right]^{b}}\right)\right] \quad \text{(A-10)}$$

Finneran (2015) proposed five functional hearing groups for marine mammals in water: low-, mid- and high-frequency cetaceans (LF, MF, and HF cetaceans, respectively), phocid pinnipeds, and otariid pinnipeds. The parameters for these frequency-weighting functions were further modified the following year (Finneran 2016) and were adopted in NOAA's technical guidance that assesses acoustic impacts on marine mammals (NMFS 2018). In the latest guidance by Southall (2019) these hearing groups were adopted however, the mid- and high-frequency cetaceans groups from NMFS (2018) were renamed high- and very high-frequency cetaceans, respectively. The updates did not

affect the content related to either the definitions of frequency-weighting functions or the threshold values. Table A-1 lists the frequency-weighting parameters for each hearing group. Figure A-3 shows the resulting frequency-weighting curves.

Table A-1. Parameters for the auditory weighting functions as recommended by Southall et al. (2019).

Hearing group	a	b	f_{lo} (Hz)	f_{hi} (kHz)	K (dB)
Low-frequency cetaceans (baleen whales)	1.0	2	200	19,000	0.13
High-frequency cetaceans (dolphins, plus toothed, beaked, and bottlenose whales)	1.6	2	8,800	110,000	1.20
Very-high-frequency cetaceans (*Kogia*, cephalorhynchid, and *L. australis*)	1.8	2	12,000	140,000	1.36
Sirenians *(Dugongs, manatees)*	1.8	2	12,000	140,000	1.36

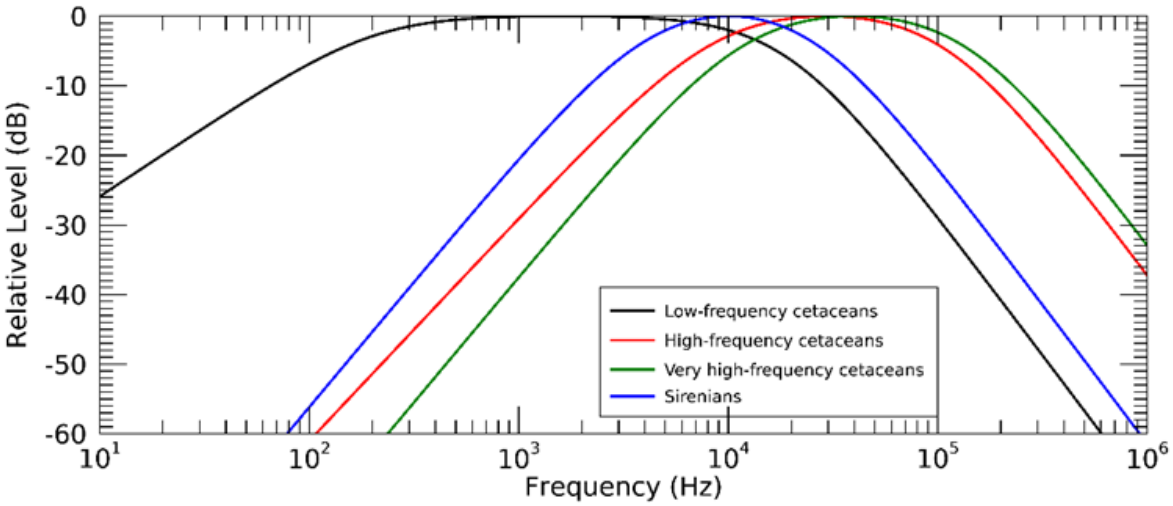


Figure A-3. Auditory weighting functions for functional marine mammal hearing groups as recommended by Southall et al. (2019).

Appendix B. Acoustic Source Model

B.1. Airgun Array Source Model

The source levels and directivity of the seismic source were predicted with JASCO's Airgun Array Source Model (AASM). AASM includes low- and high-frequency modules for predicting different components of the seismic source spectrum. The low-frequency module is based on the physics of oscillation and radiation of airgun bubbles, as originally described by Ziolkowski (1970), that solves the set of parallel differential equations that govern bubble oscillations. Physical effects accounted for in the simulation include pressure interactions between airguns, port throttling, bubble damping, and generator-injector (GI) gun behaviour discussed by Dragoset (1984), Laws et al. (1990), and Landrø (1992). A global optimisation algorithm tunes free parameters in the model to a large library of airgun source signatures.

While airgun signatures are highly repeatable at the low frequencies, which are used for seismic imaging, their sound emissions have a large random component at higher frequencies that cannot be predicted using a deterministic model. Therefore, AASM uses a stochastic simulation to predict the high-frequency (800-25,000 Hz) sound emissions of individual airguns, using a data-driven multiple-regression model. The multiple-regression model is based on a statistical analysis of a large collection of high quality seismic source signature data recently obtained from the Joint Industry Program (JIP) on Sound and Marine Life (Mattsson and Jenkerson 2008). The stochastic model uses a Monte-Carlo simulation to simulate the random component of the high-frequency spectrum of each airgun in an array. The mean high-frequency spectra from the stochastic model augment the low-frequency signatures from the physical model, allowing AASM to predict airgun source levels at frequencies up to 25,000 Hz.

AASM produces a set of "notional" signatures for each array element based on:

- Array layout
- Volume, tow depth, and firing pressure of each airgun
- Interactions between different airguns in the array

These notional signatures are the pressure waveforms of the individual airguns at a standard reference distance of 1 m; they account for the interactions with the other airguns in the array. The signatures are summed with the appropriate phase delays to obtain the far-field source signature of the entire array in all directions. This far-field array signature is filtered into decidecade-bands to compute the source levels of the array as a function of frequency band and azimuthal angle in the horizontal plane (at the source depth), after which it is considered a directional point source in the far field.

A seismic array consists of many sources and the point source assumption is invalid in the near field where the array elements add incoherently. The maximum extent of the near field of an array (R_{nf}) is:

$$R_{\mathrm{nf}} < \frac{l^2}{4\lambda} \tag{B-1}$$

where λ is the sound wavelength and l is the longest dimension of the array (Lurton 2002, §5.2.4). For example, a seismic source length of l = 21 m yields a near-field range of 147 m at 2 kHz and 7 m at 100 Hz. Beyond this R_{nf} range, the array is assumed to radiate like a directional point source and is treated as such for propagation modelling.

The interactions between individual elements of the array create directionality in the overall acoustic emission. Generally, this directionality is prominent mainly at frequencies in the mid-range between

tens of hertz to several hundred hertz. At lower frequencies, with acoustic wavelengths much larger than the inter-airgun separation distances, the directionality is small. At higher frequencies, the pattern of lobes is too finely spaced to be resolved and the effective directivity is less.

B.2. Seismic Source

Figure B-1 shows the layout of the 3050 in^3 seismic source used for modelling in this study. Table B-1 provides details of the airgun parameters.

For the modelled array, the layout is presented in a nominal cartesian coordinate system. In this coordinate system the direction of vessel travel determines the relative position of the array elements as plotted and tabulated. The layout used for acoustic modelling was produced by transforming the coordinates of client supplied layouts such that the resultant layouts correspond to a vessel travel direction along the positive X-axis and the array is centred on the X-Y origin. When used with an acoustic model the positive X-axis in this nominal coordinate system aligns with the vessel tow direction or survey line azimuth.

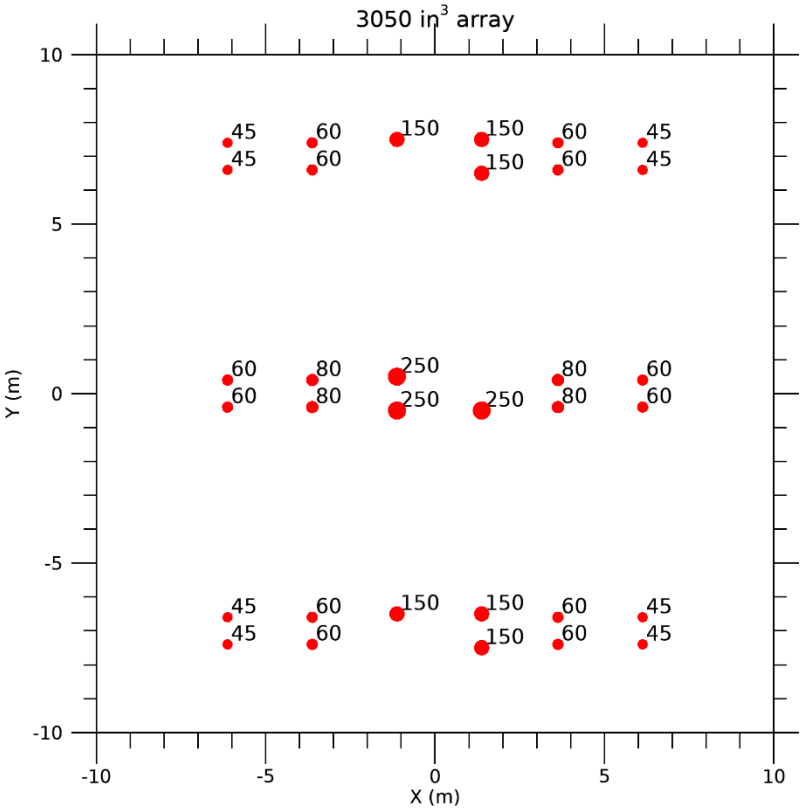


Figure B-1. Layout of the modelled 3050 in^3 seismic source. Tow depth is 8 m. The labels indicate the firing volume (in cubic inches) for each airgun. Also see Table B-1.

Table B-1. Layout of the modelled 3050 in^3 seismic source. Tow depth is 8 m. Firing pressure for all guns was 2000 psi. Also see Figure B-1.

String	Gun	x(m)	y(m)	z(m)	Vol(in3)	String	Gun	x(m)	y(m)	z(m)	Vol(in3)	String	Gun	x(m)	y(m)	z(m)	Vol(in3)
1	1	6.125	-7.4	8	45	2	13	6.125	-0.4	8	60	3	25	6.125	6.6	8	45
	2	6.125	-6.6		45		14	6.125	0.4		60		26	6.125	7.4		45
	3	3.625	-7.4		60		15	3.625	-0.4		80		27	3.625	6.6		60
	4	3.625	-6.6		60		16	3.625	0.4		80		28	3.625	7.4		60
	5	1.375	-7.5		150		17	1.375	-0.5		250		29	1.375	6.5		150
	6	3.375	-6.5		150		19	-1.125	-0.5		250		30	1.375	7.5		150
	8	-1.125	-6.5		150		20	-1.125	0.5		250		32	-1.125	7.5		150
	9	-3.625	-7.4		60		21	-3.625	-0.4		80		33	-3.625	6.6		60
	10	-3.625	-6.6		60		22	-3.625	0.4		80		34	-3.625	7.4		60
	11	-6.125	-7.4		45		23	-6.125	-0.4		60		35	-6.125	6.6		45
	12	-6.125	-6.6		45		24	-6.125	0.4		60		36	-6.125	7.4		45

B.3. Array Source Levels and Directivity

Figure B-2 shows the broadside (perpendicular to the tow direction), endfire (parallel to the tow direction) and vertical overpressure signature and corresponding power spectrum levels for the 3050 in^3 array (Appendix B.2). Horizontal decidecade-band source levels are shown as a function of band centre frequency and azimuth in Figure B-3.

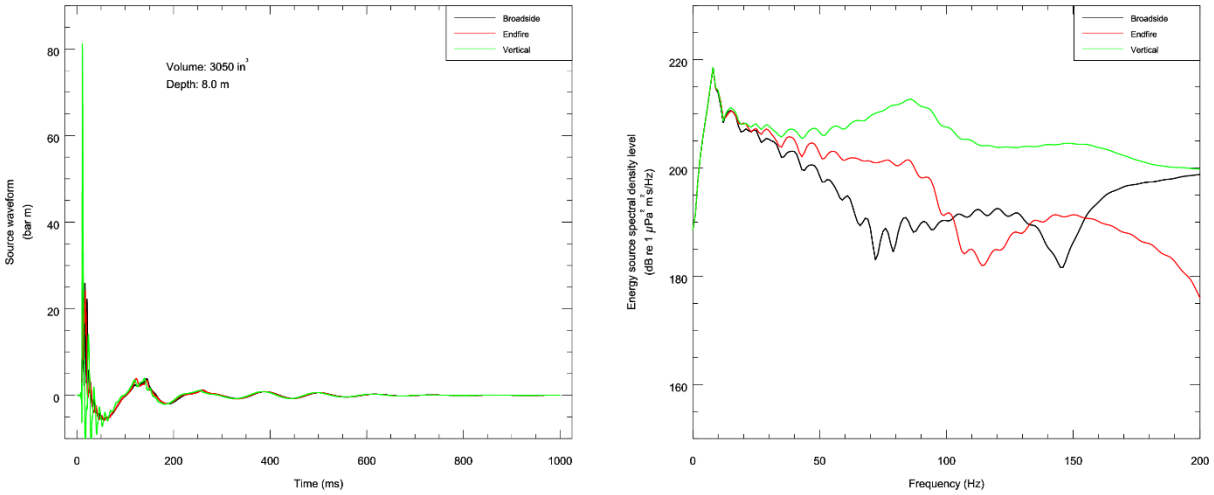


Figure B-2. Predicted source level details for the 3050 in^3 array at 8 m towed depth. (Left) the overpressure signature and (right) the power spectrum for in-plane horizontal (broadside), perpendicular (endfire), and vertical directions (no surface ghost).

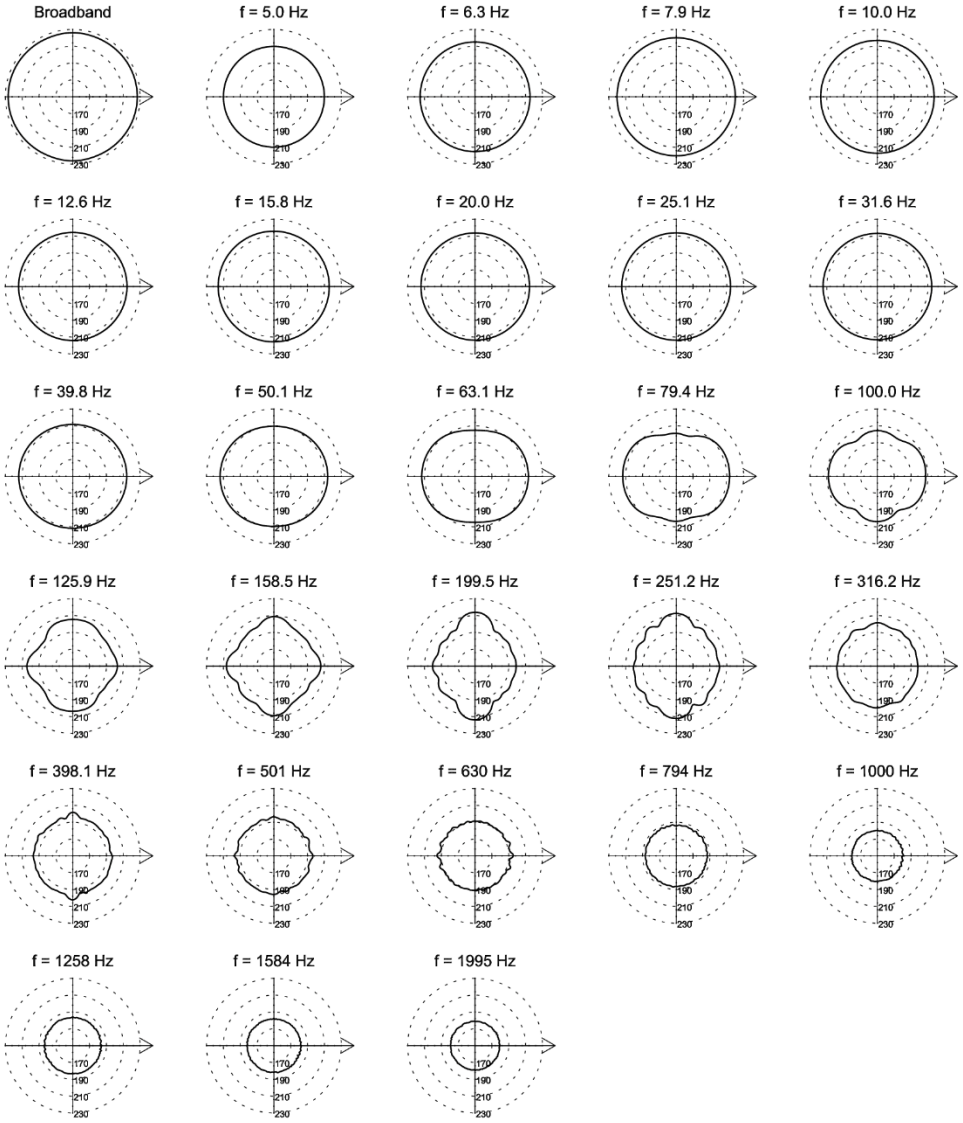


Figure B-3. Directionality of the predicted horizontal source levels for the 3050 in^3 seismic source, 5 Hz to 2 kHz. Source levels (in dB re 1 $\mu Pa^2 \cdot s\ m^2$) are shown as a function of azimuth for the centre frequencies of the decidecade bands modelled; frequencies are shown above the plots. The perpendicular direction to the frame is to the right. Tow depth is 8 m (see Figure B-2).

Appendix C. Sound Propagation Models

C.1. MONM-BELLHOP

Long-range sound fields were computed using JASCO's Marine Operations Noise Model (MONM). This model computes sound propagation at frequencies of 5 Hz to 1 kHz via a wide-angle parabolic equation solution to the acoustic wave equation (Collins 1993) based on a version of the US Naval Research Laboratory's Range-dependent Acoustic Model (RAM), which has been modified to account for a solid seabed (Zhang and Tindle 1995). MONM computes sound propagation at frequencies >1 kHz via the BELLHOP Gaussian beam acoustic ray-trace model (Porter and Liu 1994).

The parabolic equation method has been extensively benchmarked and is widely employed in the underwater acoustics community (Collins et al. 1996). MONM accounts for the additional reflection loss at the seabed, which results from partial conversion of incident compressional waves to shear waves at the seabed and sub-bottom interfaces, and it includes wave attenuations in all layers. MONM incorporates the following site-specific environmental properties: a bathymetric grid of the modelled area, underwater sound speed as a function of depth, and a geoacoustic profile based on the overall stratified composition of the seafloor.

This version of MONM accounts for sound attenuation due to energy absorption through ion relaxation and viscosity of water in addition to acoustic attenuation due to reflection at the medium boundaries and internal layers (Fisher and Simmons 1977). The former type of sound attenuation is significant for frequencies higher than 5 kHz and cannot be neglected without noticeably affecting the model results.

MONM computes acoustic fields in three dimensions by modelling transmission loss within two-dimensional (2-D) vertical planes aligned along radials covering a 360° swath from the source, an approach commonly referred to as N×2-D. These vertical radial planes are separated by an angular step size of $\Delta\theta$, yielding N = 360°/$\Delta\theta$ number of planes (Figure C-1).

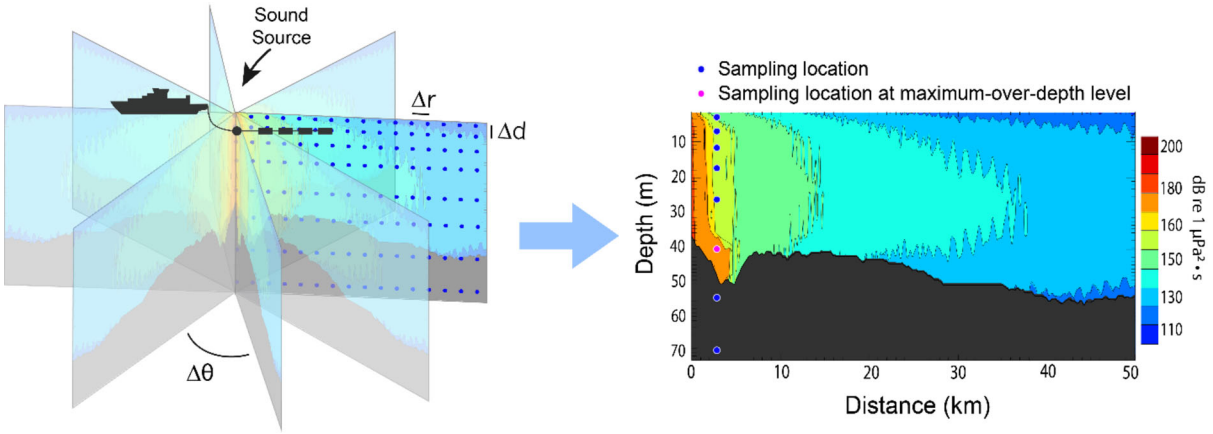


Figure C-1. The N×2-D and maximum-over-depth modelling approach used by MONM.

MONM treats frequency dependence by computing acoustic transmission loss at the centre frequencies of decidecade bands. Sufficiently many decidecade bands, starting at 5 Hz, are modelled to include most of the acoustic energy emitted by the source. At each centre frequency, the transmission loss is modelled within each of the N vertical planes as a function of depth and range from the source. The decidecade band received per-pulse SEL are computed by subtracting the band transmission loss values from the directional source level in that frequency band. Composite broadband received per-pulse SEL are then computed by summing the received decidecade band levels.

The received per-pulse SEL sound field within each vertical radial plane is sampled at various ranges from the source, generally with a fixed radial step size. At each sampling range along the surface, the sound field is sampled at various depths, with the step size between samples increasing with depth below the surface. The step sizes are chosen to provide increased coverage near the depth of the source and at depths of interest in terms of the sound speed profile. The maximum received per-pulse SEL at a many sampling depths are taken over all samples within the water column, i.e., the maximum-over-depth received per-pulse SEL. These maximum-over-depth per-pulse SEL are presented as contours around the source.

C.2. Full Waveform Range-dependent Acoustic Model: FWRAM

For impulsive sounds from the seismic source, time-domain representations of the pressure waves generated in the water are required to calculate SPL and PK. Furthermore, the seismic source must be represented as a distributed source to accurately characterise vertical directivity effects in the near-field zone. For this study, synthetic pressure waveforms were computed using FWRAM, which is a time-domain acoustic model based on the same wide-angle parabolic equation (PE) algorithm as MONM. FWRAM computes synthetic pressure waveforms versus range and depth for range-varying marine acoustic environments, and it takes the same environmental inputs as MONM (bathymetry, water sound speed profile, and seafloor geoacoustic profile). Unlike MONM, FWRAM computes pressure waveforms via Fourier synthesis of the modelled acoustic transfer function in closely spaced frequency bands. FWRAM employs the array starter method to accurately model sound propagation from a spatially distributed source (MacGillivray and Chapman 2012).

Besides providing direct calculations of the PK and SPL, the synthetic waveforms from FWRAM can also be used to convert the SEL values from MONM to SPL.

C.3. Wavenumber Integration Model

Sound pressure levels near the seismic source were modelled using JASCO's VSTACK wavenumber integration model. VSTACK computes synthetic pressure waveforms versus depth and range for arbitrarily layered, range-independent acoustic environments using the wavenumber integration approach to solve the exact (range-independent) acoustic wave equation. This model is valid over the full angular range of the wave equation and can fully account for the elasto-acoustic properties of the sub-bottom. Wavenumber integration methods are extensively used in the field of underwater acoustics and seismology where they are often referred to as reflectivity methods or discrete wavenumber methods. VSTACK computes sound propagation in arbitrarily stratified water and seabed layers by decomposing the outgoing field into a continuum of outward-propagating plane cylindrical waves. Seabed reflectivity in the model is dependent on the seabed layer properties: compressional and shear wave speeds, attenuation coefficients, and layer densities. The output of the model can be post-processed to yield estimates of the SEL, SPL, and PK.

VSTACK accurately predicts steep-angle propagation in the proximity of the source, but it is computationally slow at predicting sound pressures at large distances due to the need for smaller wavenumber steps with increasing distance. Additionally, VSTACK assumes range-invariant bathymetry with a horizontally stratified medium (i.e., a range-independent environment) which is azimuthally symmetric about the source. VSTACK is thus best suited to modelling the sound field near the source.

Appendix D. Methods and Parameters

This section details the environmental parameters used in the propagation models.

D.1. Estimating Range to Thresholds Levels

Sound level contours were calculated based on the underwater sound fields predicted by the propagation models, sampled by taking the maximum value over all modelled depths above the sea floor for each location in the modelled region. The predicted distances to specific levels were computed from these contours. Two distances relative to the source are reported for each sound level: 1) R_{max}, the maximum range to the given sound level over all azimuths, and 2) $R_{95\%}$, the range to the given sound level after the 5% farthest points were excluded (see examples in Figure D-1).

The $R_{95\%}$ is used because sound field footprints are often irregular in shape. In some cases, a sound level contour might have small protrusions or anomalous isolated fringes. This is demonstrated in the image in Figure D-1(a). In cases such as this, where relatively few points are excluded in any given direction, R_{max} can misrepresent the area of the region exposed to such effects, and $R_{95\%}$ is considered more representative. In strongly asymmetric cases such as shown in Figure D-1(b), on the other hand, $R_{95\%}$ neglects to account for significant protrusions in the footprint. In such cases R_{max} might better represent the region of effect in specific directions. Cases such as this are usually associated with bathymetric features affecting propagation. The difference between R_{max} and $R_{95\%}$ depends on the source directivity and the non-uniformity of the acoustic environment.

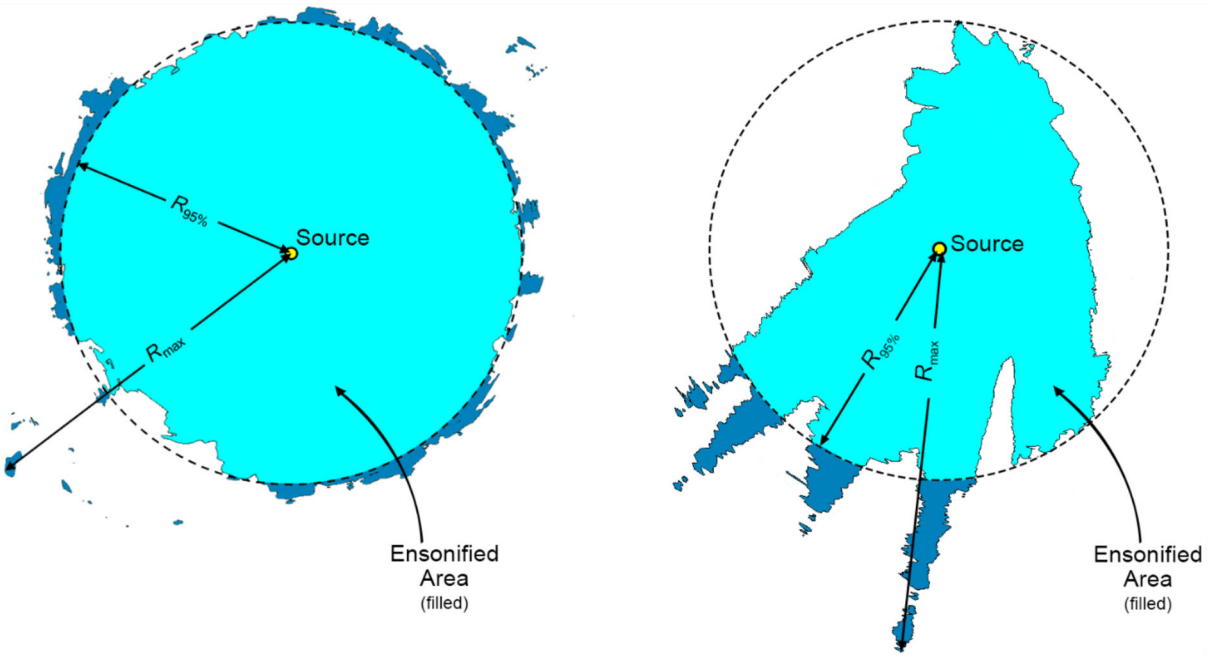


Figure D-1. Sample areas ensonified to an arbitrary sound level with R_{max} and $R_{95\%}$ ranges shown for two scenarios. (a) Largely symmetric sound level contour with small protrusions. (b) Strongly asymmetric sound level contour with long protrusions. Light blue indicates the ensonified areas bounded by $R_{95\%}$; darker blue indicates the areas outside this boundary which determine R_{max}.

D.2. Estimating SPL from Modelled SEL Results

The per-pulse SEL of sound pulses is an energy-like metric related to the dose of sound received over a pulse's entire duration. The pulse SPL on the other hand, is related to its intensity over a specified time interval. Seismic pulses typically lengthen in duration as they propagate away from their source, due to seafloor and surface reflections, and other waveguide dispersion effects. The changes in pulse length, and therefore the time window considered, affect the numeric relationship between SPL and SEL. This study has applied a fixed window duration to calculate SPL (T_{fix} = 125 ms; see Appendix A.1), as implemented in Martin et al. (2017b). Full-waveform modelling was used to estimate SPL, but this type of modelling is computationally intensive, and can be prohibitively time consuming when run at high spatial resolution over large areas.

For the current study, FWRAM (Appendix C.2) was used to model synthetic seismic pulses over the frequency range 5-1024 Hz. This was performed along all broadside and endfire radials at three sites. FWRAM uses Fourier synthesis to recreate the signal in the time domain so that both the SEL and SPL from the source can be calculated. The differences between the SEL and SPL were extracted for all ranges and depths that corresponded to those generated from the high spatial-resolution results from MONM. A 125 ms fixed time window positioned to maximize the SPL over the pulse duration was applied. The resulting SEL-to-SPL offsets were averaged in 0.02 km range bins along each modelled radial and depth, and the 90th percentile was selected at each range to generate a generalised range-dependent conversion function for each site. The range-dependent conversion function was applied to predicted per-pulse SEL results from MONM to model SPL values. Figure D-2 and Figure D-3 show the conversion offsets for the three sites for the 3050 in^3 array; the spatial variation is caused by changes in the received airgun pulse as it propagates from the source. The conversion to SPL from SEL was conducted considering the water depth and seabed geology at a given modelled site.

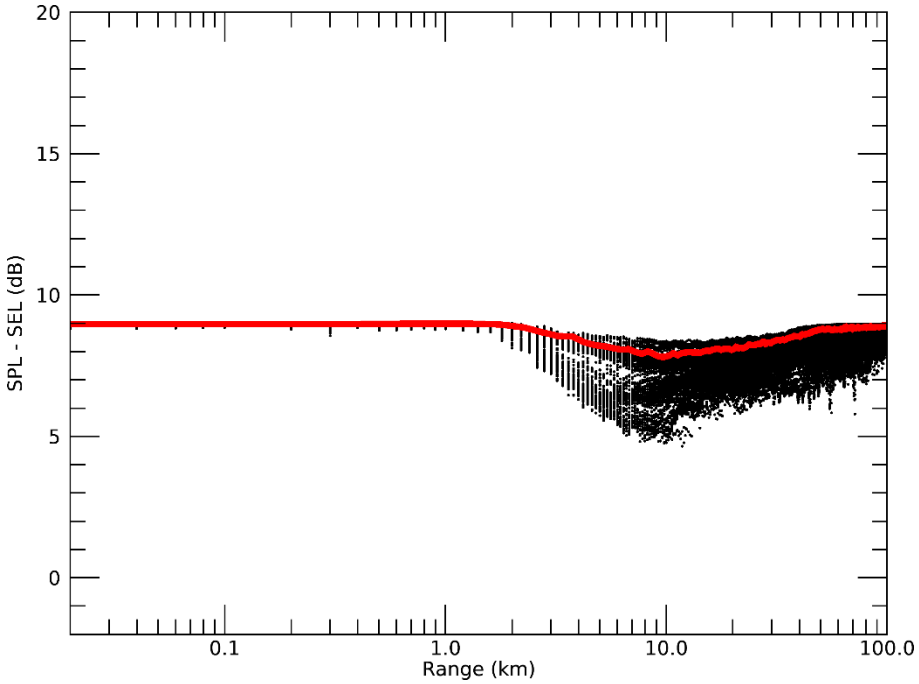


Figure D-2. *Site 2, 3050 in^3 seismic source*: Range-and-depth-dependent conversion offsets for converting sound exposure level (SEL) to sound pressure level (SPL) for seismic pulses. Black lines are the modelled differences between SEL and SPL across different radials and receiver depths; the solid red line is the 90th percentile of the modelled differences at each range.

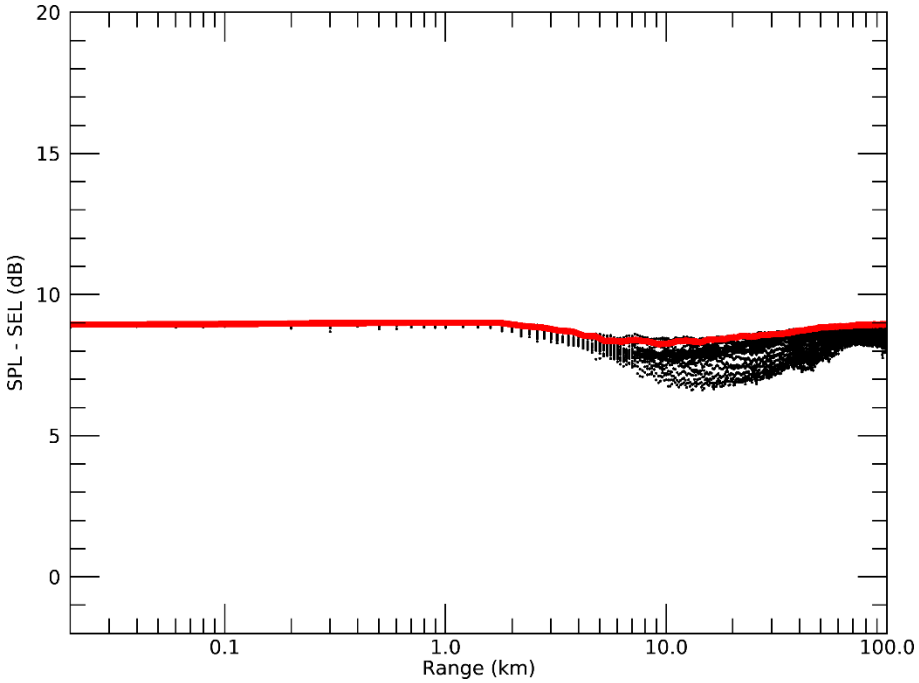


Figure D-3. *Site 3, 3050 in³ seismic source*: Range-and-depth-dependent conversion offsets for converting sound exposure level (SEL) to sound pressure level (SPL) for seismic pulses. Black lines are the modelled differences between SEL and SPL across different radials and receiver depths; the solid red line is the 90th percentile of the modelled differences at each range.

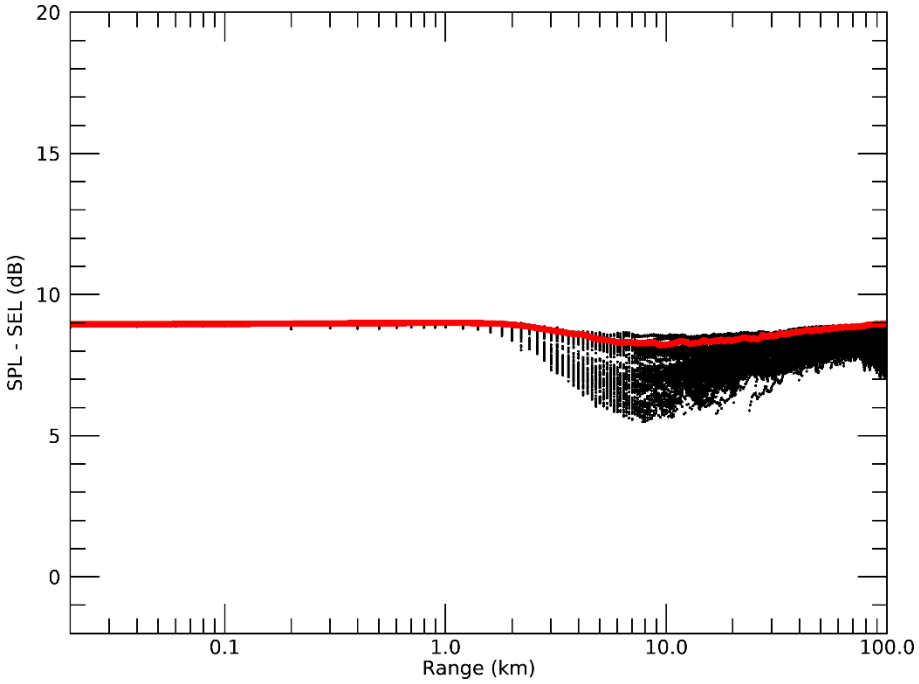


Figure D-4. *Site 6, 3050 in³ seismic source*: Range-and-depth-dependent conversion offsets for converting sound exposure level (SEL) to sound pressure level (SPL) for seismic pulses. Black lines are the modelled differences between SEL and SPL across different radials and receiver depths; the solid red line is the 90th percentile of the modelled differences at each range.

D.3. Environmental Parameters

D.3.1. Bathymetry

Water depths throughout the modelled area were extracted from the high-resolution depth model for Northern Australia, a ~30 m grid rendered for Northern Australia (Beaman 2018) for the region shown in Figure 1. Bathymetry data was extracted and re-gridded onto a Map Grid of Australia (MGA) coordinate projection (Zone 52) with a regular grid spacing of 250 × 250 m to generate the bathymetry in Figure D-5.

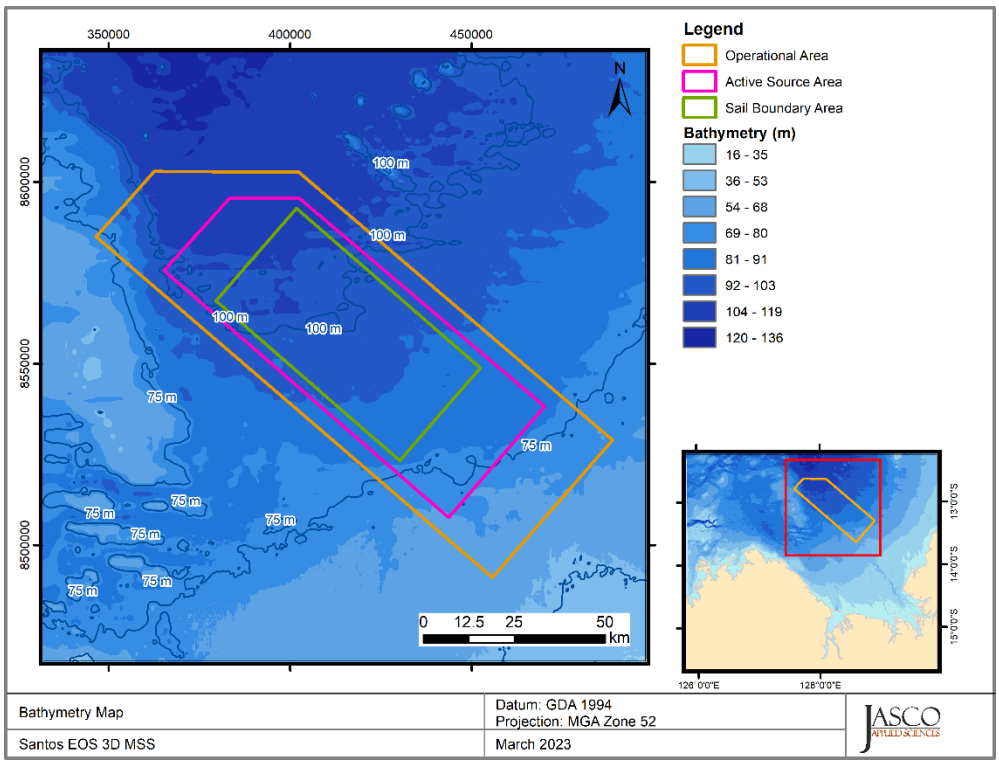


Figure D-5. Bathymetry map of the modelling area for the Santos Eos 3D Marine Seismic Survey.

D.3.2. Sound Speed Profile

The sound speed profiles for the modelled sites were derived from temperature and salinity profiles from the US Naval Oceanographic Office's Generalized Digital Environmental Model V 3.0 (GDEM; Teague et al. 1990, Carnes 2009). GDEM provides an ocean climatology of temperature and salinity for the world's oceans on a latitude-longitude grid with 0.25° resolution, with a temporal resolution of one month, based on global historical observations from the US Navy's Master Oceanographic Observational Data Set (MOODS). The climatology profiles include 78 fixed depth points to a maximum depth of 6800 m (where the ocean is that deep). The GDEM temperature-salinity profiles were converted to sound speed profiles according to Coppens (1981).

Mean monthly sound speed profiles were derived from the GDEM profiles within a 100 km box radius encompassing all modelled sites. The June sound speed profile is expected to be most favourable to longer-range sound propagation during the proposed survey time frame. As such, June was selected for sound propagation modelling to ensure precautionary estimates of distances to received sound level thresholds. Figure D-6 shows the resulting profile used as input to the sound propagation modelling.

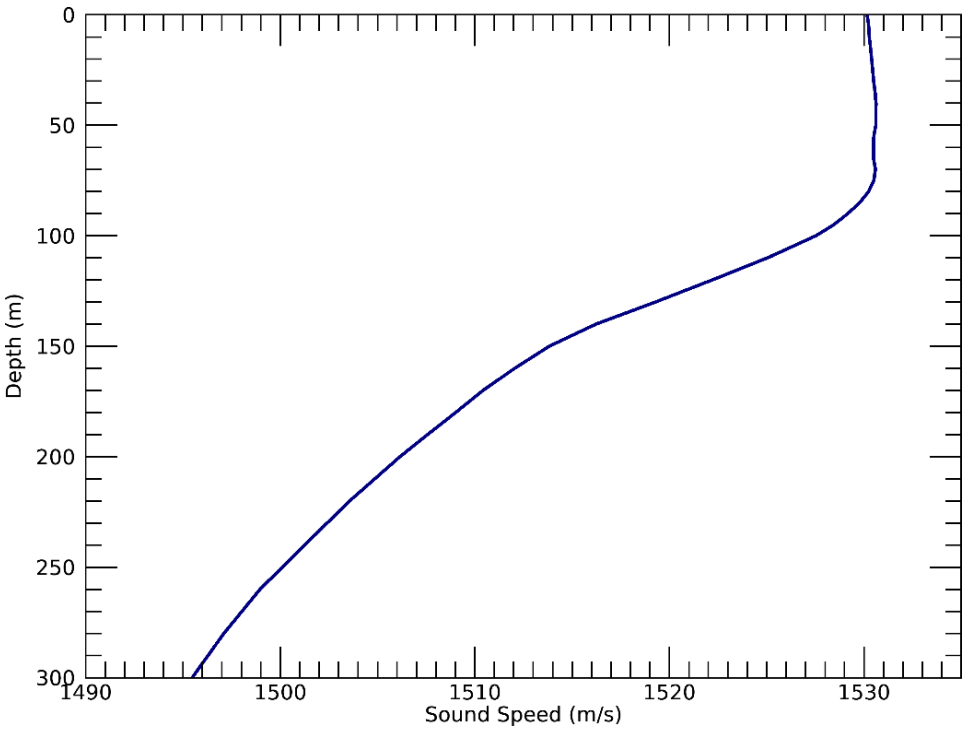


Figure D-6. The sound speed profile (June) used for the modelling showing the entire water column. The profile is calculated from temperature and salinity profiles from GDEM V 3.0 (GDEM; Teague et al. 1990, Carnes 2009).

D.3.3. Geoacoustics

Geoacoustic parameters used for modelling at all sites were derived from sedimentary grain size measurements from the Australian Government's Marine Sediments (MARS) database (Heap 2009). On average, the surficial grain size indicates silty sand is present throughout the modelled area. Representative grain sizes were used in the grain-shearing model proposed by Buckingham (2005) to estimate the geoacoustic parameters required by the sound propagation models. Table D-1 lists the geoacoustic parameters used for modelling for both sites.

Table D-1. Geoacoustic profile for all modelling sites.

Depth below seafloor (m)	Predicted lithology	Density (g/cm^3)	Compressional wave		Shear wave	
			Speed (m/s)	Attenuation (dB/λ)	Speed (m/s)	Attenuation (dB/λ)
0-10	Unconsolidated muddy sand	1.88	1624-1724	0.34-0.71	262	3.65
10-20		1.88	1724-1777	0.71-0.88		
20-50		1.88-1.90	1777-1874	0.88-1.14		
50-100	Compact muddy sand	1.90-1.92	1874-1978	1.14-1.37		
100-200		1.92-1.96	1978-2118	1.37-1.62		
200-500	Consolidated muddy sand/sedimentary rock	1.96-2.06	2118-2392	1.62-1.93		
> 500		2.06	2392	1.93		

Appendix E. Model Validation Information

Predictions from JASCO's Airgun Array Source Model (AASM) and propagation models (MONM, FWRAM and VSTACK) have been validated against experimental data from a number of underwater acoustic measurement programs conducted by JASCO globally, including the United States and Canadian Artic, Canadian and southern United States waters, Greenland, Russia and Australia (Hannay and Racca (2005), Aerts et al. (2008), Funk et al. (2008), Ireland et al. (2009), O'Neill et al. (2010), Warner et al. (2010), Racca et al. (2012a), Racca et al. (2012b), Matthews and MacGillivray (2013), Martin et al. (2015), Racca et al. (2015), Martin et al. (2017a), Martin et al. (2017b), Warner et al. (2017), MacGillivray (2018), McPherson et al. (2018), McPherson and Martin (2018)).

In addition, JASCO has conducted measurement programs associated with a significant number of anthropogenic activities which have included internal validation of the modelling (including McCrodan et al. (2011), Austin and Warner (2012), McPherson and Warner (2012), Austin and Bailey (2013), Austin et al. (2013), Zykov and MacDonnell (2013), Austin (2014), Austin et al. (2015), Austin and Li (2016), Martin and Popper (2016)).

Appendix F. Additional Results

F.1. Per-pulse SEL Contour Maps

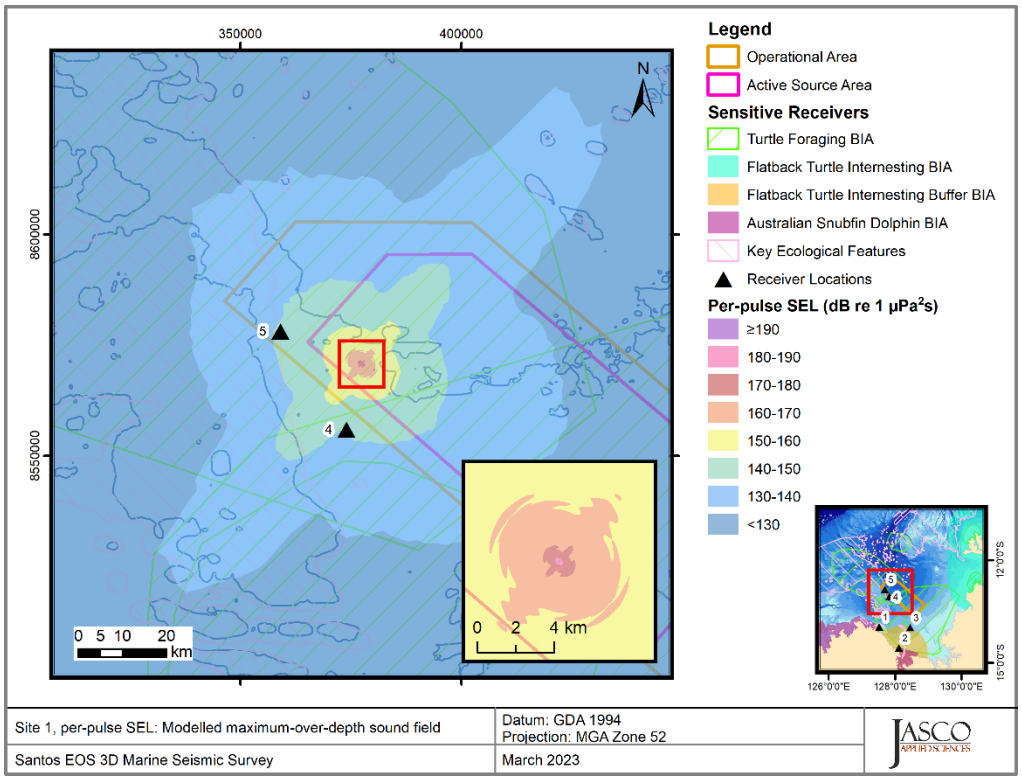


Figure F-1. *Site 1, tow azimuth 131º, SEL:* Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps.

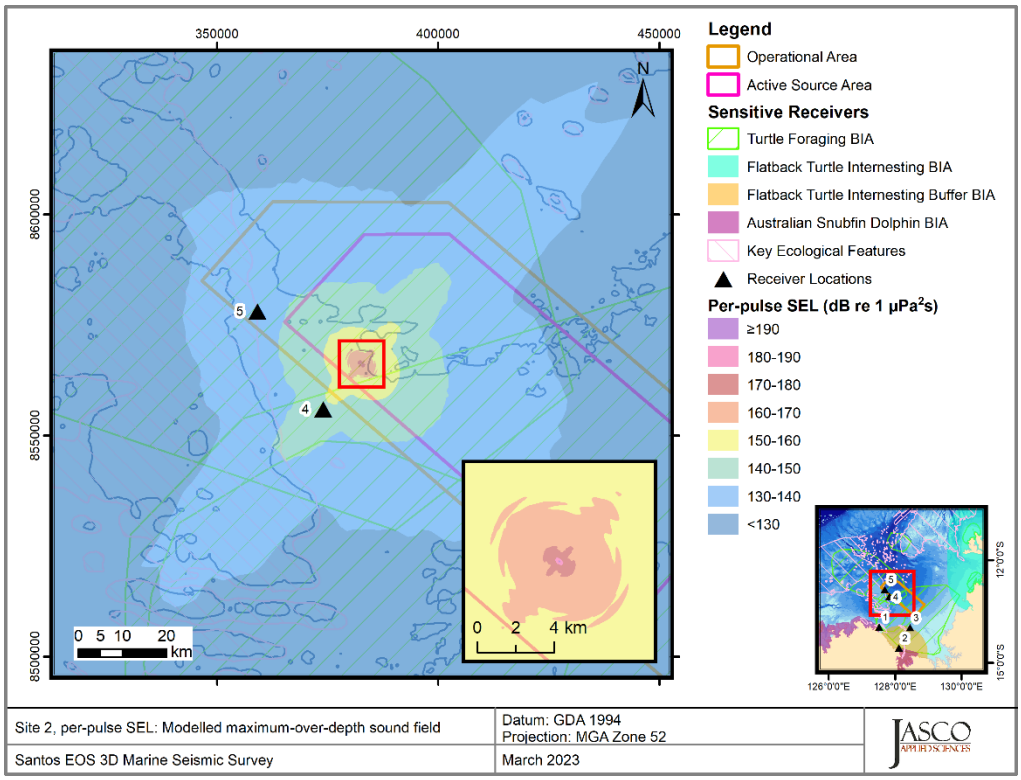


Figure F-2. *Site 2, tow azimuth 131º, SEL:* Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps.

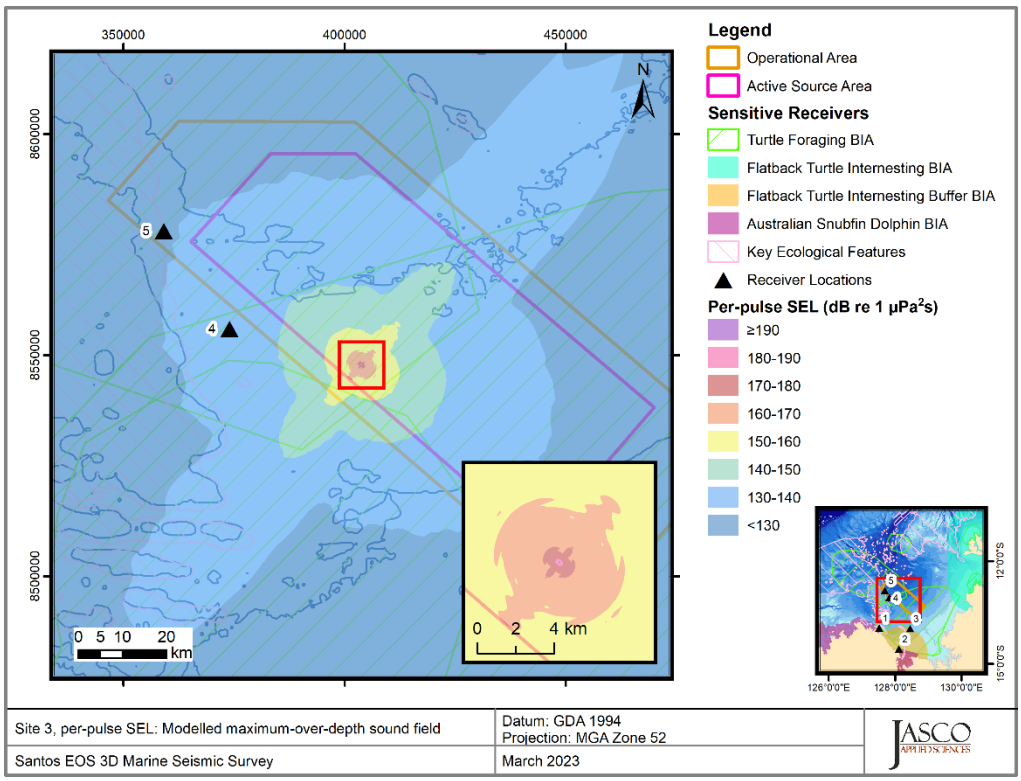


Figure F-3. *Site 3, tow azimuth 131º, SEL:* Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps.

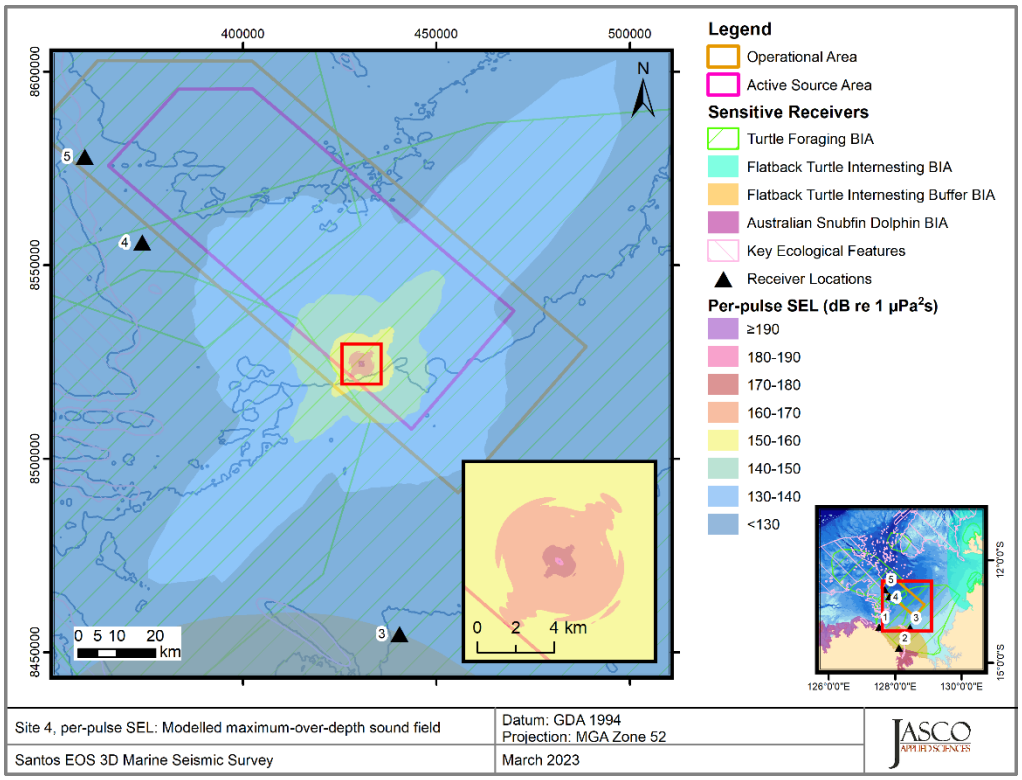


Figure F-4. *Site 4, tow azimuth 131º, SEL:* Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps.

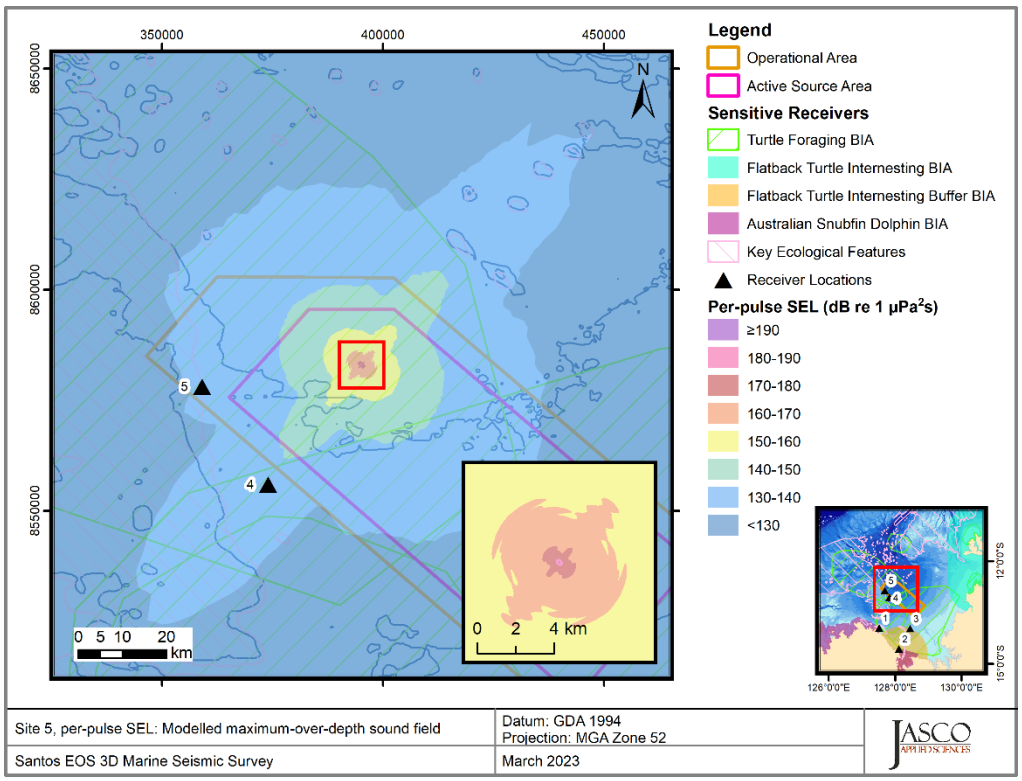


Figure F-5. *Site 5, tow azimuth 131º, SEL:* Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps.

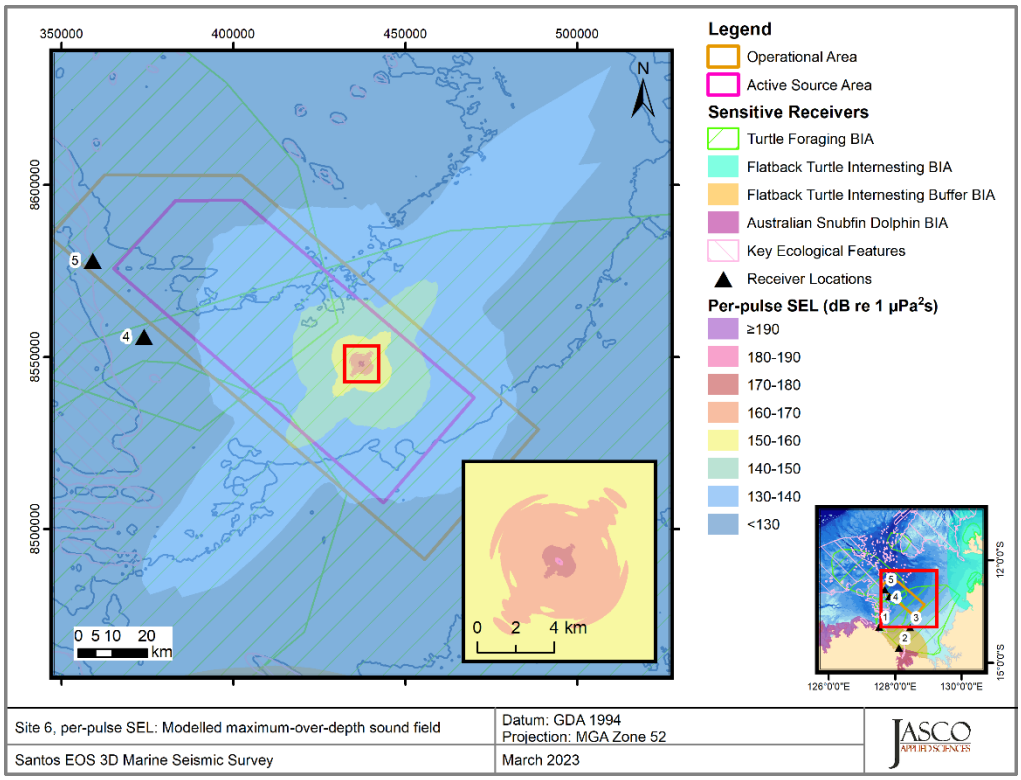


Figure F-6. *Site 6, tow azimuth 131º, SEL:* Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps.

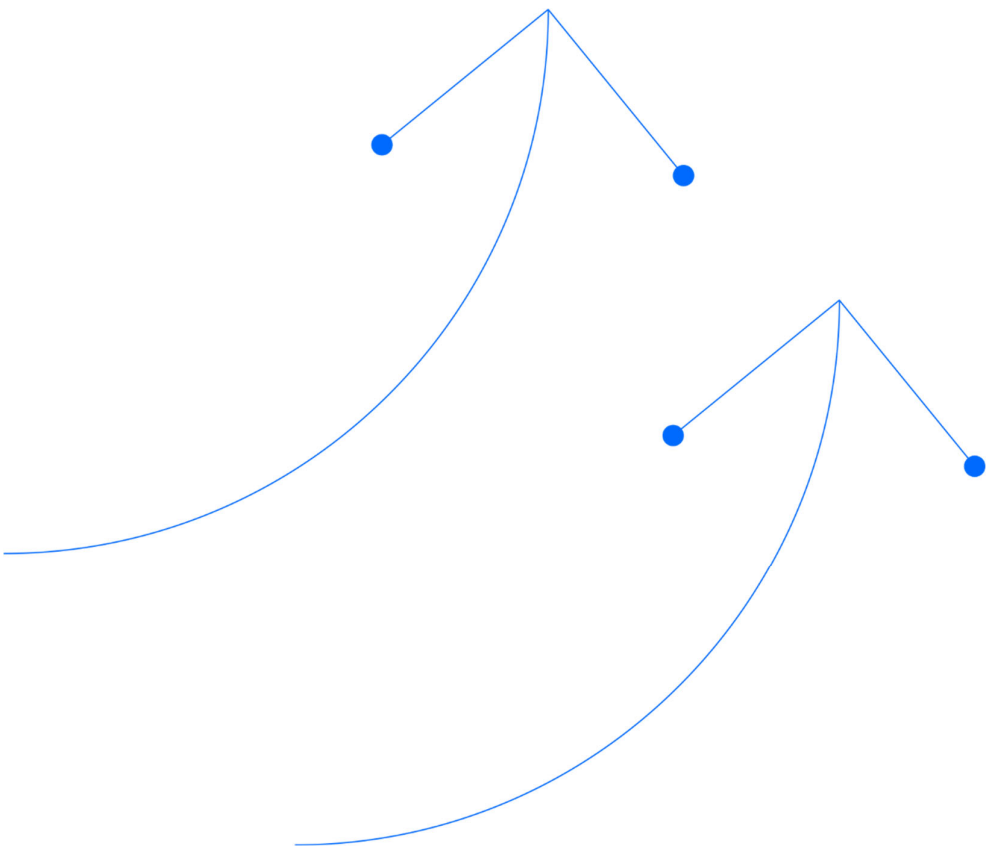
Appendix H Noise impact technical appendix

Santos

Eos 3D Marine Seismic Survey

Technical Appendix: Noise Impacts on Marine Fauna

26 May 2025



Santos

Eos 3D Marine Seismic Survey

Environment Plan

Contents

1. Hazard Identification 4

1.1 Seismic Source 4

1.2 Vessel-related sound sources 4

2. Background 5

3. Noise sources and sound propagation 6

3.1 Impulsive sounds vs continuous sounds 6

3.2 Factors influencing sound propagation 6

3.3 Metrics 7

3.3.1 Sound metric terminology 7

3.3.2 Noise effect criteria 8

4. Sound perception 10

4.1 Hearing sensitivity 10

4.2 Weighting functions 10

4.3 Noise criteria, rationale 10

5. Potential noise effects 11

5.1 Stress 11

5.2 Behaviour 11

5.3 Masking 11

5.4 Noise-induced threshold shift 12

5.5 Mortality 12

6. Species 13

6.1 Marine Invertebrates 13

6.1.1 Plankton 13

6.1.2 Bivalves 14

6.1.3 Decapod crustaceans 15

6.1.4 Squid 17

6.1.5 Benthic species 17

6.2 Fishes 18

6.2.1 Behaviour 19

6.2.2 Acoustic Masking 21

6.3 Fishing 22

6.4 Sharks 23

6.5 Sea turtles 23

6.6 Cetaceans: mysticetes (baleen whales) and odontocetes (dolphins, sperm and beaked whales) 24

6.6.1 Hearing sensitivity 24

6.6.2 Behaviour 26

6.6.3 Masking 27

6.6.4 TTS/PTS/Auditory Injury 28

6.6.5 Mortality 29
6.7 Seabirds 29
6.8 Divers 29
7. References 31

1. Hazard Identification

The following activities generating underwater sound are considered in this technical appendix:

- Sound pulses from the seismic airgun array; and
- Engine and machinery noise transmitted through the hull and propeller noise from the source and support vessels.

1.1 Seismic Source

The dominant source of underwater sound during a seismic survey is generated from the operation of the seismic source (airgun array). The configuration and source characteristics of potential seismic source options for the Keraudren Extension 3D Marine Seismic Survey (MSS) are described in the sound propagation modelling report (Koessler and McPherson 2019).
The seismic source will be fired at regular intervals, producing pulses of high-intensity low-frequency sound. Seismic pulses typically have ~98% of the signal power in dominant frequencies less than 200 Hz; predominantly in the 10 to 200 Hz range (McCauley 1994), the useful range for seismic data imaging. The airgun array comprises a series of airguns that are discharged in pre-determined order to achieve the desired sound energy and frequency of discharges with minimal interference. The underwater acoustic signatures of the array were predicted with JASCO's specialised computer model AASM, which accounts for individual airgun volumes and array geometry. Sound levels at distances from the sources were estimated using complementary underwater acoustic propagation models in conjunction with the modelled array signatures (Koessler and McPherson 2019).

1.2 Vessel-related sound sources

Sounds made by human activities at sea, whether intentional (e.g., sonar) or unintentional (shipping), can be transient or continuous, and the sounds cover varying frequency bands. The contribution of anthropogenic sound to the overall soundscape at sea has increased over the past century and is now present in almost all marine areas (Pine et al. 2012). Commercial shipping is one of the main contributing factors to the background noise in the oceans (Frisk 2012). Several studies present data recorded in various parts of the world's oceans indicating that low-frequency (<100 Hz) sound levels increased at a rate of 0.55 dB/year (~3 dB/decade) up until the 1980s (Andrew et al. 2002, Ross 2005, McDonald et al. 2006) and then slowed to 0.2 dB/year (Chapman and Price 2011). Worldwide, there are regional differences with regard to this trend (Andrew et al. 2011, Miksis-Olds and Nichols 2016), and in temperate zones, a pronounced seasonal variation in background noise is attributable to seasonal changes in human boating and recreational activities (Samuel et al. 2005).

2. Background

Sound, of all forms of energy, is transmitted underwater with the least amount of attenuation, thus sound reaches marine life over long distances. This physical characteristic is important from a biological viewpoint as it favoured, through evolution, the development of sound-producing mechanisms and sensory systems tuned to perceive sound in various marine taxa.

As in terrestrial animals, sound has also the potential to cause various effects in marine animals. The type and severity of these effects depends on the acoustic characteristics of the sound source (i.e. the emitted signal, the physical properties along path from the source to a receiver, the background noise at the receiver's position, and an animal's hearing sensitivity over frequencies included in the sound).

A sound wave can be detected underwater and classified by the pressure fluctuation it generates, as well as the particle motion associated with the propagation of the sound wave. These two components of sound, pressure and particle motion, serve as input to the sensory systems in marine animals. Different species (or taxonomic groups, taxa) developed sensors for either one of these sound components, and some are sensitive to both.

The particle motion generated by an active sound source refers to the movement of the particles that make up the media when a sound is present (Martin et al. 2016). It can be quantified in terms of particle velocity, -displacement or -acceleration; these are vector quantities having magnitude and direction.

For simple situations, such as acoustical plane-waves or spherical waves in an infinite body of water (i.e., without boundary reflections), the particle velocity can be determined from the pressure and vice-versa, as they are strongly correlated in the acoustic far-field of a sound source.

3. Noise sources and sound propagation

3.1 Impulsive sounds vs continuous sounds

Impulsive and non-impulsive sounds are primarily distinguished by their temporal pattern: Impulsive or 'pulsed' sounds can be described as discrete (single pulses) and sometimes intermittent sounds (multiple pulses) produced by sources such as airguns and pile driving. These sounds, sometimes also termed transients, are typically brief signals consisting of high peak sound pressure with rapid rise time and rapid decay (NIOSH 1998).

Non-impulsive sounds which can be intermittent or continuous produced by sound sources such as ships and pumps. Non-impulsive sounds are longer than impulsive and usually do not have the high peak sound pressure and rapid rise/decay time that impulsive sounds do (NIOSH 1998). However, especially in respect to their auditory effects, the term non-impulsive does not imply long duration signals.

3.2 Factors influencing sound propagation

It is essential to understand that a sound emitted by a source is altered along its propagation path and transformed into the signal received some distance away. A key question in the study of underwater sound is how an acoustic signal changes in nature as it propagates from its source to a receiver some distance away. This section provides a descriptive overview of key sound propagation concepts to assist with the results presented in this report. These concepts are integral to interpreting how sounds emitted by a source are transformed into those received some distance away.

The sounds are transformed by:

- Geometric spreading: Sound levels from an omnidirectional point source in the water column are reduced with range, a process known as geometric spreading loss. As sound leaves the source, each spherical sound wave propagates outward and the sound energy is spread out over this ever-expanding sphere. The farther you are from the source, the lower the sound level you will receive. The received sound pressure levels at a recorder located a distance 'r' (in m) from the source are 20log10R dB lower than the source level (SL) referenced to a standard range of 1 m. But the sound cannot spread uniformly in all directions forever. Once the waves interact with the sea surface and seabed, the spreading becomes cylindrical rather than spherical and is limited to the cylinder formed by the surface and seabed with a lower range-dependent decay of $10*\log_{10} R$ dB. Thus, the water depth is a key factor in predicting spreading losses and received sound levels. These spherical and cylindrical spreading factors provide limits for quick approximations of expected levels from a given source. In very shallow waters, sound rapidly attenuates if the water depth is less than a quarter of a wavelength (Urick 1983).

- Absorption, reflection, and scattering at the sea surface and seabed: If geometric spreading were the only factor governing sound attenuation in water, then at a given distance from a source, sound levels in shallow waters would almost always be higher than those in deep waters. In shallow water, however, the sound interacts more often with the seabed and sea surface than sound travelling in deep waters, and these interactions reflect, absorb, and scatter the sound. The sea surface behaves approximately as a pressure release boundary, where incident sound is almost completely reflected with opposite phase. As a result, the sum of the incident and reflected sounds at the sea-surface is zero. At the seabed many types of interactions can occur depending on the composition of the bottom. Soft silt and clay bottoms absorb sound, sand and gravel bottoms tend to reflect sound like a partially reflective mirror, and some hard yet elastic bottoms, such as limestone, reflect some of the sound while absorbing some of the energy by converting the compressional waves to elastic shear waves.
- Refraction due to sound speed changes: The speed of sound in water depends on the water's temperature, salinity, and pressure (i.e., water depth). Colder and fresher water has a lower sound speed, while warmer and saltier water has a higher sound speed. As the water depth increases, the pressure increases the water density slightly, which increases the sound speed (Jensen et al. 2011). These effects combine with environmental forces, such as solar heating, wind mixing, and currents, to constantly affect the sound speed in the upper 500 m of the water column, which thus has daily variations around typical seasonal means. When the sound speed changes with depth, which it always does, the sound refracts toward the depth with the lowest sound speed. This often results in sound being trapped in a 'duct' and travelling long distances with little attenuation. Conversely, in conditions where the sound speed decreases with depth, sound is refracted toward the seabed. The ability of a minimum in the sound speed profile to 'duct' sound depends on the magnitude of the sound speed change at the minimum, the vertical height of the minimum, and the sound's wavelength. Ducts must be several times larger than the wavelength to effectively trap

sound (Etter 1996). A corollary of this effect is that higher frequencies are refracted more readily by sound speed changes than lower frequencies, which have longer wavelengths.

- Absorption by sea water: As sound travels through the ocean, some of the energy is absorbed by the ionic relaxation of boric acid and magnesium sulphate, which turns the acoustic energy into heat. The amount of absorption that occurs is quantified by an attenuation coefficient, expressed in units of decibels per kilometre (dB/km). This absorption coefficient depends on the temperature, salinity, pH, and pressure of the water, as well as the sound frequency. In general, the absorption coefficient increases with the square of the frequency, so low frequencies are less affected. The absorption of acoustic wave energy has a noticeable effect (>0.05 dB/km) at frequencies above 1 kHz. For example, at 10 kHz the absorption loss over 10 km distance can exceed 10 dB, as computed according to the formulae of François and Garrison (1982b, 1982a).

Each of these aspects results in substantial changes to acoustic characteristics of the emitted signal and its propagation from the sound source to the received individual. A key question in the study of underwater sound is how a sound signal changes in nature as it propagates from its source to a receiver some distance away. At the other extreme, sounds from fin whales (20 Hz) and low-frequency energy from seismic airguns (5–100 Hz) can be detected thousands of kilometres away under the right conditions (Nieukirk et al. 2012).

3.3 Metrics

The publication of ISO 18405 Underwater Acoustics – Terminology (ISO 2017) (**Table 3-1**) provided a dictionary of underwater bioacoustics. For future reference, the terminology defined in this standard should be used to avoid ambiguity in reported sound levels. However, most of the relevant studies on noise effects in marine fauna are not compliant as they were published before the new standards were released.

Table 3-1: Metrics used to describe underwater sound

Metric	Commonly used (before 2017)	ISO (2017) / NMFS (2018)	
		Main text	Tables/equations
Sound Pressure Level	SPL_{rms}, SPL_{RMS}	SPL	SPL (L_p)
Peak Pressure	SPL_{pk}	PK	PK (L_{pk})
Sound Exposure Level	SEL_{cum}	SEL_{24h}	SEL_{24h} ($L_{E,24h}$)

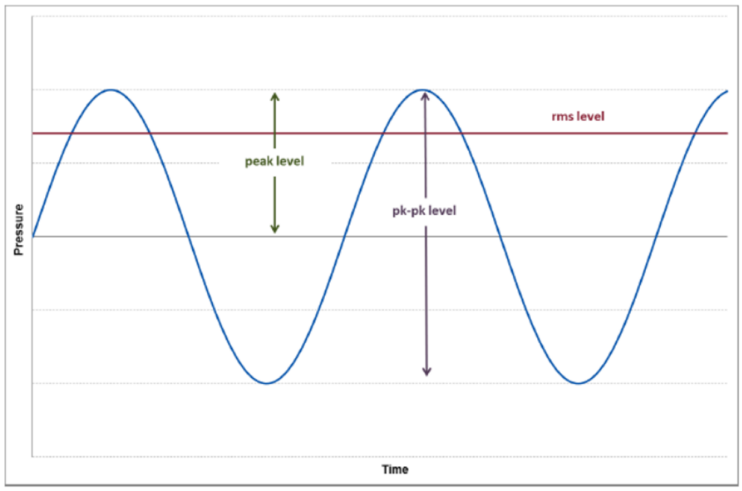
The Sound Exposure Level metric (SEL_{24h}) describes the sound energy received by a receptor over a period of 24 hours.

3.3.1 Sound metric terminology

Given the multiple measures commonly used to express sound metrics, it's important to ensure any comparisons between specific sound level values are made using the same measures. These sound level metrics are summarised in **Table 3-2.**

Table 3-2: Sound Level Metrics Definitions

Source level	Source level (SL): The sound pressure level or sound exposure level measured 1 metre from a theoretical point source that radiates the same total sound power as the actual source. It is a theoretical value for a seismic source, because a seismic source is not a point source, but rather is made up of individual elements covering a defined area. Source level can be expressed as an SPL, SEL or PK. Unit: dB re 1 μPa^2m^2 or dB 1 μPa^2m^2s.
Impulse / Pulse	The terms used to refer to the discharge of a seismic source are impulse and pulse, therefore the terms used to describe a single discharge are per-impulse or per-pulse.
Peak pressure (PK)	Zero-to-peak sound pressure (PK), the greatest magnitude of the sound pressure during a specified time interval, unit: dB re 1 µPa. PK levels are modelled to assess

Impulsive sounds	mortality and potential mortal injury to fish, turtles, fish eggs and larvae. Refer to the below for graphical representation of PK. 
Peak-to-peak pressure (PK-PK) Impulsive sounds	Peak-to-peak sound pressure (PK-PK), is the sum of the peak compressional pressure (highest pressure variation) and the peak rarefactional (pressure lowest pressure variation) during a specified time interval, unit: dB re 1 µPa. PK-PK is the difference between the maximum and minimum instantaneous sound pressure levels in a stated frequency band attained by an impulsive sound. Refer to the above for graphical representation of PK-PK.
Sound exposure level (SEL) Non-impulsive sounds	Sound exposure level (SEL), a measure related to the sound energy in one or more pulses, or the ratio of the time-integrated squared sound pressure to the specified reference value, unit: dB re 1 $\mu Pa^2 \cdot s$, and can be considered as a dose-type measurement. This measure recognises that the effects of sound are a function of exposure duration as well as maximum instantaneous peak pressure. The SEL metric integrates noise intensity over some period of exposure and is used as it allows exposure duration and the effect of exposure to multiple events to be taken into account. SEL is specified in terms of either per-impulse (per-pulse) or a defined accumulation period. The metrics determined for the defined accumulation period assume that a receptor remains stationary for the period. The accumulation period applied for this assessment is 24 hours, and therefore the SEL is referred to as either per-impulse SEL or SEL_{24h}.
Particle motion metrics	Acoustic particle motion is defined as that motion caused by a sound wave of a given infinitesimal part of the medium relative to the medium as a whole, and it is an integral part of any sound field. Unlike pressure, particle motion is directional in nature and is typically described using three-dimensional vector notation. Particle motion levels can be expressed in a variety of units related to displacement, velocity, or acceleration. Acoustic particle velocity is the time derivative of particle displacement, and likewise acceleration is the time derivative of velocity. The particle velocity (v) is the physical speed of a particle in a material moving back and forth in the direction of the pressure wave. The particle acceleration (aa) is the rate of change of the velocity with respect to time. Bivalves are sensitive to particle velocity or acceleration rather than pressure, and therefore modelled particle motion values have been referenced for the impact assessment. Many types of marine fishes are also primarily sensitive to particle motion, although limited information is currently available on the levels that may result in impacts.

3.3.2 Noise effect criteria

During a seismic survey, new sound energy of finite duration is introduced into the environment with each pulse from the seismic source. For this assessment, the sound levels emitted into the marine environment have been modelled and are expressed using the abovementioned sound metrics (i.e. SL, PK, SEL, etc.).

Whether the received noise levels injure or disturb marine fauna (i.e. have an effect) is an active research topic. The noise thresholds (i.e. the level that must be exceeded for an effect to occur) for sound-induced effects on marine fauna are described in the following sections of this document.

Noise thresholds have been defined for both the per-pulse sound energy released, as well as the total sound energy (accumulated) that marine fauna is subjected to over a defined period of time. For recent regulatory assessments of seismic surveys, the period of total sound energy integration (i.e. accumulation) has been typically defined as 24 hours; hence, was the period used for modelling and in this assessment. For fish this period is based on available research (Popper et al. 2014) which found fish experiencing a temporary threshold shift (TTS) in hearing recovered to normal hearing levels within 18 to 24 hours, and for marine mammals the period is required to be either 24 hours or the length of the activity, whichever is shorter (NMFS 2024)

Importantly, the 24-hour accumulated sound metric reflects the dosimetric impact of noise levels within 24 hours based on the assumption that an animal is consistently exposed to such noise levels at a fixed position. More realistically, marine mammals and many fish (pelagic and some demersal) would not stay in the same location or at the same range for 24 hours. Popper et al. (2014) discuss the complications in determining a relevant sound exposure period of mobile seismic surveys, as the levels received by the receptor change between impulses due to the mobile source. For marine mammals and many fish, sound exposures at the closest point to the seismic source are the primary exposures contributing to a receptor accumulated level (Gedamke et al. 2011). Hence, thresholds based on a 24-hour exposure period are a conservative measure of potential effect.

4. Sound perception

4.1 Hearing sensitivity

Marine animals will only respond to acoustic signals they can detect. The sensitivity of a subject's auditory (i.e., hearing) system is described as a function of sound frequency. The lowest intensity of a sound at a particular frequency that an individual can hear describes its hearing threshold. The graphical representation of these thresholds over the range of frequencies that are audible to the individual is called its hearing curve or audiogram. Only a few individuals in a selected number of marine species have been tested in all taxonomic groups of marine animals.

4.2 Weighting functions

The potential for anthropogenic sounds to impact marine mammals is largely dependent on whether the sound occurs at frequencies that an animal can hear well, unless the sound pressure level is so high that it can cause physical tissue damage regardless of frequency. Auditory weighting functions reflect an animal's ability to hear a sound. Sound spectra are weighted at particular frequencies in a manner that reflects an animal's sensitivity to those frequencies (Nedwell and Turnpenny 1998, Nedwell et al. 2007). Auditory weighting functions have been proposed for marine mammals acoustic thresholds expressed in metrics that consider what is known about marine mammal hearing (e.g., SEL_{24h}, L_E) (Southall et al. 2007, Erbe et al. 2016, Finneran 2016). Auditory weighting functions for cetaceans and pinnipeds have been updated in the latest guidance issued by NMFS (2024). The latest guidance for sirenian criteria was presented in Accomando et al. (2025). Refer **Table 6-1**.

Applying marine mammal auditory weighting functions emphasizes the importance of making measurements and characterizing sound sources in terms of their overlap with biologically-important frequencies (e.g., frequencies used for environmental awareness, communication, or the detection of predators or prey), and not only the frequencies of interest or concern for completing the sound-producing activity (NMFS 2018).

4.3 Noise criteria, rationale

To assess the potential impacts of the proposed survey, exposure criteria must first be established for which sound levels may be expected to negatively impact animals.

For marine mammals, NMFS issued a Technical Guidance document that provides acoustic thresholds for onset of temporary and permanent threshold shift (TTS and PTS, respectively) in marine mammal hearing for all sound sources (NMFS 2024). As discussed within Accomando et al. (2025) and NMFS (2024), intense noise exposures can cause auditory injury (represented by either AUD INJ or AINJ) without PTS occurring. In this report, the terms PTS and auditory injury can be considered to be used interchangeably, however it is acknowledged that auditory injury may occur without PTS. NMFS also provided guidance on the use of weighting functions when applying injury criteria. The NMFS Guidance recommends the use of a dual criteria for assessing injurious exposures, including an unweighted (flat) peak sound pressure level metric PK (L_{pk}) and a sound exposure level SEL_{cum} ($L_{E,24h}$) metric with frequency weighting. Both acoustic criteria and weighting function application are different for the marine mammal functional hearing groups.

Popper et al. (2014) developed a set of criteria for fishes that are based on onset levels for barotrauma injury. These criteria are supported by data by Casper et al. (2013), who showed that less acoustic energy is required for the onset of barotrauma in fishes than for the onset of hair cell damage (the 'typical' cause for hearing injury in mammals). Injuries include direct mortality, non-recoverable injury including disorientation, and recoverable injury including TTS (Hawkins and Popper 2017). Criteria were chosen for all types of acoustic signals based on results from exposures to impulsive pile driving. This represents a conservative approach, as impulsive noise has a higher potential to cause deleterious effects than continuous sounds. The guidelines suggested by Popper et al. (2014) then separated marine fishes into four classes according to available data on hearing sensitivity and onset of injury in relation to the presence of morphological adaptations to their hearing system. The logic for choosing this indicator (injury), the baseline data (pile driving) and classification (animal groups) is reasonable and supported by the best available knowledge.

5. Potential noise effects

Marine fauna use sound in a variety of functions, including social interactions, foraging, orientation, and responding to predators. Underwater noise can affect marine fauna in three main ways:

- Injury to hearing or other organs. Hearing loss may be temporary (temporary threshold shift (TTS)) or permanent (permanent threshold shift (PTS)). As discussed within Accomando et al. (2025) and NMFS (2024), intense noise exposures can cause auditory injury (represented by either AUD INJ or AINJ) without PTS occurring;
- Disturbance leading to behavioural changes or displacement of fauna. The occurrence and intensity of disturbance is highly variable and depends on a range of factors relating to the animal and situation; and
- Masking or interfering with other biologically important sounds (including vocal communication, echolocation, signals and sounds produced by predators or prey).

5.1 Stress

Stress is an integral, necessary part of the body's homeostasis, and certain stress levels are tolerable. At higher levels, if repeated too often, or continued over long durations stress can, however, become deleterious by creating an allostatic load to the body. This is expressed and can be measured as imbalances in the autonomic nervous system, central nervous system, neuroendocrine, and immune systems and/or result in changes in growth rate, disruption of diurnal rhythms and behavioural changes. Animals may not show overt signs of responding to an increase in noise but may nonetheless show physiological changes (e.g., Slabbekoorn et al. 2010, Kight and Swaddle 2011). Symptomatic stress responses include changes in respiration rate, oxygen consumption, excretion, or food consumption rates or in chronic effects such as immune suppression. The effects of increased stress levels (acute or chronic) can be expressed through a variety of metabolic and/or physiological factors. The imbalance caused by stress in these factors can lead to immune suppression and/or result in changes in growth rate, disruption of diurnal rhythms, and behavioural changes. This cascade of effects may reduce the individual's fitness through alterations in reproduction (e.g.,Sierra-Flores et al. 2015) and, ultimately, survival (see review by Slabbekoorn et al. 2010).

5.2 Behaviour

The intensity of behavioural responses of marine mammals to sound exposure ranges from subtle responses, which may be difficult to observe and have little implications for the affected animal, to obvious responses, such as avoidance or panic reactions. The context in which the sound is received by an animal affects the nature and extent of responses to a stimulus. The threshold for elicitation of behavioural responses depends on received sound level, as well as multiple contextual factors such as the activity state of animals exposed to different sounds, the nature and novelty of a sound, spatial relations between a sound source and receiving animals, and the gender, age, and reproductive status of the receiving animal.

5.3 Masking

Masking is the process by which the threshold of hearing for one sound is raised by the presence of another (masking) sound (Erbe and Farmer 1998, Erbe 2008, Erbe et al. 2016). This describes the reduction in audibility for one sound (termed 'signal') caused by the simultaneous presence of another sound (termed 'noise'). For this to occur, the sound must be loud enough, have similar frequency content to the signal, and must happen at the same time. Masking depends on the spectral and temporal characteristics of signal and noise and is reduced if the signal and noise are separated in time, frequency, or direction (space); it can occur if the noise happens shortly before or after the signal (forward and backward masking). The zone of masking can maximally be as large as the zone of audibility, as a faint noise might mask a faint signal. The masking effect can be reduced or remedied by various active or passive mechanisms for masking-release, such as spatial or temporal release from masking, the Lombard effect, or comodulation masking release.

Auditory masking can lead to disruption of a behaviour, lack of appropriate behavioural reactions, increased vulnerability to predators, reduced access to prey, reduced communication, changes in vocal behaviour, disruption of spawning activities, and stress. The biological significance of acoustic masking is directly linked to the duration of the masking sound. While masking can be detrimental to the fitness, reproduction, and survival of individuals, it ends immediately after the masking sound ceases. Both anthropogenic and natural marine sound can affect hearing and partially or completely reduce an individual's ability to effectively communicate; detect important predator, prey, and/or conspecific signals; and detect important environmental features associated with spatial

orientation (Clark et al. 2009). This is true for all marine fauna; however, masking is most frequently associated with marine mammals. Masking in fishes has not been studied in detail.

5.4 Noise-induced threshold shift

Exposure to sufficiently intense sound may lead to an increased hearing threshold in any living animal capable of perceiving acoustic stimuli. If this shift is reversed and the hearing threshold returns to normal, the effect is called a temporary threshold shift. The onset of TTS is often defined as threshold shift of 6 dB above the normal hearing threshold (e.g., Southall et al. 2007). If the threshold shift does not return to normal, the residual shift is called a permanent threshold shift (PTS). Threshold shifts can be caused by acoustic trauma from a very intense sound of short duration, as well as from exposure to lower level sounds over longer time periods (Houser et al. 2017). Injury to the hearing apparatus of a marine animal may result from a fatiguing stimulus measured in terms of sound exposure level (SEL), which considers the sound level and duration of the exposure signal. Intense sounds may also damage the hearing apparatus independent of duration, so an additional metric of peak pressure (PK) is needed to assess acoustic exposure injury risk.

5.5 Mortality

In extreme cases, exposure to intense underwater sound may lead to mortality of an exposed animal. Mortality is either a direct effect of the exposure (in case of severe injury) or indirect if an animal is moderately injured. Data on sound-induced mortality in marine animals are scarce.

6. Species

The range of species considered in this technical appendix is based on the species listed in the *Eos Seismic Survey Environment Plan, 7710-650-EMP-0011.04*. Species information is often lacking, and taxonomic groups have been collectively considered instead.

6.1 Marine Invertebrates

Exposure to anthropogenic sound sources could have a direct consequence on the functionality and sensitivity of the sensory systems of marine invertebrates. The sensory organs involved in receiving underwater sound in this taxonomic group can be classified into three groups (Budelmann 1992a):

1. Superficial receptor systems on the body surface are receptors sensitive to water displacements, therefore mainly encoding hydrodynamic cues;
2. Internal statocyst receptor systems are found in a wide range of aquatic invertebrates. These are inertial gravity receptor systems that may function as acoustic particle motion detectors and thus play a role in underwater hearing (Budelmann 1992a) or substrate-borne vibrations (Cohen et al. 1953, Cohen 1955);
3. Chordotonal organs are proprioceptive receptors that monitor joint movement, the direction of movement, and static position. These organs are sensitive to oscillation of the water column surrounding it (Budelmann 1992b).

Numerous studies have investigated the effect of sound on marine invertebrates but have been conducted in confined environments that make it difficult to control and assess the acoustic conditions. Moreover, by measuring and reporting only the pressure component of sound, the results are of reduced relevance for assessing any observed effects.

6.1.1 Plankton

Parry et al. (2002) studied the abundance of plankton after exposure to airgun sounds but found no evidence of mortality or changes in catch-rate on a population-level.

The effects of impulsive sound on fish eggs and larvae were investigated in the context of offshore pile driving. Bolle *et al*. (2012) investigated the risk of mortality in common sole larvae by exposing them to impulsive stimuli in an acoustically well-controlled study. Even at the highest exposure level tested, at an SEL of 206 dB re 1 $\mu Pa^2 \cdot s$ (corresponding to 100 strikes at a distance of 100 m) no statistically significant differences in mortality was found between exposure and control groups.

Contrary to other studies, McCauley et al. (2017) found that after exposure to airgun sounds generated with a single airgun (150 in^3) zooplankton abundance decreased and mortality in adult and larval zooplankton increased two- to threefold when compared with controls. In this first large-scale field experiment on the impact of seismic activity on zooplankton, they used a sonar and net tows to measure the effects on plankton. They determined a maximum effect-range of horizontal 1.2 km. Their findings contradicted the conventional idea of limited and very localised impact of intense sound in general, and seismic airgun signals in particular, on zooplankton. Their results indicated that there may be noise-induced effects on these taxa and that these effects may even be negatively affecting ocean ecosystem function and productivity. The study was compromised by methodological design of the study (small sample sizes, large daily variability in the baseline and experimental data) and the statistical robustness of the data and conclusions (large number of speculative conclusions that appear inconsistent with the data collected over a two-day period). The lead author stressed that even though their conclusions were based on numerous assumptions, the combined likelihood of all measured parameters occurring without being correlated to the airgun survey is extremely low (McCauley, pers. comm.).

CSIRO (Richardson et al. 2017) simulated the large-scale impact of a seismic survey on zooplankton using the mortality rate found by McCauley et al. (2017). The aim of the CSIRO study was to estimate the spatial and temporal impact of seismic activity on zooplankton on the Northwest Shelf of Western Australian. The major findings of the CSIRO study were that there was substantial impact of seismic activity on zooplankton populations on a local scale within or close to the survey area, however, on a regional scale the impacts were minimal and were not discernible over the entire Northwest Shelf Bioregion. The study found that the time for the zooplankton biomass to recover to pre-seismic levels inside the survey area, and within 15 km of the area, was only three days following the completion of the survey. This relatively quick recovery was due to the fast growth rates of zooplankton, and the dispersal and mixing of zooplankton from both inside and outside of the impacted region (Richardson et al. 2017). Though the CSIRO model was based on a hypothetical 3D survey of 2,900 km2 in size and over a 35-day period it is seen as being applicable for this impact assessment based on the following:

The CSIRO model was designed to model potential impacts to plankton on the Northwest Shelf where the Keraudren seismic survey will take place;

Richardson et al. (2017) showed that zooplankton communities can begin to recover during the seismic survey, during periods of good oceanic circulation, or “bottom out” at a maximum impact level (presumably where growth rates and/or zooplankton entering the survey area roughly approximate mortality rates) after 23 - 30 days of commencement of survey operations.

Popper et al. (2014) has published exposure guidelines for fish eggs and larvae which are based on pile driving data. Based on the available data, Popper et al. (2014) proposed a precautionary threshold for mortality of fish eggs and larvae of >207 dB re 1 µPa PK, which the authors note is likely to be conservative.

Fields et al. (2019) exposed zooplankton (copepods) to seismic pulses at various distances up to 25 m from a seismic source. The source levels produced were estimated to be 221 dB re 1 µPa2.s, comparable to the far-field source levels associated with some commercial scale seismic surveys. The study observed an increase in immediate mortality rates of up to 30% of copepods in samples compared to controls at distances of 5 m or less from the airguns. Mortality one week after exposure was significantly higher by 9% relative to controls in the copepods placed 10 m from the airguns. Fields et al. (2019) also reported that no sublethal effects occurred at any distance greater than 5 m from the seismic source. The findings of the study indicate that the potential effects of seismic pulses to zooplankton are limited to within approximately 10 m from the seismic source. Fields et al. (2019) also note that the findings of the McCauley et al. (2017) study are difficult to reconcile with the body of other available research and may, therefore, provide an overly conservative estimate of the potential effects of seismic pulses to zooplankton.

Vereide et al. (2023) undertook a field experiment to assess mortality and naupliar stage physiology (body length) of the calanoid copepod Acartia tonsa when exposed to the discharge of two 40-inch airguns. Nauplii were exposed at a distance of 50 m from the vessel transect and at a depth of 6 m for a period of 2.5 hours: The study consisted of three treatments: Exposure to multiple discharges from two airguns, a boat control, and a silent control. Immediate mortality of the nauplii was measured within 4 hours of exposure, while sub-samples were analysed for delayed mortality and body length development daily, up to 6 days after exposure. Immediate mortality in the nauplii was approximately 14% compared to less than 4% in the silent and boat control. Nearly all of the airgun exposed nauplii were dead after four days, while >50% of the nauplii in the control treatments were alive at six days post-exposure. There was also an interaction between treatment and time on naupliar body length, indicating lower growth in the nauplii exposed to the airgun discharge (growth rates after 4 days: 1.7, 5.4, and 6.1 µm/day in the airgun exposed, silent control, and boat control, respectively). These experiments indicate that the output of two small airguns affected mortality and growth of the naupliar stages of Acartia tonsa in close vicinity to the array. Vereide et al. (2023) note that despite the higher airgun exposed mortality, the immediate mortality observed in this study is much lower than the 50% mortality in zooplankton at > 1 km from the source in McCauley et al. (2017). This indicates that actual population-level effect of airgun exposure might not be detectable from the background mortality.

6.1.2 Bivalves

There are indications that New Zealand scallop (Pecten novaezelandiae) larvae exposed to extended periods of airgun signals during their ontogeny may be negatively affected as reported by Aguilar de Soto et al. (2013). The authors found an increase in abnormality and mortality rates in scallop larvae after continued exposure to playbacks of intense airgun signals in a laboratory experiment. These results indicated that there may be species-specific differences in sensitivity of early life stages to sound exposure.

In a laboratory study, Przeslawski et al. (2016) focused on potential short-term impacts of marine seismic surveys on scallops in the Gippsland Basin. Commercial scallops (Pecten fumatus) were not abundant in the study area, and there was no evidence of mortality or change in the condition of scallops two months after a marine seismic survey ended. Analysis of images and samples revealed site-specific variance in scallop abundance, size, condition, and assemblages were higher than the observed effects from exposure. The analysis of the acoustic parameters, however, is likely compromised by the erroneous use of acoustic modelling methods.

Day et al. (2016a, 2017) suggest that repeated close-range exposures of captive scallops to seismic impulses resulted in a chronic increase in mortality over timeframes of approximately four months post-exposure, though not beyond naturally occurring rates of mortality. The mortality rates (up to 17.5% mortality in scallops exposed to four passes of the seismic source) were at the low end of the range of naturally occurring mortality rates documented in the wild, which range from 11-51% with a six year mean of 38% (Day et al., 2017). Sub-lethal effects to exposed scallops were also observed by Day et al. (2016a, 2017) indicating a compromised capacity for homeostasis and potential immunodeficiency over acute (hours to days) and chronic (months) timescales post exposure. Exposures did not elicit energetically expensive behaviours (i.e. extensive swimming or long periods of valve closure), but scallops showed significant changes in some behavioural patterns during exposure (e.g. “flinch” response) and scallops showed an increase in recessing into sediment following exposure (Day et al. 2017). Maximum received sound exposures were 213 dB re 1µPa PK-PK, 181 to 188 dB re 1 µPa².s per-pulse SEL, and SELcum of 188 to 198 dB re 1µPa².s. The study also predicted ground acceleration of up to 37.57 m/s² (Day et al. 2016a, 2017).

Studies have been undertaken on the impacts of underwater explosions on several species of bivalve, including two pearl oyster species, indicated strong resilience to the shock waves created by the detonation of explosives underwater. LeProvost et al. (1986) found that no mortality occurred in the exposed animals over a 13-week period and at a minimum exposure range of 1 m from the blast centre. Extrapolating this finding to seismic sources would suggest even less impact on bivalves than explosives, that is, it is likely that bivalves would have to be within a very close range of a seismic source to experience pathological damage or mortality – available evidence would suggest ~1 to 2 m. This study does not offer any insight as to the distances at which sub-lethal effects (such as morphological, biochemical and physiological changes being indicators of some level of stress in an animal) could occur.

Parsons et al. (2023) exposed approximately 11,000 silverlip pearl oyster (Pinctada maxima) during a four-day experimental full-scale seismic survey, plus one vessel-control day. The experiemt used a seismic source with a total volume of 2,600 in3. The experiment included an inactive source (vessel control) sail line as well as six operational (exposure) sail lines, at distances of 0, −500, −1000, −1500, −2000 and −2500 m from a reference 'zero line', with each line separated in time by either 12 or 24 h. Panels of pearl oysters were deployed in rows at seven horizontal distances from the 'zero line' (−1000, 0, 300, 500, 1000, 2000, and 6000 m). This ensured that collectively, P. maxima experienced decreasing levels of exposure with distance from the seismic source from the highest exposure levels at the 0 and − 1000 m lines to the 6000 m line, a distance modelled to receive little acoustic energy from the airgun signal and therefore considered a spatial control. Pre-selected groups of panels were retrieved from the seafloor after the vessel control line and after the first, second, fourth, and sixth operational sail lines. This design resulted in groups of P. maxima with 35 different exposure histories (seven distances, five retrievals) for a biophysical study and 22 exposure histories for a mortality and pearl production study, including spatial control groups.

At full power, the airgun array produced an effective source level of 252 dB re 1 µPa) PK-PK pressure, 234 dB re 1 µPa2m2 SPL, and 228 dB re 1 µPa2m2s SEL, directly below the array (Parsons et al. 2023). The highest received levels were experienced at the 0 m sites by groups retrieved on Day 2 and Day 3 (maximum and cumulative levels of 206 and 209 dB re 1 µPa2m2s SELmax and SELcum, respectively), while the respective levels received at the 6000 m spatial control site were 139 and 169 dB re 1 µPa2m2s SELmax and SELcum. Ambient levels at the time of the exposure were under 100 dB re 1 µPa, in the 20–1000 Hz band (Parsons et al. 2023). At the highest exposure site P. maxima were estimated to receive multiple signals with ground acceleration above 150 dB re 1 µm/s2 (Parsons et al. 2023).

After exposure, P. maxima survival rates were monitored throughout a full two-year production cycle, and the number and quality of pearls produced at harvest were assessed. Oysters from two groups, on one sampling day, exhibited reduced survival and pearl productivity compared to controls, but 14 other groups receiving similar or higher exposure levels did not. The authors therefore found no conclusive evidence of an impact of the seismic source survey on oyster mortality or commercial pearl production. (Parsons et al. 2023).

The lack of mortality of P. maxima after exposure to seismic noise (Parsons et al. 2023) contrasts with the findings of Day et al. (2017), who observed increased mortality in commercial scallops (Pecten fumatus), from ≈4 % in controls to 15–17.5 % in the highest exposure, up to 120 days after exposure to one or more passes of an operational airgun. This was despite P. maxima being exposed to higher levels of acoustic pressure, particle motion and ground motion than P. fumatus.

6.1.3 Decapod crustaceans

A pilot study on snow crabs (Chionoecetes opilio) (Christian et al. 2003) exposed captive adult male crabs and egg-bearing female crabs to approximately 197–237 dB re 1 µPa PK-PK and SELs of <130–187 dB re 1 µPa².s. The crabs were exposed to 200 pulses over a 33-minute period. No acute or chronic (12 weeks post-exposure) mortality impacts were observed in the adult crabs. Stress indicators in the snow crabs also showed no evidence of significant acute or chronic impacts. The crabs also did not exhibit any overt startle response during the exposure period or avoidance of the area following exposure.

Andriguettto-Filho et al. (2005) assessed the impacts of seismic airgun exposure on species of shrimp (Litopenaeus schmitti, Farfantepenaeus subtilis and Xyphopenaeus kroyeri) in waters off Brazil, on the days before, during and after exposure to 196 dB re 1 µPa PK. No significant deleterious impact on catch rates and shrimp abundance were identified, suggesting that shrimp may be resilient to the disturbance by seismic airguns.

Payne et al. (2007) conducted a pilot study of the effects of exposure to seismic sound on various health indicators of American lobster. Adult lobsters were exposed at approximately 2 m range from a seismic source for either 20 or 200 times to average pressures of 202 dB re 1 µPa PK-PK or 50 times to 227 dB re 1 µPa PK-PK, and then monitored over several months for changes to survival, food consumption, turnover rate, and serum biochemistry. No immediate or delayed mortality was observed, nor damage to mechano-sensory systems and the ability of lobsters to right themselves when turned over. There was evidence of a decrease in serum enzymes and increases in food consumption in the weeks to months post exposure, which may indicate stress effects or potential osmo-regulatory disturbance. The results therefore indicate the potential for sub-lethal effects but there were no

obvious impacts to long-term survival and, therefore, limited ecological implications. Payne et al. (2008) did not observe any startle responses in aquarium experiments with lobsters and shrimp exposed to approximately 200 dB re 1µPa PK-PK.

Celi et al. (2013) examined the effects of an acoustic stimulus on the haemolymph and agonistic behaviour of the red swamp crayfish (*Procambarus clarkia*). After 1 hour of habituation, the behaviour of the crayfish was monitored for 2 hours. During the second hour, the animals in the test groups were exposed to a linear sweep acoustic stimulus for 30 minutes (frequency range 0.1-25 kHz; peak amplitude 148 dB re 1 µPa SPL at 12 kHz) and then monitored for a further 30 minutes before collection for anaesthesia and sampling of haemolymph. Exposure to the noise did not result in any significant effects on internal osmoregulatory capacity or total serum protein concentration, but produced significant variations in haemato-immunological parameters as well as a reduction in agonistic behaviours (fights and tail flips) compared with control specimens.

Day et al. (2016) conducted a study on the effects of exposures of southern rock lobster (*Jasus edwardsii*) and scallop to impulsive noise produced by an airgun. Their study used field and laboratory experimental approaches to investigate potential impacts of marine seismic surveys on these species. Their field study used a real airgun and had better control over the relevant experimental parameters than other reported studies. Accordingly, their results are more relevant than those obtained under laboratory conditions with animals exposed to simulated signals.

It is likely that particle motion and interface waves are the more relevant stimulus. Day et al. (2016) provide a regression of particle acceleration versus range for the single 150 in^3 airgun used in the study and showed that acceleration at the 10 and 100 m ranges were typically 26 and 5 ms^{-2}, respectively. The study also references an unpublished maximum particle acceleration measurement of 6.2 ms^{-2} from a 3130 in^3 airgun array at 477 m range in 36 m of water.

Consistent with other studies of high-intensity, low-frequency sound exposure of crustaceans and molluscs (reviewed by Edmonds et al. 2016, Carroll et al. 2017), the Day et al. (2016) study found no evidence of mass mortality directly following airgun exposure. Consequently, the authors rejected the hypothesis that exposure to seismic airguns causes immediate mass mortality.

Unlike other studies, the Day et al. (2016) uncovered a few issues concerning long-term health and ecology. Two reflex behaviours, tail tonicity or extension and righting behaviour, were assessed. These reflexes have been used in lobster fishery industries in grading animals for their likelihood of survival. While results for tail tonicity were inconclusive, there was a significant response to exposure in the righting response, which is a more complex reflex requiring neurological control and muscle coordination.

Day et al. (2019) reports on the same field study as Day et al. (2016). The results indicate impaired righting and significant damage to the sensory hairs of the mechano-sensory statocyst organ of lobsters following exposure to seismic airgun noise. The impairment remained up to 365 days post-exposure and did not improved following moulting. These results indicate that exposure to airgun signals can cause morphological damage to the statocyst of rock lobsters, which can in turn impair complex reflexes. Although ecological impacts of the chronic impairment of the righting reflex observed in exposed lobsters were not evaluated in the study, the impairment suggests there may be some impact on the ability of an exposed lobster to function in the wild.

Day et al. (2021) examined the potential impacts of seismic surveys on the larval stages of southern rock lobster (*Jasus edwardsii*) to determine whether early development and recruitment may be affected. Lobster puerulus (post-larval stage) and juveniles were held in baskets and exposed to multiple passes of a seismic source element in 10-12 m water depths. Maximum received sound exposures were 203-219 dB re 1µPa PK-PK, 181 to 190 dB re 1 $\mu Pa^2 \cdot s$ per-pulse SEL, and SELcum of 201 to 205 dB re $\mu Pa^2 \cdot s$, comparable to Day et al. (2016a, 2016b) (Day et al., 2021). Lobster puerulus were randomly assigned to control (not exposed to airgun signals) or E0 (exposed to airgun signals at a nominal range of 0 m from the sail line), and juveniles were assigned to control, E0 and E500 (exposed to airgun signals at a nominal range of 500 m from the vessel sail line). The findings of the study are as follows:

- Exposure did not result in any elevated mortality for puerulus or juveniles.
- Righting was significantly impaired for all exposure treatments immediately after exposure, indicating that the range of impact extended to at least 500 m from the source (maximum range tested in the study).
- Puerelus and juvenile E0 treatment lobsters did not show the capacity for recovery, while juvenile E500 lobsters recovered from impairment after the first moult, providing evidence of a range threshold for recovery.
- Intermoult period was significantly increased in E0 juvenile lobsters, and appeared to be increased in puerulus, while juvenile E500 treatment lobsters show a moderate, non-significant increase in moult duration.
- Increased intermoult duration suggested impacted development and potentially slowed growth, and physiological stress.

Whether the impaired righting reflexes, development and increased intermoult duration has any significant longer term implications in terms of the survival of puerulus and juvenile lobsters into adulthood in the wild is not known.

Jézéquel et al. (2021) examined whether American lobster (*Homarus americanus*) could detect sound using auditory evoked potential (AEP) methods. Greatest sensitivity was in the low frequency range of 80–120 Hz. Notably, responses were similar before and after antennules (including statocysts) were completely ablated, demonstrating that the statocysts, a long-proposed auditory structure in crustaceans, are not the sensory organs responsible for lobster sound detection. Instead, external cuticular hairs are suggested as being the feature responsible for sound (vibration) detection by lobsters.

6.1.4 Squid

André et al. (2011) and Solé et al. (2013) provide evidence of acoustic trauma in four cephalopod species (*Sepia officinalis, Octopus vulgaris, Loligo vulgaris*, and *Illex condietii*), which they exposed (under water) for 2 h to low-frequency sweeps between 50–400 Hz (1 s duration) generated by an in-air speaker. The received level at the animals' position was 157 dB re 1 µPa with peak levels (unspecified) up to 175 dB re 1 µPa. Both studies reported permanent and substantial morphological and structural alterations of the sensory hair cells of the statocysts following noise exposure, with no indication of recovery. In a recent experiment, Solé et al. (2017) exposed common cuttlefish (*Sepia officinalis*) to tonal sweeps between 100–400 Hz in a controlled exposure experiment in open water. Their results showed a clear statistical relationship between the cellular damage detected in the sensory cells of the individuals exposed to the sound sweeps and their distance from the sound source. The authors measured the particle motion and pressure of the signals received by the animals, but due to the signal type (frequency sweep), they only provided the maximum received levels or an estimate thereof, respectively; the maximal particle motion level was 0.7 ms^{-2} observed at 1 m depth, the pressure reached levels of 139–142 dB re 1 μPa^2. The reported sound pressure levels were only slightly higher than the hearing threshold determined for longfin squid (*Loligo pealeii*) measured by Mooney et al. (2010). The maximum particle motion (reported in terms of particle acceleration) reported by Solé et al. (2017) is in the same order of magnitude as the behaviourally thresholds measured at 100 Hz by Packard et al. (1990) using a standing wave acoustic tube.

6.1.5 Benthic species

Many marine invertebrates are permanently in contact with bottom sediment. The sediment, however, does not follow exactly, or at all, the movement of the surrounding water. Therefore, exposure to underwater sound will result is in a relative movement between the body of these animals and the oscillating water column. Accordingly, it is important to also consider the propagation of vibration through the ground. For benthic organisms, this type of vibration is likely of similar or greater importance than the water-borne vibration or even the compressional component of a sound (Roberts and Elliott 2017). The published scientific information on vibration sensitivity in marine invertebrates is extremely scarce (Roberts et al. 2015, Roberts et al. 2016). Only a small number of studies have indicated reception of vibration and behavioural responses in bivalves, which include the closure of the syphons and, in more active molluscs, movement away from the substrate (Mosher 1972, Ellers 1995, Kastelein et al. 2008). To date, there is no convincing evidence for any significant effects induced by non-impulsive noise in benthic invertebrates. Moreover, given the rapid attenuation of vibrational signals beyond the near-field of a sound source (Morley et al. 2014), it is unlikely that these stimuli are causing more than behavioural effects (e.g., flight or retraction) or physiological (e.g., stress) responses.

From 2013–2015, a long-term study evaluated the acoustic impacts from seismic exposure on scallops in Australia (Day *et al*. 2016b, 2017). The experimental field research maintained the scallops in mesh enclosures while a vessel with the acoustic source passed close to the animals. Seismic sound exposure did not cause mass mortality of scallops during the experiment; however, repeated exposure (i.e. more than one pass of the airgun) where maximum exposure levels were in the range of 181 to 188 dB re 1μPa^2.s SEL (191 to 213 dB re 1µPa peak-peak SPL) was considered to possibly increase the risk of mortality (Day *et al*. 2016a, 2016b).

Though Day *et al*. (2016b) recorded increased mortality with repeated exposure to a seismic source, it has not been established as to whether this was due to the seismic source exposure or other mechanism related to the study design (Przeslawski *et al*. 2016). Using a precautionary approach, if the increased mortality was due to the seismic source then the increased mortality identified translates to an annual increase of between 9.4% and 20%. These fall towards the low end of what might be expected when compared with natural mortality rates in wild scallop populations, which range from 11-51% with a six year mean of 38% (Day *et al*. 2016b).

Scallops exposed to repeated seismic sound suffered physiological damage with no signs of recovery over the four-month period; suggesting potentially reduced tolerance to subsequent stressors. In addition, changes in behaviour and reflexes during and following seismic exposure were observed. Day *et al*. (2016a, 2016b) however cautioned that it was unclear from the study whether the observed physiological (and behavioural) impairments would result in mortality beyond the timeframes considered in their study.

Przeslawski et al. (2018) concluded that there was no evidence of increased scallop mortality, or effects on scallop shell size, adductor muscle diameter, gonad size, or gonad stage due to the seismic sound from an actual seismic

survey. The authors concluded that the study provided no clear evidence of adverse effects on scallops, fish, or commercial catch rates due to the 2015 seismic survey undertaken in the Gippsland Basin. Przeslawski et al. (2018) further concluded that the study provided a robust and evidence-based assessment of the potential effects of a seismic survey on some fish and scallops.

There is limited published literature on the potential impacts of seismic noise on hard and soft corals, and unlike other faunal groups, currently there are no peer-reviewed criteria against which potential noise impacts to coral can be assessed.

Heyward *et al.*, 2018 monitored scleractinian corals, primarily plate corals in families Agaracidae and Acroporidae, and soft corals *in situ* before, during and after a 3D seismic survey with maximum received sound levels of 220 – 226 dB re 1 µPa PK. There were no detectable impacts on scleractinian coral mortality, skeletal damage or visible signs of stress immediately after and up to four months following the 3D marine seismic survey. Similarily, there was no evidence of a behavioural response, such as polyp withdrawal or flaccidity in soft corals such as *Lobophytum* spp.

6.2 Fishes

Although hearing ranges and sensitivities vary substantially between species (e.g., Ladich and Fay 2013), all fish species tested to date can hear (Dale et al. 2015). Fishes have developed two sensory mechanisms for detecting, localising, and interpreting underwater sounds and vibrations: the inner ear, which is tuned to sound detection, and the lateral line system, which allows a fish to detect vibration and water flow. Inter-specific variations in hearing range and sensitivity result from the different adaptations in these systems for perceiving sound pressure and particle motion information (Popper and Fay 2011).

Sensitivity to sound pressure seems to be functionally correlated in fishes to the presence and absence of gas-filled chambers in the sound transduction system. These enable fishes to detect sound pressure and extend their hearing abilities to lower sound levels and higher frequencies (Ladich and Popper 2004, Braun and Grande 2008). Based on their morphology, Popper et al. (2014) classified fishes into three animal groups comprising (1) fishes with swim bladders whose hearing does not involve the swim bladder or other gas volumes (e.g., some species of tuna, *Thunnus sp*., or Atlantic salmon, *Salmo salar*); (2) fishes whose hearing does involve a swim bladder or other gas volume (e.g., Atlantic cod, *Gadus morhua*, or herring, *Clupea harengus*); and (3) fishes without a swim bladder (e.g., sharks) that can sink and settle on the substrate when inactive (Popper et al. 2014, Carroll et al. 2017).

Based on their morphology, the Popper *et al*. (2014) classifications can be assigned to the following families or species of fish, common in Australian waters:

- Fishes with swim bladders or other gas volumes, but whose hearing does not directly involve the swim bladder, e.g., snappers, emperors, groupers and rock cods (Lutjanids and Lethrinids such as *Pristipomoides* spp., *Lethrinus* spp., *Lutjanus* spp., and family Serranidae), and some species of tuna (*Thunnus* sp.) (Tavolga and Wodinsky 1963, Bertrand and Josse 2000, Higgs et al. 2006, Song et al. 2006, [DoN] Department of the Navy (U.S.) 2008, Braun and Grande 2008, Engineering-Environmental Management 2008, Caiger et al. 2012);
- Fishes whose hearing does directly involve a swim bladder or other gas volume e.g., family Clupeidae (herrings, sardines, pilchards and shads), family Gadidae (true cods such as whiting), and potentially some nearshore / reef species relevant to tropical Australia, including some Pomacentridae (damsel fishes and clown fishes), some Holocentridae (soldierfishes and squirrelfishes) and some Haemulidae (grunters and sweetlips) (Nedwell et al. 2004, Braun and Grande 2008, Popper et al. 2014); and
- Fishes without a swim bladder (e.g., mackerel, *Scomberomorus* spp., some species of tuna, *Thunnus* sp, and sharks, including whale sharks, *Rhincodon typus*) (Casper *et al*. 2012, Popper *et al*. 2014, Carroll *et al.* 2017).

Most fishes are primarily sensitive to particle motion effects, while fishes with hearing that involves the swim bladder are also sensitive to sound pressure (Popper and Hawkins 2019, Popper et al. 2019). The most relevant metric for perceiving underwater sound for most fish species is, therefore, particle motion but, with the exception of few species (Popper and Fay 2011; Popper *et al*. 2014), there is an almost complete lack of relevant data on particle motion sensitivity in fishes (Popper and Hawkins 2018).

The majority of fish species detect sounds from below 50 Hz up to 500-1500 Hz. A smaller number of species can detect sounds to over 3 kHz, while a very few species can detect sounds to well over 100 kHz. The critical issue for understanding whether an anthropogenic sound affects hearing is whether it is within the hearing frequency range of a fish and loud enough to be detectable above threshold. For the sake of this impact assessment, it is assumed that all fishes can detect signals below 500 Hz and so can 'hear' the seismic source.

The Working Group on the Effects of Sound on Fish and Turtles undertook a review of experimental findings of sound on fishes. In their American National Standards Institute (ANSI) accredited report (Popper *et al*. 2014) they

presented sound exposure guidelines for different levels of effects for different groups of species), for three types of immediate effects:

- Mortality, including injury leading to death;
- Recoverable injury, including injuries unlikely to result in mortality, such as hair cell damage and minor haematoma; and
- Temporary threshold shift (TTS).

In the absence of any qualitative scientific information, acoustic masking of signals and behavioural effects caused by the reception of seismic sounds are assessed qualitatively, by assessing relative risk rather than by specific sound level thresholds.

6.2.1 Behaviour

The sound-related factors influencing behavioural reactions in fishes can include its frequency content, intensity above background noise and temporal sound characteristics. If exposed to the same stimulus over a prolonged period, an initial behavioural reaction might fade as the fish's habituate to the sound. Behavioural reactions that are usually observed in fishes in response to sound are dispersion, directed movements away from the sound source (leaving the area of the noise source, aggregation and descending closer to the bottom), startle response (fast start escapes, C-start response) at sound onset (Akamatsu *et al*. 1996; Wardle *et al*. 2001; Slotte *et al*. 2004; Woodside 2007). Effects can be acute (such as acoustic masking), or chronic (including altered distribution), lasting from the immediate duration of sound exposure to several days or weeks if fishes are displaced from their preferred areas during a survey (Engås *et al*. 1996; Slotte *et al*. 2004; Løkkeborg *et al*. 2012a,b; Streever *et al*. 2016).

The onset level of behavioural responses in fishes varies greatly between and within species, including between fishes of different ages and sizes, the behavioural and social context, and the motivation of the fishes. Existing data on behavioural responses do not provide a clear dose-response relationship and, consequently, it is currently impossible to determine single value thresholds for the onset of behavioural reactions. Instead, broad response and effect categories such as those proposed by Popper et al. (2014) seem most reasonable and may guide regulatory decisions in this context.

Strong 'startle' responses have been observed in some fish species at received sound levels of 200-205 dB re 1 µPa, indicating that sounds at or above this level may cause more severe behavioural reaction such as avoidance. Sound levels of this intensity are likely to occur 100 to 300 m from an acoustic array. Based on this, an approximate range of 200 m was estimated as the minimum distance at which fish may start avoiding the approaching seismic source (McCauley 1994). Wardle *et al*. (2001) documented that schooling reef fish swam past a seismic source array at received levels that would be received at about 20 m below a survey array consisting of 30 airguns.

Pearson *et al*. (1992) showed that that exposure to airgun sound can cause changes in schooling patterns and distribution. Løkkeborg *et al*. (2012a, b) found changes in catch rates of fish species in Norwegian waters, indicating that these species all responded to airgun sounds. However, they also showed that gillnet catches were doubled for some fish species during seismic surveying and only longline catch rates fell slightly. Except for one species, they did not find any changes in abundance or displacement from fishing grounds. Hawkins *et al*. (2014) used synthetic impulsive signals in a behavioural response study; they documented that sprat and mackerel reacted to the impulsive sound exposure generally by dispersal and depth changes (which would make it difficult to detect the true scope of effects in a study relying on fisheries technology).

Santulli *et al.* (1999) exposed caged European sea bass (a demersal species) to a 2,500 cubic inch seismic source. Limited response was observed at 2.5 km distance, a startle response was observed when the array was at a distance of approximately 800 m, but after passing within 180 m, fish behaviour appeared to return to normal within one hour. Increased biochemical stress levels were measured in some fish following exposure, returning to normal levels within 72 hours of exposure. It is noted that exposures of fish in the wild would likely result in avoidance of high sound levels prior to the seismic source approaching to as close a range and to as high sound levels as the captive fish in the experiment were exposed to.

The most recent relevant study on how the behaviour of fishes exposed to seismic signals changed is Woodside's Maxima 3D survey at Scott Reef (Woodside 2011a, 2011b; Miller and Cripps 2013). The behavioural observations of free-swimming fish conducted in these studies show that seismic airgun emissions did not cause lethal or sub-lethal effects on fish near the operating array. At close range, the vessel approach caused fishes to cease their behaviours and move towards the seabed, but the effect was short-lived, and fishes began to feed and behave normally again within 20 minutes after the passage of the seismic survey vessel. Caged fishes displayed startle responses too infrequently to analyse. However, agitation levels increased with increasing received sound exposure level for the three holocentrid species (squirrelfishes and soldierfishes, *Holocentroidei*) but were not detectable for the blue-stripe sea perch (*Lutjanus kasmira*). Sonar observations of free-swimming fishes indicated that individual animals tended to move towards the seabed on approach of the operating airgun array, consistently

out to 400 m either side of the survey test line. Schools of fishes moved towards the seabed within 200 m of the survey test line in response to the passage of the operating seismic source and stayed significantly closer to the seabed up to 63 minutes post-exposure. The vocal behaviour of fishes was unaffected from the seismic activity; fish choruses remained unchanged with regards to timing and chorus level (at daily, lunar and seasonal scales); these findings suggest that in the long term the survey had little effect on the fish that produced the choruses. Visual census revealed that diversity and abundance of both Pomacentridae (damselfishes and clownfishes) and non-Pomacentridae fish species (inhabtiting shallow-slope regions) showed no significant changes after the seismic survey compared to the long-term temporal trend before the survey. Analysis of recordings from baited remote underwater video stations showed no detectable effects of the seismic survey on the diversity and abundance of deeper water fish communities at the spatial and temporal scales examined. Also, there were no signs of loss of individuals or of systematic re-distribution of individuals and species at any of the time scales examined.

The findings from the research at Scott Reef support those by Wardle *et al*. (2001), who exposed free ranging marine fish inhabiting an inshore reef to sounds from a seismic source (maximum received levels (RL) of 195-218 dB re 1 µPa PK). The study found that fishes exhibited a startle response to all received levels, but no avoidance behaviour were observed, they showed no signs of moving away from the reef and exposure to the seismic noise did not interrupt a diurnal rhythm of fish gathering at dusk. Slight changes were recorded to the long-term day-to-night movements of two tagged pollack (*Pollachius sp.*), particularly when positioned within 10 m of their normal living positions. However, the seismic sound had little effect on the day-to-day behaviour of the resident fishes and invertebrates. Fewtrell and McCauley (2012) showed that fishes tended to remain lower in the water column and/or swim faster and form tighter schools during periods of close air-gun emissions.

Fish populations can be further impacted if behavioural responses result in deflection from migration paths, feeding grounds or disturbance of spawning, thereby affecting recruitment of fish stocks. Available evidence suggested that behavioural changes for some fish species are insignificant and short-lived; the duration of effect is less than or equal to the duration of exposure and is expected to vary between species and individuals and be dependent on the properties of received sound (DFO 2004). Such a temporary, short range displacement of pelagic or migratory fish populations would have insignificant repercussions at a population level (McCauley 1994); and for site-attached reef fish, spatial patterns of species richness, abundance and diversity does not change after airgun noise emissions (Woodside 2007; Miller and Cripps 2013). The ecological significance of such effects is expected to be low, except where they may influence reproductive activity. However, researchers have observed that once acoustic disturbances are removed, fish return to normal behaviour within about an hour (McCauley *et al*. 2000; Pearson *et al*. 1992; Wardle *et al*. 2001). In conclusion, it is evident that behavioural reactions can occur to seismic airguns, but at this point there are no data that can be applied to develop guidelines.

Davidsen et al. (2019) investigated the effects of seismic sound exposure on the physiology and behaviour of captive Atlantic cod (*Gadus morhua*) and saithe (*Pollachius virens*), both species from the family Gadidae with a swim bladder directly involved in sound detection. Experimental sound exposures were 18–60 dB above ambient. The cod exhibited reduced heart rate in response to the particle motion component of the sound from the airgun, indicative of an initial flight response. No behavioural startle response to the airgun was observed despite some observed changes in swimming depth and position, and the fish seemed to habituate both physiologically and behaviourally with repeated exposure. The authors concluded that sound exposures induced over the three-day study period appear unlikely to be associated with long-term alterations in physiology or behaviour.

Hubert et al. (2020) also exposed captive Atlantic cod to one hour of playback of seismic airgun sound pulses with a 10-second shot point interval. Results indicated no strong overall pattern of change in swimming patterns or immediate, short-term behaviours during the exposure, compared to baseline periods without playback. However, several individuals changed their time spent in several behavioural states during the one hour sound exposure, which may be indicative of changes in energy expenditure.

Van der Knaap (2021) investigated the effect of a 3.5-day, full-scale, seismic survey exposure on the movement behaviour of free-swimming Atlantic cod, using acoustic telemetry. The closest point of approach to the tagging location was 2.25 km. The study found that during the experimental survey, cod did not leave the detection area more than expected from baseline data. However, cod left more quickly than expected, from two days to two weeks after the seismic survey. Furthermore, behavioural analyses indicated that during the exposure cod decreased their activity, with time spent being locally active (moving over small distances, showing high body acceleration) becoming shorter, and time spent being inactive (moving over small distances, having low body acceleration) becoming longer. Additionally, diurnal activity cycles were disrupted with lower locally active peaks at dusk and dawn—periods when cod is known to actively feed.

Meekan et al. (2021) undertook a large-scale experiment that quantified the impacts of exposure of an assemblage of tropical demersal emperors (family Lutjanidae), snappers (family Lethrinidae) and groupers/rock cods (family Epinephelidae) targeted by commercial fisheries to a commercial-scale seismic source on the North West Shelf of Western Australia. Dominant species included spangled emperor (*Lethrinus punctulatus*), red emperor *(Lutjanus sebae*), and brownstripe snapper (*Lutjanus vitta*). A combination of Baited Remote Underwater Video Systems (BRUVS) and acoustic tagging methods were used to measure the behaviours and movements of fishes at high,

medium and low exposure sites, as well as at control sites. The high, medium and low exposure sites were located at horizontal distances from the path of the seismic source of approximately 0 – 300 m, 2 – 10 km and 11 km respectively. The maximum modelled SEL values received at the high, medium and low exposure sites were in the order of 180 – 200 dB re 1 $\mu Pa^2 \cdot s$, 130 – 160 dB re 1 $\mu Pa^2 \cdot s$ and 115 – 125 dB re 1 $\mu Pa^2 \cdot s$ respectively. There were no short-term (days) or long-term (months) effects of exposure on the composition, abundance, size structure, behaviour, or movement of fishes at any exposure sites. The authors argue that it is a reasonable assumption that the behavioural responses of demersal fishes to the bait cue provided by the BRUVS are a realistic proxy of the likely response of the same species to baited hooks or traps used by the commercial fisheries that target them. The acoustic tags and telemetry found little evidence that fish were displaced by the exposure to the seismic source. Movements of tagged fish occurred over a limited area focused on two or three acoustic receivers, and there was no evidence for the departure of tagged fish after exposure. These multiple lines of evidence suggest that seismic surveys have little impact on the behaviours of demersal fishes in this environment.

6.2.2 Acoustic Masking

Masking impairs an animal's hearing impairment with respect to the relevant biological sounds normally detected within the environment and can have long lasting effects on survival, reproduction and population dynamics of fishes. The consequences of masking for fishes, however, have not been sufficiently examined to allow a thorough assessment of effects caused in the context of this survey. Popper *et al*. (2014) surmised that "*It is likely that increments in background sound within the hearing bandwidth of fishes and sea turtles may render the weakest sounds undetectable, render some sounds less detectable, and reduce the distance at which sound sources can be detected. Energetic and informational masking may increase as sound levels increase, so that the higher the sound level of the masker, the greater the masking*." If impulsive sounds are generated repeatedly by many sources over a wide geographic area there is a possibility that the separate sounds might merge and that the overall background noise be raised (Nieukirk *et al*. 2004). However, acoustic masking only occurs while the interfering sound is present, and therefore, masking resulting from a single pulse of sound (such as an airgun impulses) or widely separated pulses would be infrequent and not likely affect an individual's overall fitness and survival.

Temporary Threshold Shift (TTS)

The following is sourced from Popper *et al*. (2014):

"Temporary threshold shift (TTS) is a temporary reduction in hearing sensitivity caused by exposure to intense sound. TTS has been demonstrated in some fishes, and its extent is of variable duration and magnitude. TTS results from temporary changes in sensory hair cells of the inner ear and/or damage to auditory nerves innervating the ear (Smith et al. 2006; Liberman 2015). However, sensory hair cells are constantly added in fishes (e.g., Corwin 1981, 1983; Popper and Hoxter 1984; Lombarte and Popper 1994) and also replaced when damaged (Lombarte et al. 1993; Smith et al. 2006; Schuck and Smith 2009), unlike in the auditory receptors of mammals. When sound-induced hair cell death occurs in fishes, its effects may be mitigated over time by the addition of new hair cells (Smith et al. 2006, 2011; Smith 2012, 2015).

After termination of a sound that causes TTS, normal hearing ability returns over a period that is variable, depending on many factors, including the intensity and duration of sound exposure (e.g., Popper and Clarke 1976; Scholik and Yan2001, 2002a, b; Amoser and Ladich 2003; Smith et al. 2004a, b, 2006, 2011; Popper et al. 2005, 2007). While experiencing TTS, fishes may have a decrease in fitness in terms of communication, detecting predators or prey, and/or assessing their environment."

McCauley *et al*. (2003) demonstrated that exposure to repeated emissions of a single airgun (SL (source level) of 222.6 dB re 1µPa PK-PK) from 5 to 15 m at the closest approach caused extensive damage to the sensory hair cells in the inner ear of caged pink snapper (*Pagrus auratus*). Although no mortality was observed, the damage was severe with no evidence of repair or replacement of damaged sensory cells up to 58 days post-exposure. However, the study did not investigate the effects on fish hearing. The study acknowledged that the fish were caged and therefore not able to swim away from sound source, and that the monitoring video suggested the fish would have fled the sound source if possible. The authors of the study also acknowledged that the impact of exposure on ultimate survival of the fish was not clear.

As part of Woodside's Maxima 3D MSS, an extensive field study was undertaken at Scott Reef. A component of this study investigated the potential physical, physiological and behavioural noise-induced effects on fish assemblages. The results showed statistically more damage to the hearing in blue-stripe sea perch (*Lutjanus kasmira*) exposed to the seismic impulses than in control fishes. However, the damage found in these fishes was marginal, and—assuming a direct relationship between hair cell density and hearing capability—a negligible effect on the fishes' hearing capability. The damage was monitored through time out to 58 days post seismic exposure and did not increase significantly through time, with almost zero damage detected by 58 days (McCauley 2008).

A study of auditory sensitivity in four species of tropical reef fishes following exposure to emissions from the 2,055 in^3 array showed that none of the four species, including the pinecone soldierfish (a species with expected to have good hearing sensitivity) experienced any hearing sensitivity loss (i.e. TTS) following exposure to SEL_{cum} up to 190

dB re 1 μPa^2·s (Hastings *et al*. 2008; Hastings and Miksis-Olds 2012). No detectable gross physiological damage was found in individuals from any of the seven species (McCauley and Salgado Kent 2012). The results of the hearing tests are consistent with the sound exposure guidelines proposed in Popper *et al*. (2014), which indicated that TTS may occur at SEL_{cum} levels >186 dB re 1 μPa^2·s while other studies (Popper and Hastings 2009; Song *et al*. 2008) indicate that TTS may occur at levels as high as SPL 205-210 dB re 1μPa (PK).

Mortality/potential mortal injury

With regard to seismic noise induced mortality in fishes Carroll et al. (2017) conclude that "For fish, there are few data on the physical effects of seismic airguns (e.g. mortality, barotrauma), and of these none have shown mortality." Fishes in open water can move away from an approaching seismic source which reduces the potential for mortality or mortal injury. Bottom-dwelling fish that show greater site attachment may be less inclined to flee from a seismic sound source and experience greater effects.

Other than physiological stress responses or hearing loss, no other physical damage to adult fish or invertebrates have been directly attributed to exposure to airgun discharges, even at close proximity (NSW DPI 2014). It should be noted that some reports of physical damage arise from studies undertaken using explosions and other high-pressure sound waves, and not from air-gun emissions that generate a lower maximum pressure and pressure change (Popper and Hastings 2009).

Bony fish apparently have the ability to regenerate the sensory cells in their hearing system to a fully functional state within weeks after a detrimental exposure. The processes involved in the recovery are not fully understood, and there is conflicting evidence from sound exposure studies, such as McCauley et al. (2003). These findings could also suggest that the process of sensory hair cell death and regeneration is species-specific.

Recovery processes take a few days to a few weeks (Scholik and Yan 2001, Mackenzie and Raible 2012), and the time course for recovering from hearing loss likely depends on the species, its normal hearing sensitivity, the sound exposure intensity and duration, and the amount of sensory epithelial damage (Smith and Monroe 2016). Noise-induced PTS has not been reported for fishes yet, which may be explained by their apparent ability to recover hair cells.

Exposure to excessive levels of any type of underwater sound can kill and injure fishes (Carlson and Johnson 2009). Impulsive sounds, with rapid changes in pressure, are more damaging to tissues than gradual changes (Popper et al. 2014).

Injurious effects caused by rapid pressure changes within the body are called 'barotrauma' (Stephenson et al. 2010, Halvorsen et al. 2011, 2012b). The range of barotrauma effects in fishes mostly depends on the temporal pattern of the pressure changes and the physiological state of the exposed fishes (Stephenson et al. 2010, Halvorsen et al. 2012a, Halvorsen et al. 2012b); they range in severity from damages with full recovery to lethal injury (McKinstry et al. 2007).

Casper et al. (2012) showed that fishes can recover from less severe injuries under laboratory conditions, suggesting that minor injuries not inevitably lead to mortality. Nevertheless, in open waters, they have the potential to reduce the animal's fitness to the extent that its ability to find food decreases and its risk of being predated increases (Halvorsen et al. 2011, 2012b).

Mortality is either a direct effect of barotrauma (in the case of severe injury) or indirect if an animal is moderately injured. Data on sound-induced mortality in fishes are scarce and mainly related to underwater explosions (see review by Popper and Hastings 2009). California Department of Transportation (2001) documented fish mortality near underwater pile driving. There is no evidence for fish mortality caused by exposure to other sound sources such seismic airguns, dredging, or vessel noise (Normandeau Associates 2012).

Whale sharks have not been tested for their auditory sensitivity or susceptibility to noise-induced effects. Like all elasmobranchs, they are lacking a swim bladder and have no air-filled chambers or accessory morphological structures to their hearing system that could serve as hearing specialisations. Accordingly, similar to other shark species, they can be considered to have relatively insensitive hearing and less likely to be negatively affected by intense underwater sound.

6.3 Fishing

Scientific evidence of acoustic impacts on fish catches are somewhat equivocal because of the lack of determination between natural movements and changes in fish abundance. One comprehensive study (Engås *et al.* 1996) observed cod and haddock moving back within an area 3-5 days after seismic survey exposure. Similarly, Slotte *et al.* (2004) observed westward movement of large masses of blue whiting and herring towards and into the survey area 3-4 days after seismic shooting, indicating that migrations proceeded as normal soon after a seismic survey. Therefore, any disruptions would likely be short-term and during the survey, with conditions returning to 'normal' levels soon after.

Studies undertaken by Lokkeborg *et al.* (2012a, b) demonstrated that gillnet catches increased substantially for redfish (86% increase) and Greenland halibut (132% increase) during seismic shooting on a Norwegian fishing ground. However, longline catch rates fell (16% for Greenland halibut, 25% for haddock). These contrary results were explained by greater swimming activity versus lowered food search behaviour in fish exposed to air-gun sound emissions. Although catch rates changed in all species studied (including saithe and ling), except for saithe, acoustic mapping of fish abundance did not suggest displacement from fishing grounds.

Not all results from studies have resulted in behavioural alteration. Feeding Atlantic herring (*Clupea harengus*) schools off northern Norway showed no changes in swimming speed, direction or school size in response to a transmitting seismic vessel as it approached from a distance of 27 to 2 km, over a 6-hour period (Peña *et al.* 2013). As fishing areas are large and commercial fish species are free-swimming, if fish are 'scared' temporarily from an area, based on evidence presented, it is likely they will be displaced temporarily to another area still within the fishing zone and so able to be caught.

A recent critical review of the potential impacts of marine seismic surveys on fish and invertebrates (Carroll et al. 2017) found that other studies on fish have positive, inconsistent, or no effects from seismic surveys on catch rates or abundance. A desktop study of four species (gummy shark, tiger flathead, silver warehou, school whiting) in Bass Strait, Australia, found no consistent relationships between catch rates and seismic survey activity in the area, although the large historical window of the seismic data may have masked immediate or short-term effects which cannot therefore be excluded (Przeslawki et al. 2016). A subsequent desktop study targeting a single seismic survey in 2015 found that catch rates in the six months following the seismic survey were different than predicted in nine out of the 15 species examined. Across two fishing gear types, six species indicated increases in catch after the seismic survey, and three species indicated decreases in catch. The authors concluded that "These results support previous work in which the effects of seismic surveys on catch seem transitory and vary among studies, species, and gear types" (Przeslawski et al. 2016).

The body of peer-reviewed literature does not indicate any long-term abandonment of fishing grounds by commercial species, with several studies indicating that catch levels returned to pre-survey levels after seismic activity had ceased (Carroll et al. 2017).

6.4 Sharks

Limited research has been conducted on shark responses to marine seismic surveys. Myrberg (2001) stated that sharks differ from bony fish in that they have no accessory organs of hearing such as a swim bladder and therefore are unlikely to respond to acoustical pressure. The study also suggested that the lateral line system does not respond to normal acoustical stimuli and is unable to detect sound-induced water displacements beyond a few body lengths, even with large sound intensities (Myrberg, 2001). Other reports indicate that sharks are highly sensitive to sound between approximately 40 and 800 Hz, which overlaps with seismic sound frequencies. Klimley and Myrberg (1979) established that an individual shark will suddenly turn and withdraw from a sound source of high intensity (more than 20 dB re 1 µPa above broadband ambient SPL) when approaching within 10 m of the sound source.

6.5 Sea turtles

Morphological studies of green sea turtles (*Chelonia mydas*) and loggerhead sea turtles (*Caretta caretta*) (Ridgway et al. 1969, Wever 1978, Lenhardt et al. 1985) found that the turtle ear is similar to other reptile ears but has adaptations for underwater listening. In-air electrophysiological and behavioural studies on green and loggerhead sea turtles found their hearing frequency range is approximately 50–2000 Hz, with highest sensitivity to sounds between 200 and 400 Hz (Ridgway et al. 1969, Bartol et al. 1999, Ketten and Bartol 2005, Bartol and Ketten 2006, Yudhana et al. 2010, Piniak et al. 2011, Lavender et al. 2012, 2014).

Underwater audiograms are only available for three species, all of whom have poor hearing sensitivity. Two of these species, the red-eared slider (*Trachemys scripta elegans*, semi-aquatic) (Christensen-Dalsgaard et al. 2012) and the loggerhead turtle (Martin et al. 2012), demonstrated highest sensitivity at around 500 Hz (Willis 2016). Piniak et al. (2016) found that green turtles have maximum underwater sensitivity between 200 and 400 Hz. Very little research has been performed on the hearing capabilities of hawksbill turtles (*Eretmochelys imbricate)*. Yudhana et al. (2010) measured auditory brainstem responses from two hawksbill turtles in Malaysia and found that peak frequency sensitivity occurred at 457 Hz in one turtle and at 508 Hz in the other.

There is no robust information on the susceptibility of sea turtles to noise-induced effects. Most studies researching the effect of seismic noise on sea turtles focused on behavioural responses, as physiological impacts are more difficult to observe in living animals. Turtles avoid low-frequency sounds (Lenhardt 1994) and sounds from an airgun (O'Hara and Wilcox 1990), but these reports did not note received sound levels. Moein et al. (1995) found that penned loggerhead turtles initially reacted to an airgun but then showed little or no response to the sound (habituated to it). Caged green and loggerhead sea turtles increased their swimming activity in response to an approaching airgun when the received SPL was above 166 dB re 1 µPa, and they behaved erratically when the received SPL was approximately 175 dB re 1 µPa (McCauley et al. 2000).

Injury/mortality/potential mortality impacts have not been reported to have occurred in turtles as a result of noise emissions during seismic surveys. Popper *et al.* (2014) suggested injury to turtles could occur for sound exposures above 207 dB re 1 µPa (PK) or above 210 dB re 1 $\mu Pa^2 \cdot s$ (SEL_{24h}). However, Accomando et al. (2025) presented revised thresholds for turtle injury and hearing impairment from impulsive noise, considering both PK and frequency weighted SEL, suggesting that PTS may occur in response to 184 dB re 1 $\mu Pa^2 \cdot s$ (SEL_{24h}) or 230 dB re 1 µPa (PK) and TTS may occur in response to 169 dB re 1 $\mu Pa^2 \cdot s$ (SEL_{24h}) or 224 dB re 1 µPa (PK)..

6.6 Cetaceans: mysticetes (baleen whales) and odontocetes (dolphins, sperm and beaked whales)

The sounds emitted by the seismic sources and vessels during the operation have the potential to cause effects in marine fauna present in the area. The type and severity of the effects depends on the sensitivity of the receiving individual and may be influenced by a variety of biological and physical factors.

The potential impacts of anthropogenic noise on marine mammals have been the subject of considerable research (see reviews by Nowacek et al. 2007; Southall et al. 2007; Weilgart 2007; Wright et al. 2007).

Southall et al. (2007), Finneran and Jenkins (2012) Wood et al. (2012), Finneran (2015) and more recently NMFS (2013, 2018), Southall et al. (2019), NMFS (2024), and Accomando et al. (2025) reviewed available literature to determine noise exposure criteria, determined based on the onset levels of non-recoverable permanent hearing loss (PTS) and temporary hearing threshold shift (TTS) in cetaceans. The NMFS (2024) criteria incorporate the best available science to inform assessment of PTS and TTS in cetaceans.

6.6.1 Hearing sensitivity

Current data and predictions show that marine mammal species differ in their hearing capabilities, in absolute hearing sensitivity, as well as frequency band of hearing (Richardson et al. 1995, Wartzok and Ketten 1999, Southall et al. 2007). While hearing measurements are available for a small number of species based on captive animal studies, direct measurements of many odontocetes and all mysticetes do not exist. As a result, hearing ranges for many odontocetes are grouped with similar species, and predictions for mysticetes are based on other methods, such as anatomical studies and modelling (Houser et al. 2001, Parks et al. 2007, Tubelli et al. 2012, Cranford and Krysl 2015), vocalizations (see reviews in Richardson et al. 1995, Wartzok and Ketten 1999, Au and Hastings 2008), taxonomy, and behavioural responses to sound (Dahlheim and Ljungblad 1990)

To better reflect the auditory similarities between phylogenetically closely related species, but also significant differences between species groups among the marine mammals, Southall et al. (2007) assigned the extant marine mammal species to functional hearing groups based on their hearing capabilities and sound production. This division into broad categories was intended to provide a realistic number of categories for which individual noise exposure criteria were developed. These groups were revised by NMFS (2018), but the categorisation as such has proven to be a scientifically justified and useful approach in developing auditory weighting functions and deriving noise exposure criteria for marine mammals.

Southall et al. (2019) also proposed new nomenclature and classification for the marine mammal functional hearing groups. The auditory weighting functions and the different functional hearing categories of cetaceans are identical in both NMFS (2018) and Southall et al. (2019); however, each uses slightly different nomenclature. The low-frequency (LF) cetacean, mid-frequency (MF) cetacean and high-frequency (HF) cetacean categories described in U.S. NMFS (2018) are LF cetaceans, HF cetaceans and very high-frequency (VHF) cetaceans , respectively in Southall et al. (2019). Southall et al. (2019) explained that, pending further knowledge and future studies, it may be possible to reassign some species to new functional hearing groups, MF cetaceans and very low-frequency (VLF) cetaceans. However, based on the most recent guidance update issued by NMFS (2024), the three existing hearing categories reflect the most up to date knowledge. To avoid confusion, the NMFS (2024) hearing categories (LF, HF and VHF cetaceans) are reflected in the remainder of this report.

6.6.1.1 Functional hearing groups

Low-frequency (LF) cetaceans	This functional hearing group comprises all baleen whale species (mysticetes); to this date, there has been no direct measurement of hearing sensitivity in any of these species. Instead, vocalization frequency ranges have been used as a proxy to determine the range of hearing for these species. However, it has to be noted that vocalisation frequencies not necessarily represent the full extent of the frequency range of best hearing and therefore are a poor predictor of best hearing thresholds (Houser *et al*. 2017). In the complete absence of direct data on auditory sensitivity in any baleen whale species, behavioural reactions provide further insight into the sound perception capabilities and sensitivities of mysticetes. Reviews or new studies presenting data on behavioural reactions of mysticetes have been published by Nowacek *et al*. (2007, 2015). However, behavioural reactions are strongly contexted specific (Ellison *et al*. 2012) and are consequently also of limited use in delineating hearing ranges or even predicting hearing sensitivity. The existing data so far suggest that some species (e.g., blue whale, fin whale) having better low-frequency sensitivity and others (e.g., humpback whale, minke whale) having better sensitivity to higher frequencies. In another approach, anatomical data are used to predict hearing ranges in mysticetes (e.g., Parks *et al*. 2007; Manoussaki *et al*. 2008). Most recently functional models were developed focussing on different components of the hearing system (Tubelli *et al*. 2012; Cranford and Krysl 2015); in combination with anatomical data on the hearing system the audible frequency range of mysticetes – collectively treated as a single functional hearing group – is approximately between 7 Hz to 36 kHz.
High-frequency (HF) cetaceans	Based on the frequency range of their vocal emissions as well as the known hearing ranges, most dolphin species, all beaked whale species and the sperm whale belong to this functional hearing group. These species produce a wide range of whistles, clicks, pulsed sounds and echolocation clicks. The frequency range of their sounds excluding echolocation clicks are mostly <20 kHz with most of the energy typically around 10 kHz, although some calls may be as low as 100 to 900 Hz, ranging from 100 to 180 dB re 1 µPa (Richardson *et al*. 1995). The sounds produced are very complex and appear to be used for communication between members of a pod during socialising and feeding activities.
Very high frequency (VHF) cetaceans	Porpoises, dwarf and pygmy sperm whales (*Kogia spp*.), river dolphins, as well as hourglass dolphins and Peale's dolphin produce narrow-band high-frequency echolocation signals. The few species out of this group which were tested for their hearing sensitivity have their best hearing sensitivity at higher frequencies and show a wider hearing range compared to all other cetaceans. Accordingly, this group of species have been collectively classified as high-frequency cetaceans.

Hearing group	**Generalized hearing range**
Low-frequency cetaceans (mysticetes or baleen whales)	7 Hz to 36 kHz
High-frequency cetaceans (odontocetes: dolphins, toothed whales, beaked whales, bottlenose whales)	150 Hz to 160 kHz
Very high-frequency cetaceans (other odontocetes: true porpoises, Kogia, river dolphins, cephalorhynchid, Hourglass dolphin, Peale's dolphin)	200 Hz to 165 kHz

6.6.2 Behaviour

Numerous studies on marine mammal behavioural responses to sound exposure have not resulted in consensus in the scientific community regarding the appropriate sound exposure metric for assessing behavioural reactions. Southall et al. (2007) presented a severity-index ranking the intensity of behavioural responses that was later amended by Ellison et al. (2012), Miller et al. (Miller 2012), and Sivle et al. (2015).

NMFS currently uses a step function with a 50% probability of inducing behavioural responses at an SPL of 160 dB re 1 µPa to assess behavioural impact (NOAA 2024). This threshold value was derived from the HESS (1999) report, which, in turn, was based on the responses of migrating mysticete whales to an airgun sounds (Malme et al. 1983, Malme et al. 1984). The HESS team recognized that behavioural responses to sound may occur at lower levels, but significant responses were only likely to occur above an SPL of 140 dB re 1 µPa. An extensive review of behavioural responses to sound was undertaken by Southall et al. (2007, their Appendix B). They found varying responses for most marine mammals between an SPL of 140 and 180 dB re 1 µPa, consistent with the HESS (1999) report, but a lack of convergence in the data prevented them from suggesting explicit step functions. Absence of controls, precise measurements, appropriate metrics, and context dependency of responses (including the activity state of the animal) all contribute to variability. In 2012, Wood et al. (2012) proposed a graded probability of response for impulsive sounds using a frequency weighted SPL metric. They also designated behavioural response categories for sensitive species (such as harbour porpoises, *Phocoena phocoena*, and beaked whales) and for migrating mysticetes (**Table 6-2**).

Table 6-2: Predicted probability of behavioural response in marine mammals as a function of frequency-weighted sound pressure level (SPL, dB re 1 µPa) (Wood et al. 2012); probabilities are not additive.

Marine mammal group	Probability of response to frequency-weighted SPL (dB re 1 µPa)			
	120	140	160	180
Sensitive species	50%	90%		
All other species		10%	50%	90%

McCauley *et al*. (2000a) monitored the effects of seismic survey sounds on humpback whales in the Exmouth Gulf region of Western Australia. They documented rapid swimming on the surface, breaching and localised avoidance behaviour by migrating whales during the seismic operation, indicating that the 'risk factor' associated with the MSS was confined to a comparatively short period and small range displacement. During their migration and breeding season, humpback whales rarely display deep dives. This tendency to stay close to the surface has been interpreted as actively utilising the 'sound shadow' (Lloyd's Mirror effect) near the surface; irrespective of the motivation for this behaviour, it reduces the risk for noise-induced effects unless at very short range from a large seismic source array.

A comparison of behavioural observations of humpback whale behaviour during seismic surveys shows the variability and context dependence of these responses (Richardson *et al*. 1995). McCauley *et al*. 2000a) estimated that humpback whales would avoid seismic surveys in key habitat (such as breeding, resting or feeding areas) at distances between 7 and 12 km, whereas migrating individuals generally showed an avoidance range of around 3 km. Some males have even been recorded approaching seismic survey vessels to within 1 to 2 km (McCauley *et al.* 2000a). It is considered that avoidance behaviour represents a temporary and minor effect, unless avoidance results in displacement of whales from breeding, resting or feeding areas.

Humpback whales migrating from winter breeding grounds to summer feeding grounds showed moderate avoidance of an active seismic source at received levels >140 dB re 1µPa²·s (SEL) only when they were within 3 km of the source. The magnitude of response was measured as change in migration speed and course deviation (Dunlop *et al*. 2017). These results indicate that the proximity of the sound source has to be considered as another factor with regard to behavioural reactions in this species.

Blackwell *et al*. (2015) found evidence for two behavioural thresholds in migrating bowhead whales responding to seismic operations in the Beaufort Sea. A moderate cessation or modification of vocal behaviour (interpreted as compensation behaviour) was found at received SEL over a 10-minute period of 94 dB re 1µPa²·s (increase of calling rates) and 127 dB re 1µPa²·s (decrease in calling rates). At received levels of >160 dB re 1µPa²·s, however, whales were completely silent. Robertson *et al*. (2013) detected changes in surfacing, respiration and diving behaviour of bowhead whales in response to seismic survey activity but did not provide any qualitative information on the received levels. Castellote *et al*. (2010) documented avoidance behaviour in fin whales in response to seismic survey activity in the Mediterranean Sea lasting over 10 days.

Observations of sperm whale behaviour during seismic surveys provided conflicting results: Stone (2003) identified that while sperm whales were frequently (visually) detected during seismic surveys, these animals did not show any observable behavioural reactions. Jochens *et al*. (2008) found sperm whales tolerant of seismic activity; however, a decrease in foraging activity was observed for a small number of animals but no horizontal avoidance was measured. In a tagging study, Jochens and Biggs (2003) found that sperm whales did not show any behavioural reaction (horizontal avoidance of the seismic vessel, change in feeding rates) at maximum received levels of 148 dB re 1µPa.

In the Gulf of Mexico, sperm whales were equipped with multisensory tags to investigate their behaviour in response to seismic surveys. The animals did not show any statistically significant changes in horizontal movement, diving and echolocation behaviour at received levels of approximately 118–131 dB re 1mPa²·s ($SEL_{M\text{-}weighted}$) (Miller *et al*. 2009).

The hearing of dolphins is less sensitive in the low frequency range of airgun impulses (< 500 Hz) and seismic operators sometimes report dolphins and other small, toothed whales near operating seismic source arrays. However, there is a component of seismic pulses in the higher spectrum and in general most toothed whales do show some limited avoidance of operating seismic vessels. Goold (1996) studied the effects of seismic surveys common dolphins (*Delphinus delphis*) in the Irish Sea. The results indicated that there was a local displacement of dolphins around the seismic operation. This observation is consistent with visual data compiled by Stone (2003) from marine mammal surveys in the North Sea that shows small toothed whale species tend to move away from operating compressed air seismic sources. In a review of behavioural effects of seismic surveys on marine mammals in UK waters Stone *et al*. (2003) reported that small odontocetes (dolphins and porpoises) showed the strongest avoidance response to the seismic survey activity, were seen less often during periods of seismic acquisition, remaining further from the airguns and showing altered behaviour (e.g. less bow-riding, orienting away from the survey vessel, faster swimming). The same study documented that killer whales also showed some localised avoidance to seismic surveys.

A reduction in feeding activity in response to seismic survey activity has been documented for harbour porpoises at estimated received SEL of 150 – 165 dB re 1µPa²·s (Pirotta *et al*. 2014). Due to the permanently high energy demands of harbour porpoises (Wisniewska *et al*. 2016) a prolonged cessation of feeding can have significant effects on the fitness of affected animals.

Southall et al. (2021) discusses the nuances of assessing marine mammal behavioural response to both acute and chronic exposures to sound. Southall et al. (2021) note that single, all-or-nothing thresholds that attempt to relate received noise levels and behavioural response across broad taxonomic grouping and sound types can lead to errors in predicting effects. Differences between species, among individuals, across situational contexts, and with the temporal and spatial scales over which exposures occur lead to variability in the probability and severity of behavioural responses. Therefore, Southall et al. (2021) do not present new numerical thresholds for onset of behavioural responses for marine mammals. The study recommends improved severity consequence scales for behavioural studies and also proposes an alternative probabilistic approach (relative risk assessment) to inform decision making, particularly where population consequence assessments consider potential impacts to vital rates such as survival, reproduction and foraging. The issues are discussed further by the lead author, Brandon Southall, in a Marine Mammal Observer Association webinar on the topic (MMOA 2022) as well as in Southall et al. (2023).

However, despite the recommendations of Southall et al. (2021), the previously established NOAA (2019) guideline values continue to be used internationally for impact assessment purposes, and were re-issued by NOAA in 2024. Therefore, the guideline values continue to apply, but recognising that some behavioural response may also occur at different sound levels and considering what the consequence of such responses may be in significant marine mammal habitat or where there may be potential for significant impacts to survival, reproduction or foraging.

Any potential change in behavioural response criteria to be adopted in Australia is likely to be addressed in the Australian Government's underwater noise guidelines, which are currently in preparation and expected to be published some time in 2025.

6.6.3 Masking

Masking is the process by which the threshold of hearing for one sound is raised by the presence of another (masking) sound (Erbe and Farmer 1998; Erbe 2008; Erbe *et al*. 2016). This describes the reduction in audibility for one sound (termed 'signal') caused by the simultaneous presence of another sound (termed 'noise'). For this to occur, the sound must be loud enough, have similar frequency content to the signal, and must happen at the same time. Masking depends on the spectral and temporal characteristics of signal and noise and is reduced if the signal and noise are separated in time, frequency, or direction (space); it can occur if the noise happens shortly before or after the signal (forward and backward masking). The zone of masking can maximally be as large as the zone of audibility, as a faint noise might mask a faint signal. The masking effect can be reduced or remedied by various active or passive mechanisms for masking-release, such as spatial or temporal release from masking, the Lombard effect, or co-modulation masking release.

Auditory masking can lead to disruption of a behaviour, lack of appropriate behavioural reactions, increased vulnerability to predators, reduced access to prey, reduced communication, changes in vocal behaviour, disruption of spawning activities, and stress. The biological significance of acoustic masking is directly linked to the duration of the masking sound. While masking can be detrimental to the fitness, reproduction, and survival of individuals, it ends immediately after the masking sound ceases. Both anthropogenic and natural marine sound can affect hearing and partially or completely reduce an individual's ability to effectively communicate; detect important predator, prey, and/or conspecific signals; and detect important environmental features associated with spatial orientation (Clark *et al*. 2009). This is true for all marine fauna; however, masking is most frequently associated with marine mammals. Masking in fishes has not been studied in detail.

Masking reduces the communication space of marine mammals (Clark et al. 2009, Hatch et al. 2012). A calculation of reductions in communication range can be a useful proxy for impact. So far, a direct assessment and quantification of masking effects in wild animals has proven impossible (Tougaard et al. 2015). It depends on the positions of the signalling and the receiving animal relative to the sound source and to each other. In humpback whales (*Megaptera novaeangliae*), tonal and grunting sounds acting as contact calls between a mother and its calf were recorded at comparatively low levels (Videsen et al. 2017). While there is controversy about the validity of conclusions, such low levels would create a small communication space (<100 m) which, in turn, would be sensitive to increases in ambient noise.

Most studies related to masking effects in marine mammals have investigated the auditory parameters that are most relevant in this context, such as auditory sensitivity, frequency-tuning (critical bandwidth and critical ratio), auditory integration time, and critical interval. Erbe et al. (2016) reviewed the current knowledge on masking in marine mammals, summarising data on marine mammal hearing as they relate to masking and discussing masking release processes of receivers. The variability seen in auditory sensitivity (Section 4.1) indicates the variability seen with respect to auditory masking.

6.6.4 TTS/PTS/Auditory Injury

In marine mammals, the onset level and growth of TTS is frequency specific, depends on the temporal pattern, duty cycle, and the hearing test frequency of the fatiguing stimuli. Exposure to intense impulse noise might be more hazardous to hearing than non-impulsive noise, and there is a positive relationship between exposure duration and the amount of TTS induced. TTS can accumulate across multiple exposures, but the resulting TTS will be less than the TTS from a single, continuous exposure with the same total SEL. Sounds generated by seismic airguns, pile-driving and mid-frequency sonars have directly been tested and proven to cause noise-induced threshold shifts in marine mammals at high received levels. Finneran (2015) reviewed the current state of knowledge on TTS and PTS. TTS typically decreases in marine mammals relative to the logarithm of the increasing recovery time. There is, however, considerable individual difference in all TTS-related parameters between subjects and species tested so far.

PTS is considered injurious in marine mammals, but there are no published data on the sound levels that cause PTS in marine mammals. Regeneration of sensory cells, as known to occur in fishes, has not been documented for any marine or terrestrial mammal. Onset levels of PTS onset are typically extrapolated from TTS onset levels and assumed growth functions (Southall et al. 2007). The NMFS (2018) and Southall et al. (2019) criteria incorporate the best available science to estimate PTS onset in marine mammals from sound energy (SEL_{24h}), or very loud, instantaneous peak sound pressure levels (**Table 6-3**). As discussed within Accomando et al (2025) and NMFS (2024), intense noise exposures can cause auditory injury (represented by either AUD INJ or AINJ) without PTS occurring.

Table 6-3: Noise exposure criteria for onset of TTS and PTS (NMFS 2024). Criteria are given separately for each cetacean functional hearing group and discriminate between impulsive and non-impulsive sounds. For the purposes of this document, PTS can be considered interchangeable with Auditory Injury (AUD INJ), although auditory injury can occur without PTS occurring.

Hearing group	AUD INJ onset thresholds (received level)		TTS onset thresholds (received level)	
	Impulsive	Non-impulsive	Impulsive	Non-impulsive
Low-frequency cetaceans	L_{pk},flat: 222 dB $L_{E,LF}$, 24h: 183 dB	$L_{E,LF}$, 24h: 197 dB	L_{pk}, flat: 216 dB $L_{E,LF}$, 24h: 168 dB	$L_{E,LF}$, 24h: 177 dB
High-frequency cetaceans	L_{pk}, flat: 230 dB $L_{E,HF}$, 24h: 193 dB	$L_{E,HF}$, 24h: 201 dB	L_{pk}, flat: 224 dB $L_{E,HF}$, 24h: 178 dB	$L_{E,HF}$, 24h: 181 dB

Very high-frequency cetaceans	L_{pk}, flat: 202 dB $L_{E,VHF}$, 24h: 159 dB	$L_{E,VHF}$, 24h: 181 dB	L_{pk}, flat: 196 dB $L_{E,VHF}$, 24h: 144 dB	$L_{E,VHF}$, 24h: 161 dB

The role of the temporal pattern of sound on TTS in marine mammals has been studied in HF and VHF cetaceans (Mooney *et al*. 2009a; Finneran *et al*. 2010b; Kastelein *et al*. 2014a; Kastelein *et al*. 2015b). The results of these studies show that TTS can accumulate across multiple exposures, but the resulting TTS will be less than the TTS from a single, continuous exposure with the same total SEL.

Only a few studies have investigated TTS in marine mammals in response to exposure to impulsive sounds such as airgun impulses. Lucke *et al*. (2009) tested the effect of a single airgun on a male harbour porpoise. They documented onset of TTS at received (unweighted) SEL of 164 dB re 1 $\mu Pa^2 \cdot s$. This equates to a (HF) weighted SEL_{24h} of 140 dB re 1 $\mu Pa^2 \cdot s$ (NOAA 2016). The main energy of the fatiguing stimulus (airgun pulse) was centred below 500 Hz, but a substantial amount of energy was also present at higher frequencies. Kastelein *et al*. (1997) tested the auditory tolerance of a harbour porpoise to playbacks of broadband pile driving sounds. After one hour of exposure an unweighted SEL 146 dB re 1 $\mu Pa^2 \cdot s$ and a SEL_{24h} of 180 dB re 1 $\mu Pa^2 \cdot s$, a TTS of 2.3 dB and 3.6 dB occurred at 4 kHz and 8 kHz, respectively. The average weighted SEL_{24h} from these exposures was 144 dB re 1 $\mu Pa^2 \cdot s$. In a study using playbacks of pile driving sounds, Kastelein *et al*. (2016) exposed harbour porpoises to a maximum single-strike unweighted broadband SEL of 145 dB re 1 $\mu Pa^2 s$ and a cumulative SEL_{24h} of up to 187 dB re 1 $\mu Pa^2 \cdot s$. TTS increased from 0 dB after 15 min exposure to 5 dB after 360 min exposure. Based on their results, they calculated an onset of TTS for this type of sound at a SEL_{24h} of approximately 175 dB re 1 $\mu Pa^2 \cdot s$. Kastelein *et al*. (2017) exposed a harbour porpoise to 10 and 20 consecutive airgun impulses at received SEL_{24h} of 188-191 dB re 1 $\mu Pa^2 \cdot s$ with a mean shot intervals of around 17 seconds. TTS of ~4.4 dB was measured at 4 kHz.

Finneran *et al*. (2015) tested the exposed three bottlenose dolphins to 10 impulses produced by a seismic air gun. The highest exposures were conducted at peak sound pressure levels (PK) of 210 dB re 1 µPa, peak-peak sound pressure levels (PK-PK) of 212 dB re 1 µPa, and cumulative (unweighted) SEL_{24h} of 195 dB re 1 $\mu Pa^2 \cdot s$. This exposure induced 9 dB TTS in one animal at 8 kHz.

6.6.5 Mortality

The only evident case of an injury to a marine mammal caused by what can clearly be considered an underwater sound source was reported by Ketten et al. (1993). However, as the most likely sound source in this case was an underwater explosion of undefined charge weight and distance to the animals, the physical cause of the injury may have been the shock wave created by the explosion.

6.7 Seabirds

Only bird species that plunge dive (such as tropicbirds, boobies, shearwaters and tern species) could potentially be exposed to underwater noise, although little or no impact is expected. Stemp (1985; as cited in LGL 2012) conducted observations on the effects of seismic exploration on seabirds and did not observe any negative effects. Lacroix *et al.* (2003; as cited in LGL 2012) investigated the effect of near shore seismic surveys on moulting long-tailed ducks in the Beaufort Sea, Alaska, and also failed to detect any negative effects. Furthermore, they noted that seismic activity did not appear to change the diving intensity of the ducks significantly.

There are no thresholds or assessment criteria for noise impacts to seabirds from seismic surveys.

6.8 Divers

Divers exposed to high levels of underwater sound can suffer from dizziness, hearing damage or other injuries to other sensitive (mainly air-filled) organs, depending on the frequency and intensity of the sound. The human auditory system is significantly less sensitive underwater than in air and is further degraded if diving equipment obstructs the ears or face (e.g. diving with a hood or full facemask).

Under water, the human ear is about 20 dB less sensitive than it is in air at low frequencies (20 Hz), increasing to 40 dB at mid-frequencies (less than 1 kHz), and increasing to 70–80 dB less sensitive at higher frequencies (Parvin 1998). Divers who wear neoprene hoods have even higher hearing thresholds (lower sensitivity) above 500 Hz because the hood material absorbs high-frequency sounds (Sims *et al*. 1999). Exposure studies related to divers have typically focused on military sonar exposure, with little information on seismic survey operations, and as such care is required when considering thresholds for non-military divers, particularly for impulsive sounds such as seismic source impulses (Ainslie 2008).

Underwater auditory threshold curves indicate that the human auditory system is most sensitive to waterborne sound at frequencies between 400 Hz to 1 kHz (Parvin *et al*. 1994); cited in Anthony *et al*. 2009), and these

frequencies have the greatest potential for damage. Within the literature (all as cited in Ainslie, 2008), there is some variation in acceptable SPLs for divers as discussed below.

The auditory threshold of hearing under-water was lowest at 1 kHz (70 dB re 1 µPa SPL) and increased for lower and higher frequencies to around 120 dB re 1 µPa at 20 Hz and at 20 kHz (Parvin 1998). Fothergill *et al*. (2000) and Fothergill *et al*. (2001) conducted controlled acoustic exposure experiments on military divers under fully controlled conditions at a US Ocean Simulation Facility and an US Open water test facility; in all tests, the divers were covered with soft or hard shell dive suits and their position and distance relative to sound source, signal characteristics and received levels were controlled and documented (Pestorius *et al*. 2009). A total of 89 male Navy divers were exposed to pure tone signals and sweeps between 160-320 Hz at SPLs up to 160 dB re 1 µPa. The divers were exposed to these sounds over 100 seconds at depths from 10 to 40 m. The divers rated the sounds on a severity scale. For frequencies between 100 and 500 Hz, at a received SPL of 130 dB re 1 µPa, divers and swimmers detected body vibration. None of the divers tested rated levels of 140 dB re 1 µPa as “very severe”; however, at 157 dB re 1 µPa, sound was rated as “very severe” 19 per cent of the time. No physiological damage was observed at the highest levels tested: 160 dB re 1 µPa (Fothergill *et al*. 2001). In a subsequent study, recreational divers were exposed to tonal signals or 30 Hz-sweeps at frequencies between 100 and 500 Hz at received levels of 130-157 dB re 1 µPa (Pestorius *et al*. 2009). Each exposure lasted for seven seconds. Nine female and 17 male scuba divers were tested, all wearing full body neoprene wetsuits. Diver aversion and perception of body vibration were used as test parameters. The results showed no sex-specific differences. The results differed as a function of frequency – while test results showed a strong overall variation between subjects, signals at 100 Hz elicited the strongest aversion in all tests and even at 148 dB a few diver ratings indicated extreme aversion. Due to this and the strong variation between test subjects, the following exposure limit for both military and recreational divers was suggested as a conservative measure: For frequencies between 100 and 500 Hz, the maximum SPL should be 145 dB re 1 µPa over a maximum continuous exposure of 100 seconds or with a maximum duty cycle of 20 per cent and a maximum daily cumulative total of three hours. The trading relation between the maximum SPL and duration was 4 dB per doubling of duration (e.g., 141 dB SPL for a 200 second exposure) (Pestorius *et al*. 2009).

In alignment with these studies, and considering only frequencies between 100 and 500 Hz, Parvin (2005) suggested 145 dB re 1 µPa as a safety criterion for recreational divers and swimmers. Seismic airgun sources are broadband sources, and therefore, for this assessment the most precautionary and conservative diver acoustic impact threshold is the 145 dB re 1 µPa SPL suggested by Parvin (2005). This does not imply that this level is associated with the onset of injury.

The latest guidance issued by the Diving Medical Advisory Committee (DMAC 2019) suggests that adverse effects to divers may be experienced at distances of up to 27 km from the seismic source, which is a considerably greater distance than has previously been recognised. However, the basis for this conclusion is not provided.

7. References

[Caltrans] California Department of Transportation. 2001. *San Francisco–Oakland Bay Bridge East Span Seismic Safety Project, Pile Installation Demonstration Project*. Marine Mammal Impact Assessment Report PIDP EA 012081, PIDP 04-ALA-80-0.0/0.5, Caltrans Contract 04A0148, Task Order 205.10.90. California Department of Transportation.

[DMAC] Diving Medical Advisory Committee. 2019. *Safe Diving Distance from Seismic Surveying Operations*. DMAC 12 Rev. 2, London, UK. 2 p. http://www.dmac-diving.org/guidance/DMAC12.pdf.

[DoN] Department of the Navy (U.S.). 2008. *Northwest training range complex draft environmental impact statement/overseas environmental impact statement*. Volume 1. United States Department of the Navy, Washington, D.C.

[HESS] High Energy Seismic Survey. 1999. *High Energy Seismic Survey Review Process and Interim Operational Guidelines for Marine Surveys Offshore Southern California*. Prepared for the California State Lands Commission and the United States Minerals Management Service Pacific Outer Continental Shelf Region by the High Energy Seismic Survey Team, Camarillo, CA, USA. 98 p. https://ntrl.ntis.gov/NTRL/dashboard/searchResults/titleDetail/PB2001100103.xhtml.

[ISO] International Organization for Standardization. 2017. *ISO/DIS 18405.2:2017. Underwater acoustics—Terminology*. Geneva. https://www.iso.org/standard/62406.html.

[NIOSH] National Institute for Occupational Safety and Health. 1998. *Criteria for a recommended standard: Occupational noise exposure. Revised Criteria*. Document 98-126. US Department of Health and Human Services, NIOSH, Cincinnati, OH, USA. 122 p. https://www.cdc.gov/niosh/docs/98-126/pdfs/98-126.pdf.

[NMFS] National Marine Fisheries Service (US). 2018. *2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts*. US Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-59. 167 p. https://www.fisheries.noaa.gov/s3//dam-migration/tech-memo-acoustic-guidance-20-pdf-508.pdf.

[NMFS] National Marine Fisheries Service (US). 2024. *2024 Update to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 3.0): Underwater and In-Air Criteria for Onset of Auditory Injury and Temporary Threshold Shifts*. Report by the US Department of Commerce and NOAA. NOAA Technical Memorandum NMFS-OPR-xx. https://www.fisheries.noaa.gov/s3/2024-05/NMSFAcousticGuidance-DraftTECHMEMOGuidance-3.0-FEB-24-OPR1.pdf.

Accomando, A.W., J.J. Finneran, E. Henderson, K. Jenkins, S. Kotecki, C. Martin, J. Mulsow, and M. Zapetis. 2025. *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase 4). Revision 2025.1*. Report by NIWC Pacific and National Marine Mammal Foundation for the US Navy. https://www.nepa.navy.mil/Portals/20/Documents/Phase%204%20Acoustic%20and%20Explosive%20Criteria%20Final%20APR2025.1.pdf.

Aguilar de Soto, N., N. Delorme, J. Atkins, S. Howard, J. Williams, and M. Johnson. 2013. Anthropogenic noise causes body malformations and delays development in marine larvae. *Scientific Reports* 3(2831): 5. https://doi.org/10.1038/srep02831.

André, M., M. Solé, M. Lenoir, M. Durfort, C. Quero, A. Mas, A. Lombarte, M. van der Schaar, M. López-Bejar, et al. 2011. Low-frequency sounds induce acoustic trauma in cephalopods. *Frontiers in Ecology and the Environment* 9(9): 489–493. https://doi.org/10.1890/100124.

Andrew, R.K., B.M. Howe, J.A. Mercer, and M.A. Dzieciuch. 2002. Ocean ambient sound: Comparing the 1960s with the 1990s for a receiver off the California coast. *Acoustics Research Letters Online* 3(2): 65.

Andrew, R.K., B.M. Howe, and J.A. Mercer. 2011. Long-time trends in ship traffic noise for four sites off the North American West Coast. *Journal of the Acoustical Society of America* 129(2): 642–651. https://doi.org/10.1121/1.3518770.

Au, W.L.W. and M.C. Hastings. 2008. Hearing in Marine Animals. 337-400.

Bartol, S.M., J.A. Musick, and M.L. Lenhardt. 1999. Auditory evoked potentials of the loggerhead sea turtle (*Caretta caretta*). *Copeia* 3: 836–840. https://doi.org/10.2307/1447625.

Bartol, S.M. and D.R. Ketten. 2006. *Turtle and tuna hearing*. *In*: Swimmer, Y. and R. Brill (eds.). Sea turtle and pelagic fish sensory biology: Developing techniques to reduce sea turtle bycatch in longline fisheries. Volume December 2006. NOAA Technical Memorandum NMFS-PIFSC-7. 98–103 p. http://www.sefsc.noaa.gov/turtles/TM_NMFS_PIFSC_7_Swimmer_Brill.pdf#page=108.

Bertrand, A. and E. Josse. 2000. Tuna target-strength related to fish length and swimbladder volume. *ICES Journal of Marine Science* 57: 1143-1146.

Braun, C. and T. Grande. 2008. Evolution of peripheral mechanisms for the enhancement of sound reception. *In* Webb JF, P.A., Fay RR (ed.). *Fish bioacoustics*. Springer, New York, NY. pp. 99-144.

Budelmann, B.U. 1992a. Hearing in crustacea. *In* Webster, D.B., R.R. Fay, and A.N. Popper (eds.). *The Evolutionary Biology of Hearing*. Springer-Verlag, New York. pp. 131–139. https://doi.org/10.1007/978-1-4612-2784-7_9.

Budelmann, B.U. 1992b. Hearing in Nonarthropod Invertebrates. (Chapter 10) *In* Webster, D.B., A.N. Popper, and R.R. Fay (eds.). *The Evolutionary Biology of Hearing*. Springer, New York. pp. 141–155. https://doi.org/10.1007/978-1-4612-2784-7_10.

Caiger, P.E., J.C. Montgomery, and C.A. Radford. 2012. Chronic low-intensity noise exposure affects the hearing thresholds of juvenile snapper. *Marine Ecology Progress Series* 466: 225–232.

Carlson, T. and G. Johnson. 2009. *Compliance Monitoring of Underwater Blasting for Rock Removal at Warrior Point, Columbia River Channel Improvement Project, 2009/2010*. *In*: USACE Portland District, P., Oregon (ed.) Report PNNL-20388. Pacific Northwest National Laboratory, Richland, WA. 69 pp + App. p.

Carroll, A.G., R. Przeslawski, A.J. Duncan, M. Gunning, and B.D. Bruce. 2017. A critical review of the potential impacts of marine seismic surveys on fish & invertebrates. *Marine Pollution Bulletin* 114(1): 9–24. https://doi.org/10.1016/j.marpolbul.2016.11.038.

Casper, B.M., A.N. Popper, F. Matthews, T.J. Carlson, and M.B. Halvorsen. 2012. Recovery of barotrauma injuries in Chinook salmon, *Oncorhynchus tshawytscha* from exposure to pile driving sound. *PLOS ONE* 7(6): e39593. https://doi.org/10.1371/journal.pone.0039593.

Casper, B.M., M.E. Smith, M.B. Halvorsen, H. Sun, T.J. Carlson, and A.N. Popper. 2013. Effects of exposure to pile driving sounds on fish inner ear tissues. *Comparative Biochemistry and Physiology Part A* 166(2): 352–360. https://doi.org/10.1016/j.cbpa.2013.07.008.

Chapman, N.R. and A. Price. 2011. Low frequency deep ocean ambient noise trend in the Northeast Pacific Ocean. *Journal of the Acoustical Society of America* 129(5): EL161–EL165. https://doi.org/10.1121/1.3567084.

Christensen-Dalsgaard, J., C. Brandt, K.L. Willis, C.B. Christensen, D.R. Ketten, P.L. Edds-Walton, R.R. Fay, P.T. Madsen, and C.E. Carr. 2012. Specialization for underwater hearing by the tympanic middle ear of the turtle, *Trachemys scripta elegans*. *Proceedings of the Royal Society B* 279(1739): 2816–2824. https://doi.org/10.1098/rspb.2012.0290.

Clark, C.W., W.T. Ellison, B.L. Southall, L.T. Hatch, S.M. Van Parijs, A.S. Frankel, and D.W. Ponirakis. 2009. Acoustic masking in marine ecosystems: Intuitions, analysis, and implication. *Marine Ecology Progress Series* 395: 201–222. https://doi.org/10.3354/meps08402.

Cohen, M.J., Y. Katsuki, and T.H. Bullock. 1953. Oscillographic analysis of equilibrium receptors in Crustacea. *Experientia* 9(11): 434–435. https://doi.org/10.1007/BF02175537.

Cohen, M.J. 1955. The function of receptors in the statocyst of the lobster *Homarus americanus*. *Journal of Physiology* 130(1): 9–34. https://doi.org/10.1113/jphysiol.1955.sp005389.

Cranford, T.W. and P. Krysl. 2015. Fin whale sound reception mechanisms: Skull vibration enables low-frequency hearing. *PLOS ONE* 10(1). https://doi.org/10.1371/journal.pone.0116222.

Dahlheim, M.E. and D.K. Ljungblad. 1990. Preliminary Hearing Study on Gray Whales (*Eschrichtius Robustus*) in the Field. *In* Thomas, J.A. and R.A. Kastelein (eds.). *Sensory abilities of Cetaceans*. Volume 196. Springer Science+Business Media, Boston. pp. 335–346. https://doi.org/10.1007/978-1-4899-0858-2_22.

Dale, J.J., M.D. Gray, A.N. Popper, P.H. Rogers, and B.A. Block. 2015. Hearing thresholds of swimming Pacific bluefin tuna *Thunnus orientalis*. *Journal of Comparative Physiology A* 201(5): 441–454. https://doi.org/10.1007/s00359-015-0991-x.

Day, R.D., R.D. McCauley, Q.P. Fitzgibbon, K. Hartmann, J.M. Semmens, and Institute for Marine and Antarctic Studies. 2016. *Assessing the Impact of Marine Seismic Surveys on Southeast Australian Scallop and Lobster Fisheries*. Impacts of Marine Seismic Surveys on Scallop and Lobster Fisheries. Fisheries Ressearch & Development Corporation. FRDC Project No 2012/008, University of Tasmania, Hobart. 159 p.

Edmonds, N.J., C.J. Firmin, D. Goldsmith, R.C. Faulkner, and D.T. Wood. 2016. A review of crustacean sensitivity to high amplitude underwater noise: Data needs for effective risk assessment in relation to UK commercial species. *Marine Pollution Bulletin* 108(1–2): 5–11. https://doi.org/10.1016/j.marpolbul.2016.05.006.

Ellers, O. 1995. Discrimination among wave-generated sounds by a swash-riding clam. *Biological Bulletin* 189(2): 128-137.

Ellison, W.T., B.L. Southall, C.W. Clark, and A.S. Frankel. 2012. A New Context-Based Approach to Assess Marine Mammal Behavioral Responses to Anthropogenic Sounds. *Conservation Biology* 26(1): 21–28. https://doi.org/10.1111/j.1523-1739.2011.01803.x.

Engineering-Environmental Management, I. 2008. *United States Coast Guard and Maritime Administration draft environmental impact statement for Port Dolphin LLC Deepwater Port licence application*. USCG Deepwater Ports Standards Division, Washington, DC.

Erbe, C. and D.M. Farmer. 1998. Masked hearing thresholds of a beluga whale (*Delphinapterus leucas*) in icebreaker noise. *Deep Sea Research Part II* 45(7): 1373–1388. https://doi.org/10.1016/S0967-0645(98)00027-7.

Erbe, C. 2008. Critical ratios of beluga whales (*Delphinapterus leucas*) and masked signal duration. *Journal of the Acoustical Society of America* 124(4): 2216–2223. https://doi.org/10.1121/1.2970094.

Erbe, C., C.J. Reichmuth, K. Cunningham, K. Lucke, and R.J. Dooling. 2016. Communication masking in marine mammals: A review and research strategy. *Marine Pollution Bulletin* 103(1): 15–38. https://doi.org/10.1016/j.marpolbul.2015.12.007.

Etter, P.C. 1996. *Underwater Acoustic Modeling - Principles, Techniques, and Applications*. Second edition. E & FN Spon, London, UK. 344 p.

Fields, D.M., N.O. Handegard, J. Dalen, C. Eichner, K. Malde, Ø. Karlsen, A.B. Skiftesvik, C.M.F. Durif, and H.I. Browman. 2019. Airgun blasts used in marine seismic surveys have limited effects on mortality, and no sublethal effects on behaviour or gene expression, in the copepod Calanus finmarchicus. *ICES Journal of Marine Science*.

Finneran, J.J. 2015. Noise-induced hearing loss in marine mammals: A review of temporary threshold shift studies from 1996 to 2015. *Journal of the Acoustical Society of America* 138(3): 1702–1726. https://doi.org/10.1121/1.4927418.

Finneran, J.J. 2016. *Auditory weighting functions and TTS/PTS exposure functions for marine mammals exposed to underwater noise*. Technical Report for Space and Naval Warfare Systems Center Pacific, San Diego, CA, USA. 49 p. https://apps.dtic.mil/dtic/tr/fulltext/u2/1026445.pdf.

François, R.E. and G.R. Garrison. 1982a. Sound absorption based on ocean measurements: Part II: Boric acid contribution and equation for total absorption. *Journal of the Acoustical Society of America* 72(6): 1879–1890. https://doi.org/10.1121/1.388673.

François, R.E. and G.R. Garrison. 1982b. Sound absorption based on ocean measurements: Part I: Pure water and magnesium sulfate contributions. *Journal of the Acoustical Society of America* 72(3): 896–907. https://doi.org/10.1121/1.388170.

Frisk, G.V. 2012. Noiseonomics: the relationship between ambient noise levels in the sea and global economic trends. *Sci Rep* 2: 437. http://www.ncbi.nlm.nih.gov/pubmed/22666540.

Halvorsen, M., B. Casper, F. Matthews, T. Carlson, and A. Popper. 2012a. Effects of exposure to pile driving sound on the lake sturgeon, Nile tilapia and hogchocker. *Proceedings of the Royal Society B*.

Halvorsen, M.B., B.M. Casper, C.M. Woodley, T.J. Carlson, and A.N. Popper. 2011. Predicting and mitigating hydroacoustic impacts on fish from pile installations. Project 25–28. *National Cooperative Highway Research Program Research Results Digest* 363. https://doi.org/10.17226/14596.

Halvorsen, M.B., B.M. Casper, C.M. Woodley, T.J. Carlson, and A.N. Popper. 2012b. Threshold for onset of injury in Chinook salmon from exposure to impulsive pile driving sounds. *PLOS ONE* 7(6): e38968. https://doi.org/10.1371/journal.pone.0038968.

Hatch, L.T., C.W. Clark, S.M. Van Parijs, A.S. Frankel, and D.W. Ponirakis. 2012. Quantifying loss of acoustic communication space for right whales in and around a U.S. National Marine Sanctuary. *Conservation Biology* 26(6): 983–994. https://doi.org/10.1111/j.1523-1739.2012.01908.x.

Hawkins, A.D. and A.N. Popper. 2017. A sound approach to assessing the impact of underwater noise on marine fishes and invertebrates. *ICES Journal of Marine Science* 74(3): 635–651. https://doi.org/10.1093/icesjms/fsw205.

Higgs, D.M., Z. Lu, and D.A. Mann. 2006. Hearing and mechanoreception. *In* Evans, D.H. and J.B. Claiborne (eds.). *The physiology of fishes*. Taylor & Francis Group, Florida, USA. pp. 391-429.

Houser, D.S., D.A. Helweg, and P.W.B. Moore. 2001. A bandpass filter-bank model of auditory sensitivity in the humpback whale. *Aquatic Mammals* 27(2): 82–91. https://www.aquaticmammalsjournal.org/share/AquaticMammalsIssueArchives/2001/AquaticMammals_27-02/27-02_Houser.PDF.

Houser, D.S., W. Yost, R. Burkard, J.J. Finneran, C.J. Reichmuth, and J.L. Mulsow. 2017. A review of the history, development and application of auditory weighting functions in humans and marine mammals. *Journal of the Acoustical Society of America* 141(3): 1371–1413. https://doi.org/10.1121/1.4976086.

Kastelein, R.A., S. van der Heul, W.C. Verboom, N. Jennings, J. van der Veen, and D. deHaan. 2008. Startle response of captive North Sea fish species to underwater tones between 0.1 and 64 kHz. *Marine Environmental Research* 65(5): 369–377. https://doi.org/10.1016/j.marenvres.2008.01.001.

Ketten, D., J. Lien, and S. Todd. 1993. Blast injury in humpback whale ears: Evidence and implications. *Journal of the Acoustical Society of America*. Volume 94(3/2). pp. 1849-1850.

Ketten, D.R. and S.M. Bartol. 2005. *Functional measures of sea turtle hearing*. ONR project final report. Document ONR Award Number N00014-02-1-0510. Office of Naval Research (US).

Kight, C.R. and J.P. Swaddle. 2011. How and why environmental noise impacts animals: An integrative, mechanistic review. *Ecology Letters* 14(10): 1052–1061. https://doi.org/10.1111/j.1461-0248.2011.01664.x.

Ladich, F. and A.N. Popper. 2004. Parallel evolution in fish hearing organs. *In* Manley, G.A., A.N. Popper, and R.R. Fay (eds.). *Evolution of the Vertebrate Auditory System*. Volume 22. Springer-Verlag, New York. pp. 95–127. https://doi.org/10.1007/978-1-4419-8957-4_4.

Ladich, F. and R.R. Fay. 2013. Auditory evoked potential audiometry in fish. *Reviews in Fish Biology and Fisheries* 23(3): 317–364. https://doi.org/10.1007/s11160-012-9297-z.

Lavender, A.L., S.M. Bartol, and I.K. Bartol. 2012. Hearing capabilities of loggerhead sea turtles (*Caretta caretta*) throughout ontogeny. *In* Popper, A.N. and A.D. Hawkins (eds.). *The Effects of Noise on Aquatic Life*. Volume 730. Springer. pp. 89–92. https://doi.org/10.1007/978-1-4419-7311-5_19.

Lavender, A.L., S.M. Bartol, and I.K. Bartol. 2014. Ontogenetic investigation of underwater hearing capabilities in loggerhead sea turtles (*Caretta caretta*) using a dual testing approach. *Journal of Experimental Biology* 217(14): 2580–2589. https://doi.org/10.1242/jeb.096651.

Lenhardt, M.L., R.C. Klinger, and J.A. Musick. 1985. Marine turtle middle-ear anatomy. *Journal of Auditory Research* 25(1): 66–72. https://europepmc.org/article/MED/3836997.

Lenhardt, M.L. 1994. Seismic and very low frequency sound induced behaviors in captive loggerhead marine turtles (*Caretta caretta*). *In*: Bjorndal, K.A., A.B. Bolten, D.A. Johnson, and P.J. Eliazar (eds.). *14th Annual Symposium on Sea Turtle*

Biology and Conservation. NOAA Technical Memorandum, NMFS-SEFSC-351, National Technical Information Service, Springfield, Virginia, Springfield, VA, USA.

Mackenzie, S. and D. Raible. 2012. Proliferative regeneration of zebrafish lateral line hair cells after different ototoxic insults. *PLoS One* 7: e47257.

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyak, and J.E. Bird. 1983. *Investigations of the Potential Effects of Underwater Noise from Petroleum Industry Activities on Migrating Gray Whale Behavior*. Report 5366. http://www.boem.gov/BOEM-Newsroom/Library/Publications/1983/rpt5366.aspx.

Malme, C.I., P.R. Miles, C.W. Clark, P.L. Tyack, and J.E. Bird. 1984. *Investigations of the Potential Effects of Underwater Noise from Petroleum Industry Activities on Migrating Gray Whale Behavior. Phase II: January 1984 Migration*. Report 5586. Report by Bolt Beranek and Newman Inc. for the US Department of the Interior and Minerals Management Service (Alaska OCS Office), Cambridge, MA, USA. https://www.boem.gov/sites/default/files/boem-newsroom/Library/Publications/1983/rpt5586.pdf.

Martin, K.J., S.C. Alessi, J.C. Gaspard, A.D. Tucker, G.B. Bauer, and D.A. Mann. 2012. Underwater hearing in the loggerhead turtle (*Caretta caretta*): A comparison of behavioral and auditory evoked potential audiograms. *Journal of Experimental Biology* 215(17): 3001–3009. https://doi.org/10.1242/jeb.066324.

Martin, S.B., D.G. Zeddies, B.J. Gaudet, and J. Richard. 2016. Evaluation of Three Sensor Types for Particle Motion Measurement. *In* Popper, A.N. and A.D. Hawkins (eds.). *The Effects of Noise on Aquatic Life II*. Springer, New York. pp. 679–686. https://doi.org/10.1007/978-1-4939-2981-8_82.

McCauley, R.D. 1994. *The Environmental Implications of Offshore Oil and Gas Development in Australia - Seismic Surveys*. *In*: Neff, J.M. and P.C. Young (eds.). Environmental Implications of Offshore Oil and Gas Develpment in Australia - The Findings of an Independent Scientific Review Swan. Australian Petroleum Exploration Association, Sydney. 19–122 p.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.-N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch, et al. 2000. *Marine seismic surveys: Analysis and propagation of air-gun signals; and effects of air-gun exposure on humpback whales, sea turtles, fishes and squid*. Report R99-15. Prepared for Australian Petroleum Production Exploration Association by Centre for Maine Science and Technology, Western Australia. 198 p. https://cmst.curtin.edu.au/wp-content/uploads/sites/4/2016/05/McCauley-et-al-Seismic-effects-2000.pdf.

McCauley, R.D., J. Fewtrell, and A.N. Popper. 2003. High intensity anthropogenic sound damages fish ears. *Journal of the Acoustical Society of America* 113(1): 638–642. https://doi.org/10.1121/1.1527962.

McCauley, R.D. and C.P. Salgado Kent. 2012. A Lack of Correlation Between Air Gun Signal Pressure Waveforms and Fish Hearing Damage. *In* Popper, A.N. and A.D. Hawkins (eds.). *The Effects of Noise on Aquatic Life*. Volume 730. Springer, New York. pp. 245–250. https://doi.org/10.1007/978-1-4419-7311-5_54.

McCauley, R.D., R.D. Day, K.M. Swadling, Q.P. Fitzgibbon, R.A. Watson, and J.M. Semmens. 2017. Widely used marine seismic survey air gun operations negatively impact zooplankton. *Nature Ecology & Evolution* 1(7): 1–8. https://doi.org/10.1038/s41559-017-0195.

McDonald, M.A., J.A. Hildebrand, and S.M. Wiggins. 2006. Increases in deep ocean ambient noise in the Northeast Pacific west of San Nicolas Island, California. *Journal of the Acoustical Society of America* 120(2): 711–718. https://doi.org/10.1121/1.2216565.

McKinstry, C., T. Carlson, and R. Brown. 2007. *Derivation of a mortal injury metric for studies of rapid decompression of depth-acclimated physostomous fish*. Document PNNL-17080. Pacific Northwest National Laboratory, Richland, WA. http://www.pnl.gov/main/publications/external/technical_reports/PNNL-17080.pdf.

Miksis-Olds, J.L. and S.M. Nichols. 2016. Is low frequency ocean sound increasing globally? *Journal of the Acoustical Society of America* 139(1): 501–511. https://doi.org/10.1121/1.4938237.

Miller, P. 2012. The Severity of Behavioral Changes Observed During Experimental Exposures of Killer (Orcinus orca), Long-Finned Pilot (Globicephala melas), and Sperm (Physeter macrocephalus) Whales to Naval Sonar. *Aquatic Mammals* 38(4): 362-401.

Moein, S.E., J.A. Musick, J.A. Keinath, D.E. Barnard, M.L. Lenhardt, and R. George. 1995. *Evaluation of Seismic Sources for Repelling Sea Turtles from Hopper Dredges, in Sea Turtle Research Program: Summary Report*. *In*: Hales, L.Z. (ed.). Report from US Army Engineer Division and US Naval Submarine Base. Technical Report CERC-95. 90 p. https://scholarworks.wm.edu/cgi/viewcontent.cgi?article=3781&context=reports.

Mooney, T.A., R.T. Hanlon, J. Christensen-Dalsgaard, P.T. Madsen, D.R. Ketten, and P.E. Nachtigall. 2010. Sound detection by the longfin squid (*Loligo pealeii*) studied with auditory evoked potentials: Sensitivity to low-frequency particle motion and not pressure. *Journal of Experimental Biology* 213(21): 3748–3759. https://doi.org/10.1242/jeb.048348.

Morley, E.L., G. Jones, and A.N. Radford. 2014. The importance of invertebrates when considering the impacts of anthropogenic noise. *Proceedings of the Royal Society B* 281(1776). https://doi.org/10.1098/rspb.2013.2683.

Mosher, J. 1972. The responses of Macoma balthica (bivalvia) to vibrations. *Proceedings of the Malacological Society of London* 40.

Nedwell, J.R. and A.W.H. Turnpenny. 1998. The use of a generic frequency weighting scale in estimating environmental effect. *Workshop on Seismics and Marine Mammals*. 23–25 Jun 1998, London, UK.

Nedwell, J.R., B. Edwards, A.W.H. Turnpenny, and J. Gordon. 2004. *Fish and marine mammal audiograms: A summary of available information*. Document 534R0214 Report 534R014. Technical report by Subacoustech Ltd for

ChevronTexaco Ltd., TotalFinaElf Exploration UK PLC, DSTL, Department of Trade and Industry, and Shell U.K. Exploration and Production Ltd. 278 p. https://tethys.pnnl.gov/sites/default/files/publications/Nedwell-2004-Audiograms.pdf.

Nedwell, J.R., A.W.H. Turnpenny, J. Lovell, S.J. Parvin, R. Workman, J.A.L. Spinks, and D. Howell. 2007. *A validation of the dB_{ht} as a measure of the behavioural and auditory effects of underwater noise*. Document 534R1231 Report by Subacoustech Ltd. for Chevron Ltd, TotalFinaElf Exploration UK PLC, Department of Business, Enterprise and Regulatory Reform, Shell UK Exploration and Production Ltd, The Industry Technology Facilitator, Joint Nature Conservation Committee, and The UK Ministry of Defence. 74 p. https://tethys.pnnl.gov/sites/default/files/publications/Nedwell-et-al-2007.pdf.

Nieukirk, S.L., D.K. Mellinger, S.E. Moore, K. Klinck, R.P. Dziak, and J. Goslin. 2012. Sounds from airguns and fin whales recorded in the mid-Atlantic Ocean, 1999–2009. *Journal of the Acoustical Society of America* 131(2): 1102–1112. https://doi.org/10.1121/1.3672648.

NOAA Fisheries. 2024. *ESA Section 7 Consultation Tools for Marine Mammals on the West Coast* (web page), 30 Jan 2024. https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/esa-section-7-consultation-tools-marine-mammals-west.

Normandeau Associates, Inc. 2012. *Effects of Noise on Fish, Fisheries, and Invertebrates in the U.S. Atlantic and Arctic from Energy Industry Sound-Generating Activities*. A Workshop Report for the US Department of the Interior, Bureau of Ocean Energy Management. Contract # M11PC00031. 361 p. https://www.cbd.int/doc/meetings/mar/mcbem-2014-01/other/mcbem-2014-01-submission-boem-04-en.pdf.

O'Hara, J. and J.R. Wilcox. 1990. Avoidance responses of loggerhead turtles, *Caretta caretta*, to low frequency sound. *Copeia* 2: 564–567. https://doi.org/10.2307/1446362.

Packard, A., H.E. Karlsen, and O. Sand. 1990. Low frequency hearing in cephalopods. *Journal of Comparative Physiology A* 166(4): 501–505. https://doi.org/10.1007/BF00192020.

Parks, S.E., D.R. Ketten, J.T. O'Malley, and J. Arruda. 2007. Anatomical predictions of hearing in the North Atlantic right whale. *The Anatomical Record* 290(6): 734–744. https://doi.org/10.1002/ar.20527.

Parry, G., S. Heislers, G. Werner, M. Asplin, and A. Gason. 2002. *Assessment of Environmental Effects of Seismic Testing on Scallop Fisheries in Bass Strait*. Document 50. Marine and Freshwater Resources Institute.

Pine, M., A. Jeffs, and C. Radford. 2012. Turbine Sound May Influence the Metamorphosis Behaviour of Estuarine Crab Megalopae. *PLoS One* 7(12): e51790.

Piniak, W.E., D.A. Mann, S.A. Eckert, and C.A. Harms. 2011. Amphibious hearing in sea turtles. *In*: Hawkins, A.D. and A.N. Popper (eds.). *2nd International Conference on the Effects of Noise on Aquatic Life*. 15–20 Aug 2010. Springer-Verlag, Cork, Ireland.

Piniak, W.E.D., D.A. Mann, C.A. Harms, T.T. Jones, and S.A. Eckert. 2016. Hearing in the juvenile green sea turtle (*Chelonia mydas*): A comparison of underwater and aerial hearing using auditory evoked potentials. *PLOS ONE* 11(10). https://doi.org/10.1371/journal.pone.0159711.

Popper, A.N. and M.C. Hastings. 2009. The effects of anthropogenic sources of sound on fishes. *Journal of Fish Biology* 75(3): 455–489. https://doi.org/10.1111/j.1095-8649.2009.02319.x.

Popper, A.N. and R.R. Fay. 2011. Rethinking sound detection by fishes. *Hearing Research* 273(1): 25–36. https://doi.org/10.1016/j.heares.2009.12.023.

Popper, A.N., A.D. Hawkins, R.R. Fay, D.A. Mann, S. Bartol, T.J. Carlson, S. Coombs, W.T. Ellison, R.L. Gentry, et al. 2014. Sound Exposure Guidelines. (Chapter 7) *In Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI*. ASA S3/SC1.4 TR-2014. SpringerBriefs in Oceanography. ASA Press and Springer. pp. 33-51.

Popper, A.N. and A.D. Hawkins. 2018. The importance of particle motion to fishes and invertebrates. *Journal of the Acoustical Society of America* 143(1): 470–488. https://doi.org/10.1121/1.5021594.

Popper, A.N. and A.D. Hawkins. 2019. An overview of fish bioacoustics and the impacts of anthropogenic sounds on fishes [Review paper]. *Journal of Fish Biology* 94(5): 692–713. https://doi.org/10.1111/jfb.13948.

Popper, A.N., A.D. Hawkins, and M.B. Halvorsen. 2019. *Anthropogenic Sound and Fishes*. Document WA-RD 891.1. Report by ICF for Washington State Department of Transportation, Research Office. 170 p.

Przeslawski, R., L. Hurt, A. Forrest, A. Carroll, and Geoscience Australia. 2016. *Potential short-term impacts of marine seismic surveys on scallops in the Gippsland Basin*. Report 2014-041. CC BY 3.0, Canberra. http://frdc.com.au/research/Final_Reports/2014-041-DLD.pdf.

Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson. 1995. *Marine Mammals and Noise*. Academic Press, San Diego, CA, USA. 576 p. https://doi.org/10.1016/C2009-0-02253-3.

Ridgway, S.H., E.G. Wever, J.G. McCormick, J. Palin, and J.H. Anderson. 1969. Hearing in the giant sea turtle, *Chelonia mydas*. *Proceedings of the National Academy of Sciences of the United States of America* 64(3): 884–890. https://doi.org/10.1073/pnas.64.3.884.

Roberts, L., S. Cheesman, T. Breithaupt, and M. Elliott. 2015. Sensitivity of the mussel *Mytilus edulis* to substrate-borne vibration in relation to anthropogenically generated noise. *Marine Ecology Progress Series* 538: 185–195. https://doi.org/10.3354/meps11468.

Roberts, L., S. Cheesman, M. Elliott, and T. Breithaupt. 2016. Sensitivity of *Pagurus bernhardus* (L.) to substrate-borne vibration and anthropogenic noise. *Journal of Experimental Marine Biology and Ecology* 474: 185–194. https://doi.org/10.1016/j.jembe.2015.09.014.

Roberts, L. and M. Elliott. 2017. Good or bad vibrations? Impacts of anthropogenic vibration on the marine epibenthos. *Science of The Total Environment* 595: 255–268. https://doi.org/10.1016/j.scitotenv.2017.03.117.

Ross, D. 2005. Ship sources of ambient noise. *IEEE Journal of Oceanic Engineering* 30(2): 257–261. https://doi.org/10.1109/JOE.2005.850879.

Samuel, Y., S.J. Morreale, C.W. Clark, C.H. Greene, and M.E. Richmond. 2005. Underwater, low-frequency noise in a coastal sea turtle habitat. *Journal of the Acoustical Society of America* 117(3): 1465–1472. https://doi.org/10.1121/1.1847993.

Santulli, A., A. Modica, C.M. Messina, L. Ceffa, A. Curatolo, G. Rivas, G. Fabi, and V. D'Amelio. 1999. Biochemical responses of European sea bass (*Dicentrarchus labrax* L.) to the stress induced by off shore experimental seismic prospecting. *Marine Pollution Bulletin* 38(12): 1105–1114. https://doi.org/10.1016/S0025-326X(99)00136-8.

Scholik, A. and H. Yan. 2001. Effects of underwater noise on auditory sensitivity of a cyprinid fish. *Hear Res* 152: 17-24.

Sierra-Flores, R., T. Atack, H. Migaud, and A. Davie. 2015. Stress response to anthropogenic noise in Atlantic cod Gadus morhua L. *Aquacultural Engineering* 67: 67-76.

Sivle, L.D., P.H. Kvadsheim, C. Curé, S. Isojunno, P.J. Wensveen, F.-P.A. Lam, F. Visser, L. Kleivane, P.L. Tyack, et al. 2015. Severity of Expert-Identified Behavioural Responses of Humpback Whale, Minke Whale, and Northern Bottlenose Whale to Naval Sonar *Aquatic Mammals* 41(4): 469-502.

Slabbekoorn, H., N. Bouton, I. van Opzeeland, A. Coers, C. ten Cate, and A.N. Popper. 2010. A noisy spring: The impact of globally rising underwater sound levels on fish. *Trends in Ecology & Evolution* 25(7): 419–427. https://doi.org/10.1016/j.tree.2010.04.005.

Smith, M. and J. Monroe. 2016. Causes and Consequences of Sensory Hair Cell Damage and Recovery in Fishes. *Adv Exp Med Biol* 877: 393-417.

Solé, M., M. Lenoir, M. Durfort, M. López-Bejar, A. Lombarte, M. van der Schaar, and M. André. 2013. Does exposure to noise from human activities compromise sensory information from cephalopod statocysts? *Deep Sea Research Part II* 95: 160–181. https://doi.org/10.1016/j.dsr2.2012.10.006.

Solé, M., P. Sigray, M. Lenoir, M. van der Schaar, E. Lalander, and M. Andre. 2017. Offshore exposure experiments on cuttlefish indicate received sound pressure and particle motion levels associated with acoustic trauma. *Sci Rep* 7: 45899.

Song, J., A. Mathieu, R.F. Soper, and A.N. Popper. 2006. Structure of the inner ear of bluefin tuna Thunnus thynnus. *Journal of Fish Biology* 68(6): 1767–1781.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene, Jr., D. Kastak, D.R. Ketten, J.H. Miller, et al. 2007. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. *Aquatic Mammals* 33(4): 411–521. https://doi.org/10.1578/AM.33.4.2007.411.

Southall, B.L., J.J. Finneran, C.J. Reichmuth, P.E. Nachtigall, D.R. Ketten, A.E. Bowles, W.T. Ellison, D.P. Nowacek, and P.L. Tyack. 2019. Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. *Aquatic Mammals* 45(2): 125–232. https://doi.org/10.1578/AM.45.2.2019.125.

Stephenson, J., A. Gingerich, R. Brown, B. Pflugrath, Z. Deng, T. Carlson, M. Langeslay, M. Ahmann, R. Johnson, et al. 2010. Assessing barotrauma in neutrally and negatively buoyant juvenile salmonids exposed to simulated hydro-turbine passage using a mobile aquatic barotrauma laboratory. *Fisheries Research* 106: 271-278.

Tavolga, W.N. and J. Wodinsky. 1963. Auditory capacities in fishes: pure tone thresholds in nine species of marine teleosts. *Bulletin of the American Museum of Natural History* 126: 177-240.

Tougaard, J., A.J. Wright, and P.T. Madsen. 2015. Cetacean noise criteria revisited in the light of proposed exposure limits for harbour porpoises. *Marine Pollution Bulletin* 90(1–2): 196–208. https://doi.org/10.1016/j.marpolbul.2014.10.051.

Tubelli, A.A., A.L. Zosuls, D.R. Ketten, and D.C. Mountain. 2012. Prediction of a mysticete audiogram via finite element analysis of the middle ear. *In* Popper, A.N. and A.D. Hawkins (eds.). *The Effects of Noise on Aquatic Life*. Volume 730. Springer, New York. pp. 57–59. https://doi.org/10.1007/978-1-4419-7311-5_12.

Urick, R.J. 1983. *Principles of Underwater Sound*. 3rd edition. McGraw-Hill, New York, London. 423 p.

Videsen, S.K.A., L. Bejder, M. Johnson, and P.T. Madsen. 2017. High suckling rates and acoustic crypsis of humpback whale neonates maximise potential for mother–calf energy transfer. *Functional Ecology* 31(8): 1561–1573. https://doi.org/10.1111/1365-2435.12871.

Wartzok, D. and D.R. Ketten. 1999. Marine Mammal Sensory Systems. (Chapter 4) *In* Reynolds, J. and S. Rommel (eds.). *Biology of Marine Mammals*. Smithsonian Institution Press, Washington, DC. pp. 117–175.

Wever, E.G. 1978. *The Reptile Ear: Its Structure and Function*. Princeton University Press, Princeton, NJ.

Willis, K.L. 2016. Underwater Hearing in Turtles. *In* Popper, A.N. and A.D. Hawkins (eds.). *The Effects of Noise on Aquatic Life II*. Springer, New York. pp. 1229–1235. https://doi.org/10.1007/978-1-4939-2981-8_154.

Wood, J.D., B.L. Southall, and D.J. Tollit. 2012. *PG&E offshore 3-D Seismic Survey Project Environmental Impact Report–Marine Mammal Technical Draft Report*. Report by SMRU Ltd. 121 p. https://www.coastal.ca.gov/energy/seismic/mm-technical-report-EIR.pdf.

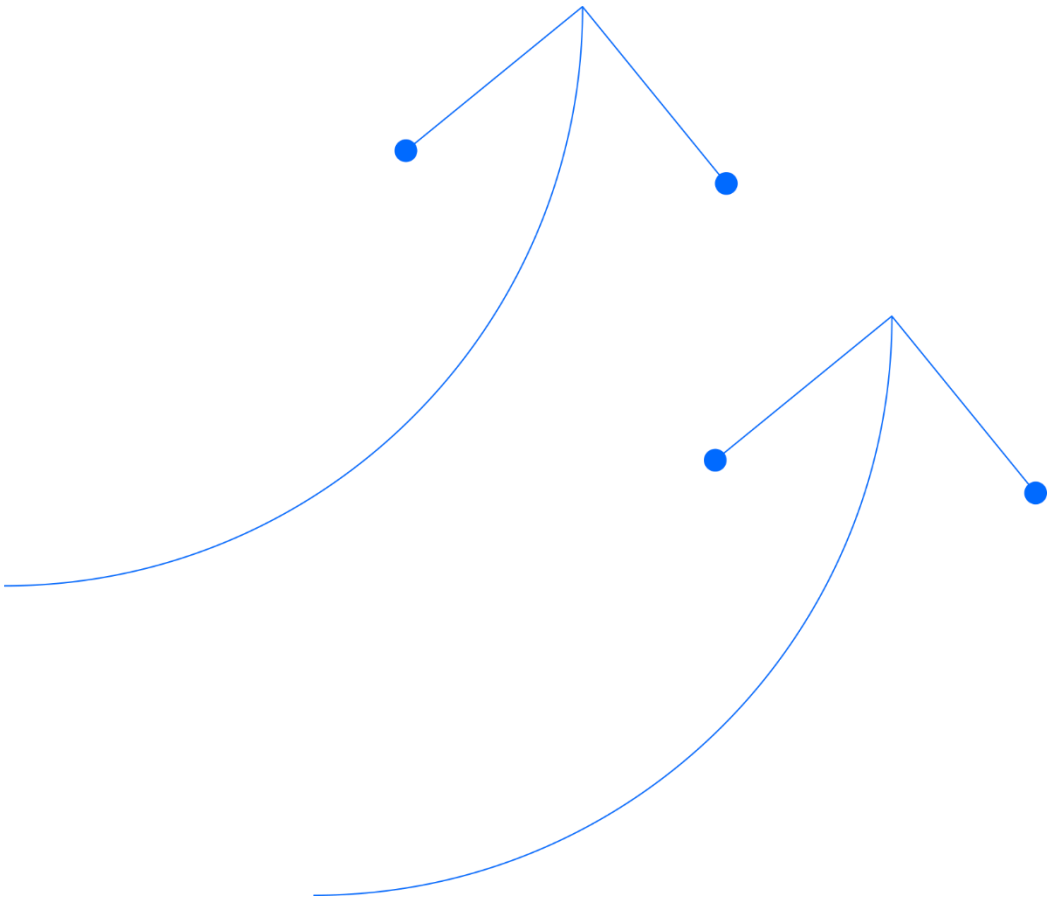
Yudhana, A., J.D. Sunardi, S. Abdullah, and R.B.R. Hassan. 2010. Turtle hearing capability based on ABR signal assessment. *Telkomnika* 8(2): 187–194. https://doi.org/10.12928/telkomnika.v8i2.620.

Appendix I Values and sensitivities of the marine and coastal environment

Santos

G-11-AP VALUES AND SENSITIVITIES OF THE MARINE AND COASTAL ENVIRONMENT

30 July 2025



Santos

Contents

1. Introduction **8**

1.1. Overview 8

1.2. Geographical Extent 8

2. Physical Environment **11**

2.1. Geomorphology 11

2.1.1. Formation History 11

2.1.2. Present Day Geological Features 11

2.1.3. Northwest Shelf Province 11

2.1.4. Northwest Shelf Transition 11

2.1.5. Timor Province 12

2.1.6. Timor Transition 12

2.1.7. Northern Shelf Province 12

2.1.8. Sediments 12

2.2. Climate 15

2.3. Oceanography 16

3. Benthic and Pelagic Habitats **18**

3.1. Coral Reefs 19

3.1.1. Northwest Shelf Transition 19

3.1.2. Timor Province 20

3.1.3. Northern Shelf Province 21

3.2. Seagrasses 21

3.2.1. Northwest Shelf Transition 21

3.2.2. Timor Province 22

3.2.3. Northern Shelf Province 22

3.3. Macroalgae 22

3.3.1. Northwest Shelf Transition 23

3.3.2. Timor Province 23

3.3.3. Northern Shelf Province 23

3.4. Non-Coral Benthic Invertebrates 23

3.4.1. Northwest Shelf Province 24

3.4.2. Northwest Shelf Transition 24

3.4.3. Timor Province 24

3.4.4. Timor Transition 25

3.4.5. Northern Shelf Province 25

3.5. Plankton 25

4. Shoreline Habitats **27**

4.1. Mangroves 27

4.1.1. Northwest Shelf Transition 27

4.1.2. Northern Shelf Province 28

4.2. Intertidal Mud/Sand Flats 28

4.2.1. Northwest Shelf Transition 28

4.2.2. Northern Shelf Province 29

4.3. Intertidal Platforms 29

4.3.1. Northwest Shelf Province and Northwest Shelf Transition 29

4.4. Sandy Beaches 29

4.4.1. Northwest Shelf Transition 30

4.5. Rocky Shorelines 30

5. Fishes and Sharks **30**

5.1. Regional Surveys 33

5.1.1. Northwest Shelf Province 33

5.1.2. Northwest Shelf Transition 33

5.1.3. Timor Province 34

5.1.4. Timor Transition 34

5.1.5. Northern Shelf Province 35

5.2. Syngnathids 35

5.3. Sharks, Rays and Sawfishes 35

5.3.1. Grey Nurse Shark 35

5.3.2. Great White Shark 36

5.3.3. Northern River Shark 36

5.3.4. Whale Shark 36

5.3.5. Speartooth Shark 39

5.3.6. Dwarf Sawfish 39

5.3.7. Freshwater and Green Sawfish 39

5.3.8. Scalloped Hammerhead Shark 40

5.3.9. Narrow Sawfish 40

5.3.10. Giant Manta Ray / Reef Manta Ray 40

5.3.11. Oceanic Whitetip Shark 40

5.3.12. Shortfin Mako and Longfin Mako Sharks 41

5.4. Biologically Important Areas / Critical Habitat – Fishes and Sharks 41

6. Marine Reptiles **41**

6.1. Marine Turtles 43

6.1.1. Loggerhead Turtle 48
6.1.2. Green Turtle 48
6.1.3. Hawksbill Turtle 49
6.1.4. Flatback Turtle 50
6.1.5. Leatherback Turtle 51
6.1.6. Olive Ridley Turtle 51
6.2. Sea Snakes 51
6.2.1. Short-nosed Sea Snake 52
6.2.2. Leaf-scaled Sea Snake 52
6.2.3. Dusky Sea Snake 52
6.3. Crocodiles 52
6.4. Biologically Important Areas/Habitat Critical – Marine Reptiles 53

7. Marine Mammals 55
7.1. Threatened and Migratory Species 58
7.1.1. Sei Whale 58
7.1.2. Pygmy Blue Whale 58
7.1.3. Fin Whale 61
7.1.4. Humpback Whale 61
7.1.5. Sperm Whale 62
7.1.6. Bryde's Whale 62
7.1.7. Killer Whale 62
7.1.8. Indo-Pacific Humpback Dolphin 62
7.1.9. Spotted Bottlenose Dolphin (Indo-Pacific bottlenose dolphin) 62
7.1.10. Australian Snubfin Dolphin (Irrawaddy Dolphin) 62
7.1.11. Dugong 65
7.2. Biologically Important Areas / Critical Habitat – Marine Mammals 65

8. Birds 68
8.1. Threatened Species 68
8.1.1. Shorebirds 71
8.1.2. Seabirds 73
8.2. Migratory Species 76
8.3. Biologically Important Areas / Critical Habitat– Birds 84

9. Protected Areas 86
9.1. World Heritage Areas 88
9.2. Wetlands of International Importance (Ramsar) 88
9.2.1. Cobourg Peninsula 88
9.2.2. Ord River Flood Plains 88

9.3. Wetlands of National Importance 89
9.3.1. Adelaide River Floodplain System 89
9.3.2. Mary Floodplain System 89
9.3.3. Cobourg Peninsula System 89
9.3.4. Daly-Reynolds Floodplain-Estuary System 89
9.3.5. Finniss Floodplain and Fog Bay Systems 90
9.3.6. Moyle Floodplain and Hyland Bay System 90
9.3.7. Ord Estuary System 90
9.3.8. Port Darwin 90
9.3.9. Shoal Bay - Micket Creek 91
9.3.10. Legune Wetlands 91
9.4. National Heritage Places 91
9.4.1. The West Kimberley 91
9.5. Commonwealth Heritage Places 91
9.5.1. Scott Reef and Surrounds – Commonwealth Area 91
9.5.2. Bradshaw Defence Area 91
9.6. Coastal Terrestrial Conservations Reserves – bound by marine waters 92
9.6.1. Coastal National Parks 92
9.6.2. Coastal Nature Reserves and Conservation Parks 93
9.1. Threatened Ecological Communities 97

10. Key Ecological Features 97
10.1. Introduction 97
10.1.1. Ancient Coastline at 125 m Depth Contour 99
10.1.2. Continental Slope Demersal Fish Communities 99
10.1.3. Seringapatam Reef and Commonwealth Waters in the Scott Reef Complex 100
10.1.4. Ashmore Reef and Cartier Island and Surrounding Commonwealth Waters 100
10.1.5. Carbonate Bank and Terrace System of the Sahul Shelf 101
10.1.6. Pinnacles of the Bonaparte Basin 101
10.1.7. Carbonate Bank and Terrace System of the Van Diemen Rise 101
10.1.8. Shelf Break and Slope of the Arafura Shelf 102

11. State Marine Conservation Reserves 102
11.1. Introduction 102
11.1.1. Lalang-gaddam Marine Park 103
11.1.2. North Kimberley Marine Park 104
11.1.3. Garig Gunak Barlu National Park 104

12. Australian Marine Parks 104
12.1. Introduction 104

12.2. North-West Marine Park Network 105
12.2.1. Kimberley Marine Park 106
12.2.2. Cartier Island Marine Park 106
12.3. North Marine Park Network 107
12.3.1. Oceanic Shoals Marine Park 107
12.3.2. Joseph Bonaparte Marine Park 108

13. Conservation Management Plans 110
13.1. Conservation Advice 110
13.2. Recovery Plans 110

14. Social and Economic Features 133
14.1. Industry 133
14.2. Other Infrastructure 133
14.3. Shipping 135
14.4. Defence Activities 137
14.5. Tourism 139
14.6. Maritime Heritage 139
14.7. Commercial Fisheries 142
14.7.1. State Fisheries 142
14.7.2. Commonwealth Fisheries 143
14.8. Aquaculture 156
14.8.1. North Coast Bioregion 156
14.8.2. Northern Territory 156
14.9. Recreational Fisheries 156
14.9.1. North Coast Bioregion 156
14.9.2. Northern Territory 157

15. Document Review 161

16. References 162
16.1. Physical Environment 162
16.2. Benthic and Pelagic Habitats 163
16.3. Shoreline and Intertidal Habitats 167
16.4. Fish and Sharks 169
16.5. Marine Reptiles 172
16.6. Marine Mammals 175
16.7. Birds 178
16.8. Protected Areas 180
16.9. Key Ecological Features 181
16.10. State Marine Parks 183

16.11. Australian Marine Parks 183
16.12. Conservation Management Plans 183
16.13. Commercial and Recreational Fisheries 186
16.14. Social and Economic Features 187

Tables

Table 1: Seasonal mean temperature, rainfall and wind speed ranges 15
Table 2: EPBC listed fish and shark species in the combined EMBA 32
Table 3: Spawning and aggregation times of key commercially caught fish species within the Northwest Shelf 33
Table 4: Biologically important areas – Fishes and Sharks 41
Table 5: EPBC listed marine reptile species in the combined EMBA 42
Table 6: Summary of habitat types for the life stages of the six marine turtle species in the combined EMBA (DSEWPaC, 2012b) 44
Table 7: Biologically Important Areas/Habitat Critical and geographic locations - reptiles 54
Table 8: Marine mammals listed as threatened or migratory under the EPBC Act 56
Table 9: Biologically Important Areas – marine mammals 66
Table 10: Birds listed as threatened under the EPBC Act 69
Table 11: Summary of information for birds listed as threatened under the EPBC Act that may be in the combined EMBA 75
Table 12: Summary of migratory birds that may occur within the combined EMBA 76
Table 13: Feeding guilds based on prey choice and foraging method (Rogers 1999) adapted from Bennelongia (2008) 78
Table 14: Birds subject to the Wildlife Conservation Plan for Migratory Shorebirds 2015 79
Table 15: Birds (migratory) subject to the Wildlife Conservation Plan for Seabirds 2020 82
Table 16: Critical habitat/ biologically important areas - birds 85
Table 17: Summary of protected areas in waters within the combined EMBA 86
Table 18: Coastal National Parks – coastal boundary in relation to inter-tidal zone 93
Table 19: Nature Reserves (NR), Conservation Parks (CP), Regional Parks (RP) and Coastal Reserves (CR) in the combined EMBA 94
Table 20: Summary of marine network values, pressures, management programs and actions applicable to the combined EMBA 109
Table 21: Summary of EPBC Act recovery plans applicable to the combined EMBA 111
Table 22: Commercial fisheries with permits to operate within the combined EMBA 144

Figures

Figure 1: IMCRA 4.0 Provincial Bioregions within the EMBA 10

Figure 2: Geomorphic/seabed features of Northern WA 13

Figure 3: Bathymetry of the combined EMBA 14

Figure 4: Seasonally averaged winds at 10 m above mean sea level 16

Figure 5: Surface currents in the NT and WA 18

Figure 6: Benthic habitats from Coral Bay to Dampier 26

Figure 7: Biologically Important Areas – Whale Shark 38

Figure 8: Foraging BIAs for marine turtles within the EMBA 46

Figure 9: Marine turtle internesting BIAs and Habitat Critical within the EMBA 47

Figure 10: Biologically Important Areas – whales – Northern WA 60

Figure 11: Biologically Important Areas – dolphins 64

Figure 12: Biologically Important Areas – birds – Northern WA 74

Figure 13: Protected areas 87

Figure 14: Protected Lands (CALM Act 1984) – terrestrial coastal reserves bounding marine waters in NT 95

Figure 15: Protected Lands (CALM Act 1984) – terrestrial conservation reserves bounding marine waters in Northern WA 96

Figure 16: Key ecological features 98

Figure 17: Existing petroleum infrastructure, permits and licences – Northern WA 134

Figure 18: Vessel traffic 136

Figure 19: Defence activities 138

Figure 20: Shipwrecks –NT 140

Figure 21: Shipwrecks – Northern WA 141

Figure 22: NT state commercial fishing zones 158

Figure 23: WA state commercial fishing zones 159

Figure 24: Commonwealth commercial fishing zones 160

Appendices

Appendix A: EPBC Act Protected Matters Report 189

1. Introduction

1.1. Overview

Santos Energy Limited (Santos) is the titleholder of the G-11-AP greenhouse gas assessment permit located in marine waters off north-western Western Australia and the Northern Territory. This document describes the combined EMBAs of the Eos 3D Marine Seismic Survey and G-11-AP CCS Drilling activities within the G1-11-AP permit and includes details of the relevant values and sensitivities of that environment as required by the Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023.

The worst case loss of containment scenario for both the Eos 3D MSS and the G-11-AP drilling activities is a vessel collision scenario.

The Eos 3D MSS represents the worst case environment that may be affected (EMBA) for both activities and encompasses the G-11-AP EMBA entirely. This is because the modelling conducted for Eos 3D MSS activity adopted the low hydrocarbon exposure values as defined in NOPSEMA's '*Environmental Bulletin – Oil Spill Modelling*' (April 2019), where-as the G-11-AP oil spill modelling adopted higher thresholds.

Worst-case hydrocarbon spills generally have the largest EMBA of all the environmental impacts and risks managed by Santos. Santos routinely commissions hydrocarbon spill modelling studies to assist in assessing the environmental risk of a hydrocarbon spill.

The worst case Eos 3D MSS EMBA encompasses the full range of values (including ecosystem, spiritual and monetary provision) and sensitivities (receptors vulnerable to impact) that might be contacted by surface and subsurface hydrocarbons in the unlikely event of any worst-case oil spill from Santos' activities. These receptors include more broadly the physical environments and biological communities present, as well as protected species and areas, socio-economic and cultural features and values.

This document is informed by searches of:

- the Protected Matters search tool (PMST) published by the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW). The Eos EMBA PMST search was undertaken in April 2025 and is provided in Appendix A
- published scientific literature and studies, and
- State and Territory protected species databases where applicable.

Descriptions of marine and coastal fauna within the EMBA that may credibly be impacted by Santos' activities are provided, with a focus on protected species that are threatened and migratory.

The PMST searches were made using the combined EMBA. The combined EMBA includes the same spatial data used to inform the figures in Santos' respective Environment Plans (EPs), ensuring that the combined EMBA encompasses the full range of environmental receptors that might be affected by surface and subsurface hydrocarbons at the low exposure level within the EMBA.

Figures provided throughout this document are scaled up to the relevant data represented to allow detail to be shown at a readable scale.

1.2. Geographical Extent

The combined EMBA includes the coastal waters and shoreline habitats of Western Australia (WA) and part of the Northern Territory (NT), encompassing north-west of WA to the north-west coastlines of the NT in the north, and extending into Commonwealth marine waters. This area largely overlaps the Commonwealth North-West Marine Region (NWMR) and the North Marine Region (NMR). Based on the Integrated Marine and Coastal Regionalisation of Australia (IMCRA) Version 4.0 spatial framework, there are 5 provincial-scale bioregions that occur within the combined EMBA. These bioregions are based on the characteristics of fish assemblages, benthic habitats, and oceanographic data (IMCRA v. 4.0). Where relevant, the physical, biological, and social environments within the combined EMBA are discussed with reference to the IMCRA Provincial Bioregions. The bioregions within the EMBA (**Figure 1**) include:

North-west Marine Region:

- Northwest Shelf Transition
- Timor Province
- Northwest Shelf Province

North Marine Region:

- Northwest Shelf Transition (as above)
- Timor Transition
- Northern Shelf Province.

The EMBA has a slight overlap with the international waters of Indonesia in deep, open ocean with no particular values or sensitivities overlapping the EMBA. Therefore, international waters are not described further throughout this document.

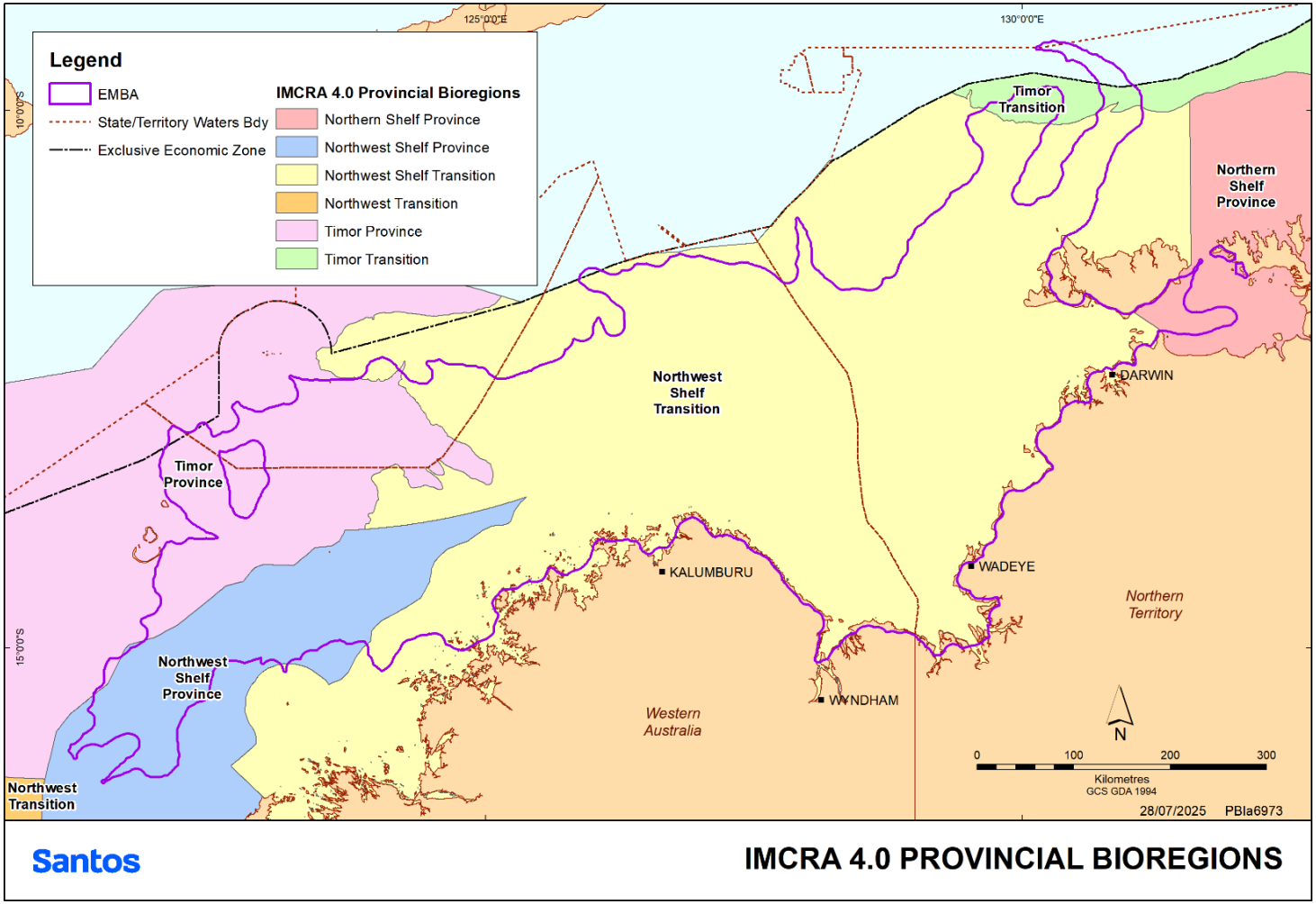


Figure 1: IMCRA 4.0 Provincial Bioregions within the EMBA

2. Physical Environment

2.1. Geomorphology

2.1.1. Formation History

Approximately 550–160 million years ago, the northern and western parts of the present-day Australian continent formed part of the northern margin of Gondwana. About 300 million years ago, crustal stretching, rifting and breakup initiated the development of an extensive basin that became the site for deposition of sediments (Baker et al. 2008 in Department of the Environment, Heritage, Water, and the Arts (DEWHA, 2008a). Approximately 135 million years ago the continent broke up resulting in the separation of greater India and Australia. Ocean spreading associated with the continental break-up resulted in the creation of the Argo and Cuvier abyssal plains. Subsidence of the rifted margin resulted in the formation of the Exmouth and Scott plateaux and the Rowley Terrace.

2.1.2. Present Day Geological Features

The EMBA predominantly consists of two major landform features: continental shelf and continental slope. Limited surveys have shown that the continental slope in the combined EMBA comprises diverse geological features such as canyons, plateaux, terraces, pinnacles, reefs, banks and shoals (DEWHA, 2008a) (**Figure 2**). These features are significant in that over half of the total area of banks and shoals across Australia's entire marine jurisdiction occurs in the Commonwealth waters from the South Australian border to the Northern Territory border, as well as 39 % of terraces and 56 % of deeps, holes and valleys (DEWHA, 2008a).

The continental shelf north of Cape Leveque is characterised by a rimmed ramp where the waters over the outer margins of the shelf (approximately 50 to 100 m water depth) are shallower than the middle portions (up to 150 m water depth). The rim at its outer edge is the site of several coral reefs including Ashmore, Cartier, Scott and Seringapatam (DEWHA, 2008a).

Several geomorphic formations within the combined EMBA have been associated with Key Ecological Features (DEWHA, 2008a) and these are discussed in **Section 9.1**.

2.1.3. Northwest Shelf Province

The Northwest Shelf Province is located almost entirely on the continental shelf, except for a small area to the north of Cape Leveque that extends onto the continental slope. This bioregion includes more than 60 % of the continental shelf in the North-west Marine Region (DEWHA, 2008a). The shelf gradually slopes from the coast to the shelf break but displays a number of sea floor features such as banks/shoals and holes/valleys. These are thought to be morphologically distinct from other features of these types found elsewhere in the North-west Marine Region, and have a different sedimentology (DEWHA, 2008a). For example, the Glomar Shoals occur approximately 30–40 km offshore of Dampier in water depths of between 26–70 m and are distinguished by highly fractured molluscan debris, coralline rubble, and coarse carbonate sand. The province also includes the Leveque Rise, a large plateau, and one of only two shelf plateaux within the North-west Marine Region (DEWHA, 2008a).

2.1.4. Northwest Shelf Transition

The Northwest Shelf Transition is predominantly located on the continental shelf with a small portion extending onto the continental slope causing waters in the area to be relatively shallow, only up to 330 m. It also consists of geomorphic features that are unique to the Northwest Shelf Transition and not found elsewhere in the North-west Marine Region (DEWHA, 2008a). An example of this is that 90 % of the Region's carbonate banks are located within the Northwest Shelf Transition (DEWHA, 2008a).

The Bonaparte Depression lies within the Northwest Shelf Transition, which is a 45 000 km^2 geomorphic basin that is the only occurrence of its type in the North-west Marine Region (DEWHA, 2008a). The Bonaparte Depression is a relatively flat feature with a higher content of mud and gravel than what is found elsewhere in the Northwest Shelf Transition and it has a number of pinnacles of which form the key ecological feature 'pinnacles of the Bonaparte Basin' (see **Section 10.1.6**).

2.1.5. Timor Province

The Timor Province is located on the continental slope. The notable topographical features include the Scott Plateau, the Ashmore Terrace and part of the Rowley Terrace and Argo Abyssal Plain (DEWHA, 2008a). Of these, the Scott Plateau is particularly significant with water depths of up to 3,000 m and being fringed by spurs and valleys (DEWHA, 2008a). The Scott Plateau is also separated from Rowley Terrace by canyons that are up to 50 million years old (DEWHA, 2008a).

The Timor Province encompasses almost half of the reefs in the North-west Marine Region, including Scott Reef and Seringapatam Reef which are within the combined EMBA (DEWHA, 2008a).

2.1.6. Timor Transition

The Timor Transition is predominantly shelf terrace and slope, which extend into waters that are 200-300 m deep. The deepest point (300 m) is the Arafura Depression. The Timor Transition is also dominated by a series of canyons that represent a drowned river system from the Pleistocene era (DEWHA, 2008b). The canyons are approximately 80-100 m deep and up to 20 km wide (DEWHA, 2008b).

2.1.7. Northern Shelf Province

The Northern Shelf Province consists of large areas of relatively featureless sandy and muddy sediments (DWEHA, 2008c). A significant feature of the Northern Shelf Province is the Gulf of Carpentaria, which is outside the combined EMBA, the majority of the reefs in the Northern Shelf Province are also outside the combined EMBA and form a broken margin around the Gulf of Carpentaria. However, within the combined EMBA is the Arafura Shelf which is characterised by continental shelf, canyons, terraces, the Arafura Sill and the Arafura Depression (DEWHA, 2008b).

2.1.8. Sediments

Terrestrial environments are not a major source of sediment to the EMBA and terrigenous sediments tend to be confined to the inner shelf (generally less than 100 m water depth), particularly in areas adjacent to rivers. Sediments in the area generally become finer with increasing water depth, ranging from sand and gravels on the shelf to mud on the slope and abyssal plain. Joseph Bonaparte Gulf is an exception to this pattern, as sediments with high mud content extend across the inner and mid shelf within the Gulf, graduating to sands and gravels in the Bonaparte Depression.

The distribution and resuspension of sediments on the inner shelf is strongly influenced by the strength of tides across the continental shelf as well as episodic events such as cyclones. Further offshore, on the mid to outer shelf and on the slope itself, sediment movement is primarily influenced by ocean currents and internal tides. Internal tides describe the tidal movement across a slope of water stratified by marked differences in density.

Shoals and banks are naturally forming, submerged and made of consolidated material such as sand. Normally, the shoal or bank rises close to the water surface having been created when an ocean current deposits sediment. Shoals and banks are found within the EMBA.

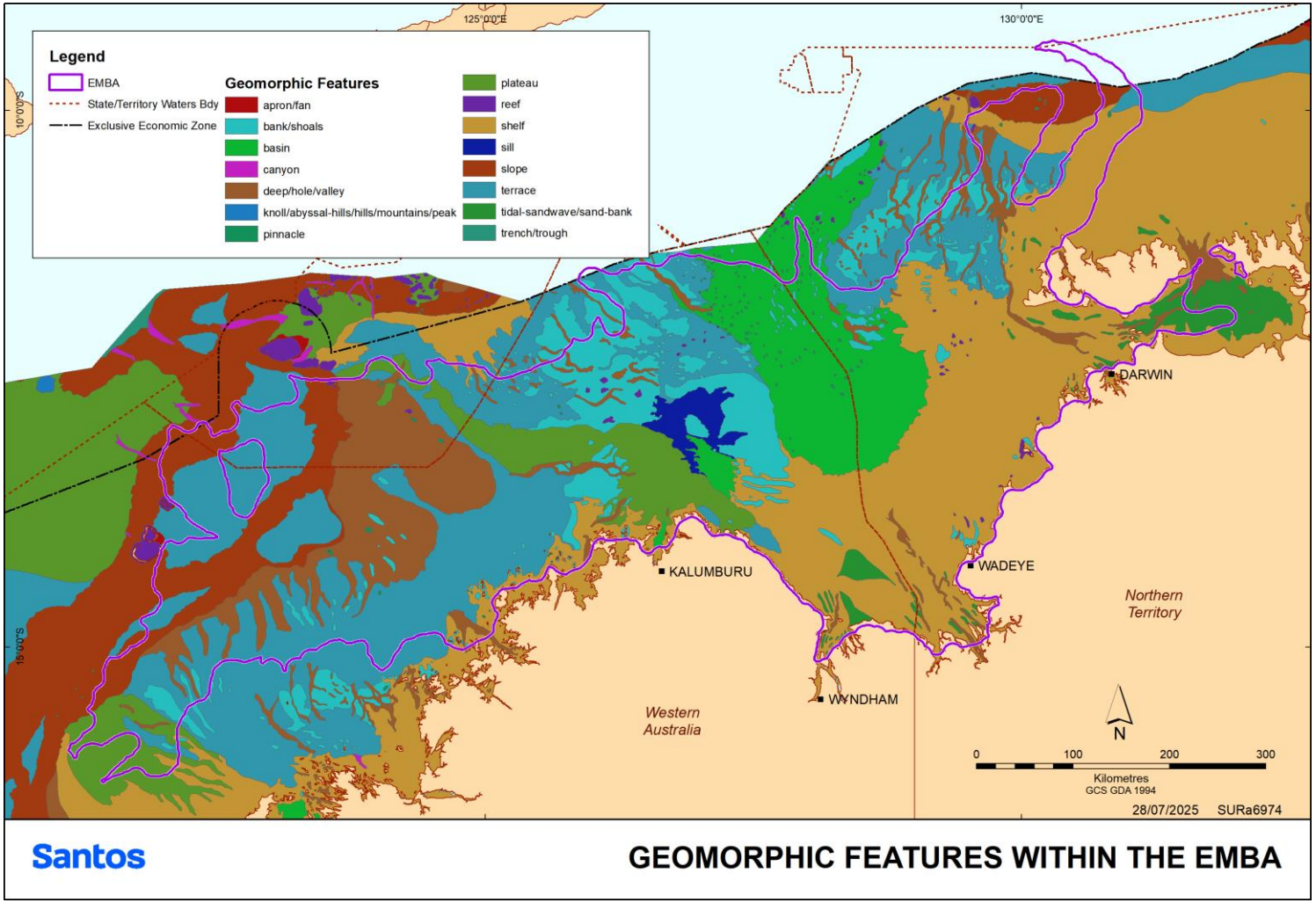


Figure 2: Geomorphic/seabed features of Northern WA

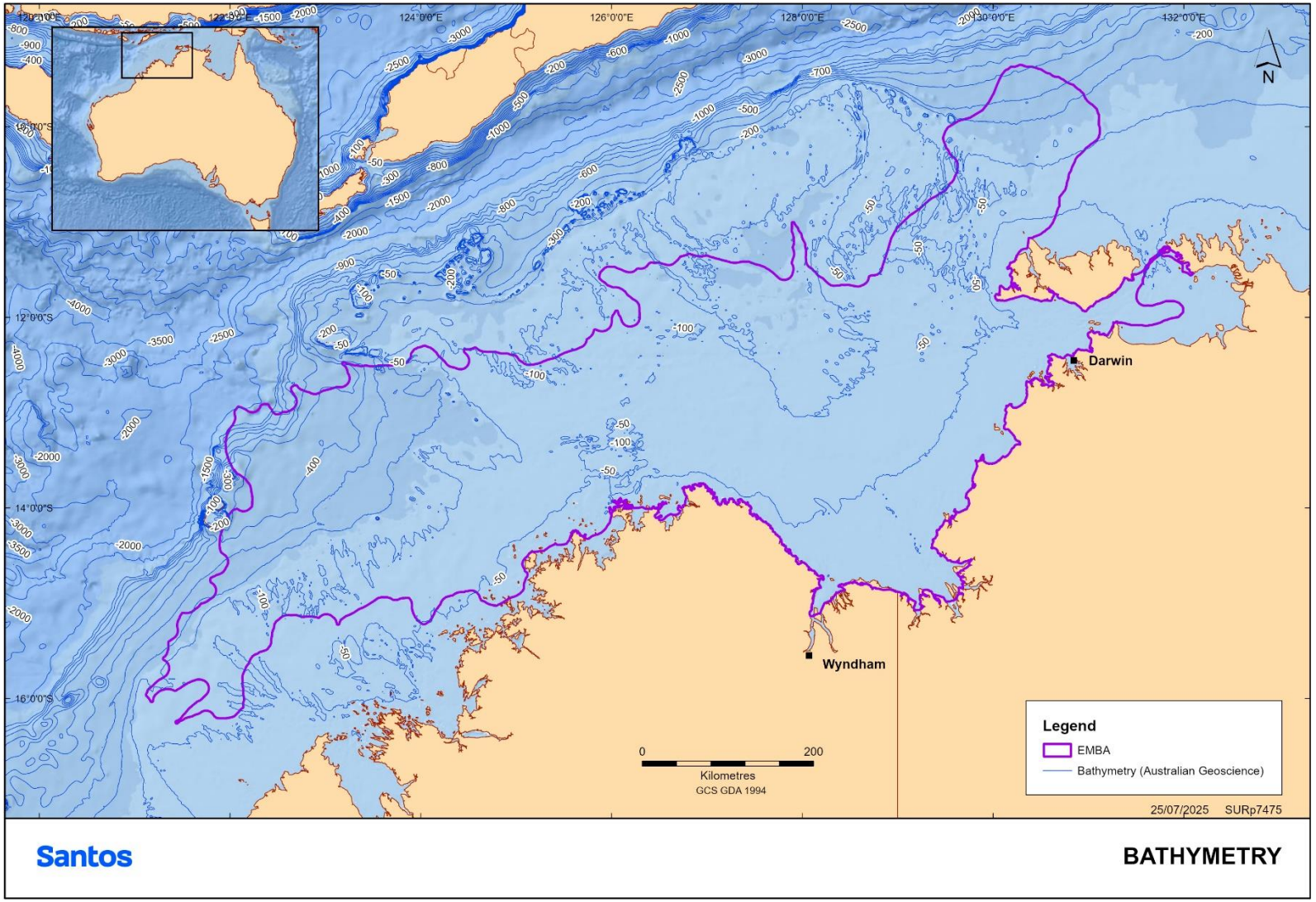


Figure 3: Bathymetry of the combined EMBA

2.2. Climate

Waters in northern Western Australia predominantly lie in the arid tropics, experiencing high summer temperatures and periodic tropical cyclones in summer. Rainfall in the region is low, although intense rainfall may occur during the passage of summer tropical cyclones and thunderstorms (Condie et al., 2006). Mean air temperatures range from a minimum of 17°C in winter to a maximum of 34°C in summer (BoM, 2025a). Due to the arid climate, daytime visibility in the area is generally greater than 5 nautical miles (SSE, 1991).

The region has a tropical monsoonal climate with two distinct seasons known as the North-west Monsoon or "wet season" (late October to mid-March) and the South-east Monsoon or "dry season" (May to mid-October) (DSEWPaC, 2012). The North-west Monsoon is characterised by regular and high rainfall, particularly over coastal areas and during cyclones. This is due to large amounts of moisture being gathered as the monsoon crosses the sea from the Asian high-pressure belt on its way to the intertropical convergence zone, which migrates southward close to or over northern Australia. Conversely, the South-east Monsoon originates from the Southern Hemisphere high-pressure belt and is relatively dry and cool (DSEWPaC, 2012). The summer and winter seasons fall into the periods September–March and May–July, respectively. Winters are characterised by clear skies, fine weather, predominantly strong east to southeast winds and infrequent rain (**Figure 5**). In the Kimberley region, the mean monthly rainfall in the wet season ranges from approximately 50-340 mm, and 0.4-20 mm in the dry season. Rainfall in the Darwin region ranged from approximately 100-450 mm each month in the wet season, and 1-65 mm in the dry season. Mean monthly rainfall for weather stations in proximity to the combined EMBA are presented in **Table 1**. Heavy rainfall events are becoming more intense across northern Australia, particularly short-duration, extreme rainfall events, which have increased by 10% or more in some regions since the 1970s (Commonwealth of Australia, 2022). Summer winds are more variable, with strong south-westerlies dominating. Transitional wind periods, during which either pattern may predominate, can be experienced in April–May and September of each year.

Dum In Mirrie Airstrip, Channel Point, Port Keats Airport and Truscott are four weather stations within or adjacent to the combined EMBA, providing an overview of the localised climate. A summary of the seasonal ranges in mean temperature, rainfall and wind speeds recorded at these sites are summarised in **Table 1**.

Table 1: Seasonal mean temperature, rainfall and wind speed ranges

Weather station	Approx. distance from EMBA	Season	Temperature (°C)	Monthly rainfall (mm)	Wind speed (km/h)
Dum In Mirrie Airstrip	Overlapping	Wet	24.3 – 33.3	98.1 – 426.2	10.1 – 15.5
		Dry	18.0 – 33.0	1.3 – 61.4	9.5 – 15.7
Channel Point	Overlapping	Wet	23.7 - 32.9	98.0 – 463.9	5.4 – 10.7
		Dry	17.1 – 24.3	1.2 – 70.3	5.6 – 13.0
Port Keats Airport	10 km south (NT)	Wet	22.6 – 34.6	81.6 – 376.3	No data
		Dry	16.9 – 24.2	0.6 – 42.6	No data
Truscott	10 km south (WA)	Wet	24.2 – 35.1	40.9 – 346.5	No data
		Dry	18.3 – 34.5	0.3 – 18.7	No data

BoM 2025b, 2025c, and 2025d. N.B. Wind speed ranges include both 9am and 3pm conditions.

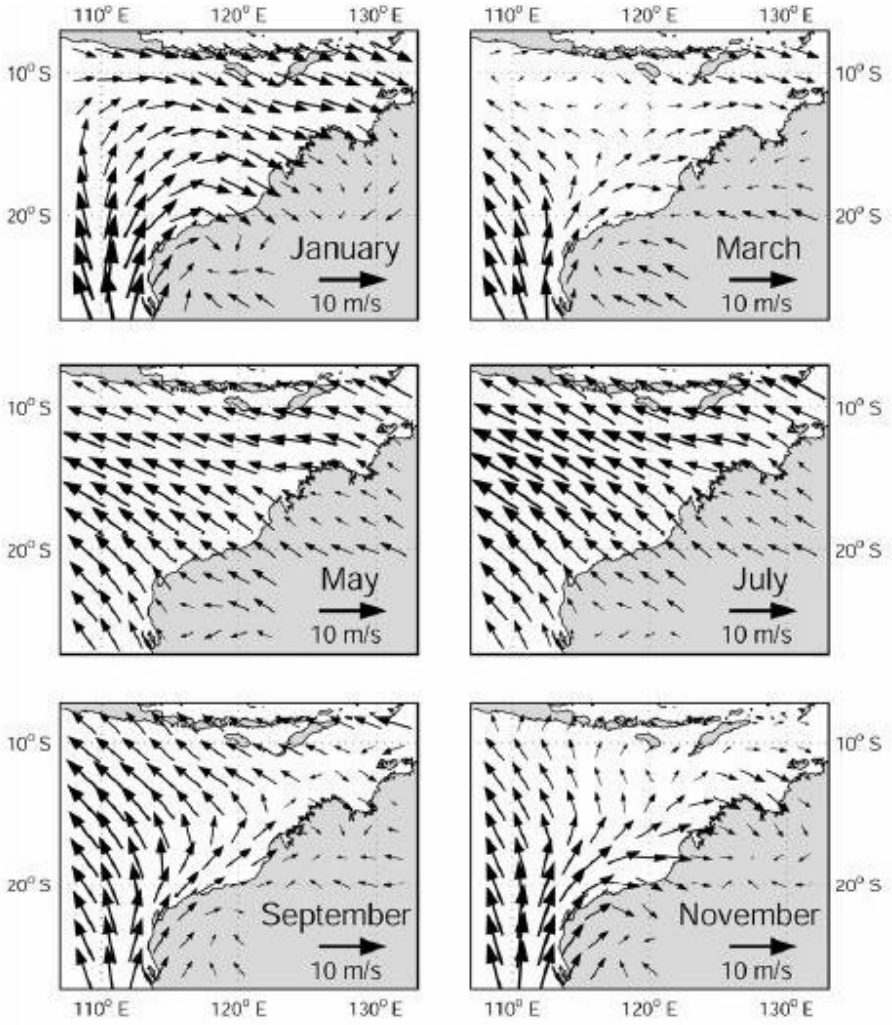


Figure 4: Seasonally averaged winds at 10 m above mean sea level

Calculated from NCEP-NCAR dataset measured from 1982 to 1999. Source: Condie et al. (2006)

Tropical cyclones are common in the region, occurring between December and April (BoM, 2019). These phenomena result in severe storms with gale force winds and a rapid rise in water levels. Tropical cyclones develop in the eastern Indian Ocean, and the Timor and Arafura Seas during the summer months, and usually form in an active monsoon trough producing heavy rains, strong wind, large swells and storm surges. On average, about five cyclones occur each year in the NWMR, two of which make landfall and one of which is severe (Category 3 or higher) (BoM, 2025a).

The Bonaparte Basin and Timor Sea region in the north has a tropical climate. These areas experience a distinct 'wet' season with summer monsoonal conditions from October to March and a distinct 'dry' season with cooler and drier conditions from April to September. The wet season usually comprises south-westerly winds capable of generating thunderstorm activity, high rainfall and cyclones. The dry season usually comprises dry and warm conditions with little rainfall (Fugro, 2015).

2.3. Oceanography

Major drivers of marine ecosystems include ocean currents, tides, waves, temperature and salinity. The Holloway Current is the prevailing seasonal current, travelling south-west along the north West Australian coast in winter and north-east in summer (**Figure 5**) (Brewer et al., 2007). It is a relatively narrow boundary current that flows along the north-west shelf at between 100 m and 200 m depth, flowing towards the north-east in summer and the south-west in winter (Fugro, 2015).

The Indonesian Throughflow brings warm, low-salinity water from the Pacific into the Indian Ocean. Seasonal winds and cyclones enhance productivity by mixing deeper, nutrient-rich waters with surface waters, supporting ecological processes in the region (Department of Sustainability Environment and Water Population and Communities, 2012a) (**Figure 5**). Recent studies indicate that the Indonesian throughflow plays a critical role in the global ocean circulation, affecting not only local marine ecosystems but also broader climate patterns. As the climate continues to warm, these currents are expected to undergo further changes, impacting the transport of heat and nutrients in marine environments (Commonwealth of Australia, 2022). Ocean temperatures across Australia have warmed by more than 1°C since 1900, with marine heatwaves becoming more frequent and lasting longer, particularly off southern and western Australia (Commonwealth of Australia, 2022).

Currents in the coastal zone and over the inner to mid-shelf are largely driven by tides and winds, whereas offshore, over the continental shelf, slope and rise are influenced by large scale regional circulation (DEWHA, 2008a). In the North Marine Region, tidal flows play a dominant role in water movement, with oceanographic currents like the Indonesian Throughflow having a minor seasonal influence (Department of Sustainability Environment and Water Population and Communities, 2012a). Large-scale currents of the Timor and Arafura seas in the north are dominated by the Indonesian Throughflow.

Tides increase in amplitude from south to north, corresponding with the increasing width of the shelf (Holloway, 1983). Tides in the area are generally semi-diurnal (i.e. two high tides and two low tides per day) with a spring/neap cycle. The northern area experiences some of the largest tides in the world. In the Kimberley, the daily tidal range is up to 10 m during spring tides and less than 3 m during some neap tides. Mid-shelf tidal currents are predicted to have average speeds of approximately 0.25 knots during neap tides and up to 0.5 knots during spring tides (NSR, 1995; WNI, 1995).

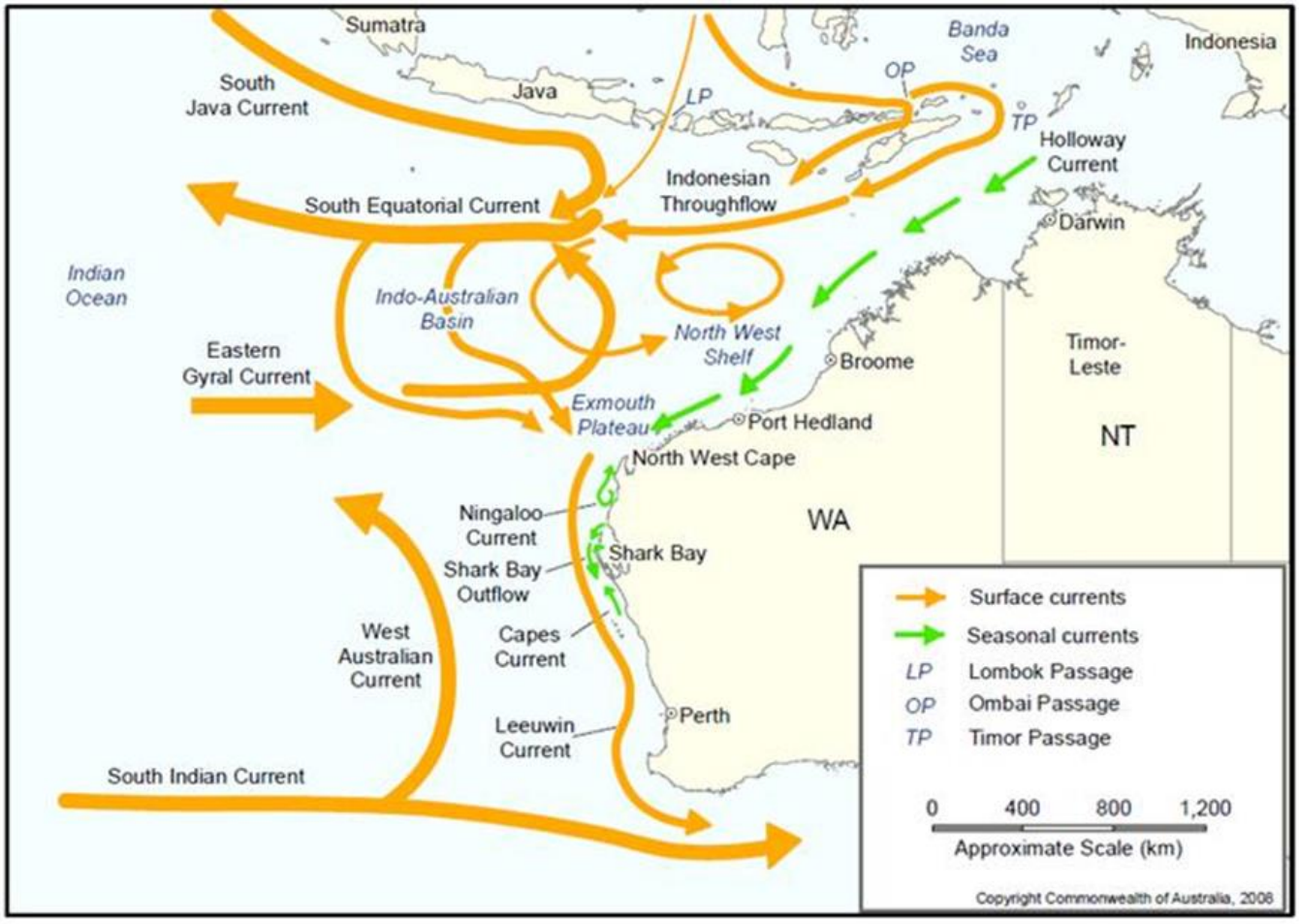
The wave climate in the northwest is composed of locally-generated wind waves (seas) and swells that are propagated from distant areas (WNI, 1995). In summer the seas typically approach from the west and southwest, while in winter the seas typically approach from the south and east. Mean sea wave heights are typically less than 1 m and peak heights of less than 2 m are experienced in all months of the year (WNI, 1995). Cyclones and tropical storms can greatly increase wave heights by up to 8 m in the outer Timor Sea during the cyclone season (Przeslawski et al., 2011).

Circulation in the Joseph Bonaparte Gulf (JBG) is dominated by the large tidal currents, which rotate in a clockwise direction. Current speeds increase towards the shoreline and become increasingly directed longshore. These large currents are responsible for the generation of dune forms on the seabed, as noted in Admiralty Charts for the region (ENI, 2021).

Average swell heights are low, around 0.4–0.6 m in all months. The greatest exposure to swells is from the west (SSE, 1993). Tropical cyclones have generated significant swell heights of up to 5 m in this area, although the predicted frequency of swells exceeding 2 m is less than 5% (WNI, 1996). In the open ocean, sustained winds result in wind-forced currents of approximately 3% of the wind speed (Holloway & Nye, 1985).

Waters on the continental shelf are usually thermally-stratified, with a marked change in water density at approximately 20 m (SSE, 1993). Surface temperatures vary annually, being warmest in March (32°C) and coolest in August (19°C). Vertical gradients are related to the seasonality of sea surface temperatures and are greatest during the warm-water season (SSE, 1991).

Pronounced shifts in water column characteristics can occur following the passage of tropical cyclones (McKinnon et al., 2003). Changes in water temperature and salinity characteristics can result from changes in local heating and evaporation following the southward movement of warmer water due to southward-moving cyclones and can have flow-on effects to primary and secondary productivity (McKinnon et al., 2003).



Source: DEWHA (2008b)

Figure 5: Surface currents in the NT and WA

3. Benthic and Pelagic Habitats

Benthic habitats are defined as those subtidal habitats lying below the lowest astronomical tide (LAT). Benthic habitats are partially driven by light availability. Primary producers (photosynthetic corals, seagrasses and macroalgae) are limited to the photic zone, whereas benthic invertebrates including filter feeding communities may be found in deeper waters. The depth of the photic zone varies spatially and temporally and is predominantly dependent on the volumes of suspended material in the water column. The photic zone in the offshore north extends to 100 m (DEWHA, 2008b).

The soft sediment habitats that cover the majority of the EMBA are only sparsely covered by sessile filter-feeding organisms (e.g. gorgonians, sponges, ascidians and bryozoans) and mobile invertebrates (e.g. echinoderms, prawns and detritus-feeding crabs) (Brewer et al., 2007; DSEWPaC, 2012). Previous surveys in the JBG have not recorded seagrass or macroalgae beyond coastal habitats (Brewer et al., 2007). The dominant habitat type across most of the EMBA is infaunal plains, which are characterised by flat, soft substrates with occasional rocky outcrops, scattered epifauna and biota dominated infauna (Przeslawski et al., 2011). This habitat type is dominant across all shelf and basin features.

The following sections broadly categorise benthic habitats as four biological communities: coral, seagrasses, macroalgae and non-coral benthic invertebrates. These communities are discussed in terms of the 18 IMCRA v. 4.0 bioregions.

3.1. Coral Reefs

Corals are both primary producers and filter feeders and thus play a role in the provision of food to marine fauna and in nutrient recycling to support ecosystem functioning (Conservation and Land Management (CALM) & Marine Parks and Reserves Authority (MPRA), 2005a).

Corals create settlement substrate and shelter for marine flora and fauna. Studies have shown that declines in the abundance, or even marked changes in species composition of corals, has a marked impact on the biodiversity and productivity of coral reef habitats (Pratchett et al., 2008). As part of the reef building process, Scleractinian corals are also important for protection of coastlines through accumulation and cementation of sediments and dissipation of wave energy (CALM & MPRA, 2005a).

The waters in the combined EMBA contain extensive coral communities. Coral reefs in the area fall into two general groups: the fringing reefs around coastal islands and the mainland shore; and large platform reefs, banks and shelf-edge atolls offshore (Woodside, 2011). The distribution of corals is governed by the availability of hard substrate for attachment and light availability.

Coral reefs are dynamic environments that regularly undergo cycles of disturbance and recovery. Depending on how frequent and severe the disturbances are, recovery can take a few years or more than a decade. Disturbances can include bleaching, cyclones and disease outbreaks (Australian Institute of Marine Science (AIMS), 2014).

Corals in the northwest provinces have experienced bleaching events and subsequent recovery. Bleaching is the process where symbiotic algae are expelled from the coral tissue, often leading to the death of the colony. Causes of bleaching include high temperatures (Scott Reef; 1998 and 2016) (information available at AIMS.gov.au), anoxic conditions (Pezner et al., 2023) or smothering (Waples & Hollander 2008, Gilmour et al., 2013). Coral susceptibility to bleaching and their ability to recover is an important consideration in the context of potential anthropogenic impacts.

The Northwest Shelf Province and Timor Transition Province overlap the EMBA entirely in deep waters below the photic zone. Corals are not present hence these bioregions are not discussed.

3.1.1. Northwest Shelf Transition

Coral communities of the Northwest Shelf Transition have historically not been well studied. However, based on the scale of reef development and the diversity of coral species recorded through limited surveys, it is highly likely that further surveys will demonstrate that the Kimberley contains a coral reef province of global significance (Masini et al. 2009). Coral communities of the Northwest Shelf Transition typically include fringing reefs around coastal islands and some mainland shores. Development of coral communities in inshore areas is limited due to persistent high turbidity. Coral and seagrass communities are not expected in the deeper waters but may be present on pinnacle and shoal features in the region.

Coral reefs in the province include fringing reefs around coastal islands and some mainland shores. Development of coral communities in inshore areas is limited due to persistent high turbidity. Known examples of coral reefs in the bioregion are given below, however further mapping is required.

Benthic habitat surveys at Adele and Long Islands in 2009 and 2010 revealed extensive development of hard and soft coral communities (Richards et al., 2013). Scleractinian coral communities at Adele Island were diverse, supporting 176 species in intertidal and subtidal areas up to 14 m depth. At Long Island approximately 200 species of scleractinian corals were recorded in intertidal and subtidal areas. These surveys also identified two significant and unique habitats; a zone of mixed corallith and rhodolith habitat at Adele Island and an Organ Pipe Coral habitat zone with unusually high benthic cover at Long Island (Richards et al., 2013).

Studies by the Western Australian Department of Biodiversity, Conservation and Attractions (DBCA) and the liquified natural gas (LNG) industry indicate that fringing and emergent coral reefs are well developed in the Heyward Island group, around islands in the Bonaparte Archipelago, and off mainland shores of Cape Voltaire and Cape Bougainville. Surveys by INPEX of Maret, Bethier and Montalivet islands, which were largely restricted to the intertidal zone, have recorded 280 species of coral from at least 55 genera, making the Kimberley Bioregion the most coral-diverse area in WA (INPEX, 2008).

Browse Island is surrounded by a minor fringing coral reef. Assemblages at Browse Island are characteristic of coral platform reefs throughout the Indo-West Pacific region, particularly Cartier Island. Coral diversity was greatest on the reef faces and shallow lagoons, but these areas were of very limited extent (URS, 2010a).

Hard corals have been recorded at Echuca Shoals, but the community was low in both species richness and abundance (URS, 2010a). The presence of occasional large outcrops suggests that larger coral structures have occurred previously and may still occur elsewhere on the shoal (RPS Environmental, 2008).

Scattered areas of coral have been reported in Beagle Gulf and Darwin Harbour (Udyawer et al., 2021, AIMS, 2021), Van Diemen Gulf/Cobourg Peninsula (NT Government, 2011) and some islands, reefs and other raised features in the inner Joseph Bonaparte Gulf may support isolated corals (Prezlawski et al., 2011). Corals in turbid waters are likely dominated by members of the genus Turbinaria (IMCRATG, 1998), while Acropora and Montipora species are reported to occur in clearer waters at the Vernon Islands (Smit et al., 2000; Calnan, 2006; IMCRATG, 1998).

3.1.2. Timor Province

Although water depths in this province are generally deep (200 m to almost 6,000 m) there are several reefs and islands that are regarded as biodiversity hotspots (DEWHA, 2008a).

Ashmore Reef, Cartier Island, Hibernia, Scott and Seringapatam Reefs are areas of enhanced local biological productivity, within an area of relatively unproductive waters. Ashmore Reef National Nature Reserve supports one of the greatest number of coral species of any reef off the West Australian coast, with 255 species of reef-building corals in 56 genera (Veron, 1993). Taxonomic revisions and additional surveys have resulted in a net increase in species numbers to 275 (Griffith, 1997, Ceccarelli et al., 2011). Species are typical of the Indo-pacific region and none are unique or considered endemic. However, 41 species (15% of the total hard coral species at the site) are listed as vulnerable on the International Union for Conservation of Nature (IUCN) Red List (IUCN, 2019). In 1998, hard coral covered an area of around 717 ha at Ashmore Reef. The majority of hard corals occur in the deep lagoon (265 ha) and shallow reef top (315 ha) with small areas in the shallow lagoons, and reef edge/slope habitats (Skewes et al., 1999a). The soft, non-reef building corals are less well studied at Ashmore Reef than the hard corals (Hale & Butcher, 2013). In 1986, 39 soft coral taxa were recorded within the Ashmore Reef, including the vulnerable blue coral (*Heliopora coerulea*) which was moderately common on the reef flats (Marsh, 1993). In 1998, the total cover of soft coral at Ashmore Reef was 323 ha and *Sarcophyton* spp. was the dominant taxa covering around 19 ha in total (Skewes et al., 1999b, Hale & Butcher, 2013).

The species composition of all the hard coral reefs in the bioregion is very similar and reflects strong links with Indo-West Pacific fauna, largely as a result of the dispersal of coral spawn via regional currents. The reefs and islands in this bioregion are thought to be important biological stepping-stones between centres of biodiversity in the Indo–Pacific and reef ecosystems further south (DEWHA, 2008a).

Seringapatam Reef is a regionally important scleractinian coral reef as it has a high biodiversity, which is comparable to Ningaloo Reef. Results from the Western Australian Museum (WAM) survey in 2006 noted 159 species of scleractinian corals with a hard coral cover of approximately 16% (WAM, 2009). The dominant benthic habitats of the reef were observed to include hard and soft corals (Heyward et al., 2013 cited in ConocoPhillips, 2018).

Scott Reef consists of two reefs, North Scott Reef and South Scott Reef, which are separated by a deep (400–700 m) channel. North Scott Reef is an annular reef which encloses a lagoon that is connected to the ocean. South Scott Reef is a crescent-shaped reef which forms an arc and partially encloses another lagoon. Light penetration at Scott reef is high due to low turbidity. Light penetration depths to the deeper part of South Reef Lagoon are in excess of 50m with corals able to survive at depths of up to 70 m (Woodside Energy Limited et al., 2010). Studies at Scott reef have identified over 300 scleractinian coral species in the shallow water habitats alone, from almost 60 genera and 14 different families (Gilmour et al., 2013). The Scott reef system has experienced two mass bleaching events in 1998 and 2016, with the latter showing > 90% decreases in cover of branching corals (Porites, Acropora, Millepora, Isopora and Pocillopoiridae) (Gilmour et al., 2021). Regular monitoring following the 1998 mass bleaching event showed increasing cover of branching corals 5 years post bleaching event, with most coral groups recovering approximately 12 years later (Gilmour et al., 2021).

Hibernia Reef consists of an approximately oval-shaped reef, with large areas of the reef becoming exposed at low tide. Hibernia Reef is also characterised by a deep central lagoon and drying sand flats.

There are a number of shoals and banks in the NMR and NWMR. Relatively few studies have been undertaken of these features with the majority of the understanding derived from the Big Bank Shoals study (Heyward et al., 1997), PTT Exploration and Production Public Co Ltd (PTTEP) surveys initiated in response to the Montara incident (Heyward et al., 2010; Heyward et al., 2011) and ConocoPhillips baseline surveys undertaken to support the Barossa Area Development (Heyward et al., 2017). The PTTEP surveys completed at Ashmore, Cartier and

Seringapatam Reefs were undertaken during a coral bleaching disturbance likely to be attributed to regional thermal stress indicated by both *in situ* and satellite-based data for the region. The condition of the reefs communities was consistent with previous surveys within the area and did not indicate any disturbance from the Montara incident (Heyward et al., 2010; Heyward et al., 2012).

In general, the submerged features are characterised by abrupt bathymetry, rising steeply from the surrounding outer continental shelf at depths of 100 m–200 m. The shoals and banks tend to flatten at depths of 40-50 m, with horizontal plateau areas of several square kilometres generally present at 20-30 m depths (Heyward et al., 2010). The shoals and banks support a diverse and varied range of benthic communities, including algae, reef-building soft corals, hard corals and filter-feeders (Heyward et al., 1997, Heyward et al., 2012). The plateau areas were dominated by benthic primary producer habitat, with interspersed areas of sand and rubble patches (Heyward et al., 2012).

3.1.3. Northern Shelf Province

While, the Northern Shelf Province contains submerged patch reefs (small, isolated reefs usually occurring between fringing and barrier reefs, vary greatly in size) or barrier reefs (run parallel to the coastline, separated from the coast by a wide lagoon, at the shallowest point barrier reefs can reach the water's surface) in approximately 30-50 m depth of water, these mainly occur around the margin of the Gulf of Carpentaria, which lies outside the combined EMBA (DEWHA, 2008b). The majority of the province is relatively featureless with sandy and muddy sediments (DEWHA, 2008b), which is expected to be the case for the portion of the combined EMBA that overlaps the Northern Shelf Province as no significant reefs have been observed within the combined EMBA boundary to date.

3.2. Seagrasses

Seagrasses are biologically important for four reasons:

- As sources of primary production
- As habitat for juvenile and adult fauna such as invertebrates and fish
- As a food resource
- For their ability to attenuate water movement and trap sediment (Masini et al. 2009).

Twenty-five species of seagrass have been recorded in WA, the highest diversity in the world, and over 30 species of seagrasses have been recorded as occurring within Australian waters (Masini et al., 2009). Waters extending from Busselton to the NT border support predominantly tropical species. One species, *Cymodocea angustata*, is endemic to WA (Department of Parks and Wildlife (DPAW), 2013). Other seagrass meadows of note include those around Tiwi Islands which provide significant habitat to several species. Seagrass habitats also occur within shallower waters near islands and have potential to occur closer to the Indonesian and Timor-Leste coastlines.

The main seagrasses of the northern region of the EMBA are small, ephemeral species that grow on soft sediments and have a seed bank in the surficial sediments that allows them to recover quickly from disturbance (Walker, 1989). Small, ephemeral species of seagrass tend to form mixed associations with macroalgae (CALM & MPRA, 2005; DEC & MPRA, 2007; BHPBIO, 2011) and usually cover less than 5% of the substrate (BHPBIO, 2011; van Keulen & Langdon, 2011). Areas occupied by these seagrass species vary markedly both seasonally and interannually and it is not clear why some areas of suitable substrate will support seagrass in one year but not the next. It appears that recruitment to what may otherwise be suitable substrate is haphazard, lending weight to the descriptions of these seagrass communities as ephemeral (CALM & MPRA, 2005; DEC & MPRA, 2007).

The Northwest Shelf Province and Timor Transition Province overlap the EMBA entirely in deep waters below the photic zone. Seagrasses are not present hence these bioregions are not discussed.

3.2.1. Northwest Shelf Transition

Extensive and diverse intertidal seagrass meadows are known from islands in the southern Kimberley, particularly in the Sunday Island One Arm Point area (Walker, 1995; Walker & Prince, 1987). Ten species of seagrasses have been recorded at One Arm Point, with the majority of meadows low to moderate in abundance and dominated by *Thalassia hemprichii* with *Halophila ovalis*, *Halodule uninervis* and *Enhalus acoroides* (Seagrass-Watch, 2019).

While some seagrasses have been collected from intertidal sites in the central and north Kimberley (Walker et al., 1996; Walker 1997), these areas were not found to be species rich and did not support extensive seagrass meadows like those found in the southern Kimberley. Subtidal seagrass meadows across the Northwest Shelf Transition are not well mapped. Those mapped in Darwin Harbour and Van Diemen Gulf were found to be patchy (AIMS, 2021), although dugongs are known to feed on seagrass communities in coastal waters of the Joseph Bonaparte Gulf (DEWHA, 2008a). Previous surveys in the JBG have not recorded seagrass beyond coastal habitats (Brewer et al., 2007).

3.2.2. Timor Province

Seagrass has been reported on the reef flats of offshore reefs of this bioregion (Whiting, 1999; Hale & Butcher, 2013). Five species of seagrass were reported at Ashmore Reef with *Thalassia hemprichii* being the dominant species (Pike & Leach, 1997; Skewes et al., 1999b; Brown & Skewes, 2005). The total area of seagrass at Ashmore Reef in 1999 was estimated to be 470 ha (Skewes et al., 1999b). However, much of this was very sparse cover and there were only 220 ha of seagrass with a greater than 10% cover (Brown & Skewes, 2005). Seagrass grew in a sparse, patchy distribution across the sand flats, but had a higher coverage on the reef flat area, where it extended to within 100 m of the reef crest. The area of greatest cover and diversity was in the west and south-west areas of the reef on the inner reef flat (Brown & Skewes, 2005). These seagrass meadows support a small but significant population of dugongs estimated at around 100 individuals comprising all age classes from calves to adults (Hale & Butcher, 2005).

Similarly, Scott Reef supports five species of seagrass (URS, 2006), with *Thalassia hemprichii* most abundant (Skewes et al., 1999a; URS, 2006). The area of seagrass at Scott Reef is significantly less than that recorded for Ashmore Reef (approximately 100 ha) (Woodside, 2011). The highly energetic environment and significant tidal exposure of Scott Reef restricts the area of habitats potentially suitable for seagrass establishment to a small proportion of the total area, resulting in low abundance (Skewes et al., 1999a; URS, 2006).

Seringapatam Reef was found to have a seagrass cover of 2 ha out of 5,519 ha (0.04%) composed of *Thalassia hemprichii* and *Halophila ovalis* in approximately equal quantities (Skewes et al., 1999a). This finding contrasts with a more recent survey where only one species of seagrass (*Halophila decipiens*) was recorded at Seringapatam (Huisman et al., 2009).

Ashmore and Hibernia Reefs were found to support four species of seagrasses from two seagrass families; *Thalassodendron ciliatum* in family Cymodoceacaea, and *Halophila decipiens, Halophila ovalis* and *Thalassia hemprichii* from family Hydrocharitaceae (Huisman et al., 2021).

3.2.3. Northern Shelf Province

In the Northwest Shelf Province, seagrasses are present but sparsely distributed to depths of approximately 30 m (LEC & Astron, 1993; URS, 2009; CALM, 2005a). The abundance and distribution of tropical (and subtropical) seagrass species can vary greatly due to seasonal changes in water quality (turbidity, light penetration) and conditions (wave action, temperature), with biomass tending to peak in summer (Lanyon & Marsh, 1995). Coastlines adjacent to the Northern Shelf Province contain seagrasses providing habitat to a number of marine species, particularly juvenile tiger prawns, which make up approximately 50% of the total prawn catch in the province. However, majority of these seagrass habitats exist within the Gulf of Carpentaria, which lies outside the combined EMBA.

3.3. Macroalgae

Macroalgae are important contributors to primary production and nutrient cycling in the EMBA, providing food and habitat for vertebrate and invertebrate fauna. Macroalgae are also recognised for their role in spatial subsidies; the movement of nutrients or energy between neighbouring habitats. Spatial subsidies involving macroalgae include the movement of wrack from macroalgal beds to seagrass meadows, bare substrates and shorelines (Orr, 2005; Mellbrand et al., 2011).

Macroalgae are primarily associated with hard substrates. They occur in moderate to high cover on exposed hard substrates but typically have lower cover on hard substrates that are covered with a veneer of sediment (SKM, 2009; BHPBIO, 2011). Macroalgae exhibit very high seasonal and interannual variation in biomass (Heyward et al., 2006) and distribution, abundance, and biodiversity (Rio Tinto, 2009; BHPBIO, 2011). The distribution of hard substrates therefore indicates areas that may support macroalgal communities, although abundance and diversity may fluctuate annually.

Macroalgae are susceptible to disturbance from factors such as sedimentation, scouring and turbidity but the marked seasonality in biomass, abundance, diversity, and distribution suggests macroalgae are likely to be resilient to acute, short-term disturbance acting at local scales. Macroalgae may be more susceptible to impacts acting over longer time scales (years) and at certain times of the year, where recruitment at a regional scale could be affected. Indirect impacts affecting the numbers, distribution and community structure of herbivorous fish can also be expected to have impacts (either positive or negative) on macroalgal habitats (Vergès et al., 2011).

The Northwest Shelf Province and Timor Transition Province overlap the EMBA entirely in deep waters below the photic zone. Macroalgae is not present hence these bioregions are not discussed.

3.3.1. Northwest Shelf Transition

There is a lack of information regarding the marine benthic flora of north-west Western Australia and no comprehensive marine flora list exists for the region (Huisman, 2004). Previous surveys in the JBG have not recorded macroalgae beyond coastal habitats (Brewer et al., 2007), however, about 70 algae species were collected during a survey of intertidal reefs on the central Kimberley coast in 1997 (Walker, 1997).

Tropical macroalgae species are typically associated with areas of hard substrate and various types of macroalgae occur on rock platforms intermingled with coral and sponge. Abundance and biomass typically exhibit strong seasonal trends (Heyward et al., 2006).

The diversity and abundance of algae in the Kimberley is probably linked to the region's extreme tidal exposure and highly turbid waters, reducing light penetration and resulting in deposition of fine sediments (Walker, 1997). However, the role of algae appears crucial to the growth of reefs in the highly turbid waters of the Kimberley coast and islands (Brooke, 1997). *Sargassum* spp. and coralline algae may be dominant (DPAW, 2013).

It is also considered that in offshore parts of the Northwest Shelf Transition, there are high levels of primary production, including macroalgae. This is due to light penetration through relatively clear, shallow waters (DEWHA, 2008a). In particular, carbonate banks and reefs in the Northwest Shelf Transition are considered to support macroalgae, therefore macroalgae would be expected to be present within the Carbonate Bank and Terrace System of the Van Diemen Rise key ecological feature, located within the Northwest Shelf Transition.

3.3.2. Timor Province

Macroalgae at Ashmore Reef are estimated to cover over 2,000 ha, mostly on the reef slope and crest areas (Hale & Butcher, 2013). The algal community is dominated by turf and coralline algae, with fleshy macroalgae comprising typically less than 10% of total algal cover (Skewes et al., 1999b).

Surveys at Scott and Seringapatam Reefs recorded over 100 species of marine algae (Huisman et al., 2009). The marine algal community was similar between reefs and also similar to the Rowley Shoals. Algae found at these offshore atolls forms a small subset of the Indo-Pacific algal flora, with virtually all of the species identified thus far having been previously collected from north-western Australia or from localities further north. Although further research is necessary, at present there is nothing to suggest that the macroalgae communities of these offshore atolls are unique within the Indo-Pacific (Huisman et al., 2009).

3.3.3. Northern Shelf Province

Macroalgae is sparse in the Northern Shelf Province (DEWHA, 2008b). However, around reef areas, there have been observations of phytoplankton blooms, thought to occur at localised micro-upwellings of nutrients potentially driven by wind and tidal eddies (DEWHA, 2008b).

3.4. Non-Coral Benthic Invertebrates

The offshore marine environment from Busselton to the Northern Territory is overwhelmingly dominated by soft sediment seabeds; sandy and muddy substrates, occasionally interspersed with hard substrates covered with sand veneers, and rarely, exposed hard substrate. In shallow waters, non-coral benthic invertebrates may form part of the mosaic of benthic organisms found on hard substrates, alongside macrophytes and coral colonies. As light reduces with water depth, non-coral benthic invertebrates are the dominant community, albeit at low densities.

Non coral benthic invertebrates feed by filtering small particles from the seawater, typically by passing the water over a specialised filtering structure. Examples of filter feeders are sponges, soft and whip corals and sea squirts.

3.4.1. Northwest Shelf Province

This bioregion is located primarily on the continental shelf in water depths from 0 to 200 m (DEWHA, 2008a). The sandy substrates on the shelf within this bioregion are thought to support low density benthic communities of bryozoans, molluscs and echinoids (DEWHA, 2008a). Sponge communities are also sparsely distributed on the shelf but are found only in areas of hard substrate.

In 2007, CSIRO conducted extensive benthic habitat mapping surveys and epibenthic fauna (living on the surface and ≥1 cm body size) sampling in deep waters (100–1,000 m) spanning thirteen sites between Barrow Island and Ashmore Reef running along the continental shelf and across the continental slope of the North West Shelf (Williams et al., 2010). At the continental shelf margin (approximately 100 m water depth) Williams et al. (2010) reported that similar benthic habitats occurred at each survey site across the breadth of the North West Shelf. Benthic habitats at this depth comprised a mix of riffled muddy sand (sometimes as a veneer over rocky sub-crops) together with gravel to pebble-sized rubble, cobbles, boulders and some rock outcrops. Typical epifauna found at these depths included scattered isolated hydroids, sea fans and soft corals and often small sponges. Other fauna observed at some of the sites included scattered isolated sea whips, crinoids, sea pens, urchins and anemones. Epibenthic fauna along the continental shelf margin were quantified as sparse and low diversity (Williams et al., 2010). Modelling indicated that a trawl sample of 1 km length would generally be expected to yield approximately 80 individuals represented by 15 species (Williams et al., 2010) in 100 m depth waters.

At the shelf edge (approximately 200 m water depth), two sites were surveyed. Both sites were similar to the continental shelf margin, except the northern site mainly comprised coarse material. Epifauna observed at the northern site was similar at 200 m as at 100 m. At the southern site, epifauna included sparse and scattered individual soft corals, anemones, glass sponges and stalked crinoids (Williams et al., 2010). Modelling indicated epibenthic fauna were sparse and had low diversity, numbering approximately 20–40 individuals in a 1 km long trawl sample represented by approximately 5–10 species (Williams et al., 2010).

3.4.2. Northwest Shelf Transition

The Northwest Shelf Transition is located on the continental shelf with a small area extending onto the continental slope, with water depths ranging from 0–330 m. Nearshore areas may support significant filter feeding communities, but these have not yet been described (Masini et al., 2009).

Pipeline route surveys north of the Kimberley in water depths from 10–250 m recorded a seabed largely devoid of hard substrate, with only sparse epibenthic fauna noted on the predominantly sandy substrate. Occasional epibenthic fauna (featherstars, gorgonians, bryozoans, sea urchins, hydroids and sponges) were recorded in areas where rocky substrate or outcrops were present (URS, 2010a).

In contrast, benthic surveys at Echuca Shoals identified broad areas of hard substrate with substantial epibenthic fauna. The shallow shoal areas were dominated by a flat ‘reef’ platform with crinoids, sea whips, soft corals and low densities of hard corals. With increasing depth (25–80 m) soft corals and sponges became increasingly dominant. At greater depths (80–100 m) the density of epibenthic fauna decreased substantially with sea whips and sea fans became dominant (URS, 2010a).

3.4.3. Timor Province

The Timor Province is located on the continental slope and abyssal plain and water depths range from 200 m to almost 6,000 m. Benthic studies in this bioregion are scarce, however data from the North West Slope Trawl Fishery suggests that muddy sediments in the Timor Province support significant populations of crustaceans (Brewer et al., 2007). Additionally, research into the demersal fish communities of the continental slope has identified the Timor Province as an important bioregion. This is due to the presence of a number of endemic fish species, and two distinct demersal community types associated with the upper slope (water depths of 225–500 m) and mid-slope (water depths of 750–1,000 m) (Last et al., 2005). The current understanding of the relationship between demersal fish communities and benthic environments on the continental slope is rudimentary (DEWHA, 2008a).

Over 130 species of sponges have been recorded at the Ashmore Reef National Nature Reserve (Russell & Hanley, 1993).

Studies of Seringapatam Reef have observed the dominant benthic habitats to include filter feeders, such as sponges, gorgonians, hydroids and seapens (Heyward et al., 2013 cited in ConocoPhillips, 2018).

3.4.4. Timor Transition

Carbonate banks and reefs of the Timor Transition have been found to support non-coral communities and benthic invertebrate communities associated with hard substrates (DEWHA, 2008b). Of particular note is the Shelf Break and Slope of the Arafura Shelf key ecological feature which is located within the Timor Transition. This key ecological feature has been recognised for the invertebrates that is hosts, which are thought to be the basis for the offshore food webs in the area (DEWHA, 2008b). Furthermore, the Tributary Canyons of the Arafura Depression key ecological feature is also in the Timor Transition and surveys of this key ecological feature identified around 245 macroscopic species of invertebrates (Wilson, 2005).

3.4.5. Northern Shelf Province

Studies of taxa within the Northern Shelf Province found 684 taxa of infaunal benthic invertebrates in waters deeper than 20 m. However, the Gulf of Carpentaria Basin contains the most significant non-coral benthic habitats within the Northern Shelf Province, which is outside the boundary of the combined EMBA (DEWHA, 2008b).

3.5. Plankton

Plankton abundance and distribution is patchy, dynamic, and strongly linked to localised and seasonal productivity (Trebilco et al., 2021). Fluctuations in abundance and distribution occur both vertically and horizontally in response to tidal cycles, seasonal variation (light, water temperature and chemistry, currents and nutrients) and cyclonic events. As a key indicator for ecosystem health and change, plankton distribution and abundance has been measured for over a century in Australia (Richardson et al., 2015). The compilation of this data has been made publicly available through the Australian Ocean Data Network (Australian Ocean Data Network, 2022) and has been used in the Australia State of the Environment 2021 report (Trebilco et al., 2021) to nationally assess marine ecosystem health. According to their findings, primary production has decreased in the north-west and north-east shelf and offshore in the Indian Ocean.

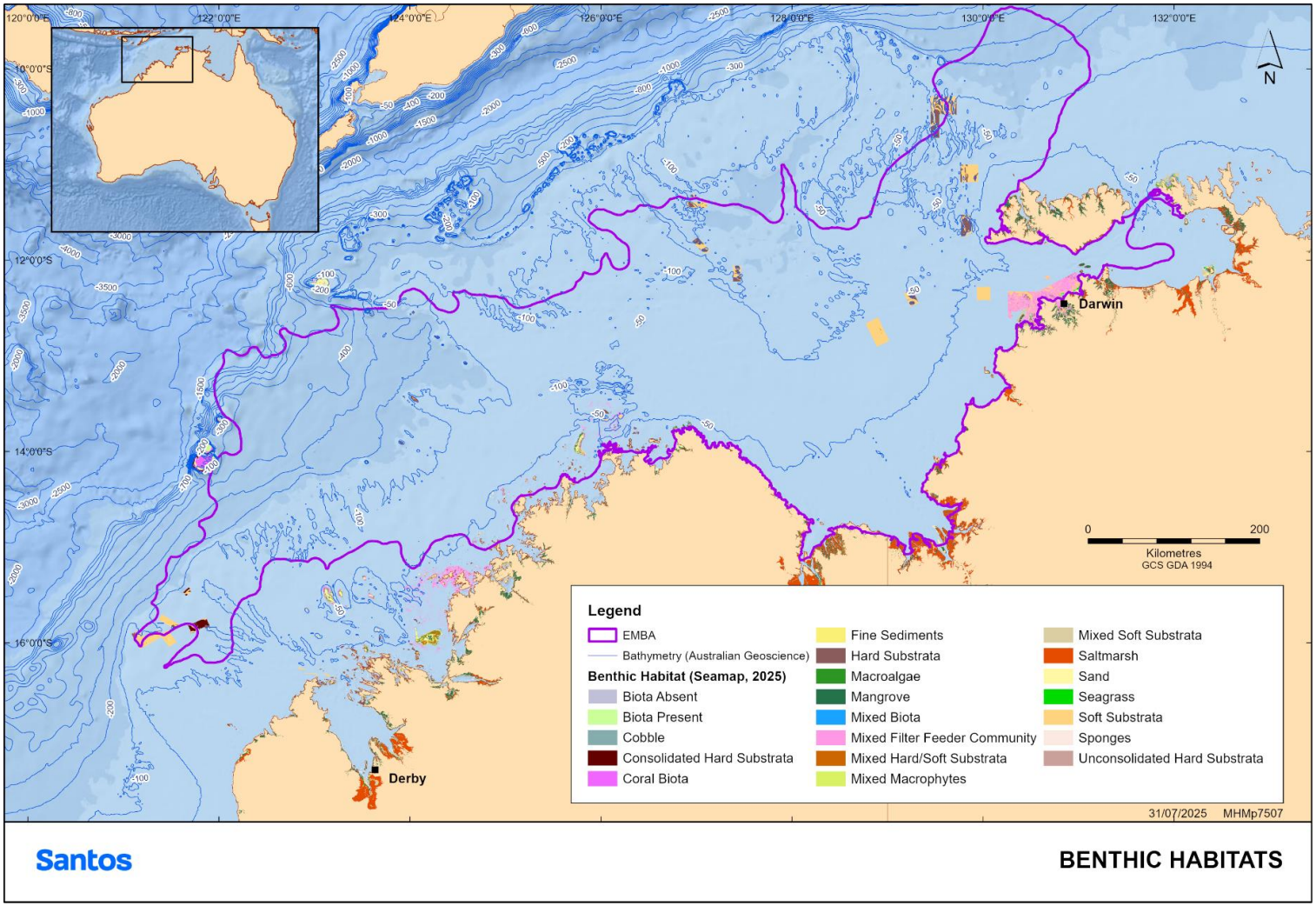


Figure 6: Benthic habitats

4. Shoreline Habitats

Shoreline habitats are defined as those habitats that are adjacent to the water along the mainland and of islands that occur above the Lowest Astronomical Tide (LAT) and most often in the intertidal zone.

The following section broadly categorises shoreline habitats as the following biological communities; mangroves, intertidal mud/sand banks, beaches, and rocky shores. These communities are discussed in **Sections 4.1- 4.5**, in terms of the 18 IMCRA v. 4.0 bioregions where relevant and where information is available.

4.1. Mangroves

Mangroves commonly occur in sheltered coastal areas in tropical and sub-tropical latitudes (Kathiresan and Bingham, 2001). Up to eight species of mangroves are found further north in the Central Western Shelf Transition region, but at most locations the dominant mangrove (in terms of area of intertidal zone occupied) is *Avicennia marina*, with the stilt rooted mangrove *Rhizophora stylosa* often occurring as thin zones of dense thickets within the broad zone of *A. marina*. Mangroves are found wherever suitable conditions are present including wave dominated settings of deltas, beach/dune coasts, limestone barrier islands and ria/archipelago shores (Semeniuk, 1993). Mangrove plants have evolved to adapt to fluctuating salinity, tidal inundation and fine, anaerobic, hydrogen sulfide rich sediment (Duke et al., 1998).

Mangroves are important primary producers and have a number of ecological and economic values. For example, they play a key role in reducing coastal erosion by stabilising sediment with their complex root systems (Kathiresan and Bingham 2001). They are also recognised for their capacity to help protect coastal areas from the damaging effects of erosion during storms and storm surge. Mangroves are also important in the filtration of run-off from the land which helps maintain water clarity for coral reefs which are often found offshore in tropical locations (National Oceanic and Atmospheric Administration (NOAA), 2010). The intricate matrix of fine roots within the soil also binds sediments together.

Mangroves play an important role in connecting the terrestrial and marine environments (Alongi, 2009). Numerous studies (e.g. Nagelkerken et al 2000; Alongi 2002 Alongi 2009 Kathiresan and Bingham 2001) have shown mangroves to be highly productive and an important breeding and nursery areas for juvenile fish and crustaceans, including commercially important species (Kenyon et al., 2004). They also provide habitat for many juvenile reef fish species.

Mangroves also play an important ecosystem role in nutrient cycling and carbon fixing (NOAA, 2010). The trees absorb carbon dioxide from the atmosphere and the organic matter such as fallen leaves forms nutrient rich sediments creating a peat layer that stores organic carbon (Alongi, 2009; Ayukai, 1998).

The muddy sediments that occur in mangrove forests are home to a variety of epibenthic, infaunal and meiofaunal invertebrates (Kathiresan and Bingham 2001). Crustaceans known to inhabit the mud in mangrove systems include fiddler crabs, mud crabs, shrimps and barnacles. Within the water channels of the estuary, various finfish are found from the smaller fish such as gobies and mudskippers (which are restricted to life in the mangroves) through to larger fish such as barramundi (*Lates calcarifer*) and the mangrove jack (*Lutjanus argentimaculatus).* Mangroves and their associated invertebrate-rich mudflats are also an important habitat for migratory shorebirds from the northern hemisphere, as well as some avifauna that are restricted to mangroves as their sole habitat (Garnet and Crowley, 2000).

The Northwest Shelf Province and Timor Transition Province overlap the EMBA entirely in deep waters below the photic zone. Mangroves are not present hence these bioregions are not discussed.

4.1.1. Northwest Shelf Transition

Mangroves are also a prominent feature of the North Kimberley. Fringing mangroves have developed around the edge of Prince Frederick Harbour and to the east of Cape Voltaire extending along the shores of Walmesly Bay and Port Warrender (Zell 2007). This region is humid and *Xylocarpus granatum* is localised here (Cresswell and Semeniuk 2011). The rocky coastline between Cape Pond and Cape Voltaire does not lend itself to mangrove development; instead coastal woodland grows on the shores above high-water mark. Mangroves are interspersed with rocky outcrops and beaches around much of the Admiralty Gulf, Vansittart Bay and Napier Broome Bay (with

extensive stands around the Drysdale estuary). Cape Londonderry marks the westerly limit of *Scyphiphora hydrophylacea* (Duke et al 2010).

Between Cape Londonderry and Cape Dussejour mangrove communities are sparse, and limited to a few small stands in the bays as this part of the coastline is dominated by high relief rocky shores which are exposed to the prevailing easterly winds (Wilson 1994). Extensive mangroves do however line the shores of the islands and rivers in the Cambridge Gulf, where 12 mangrove species have been recorded (Wilson 2013). The mangroves of the Ord River are notable in terms of their structural complexity and diversity. Fourteen species of mangrove have been recorded in the boundaries (Pedretti and Paling 2001). The mangroves of the Cambridge Gulf are important for saltwater crocodiles and mangrove bird communities. A unique type of flycatcher which is an intermediate between *Microcea flavigater* and *Microeca tormenti* has been identified in the mangroves of the Cambridge Gulf (Johnstone 1984). Additionally, the area is important for maintaining stocks of the commercially exploited species of the Red-Legged Banana Prawns (*Penaeus indicus)* (Kenyon et al 2004).

Further north, mangroves also occur at the Tiwi Islands. Mangrove communities in the Tiwi Islands are predominantly within tidal creeks and are not expected along the shoreline. The Northern Territory mainland coastline, however, has a number of estuaries and rivers that drain into the surrounding hinterland during the wet season, this includes Darwin Harbour that contains approximately 260 km^2 of mangroves (INPEX, 2010).

4.1.2. Northern Shelf Province

Coastlines within the Northern Shelf Province are described as being dominated by mangroves, which provide significant habitat for commercial and non-commercial fish species. In particular, banana prawns tend to favour mangrove areas with the highest catch of banana prawns being recorded in areas with the highest concentration of mangroves (DEWHA, 2008).

4.2. Intertidal Mud/Sand Flats

Intertidal mudflats form when fine sediment carried by rivers and the ocean is deposited in a low energy environment. Tidal mudflats are highly productive components of shelf ecosystems responsible for recycling organic matter and nutrients through microbial activity. This microbial activity helps stabilise organic fluxes by reducing seasonal variation in primary productivity which ensures a more constant food supply (Robertson 1988). Intertidal sand and mudflats support a wide range of benthic infauna and epifauna which graze on microscopic algae and microbenthos, such as bivalves, molluscs, polycheate worms and crustaceans (Zell 2007).

The high abundance of invertebrates found in intertidal sand and mudflats provides an important food source for finfish and shellfish which swim over the area at high tide. Mudflats have also been shown to be significant nursery areas for flatfish. During low tide, these intertidal areas are also important foraging areas for indigenous and migratory shorebirds. Mudflats also play a vital role in protecting shorelines from erosion (Wade and Hickey 2008).

The Northwest Shelf Province and Timor Transition Province overlap the EMBA entirely in deep waters below the photic zone. Intertidal mud/sand flats are not present hence these bioregions are not discussed.

4.2.1. Northwest Shelf Transition

Extensive mud flats are located in Collier Bay, where the highest tidal range in Australia is found. (Wilson 2013 Zell 2007). A study by (Duke et al 2010 Masini et al 2009) also identified fringing mudflats around Walcott Inlet, and Doubtful Bay. The tidal mudflats of Walcott Inlet are up to 5 km wide and support a rich intertidal invertebrate community (Gibson and Wellbelove 2010). These invertebrate communities in turn also support large numbers of waterbirds (Wilson 1994).

Extensive intertidal mudflats occur in Prince Frederick Harbour and are generally backed by mangroves. The mudskipper is known to feed on these mudflats at low tide. Intertidal flats are also a feature of the estuary of the Mitchell River. The mudflats of Port Warrender are known to support 20 shorebird species and tern species and it is likely the other mudflats in the region also support high numbers of birds. The ecological significance of the wetlands of the Mitchell River has been recognised in *A Directory of Important Wetlands in Australia*. Mud and sand flats are also known to surround much of Deep Bay and Napier Broome Bay.

Intertidal sand and mudflats are a common feature of the East Kimberley. Large sand bars are present on the river mouths of the King George River, Berkeley River and Lyne River and intertidal mudflats are extensive along the edges of the Cambridge Gulf. The estuary is wide and very shallow in some sections, and the silt and clay is

continually picked up and redeposited by strong tidal currents (Robson et al 2008). The tidal flats of the Ord River in the Cambridge Gulf have been listed as a wetland of international importance for the conservation of waterbirds under the Ramsar convention. The area supports a variety of fauna including shorebirds and mudskippers. Tidal mudflats are also extensive along the coast between the Cambridge Gulf and the WA-NT Border.

Further north, the Tiwi islands have also been identified as containing tidal flats, whilst the extent of these are not well documented they are thought to be closely related to the mangrove habitats at the Tiwi Islands (ConocoPhillips, 2020).

4.2.2. Northern Shelf Province

The subtidal and intertidal communities in Darwin Harbour and around the NT coastline, within the Northern Shelf Province are characterised as including a variety of shoreline habitats, including intertidal mud flats (URS, 2010). The Tiwi Islands are also partially located within the Northern Shelf Province and are identified as supporting a number of shoreline habitats including sand and mud flats.

4.3. Intertidal Platforms

Intertidal platforms are areas of hard bedrock and/or limestone with or without a sediment veneer of varying thickness. These platforms can vary from low to high relief and provide a habitat for a diverse range of intertidal organisms (Morton and Britton in Jones, 2004; SKM, 2009, 2011; Hanley and Morrison, 2012) and some species of shore birds (Garnet and Crowley, 2000). They are common within each of the coastal bioregions within the combined EMBA.

4.3.1. Northwest Shelf Province and Northwest Shelf Transition

Large tidal regimes are likely to be the defining environmental factor influencing the distribution of intertidal flora and fauna in the Northwest Shelf Province and Northwest Shelf Transition. The intertidal area of the Kimberley has an extreme tidal range (hypertidal) which creates unique environmental conditions and habitats not seen else anywhere else in the world. As a remote area many of the habitats are untouched and they are recognised as having significant conservation value (DPaW, 2013). DPaW (2013) reports that as a result of the monsoonal influxes of freshwater and land-derived nutrients distinctive tropical marine ecosystems have occurred. The subtidal and intertidal communities in Darwin Harbour and around the NT coastline are characterised as including a variety of shoreline habitats, including intertidal mud flats (URS, 2010). The Tiwi Islands are identified as supporting a number of shoreline habitats including sand and mud flats.

4.4. Sandy Beaches

Sandy beaches are those areas within the intertidal zone where unconsolidated sediment has been deposited (and eroded) by wave and tidal action. Sandy beaches can vary from low to high energy zones; the energy experienced influences the beach profile due to varying rates of erosion and accretion. Sandy beaches are found across the combined EMBA and vary in length, width, and gradient. They are interspersed among areas of hard substrate (e.g. sandstone) that form intertidal platforms and rocky outcrops. There is a wide range of variation in sediment type, composition, and grain size along the combined EMBA.

Sandy beaches provide habitat to a variety of burrowing invertebrates and subsequently provide foraging grounds for shorebirds (Garnet and Crowley, 2000). The number of species and densities of benthic macroinvertebrates that occur in the sand are typically inversely correlated with sediment grain-size and exposure to wave action, and positively correlated with sedimentary organic content and the amount of detached and attached macrophytes (Wildsmith et al., 2005). However, the distributions of these faunas among habitats will also reflect differences in the suite of environmental variables that characterize those habitats (Wildsmith et al., 2005).

Sandy habitats are important for both resident and migratory seabirds and shorebirds (refer **Section 1**). While sand flats and beaches generally support fewer species and numbers of birds than mudflats of similar size; some species such as the beach thick knee (*Esacus giganteus*) a crab eater, are commonly associated with sandy beaches (Garnet and Crowley, 2000). Sandy beaches can also provide an important habitat for turtle nesting and breeding (see marine turtles **Section 6.1**).

The Northwest Shelf Province and Timor Transition Province overlap the EMBA entirely in deep waters below the photic zone. Sandy beaches are not present hence these bioregions are not discussed.

4.4.1. Northwest Shelf Transition

Sand habitat within the Camden Marine Park is mainly associated with shorelines and inlets on both mainland and island shores. Some beach deposits on islands in the Kimberley are composed of skeletal carbonate sand, while they may also consist of sediments from inland areas carried to the sea by rivers and gullies (DPaW, 2013). The sediment coarseness of the sand may vary, and may also be littered with dead shell, rock and/or coral material. Sea cucumbers that ingest sand and filter out microscopic food are often common in this habitat (DPaW, 2013).

Significant sandy beaches occur on the Tiwi Islands, specifically the west coast of Bathurst Island and the north coast of Melville Island. These beaches are important areas for marine turtles with nesting dominated by flatback and olive ridley turtles (peak nesting in March to May) (Chatto and Baker, 2008).

Generally, in this region, sand habitat is adjacent to either dense mangrove stands or rocky cliffs (DPaW, 2013). Beaches can be highly influenced by tide and weather conditions. Those that overlie rock are likely to shift and be ephemeral in nature.

4.5. Rocky Shorelines

Rocky shorelines are found across the combined EMBA and are often indicative of high energy areas (wave action) where sand deposition is limited or restricted (perhaps seasonally or during a cyclone). They are formed from limestone pavement extending out from the beach into subtidal zones.

Rocky shores can include pebble/ cobble, boulders, and rocky limestone cliffs (often at the landward edge of reef platforms). Rocky outcrops typically consist of hard bedrock, but some of the coastline has characteristic limestone karst cliffs with an undercut notch. Rocky shorelines can vary from habitats where there is bedrock protruding from soft sediments to cliff like structures that form headlands. Rocky shorelines are an important foraging area for seabirds and habitat for invertebrates found in the intertidal splash zone (Morton and Britton cited in Jones, 2004). For example, oyster catchers and ruddy turnstones feed along beaches and rocky shorelines (see seabirds in **Section 8.1.2**).

5. Fishes and Sharks

Fish distributions in the combined EMBA are discussed with respect to the IMCRA Provincial Bioregions which were defined using CSIRO's 1996 regionalisation of demersal fish on the continental shelf to the shelf break, and their 2005 regionalisation of demersal fish on the continental slope to approximately 1,200 m depth (DEH, 2006). The EPBC species listed as threatened and migratory found in the combined EMBA, according to the Protected Matters search (**Appendix A**), are shown in **Table 2,** along with their WA and NT conservation listings (as applicable) and discussed in **Section 5.3** below.

The following WA conservation codes apply to WA conservation significant fauna:

- Threatened species (listed under the *Biodiversity Conservation Act 2016* (WA) (BC Act)):
  - Critically endangered
  - Endangered
  - Vulnerable
- Specially protected species (listed under BC Act):
  - Migratory
  - Species of special conservation interest (conservation dependant fauna)
  - Other specially protected species
- Priority species (non-statutory state based administrative process):
  - Priority 1, 2 and 3: poorly-known species – possible threatened species that do not meet survey criteria or are otherwise data deficient. Ranked in order of priority. In urgent need of further survey.

  - Priority 4: species that are adequately known, are either: rare but not threatened; meet criteria for near threatened; or delisted as threatened species within last five years for reasons other than taxonomy. Requiring regular monitoring.

The following NT conservation codes apply to NT conservation significant fauna:

- Threatened wildlife (listed under the *Territory Parks and Wildlife Conservation Act 1976* (TPWC Act))
  - Extinct in the wild
  - Critically endangered
  - Endangered
  - Vulnerable
- Protected wildlife (listed under the TPWC Act)
  - Wildlife in a Territory park, reserve, sanctuary, wilderness zone or area of essential habitat
  - Any vertebrate that is indigenous to Australia

A detailed account of commercial and recreational fisheries that operate in the region is provided in the Commercial Fisheries Section 14.7 and detailed in *The State of the Fisheries Report* 2021/2022 (Newman et al., 2023).

Table 2: EPBC listed fish and shark species in the combined EMBA

Species	Conservation Status				Likelihood of occurrence in EMBA	BIA[1] in EMBA
	EPBC Act 1999	BC Act 2016[2]	Other WA Conservation Code	TPWC Act 1976		
Grey nurse shark (*Carcharias taurus*)	Vulnerable	Vulnerable	-	-	Species or species habitat may occur within area.	None - No BIA defined
White shark, Great white shark (*Carcharodon carcharias*)	Vulnerable & Migratory	Vulnerable	-	-	Species or species habitat may occur within area.	None - No BIA defined
Whale shark (*Rhincodon typus*)	Vulnerable & Migratory	Migratory	-	-	Foraging, feeding or related behaviour known to occur within area.	Yes – Refer to Table 4
Northern river shark, New Guinea river shark (*Glyphis garricki*)	Endangered	-	Priority 1	Endangered	Breeding known to occur within the area.	None - No BIA defined
Speartooth shark (*Glyphis glyphis*)	Critically Endangered	-	-	Vulnerable	Species or species habitat known to occur within area.	None - No BIA defined
Dwarf sawfish, Queensland sawfish *(Pristis clavata*)	Vulnerable & Migratory	Migratory	Priority 1	Vulnerable	Breeding known to occur within area.	None - No BIA defined
Freshwater sawfish, Largetooth sawfish, River sawfish, Leichhardt's sawfish, Northern sawfish (*Pristis pristis)*	Vulnerable & Migratory	Migratory	Priority 3	Vulnerable	Species or species habitat known to occur within area.	None - No BIA defined
Narrow sawfish, Knifetooth sawfish (*Anoxypristis cuspidata*)	Migratory	Migratory	-	-	Species or species habitat known to occur within area.	None - No BIA defined
Green sawfish, Dindagubba, Narrowsnout sawfish (*Pristis zijsron*)	Vulnerable & Migratory	Vulnerable	-	Vulnerable	Species or species habitat known to occur within area.	None - No BIA defined
Oceanic whitetip shark (*Carcharhinus longimanus*)	Migratory	-	-	-	Species or species habitat may occur within area.	None - No BIA defined
Shortfin mako, Mako shark (*Isurus oxyrinchus*)	Migratory	Migratory	-	-	Species or species habitat likely to occur within area.	None - No BIA defined
Longfin mako (*Isurus paucus*)	Migratory	Migratory	-	-	Species or species habitat likely to occur within area.	None - No BIA defined
Reef manta ray, Coastal manta ray (*Manta alfredi*)	Migratory	Migratory	-	-	Species or species habitat known to occur within area.	None - No BIA defined
Giant manta ray (*Manta birostris*)	Migratory	Migratory	-	-	Species or species habitat likely to occur within area.	None - No BIA defined
Scalloped hammerhead shark (*Sphyrna lewini)*	Conservation Dependent	-	-	-	Species or species habitat known to occur within area	None - No BIA defined

[1] Biologically Important Area
[2] The Wildlife Conservation (Specially Protected Fauna) Notice 2018 has been transitioned under regulations 170, 171 and 172 of the Biodiversity Conservation Regulations 2018 to be the lists of threatened, extinct and specially protected species under Part 2 of the BC Act.

5.1. Regional Surveys

Within the combined EMBA a number of important geographical areas for fish exist.

5.1.1. Northwest Shelf Province

The demersal zone of the North West Shelf (which includes the Northwest Province and Northwest Shelf Province) hosts a diverse assemblage of fish of tropical Indo-west Pacific affinity, with up to 1,400 species known to occur, with a great proportion of these occurring in shallow coastal waters (Allen et al., 1988). Last et al. (2005) and Fox and Beckley (2005) described the North-west Province as being characterised by a high level of endemism and species diversity.

Pelagic fish in the Northwest Shelf Province include tuna, mackerel, herring, pilchard and sardine, and game fish such as marlin and sailfish (BBG, 1994; Brewer et al., 2007), some of which are targeted by both commercial and recreational fishers. In particular, adult and juvenile southern bluefin tuna are thought to migrate through the North West Shelf on their way to and from spawning grounds in the north-eastern Indian Ocean. However, the timing of these migrations and the use of regional currents to assist their migration is still unclear. The oceanic waters of the North West Shelf are also believed to provide important spawning and nursery grounds for a number of large pelagic fish species. **Table 3** provides a summary of the key fish species and likely timing of their spawning in the region (DoF correspondence).

5.1.2. Northwest Shelf Transition

Creek systems, mangroves and rivers, and ocean beaches within this region provide habitat for a variety of species including barramundi, tropical emperors, mangrove jack, trevallies, sooty grunter, threadfin and cods (Fletcher and Santoro, 2013). The offshore atolls and the continental shelf waters in the Northwest Shelf Transition are also geographically important for fish species. They support species of recreational and commercial interest, including saddle-tail snapper and red emperor, cods, coral and coronation trout, sharks, trevally, tuskfish, tunas, mackerels and billfish (Gaughan et al., 2019).

Table 3: Spawning and aggregation times of key commercially caught fish species within the Northwest Shelf

Species		Month											
Species Common Name	Species Latin Name	J	F	M	A	M	J	J	A	S	O	N	D
Blacktip shark	*Carcharhinus tilstoni* and *C. limbatus*	■										■	■
Goldband snapper	*Pristipomoides multidens*	■	■	■	■	■					■	■	■
Rankin cod	*Epinephelus multinotatus*			■	■			■	■	■	■	■	■
Red emperor	*Lutjanus sebae*	■	■	■	■	■	■		■	■	■	■	■
Sandbar shark	*Carcharhinus plumbeus*		■		■								
Spanish mackerel	*Scomberomorus commerson*									■	■	■	■
Pink snapper	*Pagrus auratus*					■	■	■					

Species		Month											
Species Common Name	Species Latin Name	J	F	M	A	M	J	J	A	S	O	N	D
Baldchin groper	*Choerodon rubescens*												
Crystal (snow) crab	*Chaceon spp.*												
King George whiting	*Sillaginodes punctatus*												
Spangled emperor	*Lethrinus nebulosus*												
Pearl oyster	*Pinctada maxima*												
Blue-spotted emperor	*Charaxes cithaeron*												
Dusky whaler	*Carcharhinus obscurus*	May occur throughout the year											
Whiskery shark	*Furgaleus macki*												
Gummy shark	*Mustelus antarcticus*	Peak pupping periods unknown											
Fish	Other species	Timing of spawning activity varies between species											

5.1.3. Timor Province

The diversity of demersal fish assemblages on the continental slope in the Timor Province (as well as the Northwest Transition and the Northwest Province) is high compared to elsewhere along the Australian continental slope (DSEWPaC, 2012). Elements of the Timor Province are not well known, due to limited survey data in the northern limits of the region. The province is geographically extensive and includes 418 fish species, 64 of which are endemic to the region (Last et al., 2009). Key indicator species include *Bembrops nelsoni*, *Bythaelurus* sp., *Halicmetus* sp., *Malthopsis* spp, *Neobythites australiensis*, *Nobythites bimaculatus*, *Neobythites macrops*, *Neobythites soelae*, *Parapterygotrigla* sp., *Physiculus roseus* (Last et al., 2005).

Scott and Seringapatam Reefs are regionally important for the diversity of their fauna, including 558 fish species (Department of the Environment (DoE), 2014). Scott Reef has enormous habitat diversity and is considered a hot spot for fish, with five endemic species (DoE, 2014a). Scott Reef has biogeographic significance due to the presence of species which are at or close to the limits of their geographic ranges, including fish known previously only from Indonesian waters such as cardinalfish, azure damselfish (*Chrysoptera hemicyanea*), comb-tooth blenny (*Escnius schroederi*) and several Gobiids (DoE, 2014a).

The diversity of fish at Ashmore Reef is also higher than other comparable reefs in the bioregion with over 760 species recorded (Russell et al., 2005; Kospartov et al, 2006). The majority of fish species are shallow water, benthic taxa that typically inhabit depths down to 100 m and are widely distributed throughout the Indo-West Pacific (Russell et al., 2005). The most species rich groups are gobies (Gobiidae), damselfishes (Pomacentridae), wrasses (Labridae), cardinal fishes (Apogonidae), moray eels (Muraenidae), butterflyfishes (Chaetodontidae), and rockcods and groupers (Serranidae) (Allen, 1989; Russell et al., 2005).

5.1.4. Timor Transition

Records show that the Timor Transition hosts at least 284 demersal fish species (DEWHA, 2008c). The Timor Transition is also known to have a number of pelagic species that are prominent in the open water environment, including some which also have pelagic larval stages in the area (DEWHA, 2008c). The North Marine Bioregional

Plan Profile specifically describes pelagic species found within the trough of the Timor Transition including snaggle-teeth fish, hatchet fish and lantern fish (DEWHA, 2008c). The soft-edge/slope of the Timor Transition is also known to support whale sharks and threadfin fish species, with the canyons and channels having distance genetic stocks of red snapper (DEWHA, 2008c).

5.1.5. Northern Shelf Province

Records of the fish species in the Northern Shelf Province show that the majority of available information shows an abundance of fish species in the Gulf of Carpentaria, which is outside the combined EMBA. However, other fish species, including sharks and sawfish are known to occur within the estuarine waters and coastal waters of the Northern Shelf Province (DEWHA, 2008c).

Within the combined EMBA, the Arafura Shelf supports a number of submerged reefs that are used for breeding and aggregation of a number of fish species including mackerel, mangrove jack and snapper (DEWHA, 2008c). Sea snakes and shark species have also been observed in the reef areas (DEWHA, 2008c). Furthermore, the Canyons of the Arafura Depression key ecological feature, which is also within the combined EMBA, is specifically identified as attracting aggregations of predatory fish, whale sharks and sawfish (DEWHA, 2008c).

5.2. Syngnathids

The EPBC Protected Matters search also identified 35 listed marine species of fish which are largely from the family Syngnathidae (**Appendix A**). Syngnathids are a group of bony fishes that include seahorses, pipefishes, pipehorses and sea dragons, although taxonomic uncertainty still surrounds a number of these (DEWHA, 2012a). Knowledge about the distribution, abundance and ecology of syngnathids is limited, although no species is currently listed as threatened or migratory.

5.3. Sharks, Rays and Sawfishes

The diversity of marine environments in the waters within the NWMR has led to a rich fauna of cartilaginous fish (sharks and rays). Of the approximately 500 shark species found worldwide, 19% (94) are found in the region (DEWHA, 2008a). The EPBC Act Protected Matters search (**Appendix A**) identified six species of shark and three species of sawfishes listed as threatened within the EMBA (**Table 2**), including:

- Grey nurse shark (*Carcharias taurus*)
- Great white shark (*Carcharodon carcharias*)
- Northern river shark (*Glyphis garricki*)
- Whale shark (*Rhincodon typus*)
- Speartooth shark (*Glyphis glyphis*)
- Dwarf sawfish (*Pristis clavata*)
- Freshwater sawfish (*Pristis pristis*)
- Green sawfish (*Pristis zijsron*)
- Scalloped hammerhead shark (*Sphyrna lewini)*

Stingrays are found in Australia's coastal waters throughout the combined EMBA, primarily occupying shallow benthic habitats. Some nearshore and intertidal habitats, particularly in regions of northern Australia that experience greater tidal ranges have been identified as important nursery areas for many of these species (DBCA, 2014).

The Biologically Important Areas (BIAs) for relevant species detailed above are illustrated in **Figure 7.**

5.3.1. Grey Nurse Shark

The grey nurse shark (*Carcharias taurus*) is listed as vulnerable under the EPBC Act and the BC Act *and* may be found within the combined EMBA. In Australia, the grey nurse shark is now restricted to two populations, one on the east coast from southern Queensland to southern NSW and the other is predominantly found around the

southwest coast of WA but has been recorded on the North West Shelf (DEWHA, 2012b; Pogonoski et al., 2002). It is believed that the east and west coast populations do not interact, and ongoing research will probably confirm that the populations are genetically different (Last and Stevens, 2009).

While it is thought that grey nurse sharks have a high degree of site fidelity, some studies (McCauley, 2004) suggest that grey nurse sharks move between different habitats and localities, exhibiting some migratory characteristics. In certain areas grey nurse sharks are vulnerable to localised pressure due to high endemism. The status of the west coast population is poorly understood although they are reported to remain widely distributed along the WA coast and are still regularly encountered, albeit with low and indeterminate frequency (Chidlow et al., 2006).

Grey nurse sharks are often observed hovering motionless just above the seabed, in or near deep sandy-bottomed gutters or rocky caves, and in the vicinity of inshore rocky reefs and islands (Pollard et al., 1996). The species has been recorded at varying depths but is generally found between 15–40 m (Otway & Parker, 2000). Grey nurse sharks have also been recorded in the surf zone, around coral reefs, and to depths of around 200 m on the continental shelf (Pollard et al., 1996). Grey nurse sharks feed primarily on a variety of teleost and elasmobranch fishes and some cephalopods (Gelsleichter et al., 1999; Smale, 2005).

No grey nurse shark BIAs were identified in the combined EMBA.

5.3.2. Great White Shark

The great white shark (*Carcharodon carcharias*) is listed as vulnerable and migratory under the EPBC Act *and* is listed as vulnerable under the BC Act and may be found within the combined EMBA. In Australia, great white sharks have been recorded from central Queensland around the south coast to northwest WA but may occur further north on both coasts (Last and Stevens, 2009). There are no known aggregation sites for white sharks in the North-west marine region, but the species has been recorded in North West Shelf waters during humpback migrations (DEWHA, 2012b). They are widely but not evenly distributed in Australian waters and are considered uncommon to rare compared to most other large sharks (CITES, 2004).

Study into great white shark populations is difficult (Cailliet, 1996) given the uncertainty about their movements, emigration, immigration and difficulty in estimating the rates of natural or fishing mortality.

Great white sharks can be found from close inshore around rocky reefs, surf beaches and shallow coastal bays to outer continental shelf and slope areas (Pogonoski et al., 2002). They also make open ocean excursions and can cross ocean basins (for instance from South Africa to the western coast of Australia and from the eastern coast of Australia to New Zealand). Great white sharks are often found in regions with high prey density, such as pinniped colonies (DEWHA, 2009).

No great white shark BIAs were identified in the combined EMBA.

5.3.3. Northern River Shark

The northern river shark (*Glyphis garricki*) is listed as endangered under the EPBC Act and is one of the rarest species of shark in the world. Adults are only recorded in marine habitats, whereas neonates, juveniles and subadults recorded in freshwater, estuarine and marine environments. It is also listed as a Priority 1 conservation species in WA and as Endangered under the NT TPWC Act.

The associated recovery plan (Sawfish and River Sharks Multispecies Recovery Plan, Commonwealth of Australia, 2015) identifies adults and juveniles are being known in WA marine waters north of Derby. Pupping and juvenile sharks are identified as known to occur in Cambridge Gulf and pupping is also identified as likely to occur in King Sound. Under the associated recovery plan all areas where aggregations of individuals have been recorded displaying biologically important behaviours such as breeding, foraging, resting or migrating are considered critical to the survival of the species unless population data suggests otherwise.

5.3.4. Whale Shark

The whale shark (*Rhincodon typus*) is listed as vulnerable and migratory under the EPBC Act and is also listed as a specially protected species under the BC Act as a species of special conservation interest (conservation dependent fauna). The species is also classified as vulnerable on the World Conservation Union's Red List of Threatened Species (Norman, 2005) and are protected under the WA *Conservation and Land Management Act 1984, NT TPWC Act* and *WA Fish Resources Management Act 1994*.

The whale shark is the largest of all fish (>18 m; Borrell et al., 2011; Chen et al., 1997; Compagno, 2001) and is a migratory species with worldwide geographical ranges between 30º N and 35º S (Last and Stevens, 2009). Whale sharks are mostly epipelagic, whereby they spend a large amount of time in the top 200 m of the ocean (Tyminski et al., 2015), with a significant portion being spent at surface (<20 m) (Rowat & Brooks, 2012). This leads to an increased potential risk of vessel collision, which has been demonstrated from tracking data of 348 individuals (across all areas of distribution) showing a 92% horizontal and nearly 50% vertical space overlap with persistent large vessel (>300 gross tons) traffic (Womersley et al., 2022). There is a general lack of knowledge on many aspects of whale shark biology, however, the species is known to have a slow rate to sexual maturity, with field-based studies from the Maldives estimating male sexual maturity to be approximately 25 years (Perry et al., 2018), with females potentially maturing even later (Pierce et al., 2021). This 'slow' life-history strategy places whale sharks at increased vulnerability to anthropogenic impacts (Pierce et al., 2021).

The species is oceanic but often forms aggregations in coastal waters at sites throughout the tropics. Typically, these aggregations are seasonal and often coincide with specific productivity events that are a focus of feeding for the animals. For example, whale sharks aggregate to feed on dense swarms of copepods in Baja California (Clark and Nelson, 1997), fish spawn off Belize (Heyman et al., 2001) and red crab larvae at Christmas Island (Meekan et al., 2009). However, recent studies analysing fatty acids within whale shark tissue, suggest the species may also feed on benthic food sources, such as floating macroalgae (Meekan et al*.,* 2022; Courturier et al*.,* 2013*;* Marcus et al., 2016).

Whale sharks are known to be highly migratory with migrations of 13,000 km being recorded (Eckert and Stewart, 2001). Research on the migration patterns of whale sharks in the western Indian Ocean, and isolated and infrequent observations of individuals, indicate that a small number of the Western Australian population migrate through the North West Shelf. Wilson et al. (2006) tagged 19 whale sharks in 2003 and 2004, with long term movements patterns successfully recorded from six individuals. All travelled north-east into the Indian Ocean after departing Ningaloo Reef, with one tracked to Ashmore Reef and another to Scott Reef. Whale sharks are occasionally observed from Santos'' offshore oil and gas facilities on the North West Shelf (Harriet Alpha and Stag platforms). In general, migration along the northern WA coastline broadly follows the 200 m isobath and typically occurs between July and November (DoE, 2015).

A common method for monitoring individual whale sharks is the use of variations in spot patterns, which has recently been tested to be 100% successful based on 154 photographic and genetic markers (Meenakshisundaram, 2021).

A biologically important area for whale sharks is located in northern WA, offshore of the Kimberley coastline, and broadly follows the 200 m isobath. The relevant whale shark BIA in the combined EMBA are detailed in **Table 4** and is shown in **Figure 7.**

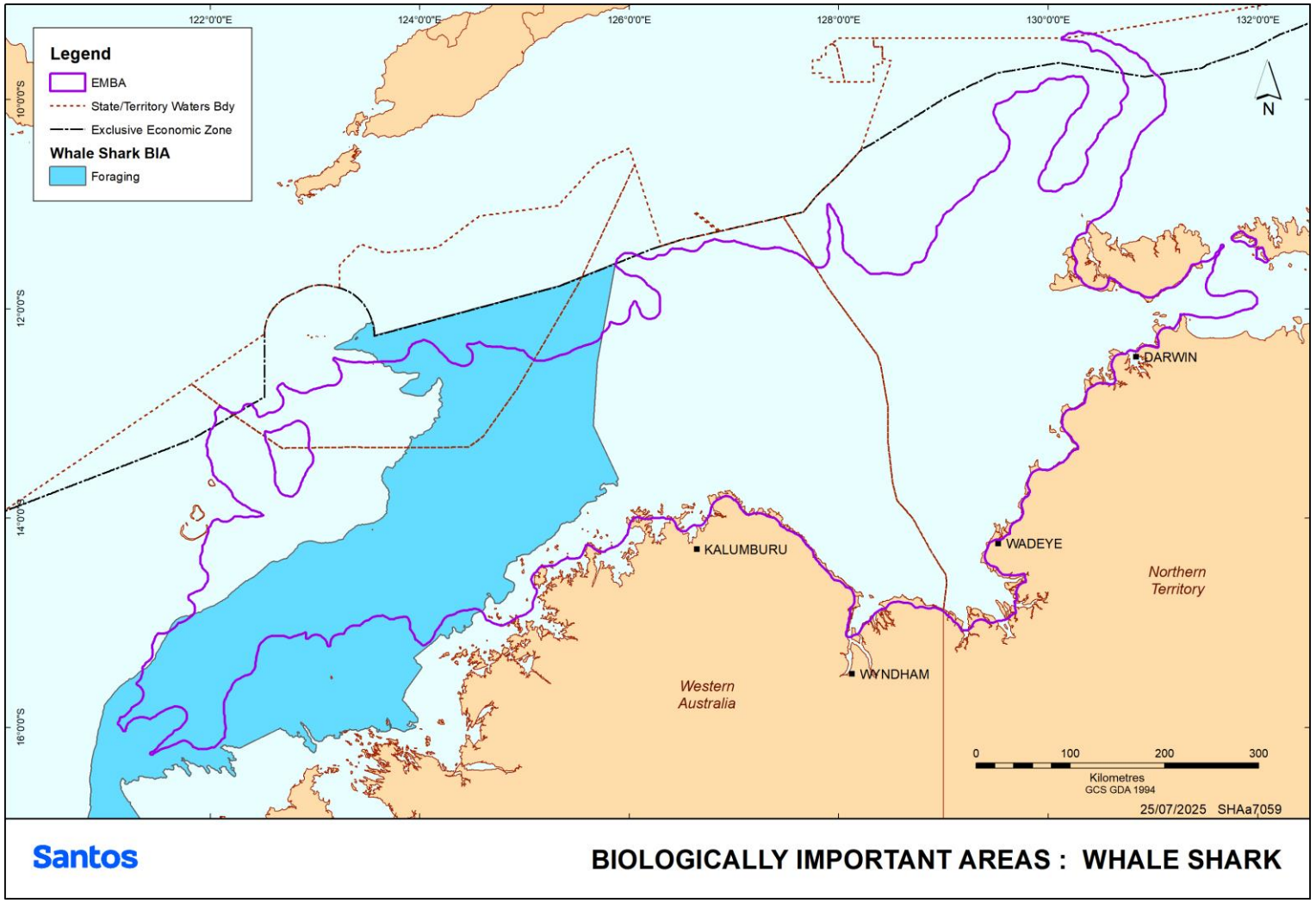


Figure 7: Biologically Important Areas – Whale Shark

5.3.5. Speartooth Shark

The speartooth shark (*Glyphis glyphis)* is a medium sized shark found in tidal rivers and estuaries within the Northern Territory and Queensland (Stevens et al., 2005). It is listed as critically endangered under the EPBC Act and Vulnerable under the NT TPWC Act.

There are three distinct geographical locations where the speartooth shark is known to occur with only one of these areas within the combined EMBA, the Van Diemen Gulf.

5.3.6. Dwarf Sawfish

The dwarf sawfish (*Pristis clavata*) is listed as vulnerable under the EPBC Act and thought to be restricted to Australia (DoE, 2014b). It is also listed as a Priority 1 conservation species in WA and as Vulnerable in the NT. The Australian distribution of the dwarf sawfish is considered to extend across northern Australia and along the Kimberley and Pilbara coasts (Last and Stevens, 2009; Stevens et al., 2005). However, the majority of records of dwarf sawfish in WA and the NT have come from shallow estuarine waters of the Kimberley region which are believed to be nursery (pupping) areas, with immature juveniles remaining in these areas up until three years of age (Thorburn et al., 2004). Adults are known to seasonally migrate back into inshore waters (Peverell, 2007); although it is unclear how far offshore the adults travel as captures in offshore surveys are very uncommon. The species' range is restricted to brackish and salt water (Thorburn et al., 2007).

The recovery plan identifies pupping as known to occur in King Sound, Cambridge Gulf and 80 Mile Beach, none of which are located within the combined EMBA. Pupping for this species is likely to occur at a number of locations along the Pilbara and Kimberley coastline (Commonwealth of Australia, 2015). Under the associated recovery plan all areas where aggregations of individuals have been recorded displaying biologically important behaviours such as breeding, foraging, resting or migrating are considered critical to the survival of the species unless population data suggests otherwise.

5.3.7. Freshwater and Green Sawfish

The freshwater sawfish (*Pristis pristis) (*also previously listed as the Largetooth sawfish*)* and green sawfish (*Pristis zijsron)* are listed as vulnerable under the EPBC Act. The freshwater sawfish is listed as a Priority 3 conservation species in WA, while the green sawfish is listed as Vulnerable under the BC Act and both species are listed as Vulnerable in the NT under the TPWC Act. The freshwater species are wider-ranging than the dwarf sawfish and are also found in the Indo-west Pacific (DoE, 2014c; DoE, 2014d). Important areas for sawfishes include King Sound, and the Fitzroy, Durack, Robinson and Ord rivers for the freshwater sawfish; and Cape Keraudren for the green sawfish (Stevens et al., 2008; Thorburn et al., 2007, 2008). None of these important areas overlap the combined EMBA.

Sawfishes generally inhabit inshore coastal, estuarine and riverine environments. The freshwater sawfish has been recorded in north-west Australia from rivers (including isolated water holes), estuaries and marine environments (Stevens et al., 2005). Newborns and juveniles primarily occur in the freshwater reaches of rivers and in estuaries, while most adult freshwater sawfish have been recorded in marine and estuarine environments (Peverell, 2005; Thorburn et al., 2007). It is believed that mature freshwater sawfish enter less saline waters during the wet season to give birth (Peverell, 2005) and freshwater river reaches play an important role as nursery areas (DoE, 2014c).

The green sawfish has predominantly been recorded in inshore coastal areas, including estuaries and river mouths with a soft substrate, although there have been records of sawfish offshore in depths up to 70 m (Stevens et al., 2005). This species does not occupy freshwater habitats (DoE, 2014d).

Short-term tracking has shown that green sawfish appear to have limited movements that are tidally influenced, and they are likely to occupy a restricted range of only a few square kilometres within the coastal fringe, with a strong association with mangroves and adjacent mudflats (Stevens et al., 2008). Sawfishes feed close to the benthos on a variety of teleost fishes and benthic invertebrates, including cephalopods, crustaceans and molluscs (Compagno & Last, 1999; Last & Stevens, 2009; Pogonoski et al., 2002; Thorburn et al., 2007, 2008).

No sawfish BIAs were identified in the combined EMBA.

5.3.8. Scalloped Hammerhead Shark

The scalloped hammerhead shark (*Sphyrna lewini*) is listed as conservation dependent under the EPBC Act and may be found within the combined EMBA. Globally distributed, in Australia, scalloped hammerhead sharks are found in both coastal and oceanic environments, in warm-temperate to tropical waters typically across the northern coastline. There are no aggregation sites identified for scalloped hammerhead sharks in the combined EMBA, however juveniles of the species utilise shallower nearshore habitats of northern Australia, and there are some indications that there may be important nursery habitats in the area. As a species that is slow to mature and has low fecundity, the scalloped hammerhead shark is vulnerable to overfishing, with its unique head morphology also increasing its likelihood of capture as bycatch in net fisheries. Although no longer targeted by commercial fisheries, global population declines have prompted recent changes to national and state-based approaches to stock management, including total allowable catch limits (Northern Territory) or complete prohibition of take (Queensland) (DCCEEW, 2024).

No scalloped hammerhead shark BIAs were identified in the combined EMBA.

5.3.9. Narrow Sawfish

The narrow sawfish (*Anoxypristis cuspidata*) is listed as migratory under the EPBC Act. It is a marine or marginal (brackish water) species found from inshore waters to a depth of 40 m (Compagno et al., 2006). Though details of its ecology are not precisely known, it probably spends most of its time on or near the bottom in shallow coastal waters and estuaries. A study showed the narrow sawfish to be the most abundant amongst the sawfish sampled in the Gulf of Carpentaria (Peverell, 2005) which holds some consistency with the offshore distribution of the species as shown by a study of Northern Prawn Fishery by-catch. Peverell (2005) also used catch data of offshore surface net fisheries to conclude that narrow sawfish also inhabit the mid-water column and can thus be described as a benthopelagic animal. The narrow sawfish is known to form aggregations of mature females during the months of October to November. Its Australian distribution is unclear though it is most common in the Gulf of Carpentaria with southward ranges extending the Pilbara Coast (circa 116°E), Western Australia (Last & Stevens, 2009).

5.3.10. Giant Manta Ray / Reef Manta Ray

The giant manta ray appears to be a seasonal visitor to coastal or offshore sites. Giant manta rays are often seen aggregating in large numbers to feed, mate, or clean. Sightings of these giant rays are often seasonal or sporadic but in a few locations their presence is a more common occurrence. This species is not regularly encountered in large numbers and, unlike some other rays do not often appear in large schools (>30 individuals) when feeding. Overall, they are encountered with far less frequency than the smaller manta species, despite having a larger distribution across the globe (IUCN, 2019).

The giant manta ray (*Mobula birostris*) occurs in tropical, sub-tropical and temperate waters of the Atlantic, Pacific and Indian Oceans. They are commonly sighted along productive coastlines with regular upwelling, oceanic island groups and particularly offshore pinnacles and seamounts. The giant manta ray is commonly encountered on shallow reefs while being cleaned or is sighted feeding at the surface inshore and offshore. It is also occasionally observed in sandy bottom areas and seagrass beds (IUCN, 2019).

The reef manta ray (*Mobula birostris*) has a circumtropical and sub-tropical distribution, existing in the Pacific, Atlantic and Indian Oceans. Within this broad range, however, actual populations appear to be sparsely distributed and highly fragmented. This is likely due to the specific resource and habitat needs of this species.

Overall population size is unknown, but subpopulations appear, in most cases, to be small (about 100–2,000 individuals). A proportion of the individuals in some populations undertake significant coastal migrations (IUCN, 2019). Since the species is migratory it is possible that individuals may be encountered in the EMBA, however, given that they generally do not aggregate in large groups, high numbers are not expected to be encountered.

5.3.11. Oceanic Whitetip Shark

The oceanic whitetip shark (*Carcharhinus longimanus*) is listed as migratory under the EPBC Act. The oceanic whitetip shark is widespread throughout tropical and subtropical waters of the world (30° N to 35° S) (IUCN, 2019). They are an oceanic and pelagic species that regularly occurs in waters of 18 to 28°C, usually >20°C (IUCN, 2019). Within Australian waters, they are found from Cape Leeuwin (Western Australia) through parts of the Northern Territory, down the east coast of Queensland and New South Wales to Sydney (Last and Stevens 2009). They are usually found in surface waters, though can reach depths of >180 m (Castro et al., 1999). They

have occasionally been recorded inshore but are more typically found offshore or around oceanic islands and areas with narrow continental shelves (Fourmanoir, 1961; Last and Stevens, 1994).

5.3.12. Shortfin Mako and Longfin Mako Sharks

The shortfin mako and longfin mako sharks are listed as migratory under the EPBC Act. The longfin mako is widely distributed but rarely encountered oceanic shark that ranges from Geraldton around the north coast to at least Port Stephens in New South Wales (DSEWPaC, 2012). The shortfin mako is an oceanic and pelagic species, although they are occasionally seen inshore. They are found throughout temperate seas but are rarely found in waters colder than 16°C.

5.4. Biologically Important Areas / Critical Habitat – Fishes and Sharks

BIAs are spatially defined areas where aggregations of individuals of a species are known to display biologically important behaviour such as breeding, foraging, resting or migration**.** BIAs are identified by DCCEEW; however, they have no legal status but are designed to assist decision making under the EPBC Act. They are not designed to identify protected areas but may inform such processes. **Table 4** below provides an overview of BIAs in the combined EMBA for fish and sharks.

The DCCEEW may make recovery plans for threatened fauna listed under the EPBC Act. The EPBC Act requires that 'habitat critical to the survival of the listed threatened species' is identified in recovery plans, and summary of relevant recovery plans is listed in **Section 13.2**. BIAs may overlap these sites but may be identified for other purposes. DCCEEW state that the criteria used to identify 'habitat critical to the survival of the species' are more complex than those used to identify BIA. Specifically, the Sawfish and River Sharks Multispecies Recovery Plan (DoEE, 2015) cites that *"all areas where aggregations of individuals have been recorded displaying biologically important behaviour such as breeding, foraging, resting or migrating, are considered critical to the survival of the species unless population survey data suggests otherwise"*.

In addition, both the EPBC Act and WA BC Act and associated regulations (2018) provide for the listing of critical habitat - habitat 'critical to the survival of the threatened species'. To date no critical habitat in WA has been listed under either Act. No provision is made under the TPWC Act for listing critical habitat.

Table 4: Biologically important areas – Fishes and Sharks

Species	Scientific name	Aggregation area and use	Specific geographic locations for species
Whale shark	*Rhincodon typus*	Foraging – Kimberley Region	Northward from Ningaloo along 200 m isobath

6. Marine Reptiles

Thirty-three species of listed marine reptiles under the Commonwealth EPBC Act are known to occur in Australian waters in the combined EMBA, according to the Protected Matters search (**Appendix A**). An examination of the species profile and threats database (DoEE, 2019) showed that some listed reptile species are not expected to occur in significant numbers in the marine and coastal environments in the combined EMBA due to their terrestrial distributions. Hence, these species are not discussed further.

Of the remaining reptile species identified in the Protected Matters search (**Appendix A**), nine are listed as threatened and seven are listed as migratory. These species are show in **Table 5** along with their WA and NT conservation listings (as applicable)[3]. BIAs within the combined EMBA area discussed in **Table 7**.

[3] An overview of WA fauna conservation codes is provided in **Section 5** (fish and sharks).

Table 5: EPBC listed marine reptile species in the combined EMBA

Species	Conservation Status				Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code	TPWC Act 1976		
Green turtle (*Chelonia mydas*)	Vulnerable Migratory	Vulnerable	-	Listed nationally	Breeding known to occur within area	Yes – refer to Table 7
Flatback turtle (*Natator depressus*)	Vulnerable Migratory	Vulnerable	-	Listed nationally	Breeding known to occur within area	Yes – refer to Table 7
Hawksbill turtle (*Eretmochelys imbricata*)	Vulnerable Migratory	Vulnerable	-	Vulnerable	Breeding known to occur within area	Yes – refer to Table 7
Loggerhead turtle (*Caretta caretta*)	Endangered Migratory	Endangered	-	Vulnerable	Foraging, feeding or related behaviour known to occur within area	Yes – refer to Table 7
Olive ridley turtle (*Lepidochelys olivacea*)	Endangered Migratory	Endangered	-	Vulnerable	Breeding known to occur within area	Yes – refer to Table 7
Leatherback turtle (*Dermochelys coriacea*)	Endangered Migratory	Vulnerable	-	Critically Endangered	Species or species habitat known to occur within area	None - No BIA defined
Short-nosed sea snake (*Aipysurus apraefrontalis*)	Critically Endangered	Critically Endangered	-	-	Species or species habitat likely to occur within area	None - No BIA defined
Leaf-scaled sea snake (*Aipysurus foliosquama*)	Critically Endangered	Critically Endangered	-	-	Species or species habitat may occur within area	None - No BIA defined

Species	Conservation Status				Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code	TPWC Act 1976		
Dusky sea snake (*Aipysurus fuscus*)	Endangered	-	-	-	Species or species habitat known to occur within area	None - No BIA defined
Salt-water crocodile (*Crocodylus porosus*)	Migratory	Migratory	-	-	Species or species habitat may occur within area	None - No BIA defined

6.1. Marine Turtles

Six species of marine turtle occur in, use the waters, and nest on sandy beaches, in and around the combined EMBA. These are the green turtle (*Chelonia mydas*), flatback turtle (*Natator depressus*), hawksbill turtle (*Eretmochelys imbricata*), loggerhead turtle (*Caretta caretta*), olive ridley turtle (*Lepidochelys olivacea)* and leatherback turtle (*Dermochelys coriacea*) (**Table 5**).

These six species are listed on the EPBC Act List of Threatened Species as either ‘endangered’ or ‘vulnerable’ and all six species are also listed as ‘migratory’. They are also listed as threatened species under the BC Act and the hawksbill turtle, loggerhead turtle and leatherback turtle are also protected under the NT TPWC Act.

A summary of the different habitat types used during the various life stages of marine turtle species identified in the combined EMBA is given in **Table 6.**

Figure 8 illustrates the BIAs for marine turtles (as defined in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017a) and **Figure 9** illustrates the interesting BIAs and habitat critical for relevant marine turtle species within the EMBA.

Table 6: Summary of habitat types for the life stages of the six marine turtle species in the combined EMBA (DSEWPaC, 2012b)

Life Stage		Green turtle	Flatback turtle	Hawksbill turtle	Loggerhead turtle	Olive ridley turtle	Leatherback turtle
Post-hatchling		Open ocean pelagic habitats (poorly studied for Australian populations)	Coastal waters (poorly studied for Australian populations)	Open ocean pelagic habitats (poorly studied for Australian populations)	Pelagic (poorly studied for Australian populations)	Pelagic (poorly studied for Australian populations)	Pelagic (no data for Australian populations)
Adult	Mating	Offshore from nesting beaches.	Currently unknown for North West Shelf region.	Offshore from nesting beaches.	Little is known for North West Shelf region but expected to occur either en-route or adjacent to nesting beaches.	Not recorded within North West Shelf region.	Not recorded within North West Shelf region.
	Nesting	Typically, high energy, steeply sloped beaches with deep sand and deep-water approach.	Typically, low-energy beaches that are narrow with a low to moderate slope. Beach approach obstructed by broad intertidal mud or limestone platforms.	Typically beaches close to nearshore coral reefs and sediment comprised of coarse sand and coral rubble.	Poorly studied for North West Shelf region by generally prefer high energy, relatively narrow, steeply sloped, coarse-grained beaches.	Not recorded within North West Shelf region.	Not recorded within North West Shelf region.
	Internesting	Shallow coastal waters within several km of nesting beach. Internesting buffers of 20 km identified around all nesting habitats.	Shallow nearshore waters within 5-60 km of nesting beach. Internesting buffers of 40-60 km identified around all nesting habitats.	Shallow coastal waters within several kilometres of nesting beach. Internesting buffers of 20 km identified around all nesting habitats.	Shallow coastal waters within several kilometres of nesting beach. Internesting buffers of 20 km identified around all nesting habitats.	Not recorded within North West Shelf region. Internesting buffers of 20 km identified around all nesting habitats.	Danger Point, Cobourg Peninsula. 20 km internesting buffer around nesting sites

Life Stage		Green turtle	Flatback turtle	Hawksbill turtle	Loggerhead turtle	Olive ridley turtle	Leatherback turtle
	Foraging	Neritic habitats associated with seagrass and algae, and mangrove habitats.	Turbid, shallow inshore waters, subtidal, soft-bottomed habitats of the continental shelf.	Subtidal and intertidal coral and rocky reef habitats of the continental shelf.	Subtidal and intertidal coral and rocky reefs, seagrass and deeper soft-bottomed habitats of the continental shelf.	Many feed within continental shelf waters, however it is not known if others are pelagic, as with the east Pacific population.	Mostly pelagic but will forage close to shore and over continental shelf in temperate waters.

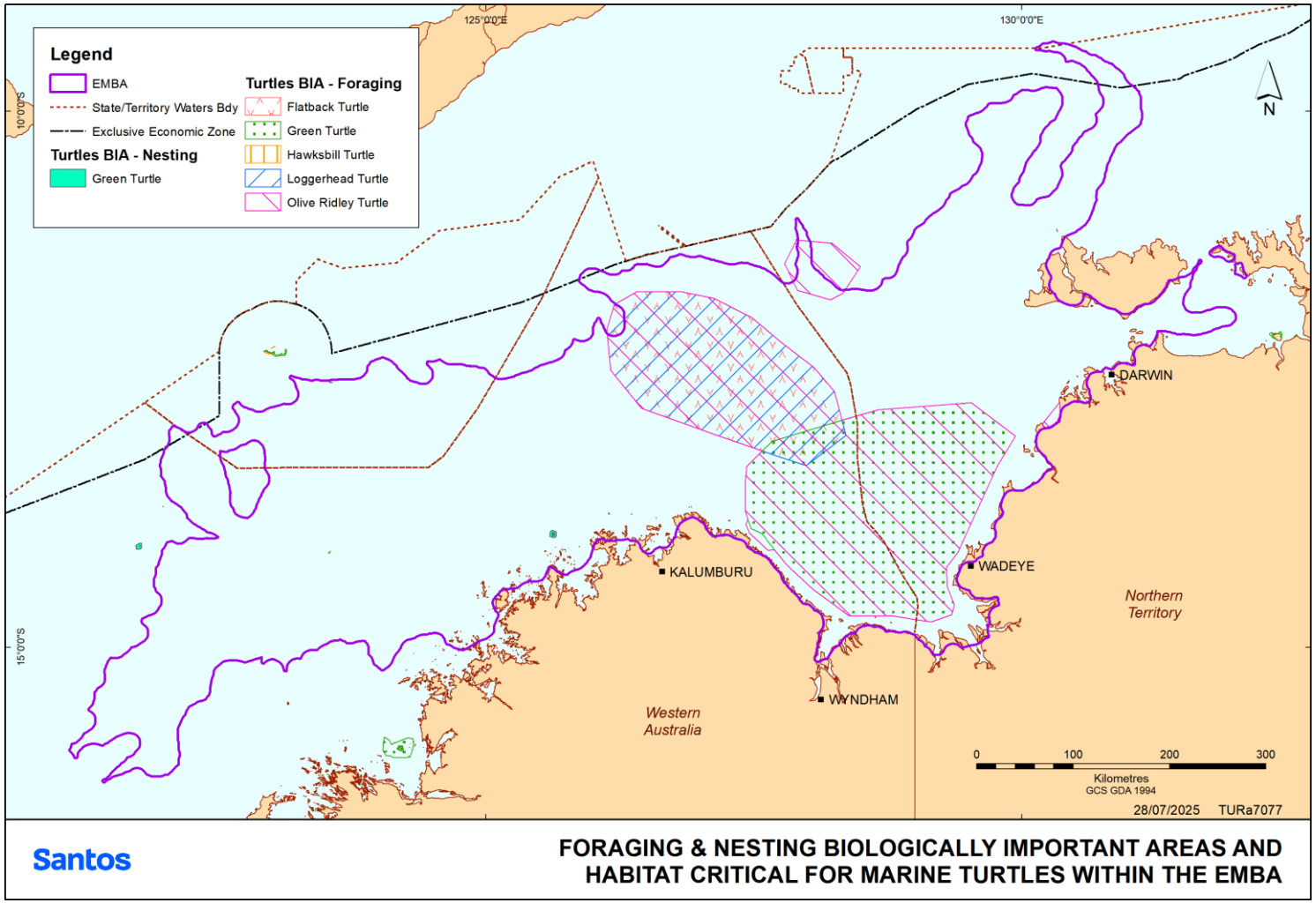


Figure 8: Foraging BIAs for marine turtles within the EMBA

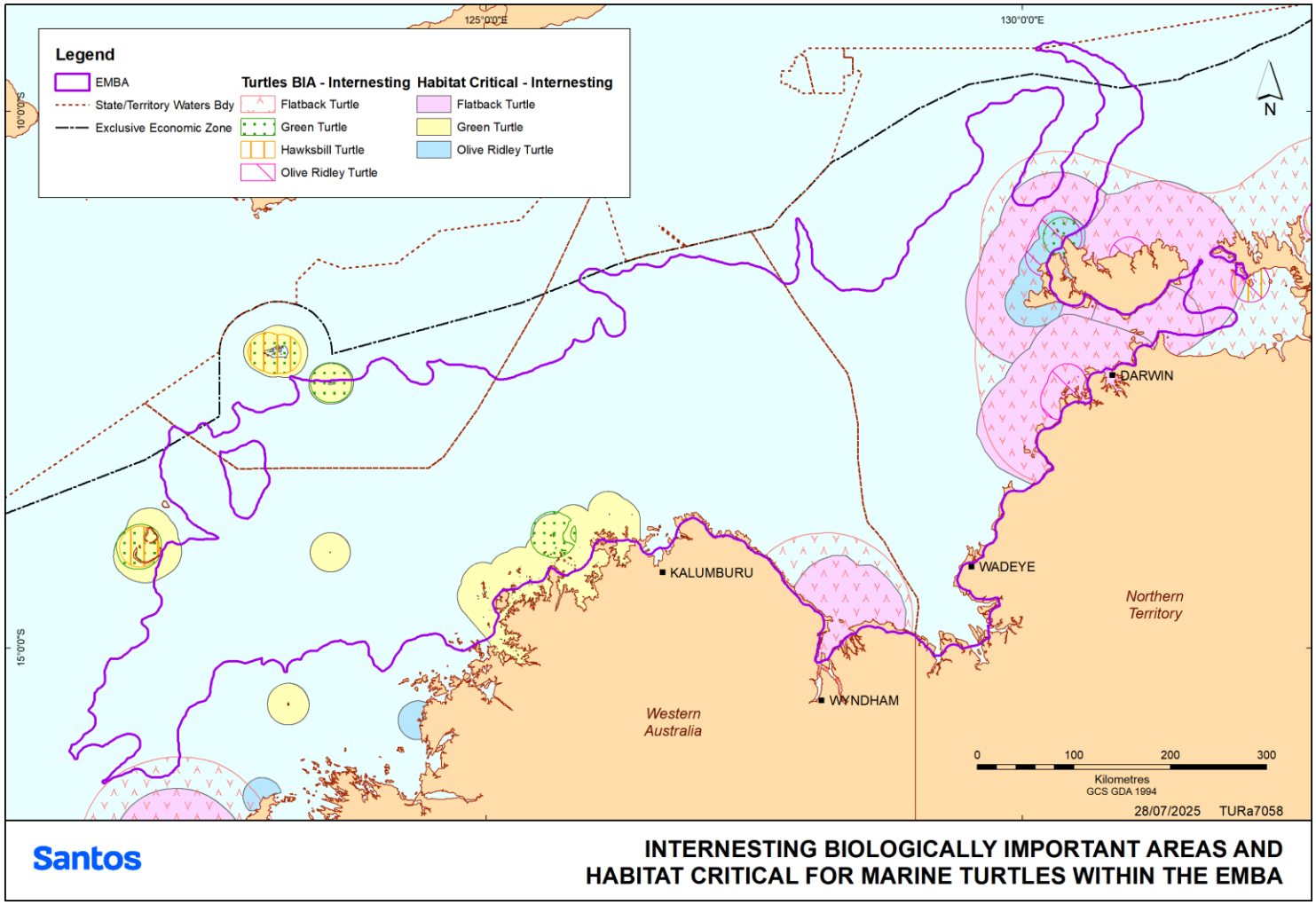


Figure 9: Marine turtle internesting BIAs and Habitat Critical within the EMBA

6.1.1. Loggerhead Turtle

The loggerhead turtle (*Caretta caretta*) has a worldwide distribution, living and breeding in subtropical to tropical locations (Limpus, 2008b). Breeding aggregations in Australia occur on both the east coast (Queensland and NSW) and the west. The annual nesting population in Western Australia is thought to be 3,000 females annually (Baldwin et al., 2003), and this is considered to support the third largest population in the world (Limpus, 2008b). Loggerhead turtles have one genetic breeding stock within Western Australia (Commonwealth of Australia, 2017a).

The WA distribution of sandy beach nesting areas extends from Shark Bay to the southern area of the North West Shelf, with occasional late summer nesting crawls recorded as far north as Barrow and Varanus Islands and the Lowendal and Rosemary Islands (DSEWPaC, 2012d). Major nesting locations include the Muiron Islands, the Ningaloo Coast south to Carnarvon and the islands around Shark Bay, which includes Dirk Hartog Island, one of the principal nesting and internesting sites in WA (Limpus, 2008). Loggerhead nesting and breeding occurs from November to March, with a peak in late December/early January (Limpus, 2008b). Foraging areas are widespread for loggerhead turtle populations and migrations from nesting to feeding grounds can stretch thousands of kilometres, including feeding grounds as far north as the Java Sea of Indonesia for the WA population (Limpus, 2008b). Loggerhead turtles are carnivorous and feed primarily on benthic invertebrates from depths of up to approximately 50 m to near shore tidal areas including areas of rocky and coral reef, muddy bays, sand flats, estuaries and seagrass meadows (Limpus, 2008b).

Loggerhead turtles from both WA and eastern Australia have been recorded foraging in the NT, and further afield in Indonesia and Papua New Guinea (Perez et al., 2022; Pendoley, 2023). In the Kimberley region, loggerhead turtles are thought to be transient or end-of-migration foragers with no documented nesting sites in the area (Tucker et al., 2021).

Figure 8 illustrates the BIAs and habitat critical (draft) for loggerhead turtles (as defined in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017a).

6.1.2. Green Turtle

Australian population of green turtles is estimated to be approximately 70,000 and is divided into seven genetically distinct breeding aggregations. The species is widespread and abundant in WA and NT waters with an estimated 20,000 individuals occurring, arguably the largest population in the Indian Ocean (Limpus, 2008a). Within Australia, green turtles typically nest, forage and migrate across tropical northern Australia (DCCEEW, 2023a). There are three distinct breeding stocks in WA waters which include: the North west Shelf stock, the Scott-Browse stock and the Ashmore Stock (Commonwealth of Australia, 2017a).

The North west Shelf population is one of the largest in the world and the most significant rookery is the western side of Barrow Island (Prince, 1994; Limpus, 2008a). Other principal rookeries include the Lacepede Islands, Montebello Islands, Dampier Archipelago, Browse Island and North West Cape (Prince, 1994; Limpus, 2008a; DSEWPaC, 2012b). See **Table 7** for a complete list.

Green turtles have also been recorded nesting in the Bonaparte or Van Diemen Gulf bioregions and some nesting has been recorded on the west coast of Bathurst Island in the Tiwi Islands and Melville Island. BIAs for Green turtles occur on the north coast of the Tiwi Islands and an internesting buffer has been defined 20 km from the Tiwi Islands with internesting expected between October and April (DoEE, 2017).

Green turtle nesting abundance and timing fluctuates significantly from year to year depending on environmental variables, locality and food availability (Pendoley Environmental, 2011). Nesting of green turtles has been recorded from August to March on Serrurier Island (Woodside, 2002), from December to March along coast adjacent to Ningaloo (CALM, MPRA, 2005a), from October to February on Varanus Island (Pendoley Environmental, 2011) and year-round on Barrow Island (Chevron, 2005 and 2008; Pendoley, 2005). Nesting on the Scott Reef-Sandy Islet and Browse Island has been observed all year round with peaks between December and January (Commonwealth of Australia, 2017a).

In northern Australia, fluctuations in green nesting numbers have been linked the Southern Oscillation Index (Limpus & Nicholls, 1994; Limpus & Nicholls, 1988) and sea surface temperatures (Solow et al., 2002). In the NT nesting sites occur mostly from the western end of Melville Island to near the border with Queensland (Northern Territory Government, n.d). There are also four nationally significant nesting sites in the NT, however only the Cobourg Peninsula nesting site overlaps the EMBA.(Northern Territory Government, n.d). The Cobourg Peninsula genetic stock of green turtles is the closest to those found within the combined EMBA on the Tiwi Islands. The nesting period for these are between October and April with the peak nesting period occurring between December and January.

Green turtles spend the first five to ten years of their life drifting on ocean currents, before moving to reside in shallower benthic habitats, including tropical coral and rocky reefs and seagrass beds. Green turtles have been known to migrate more than 2,600 km between feeding and breeding grounds (Limpus, 2008a).

Green turtles are omnivores, mainly feeding in shallow benthic habitats on seagrass and/ or algae, but are also known to feed on sponges, jellyfish and mangroves (Limpus, 2008a). Green turtles are unlikely to forage or dwell within deeper offshore waters due to the water depths; however, they may occasionally migrate through it with 86 % of post-nesting turtles being found to migrate to neritic foraging grounds and 14 % having local residency to their rookery in Western Australia (Ferriera et al., 2020).

Ferriera et al. (2020) spatial examination of inter-nesting green turtles found the existing BIA for encompassed the spatial extent, however the BIA is likely largely underestimated for foraging areas.

Figure 8 and **Figure 9** illustrates the BIAs and habitat critical (draft) for green turtles (as defined in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017a).

6.1.3. Hawksbill Turtle

Hawksbill turtles (*Eretmochelys imbricata*) have a global distribution throughout tropical and sub-tropical marine waters. The Western Australian stock is concentrated on the North West Shelf (Dampier Archipelago) (Limpus, 2009a) and is considered to be one of the largest hawksbill populations remaining in the world. The estimated number of nesting hawksbill turtles in WA waters is between 2,000 and 4,500 individuals (Morris, 2004). There is a second major population of Hawksbill turtles in Australia, which is genetically isolated from the North West Shelf population located along the Northern Territory coast and north-eastern Queensland (Northern Territory Government, n.d).

In WA, their nesting range is relatively small and does not overlap the EMBA, extending from the Muiron Islands to the Dampier Archipelago The most significant breeding areas, that support hundreds of nesting females annually, are around sandy beaches within the Dampier Archipelago, Montebello Islands, Lowendal Islands and Barrow Island (Pendoley, 2005; Limpus, 2009a).In the NT, nesting occurs on islands rather than on mainland beaches. In particular, NT nesting sites are concentrated around north-eastern Arnhem land and Groote Eylandt (Northern Territory Government, n.d). Within the combined EMBA, nesting is known to occur at Ashmore Reef. Although Scott Reef has been described as a nesting beach for hawksbill turtles, this is based on the tagging and recapture of a single hawksbill at this location (Guinea, 2009). Small numbers of Hawksbill turtles also nest on Cocos (Keeling) Islands (mainly the north island). However, thousands of individuals forage in the shallow reef environments feeding on encrusting algae and sessile invertebrates (Brewer et al., 2009).

Nesting is reported to occur between October and February in WA (Commonwealth of Australia, 2017a). Hawksbill turtles have been observed breeding on the North West Shelf between July and March with peak nesting activity around the Lowendal Islands between October and December (Limpus, 2009a). In the NT nesting is reported to occur from July – December (Chatto, 1997, 1998).

Female hawksbills skip annual breeding opportunities (Kendall & Bjorkland, 2001), presumably due to high energy demands of breeding (Chaloupka & Prince, 2012).

Individuals may migrate up to 2,400 km between their nesting and foraging grounds (DSWEPaC, 2012a), however a recent tagging study showed that turtles migrating from WA rookeries remain on the continental shelf (< 200 m depth) and within Australian waters during their inter-nesting, migrating and foraging phases (Fossette et al., 2021). Satellite tracking of nesting turtles on Varanus Island (788 km SW) and Rosemary Island has shown adult turtles to feed between 50 and 450 km from their nesting beaches (DSWEPaC, 2012a).

Adults tend to forage in tropical tidal and sub-tidal coral and rocky reef habitat where they feed on an omnivorous diet of sponges, algae, jelly fish and cephalopods (DSWEPaC, 2012a). Hawksbill turtles are unlikely to spend significant time within offshore waters as it is too deep to act as a feeding ground. However, it is likely they may migrate through those areas.

In order to better quantify and map the important areas used by Hawksbill turtles, AIMS was engaged in 2020 to lead the North West Shoals to Shores Research Program. During this program, AIMS combined available existing satellite tracking data for 20 adult turtles with data from newly deployed satellite tags on 20 adults in the Lowendal Islands and Dampier Archipelago (AIMS, 2021). Results showed that critical habitat designated by the Australian Government for inter-nesting largely protects the nesting areas calculated (AIMS, 2021), however the existing foraging BIAs do not include the majority of foraging areas calculated (AIMS, 2021). While approximately 23% of the hawksbill turtles foraging distribution occurred within MPAs, the existing BIAs are largely underestimating the important foraging areas for the turtles (AIMS, 2021). This supports the results of a joint study conducted by Fossette et al. (Fossette et al., 2021), which found only 10% of foraging areas utilised by 42 nesting turtles (between 2000 and 2017) were encompassed by the designated foraging BIA. Fossette et al. (2021) found that the highest overlap of individual turtles occurred within the Migratory BIA corridor.

Figure 8 and **Figure 9** illustrates the BIAs and habitat critical for hawksbill and olive ridley turtles (as defined in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017a).

6.1.4. Flatback Turtle

The flatback turtle (*Natator depressus*) has an Australasian distribution, with all recorded nesting beaches occurring within tropical to sub-tropical Australian waters. One third of the total breeding for the species occurs in Western Australia (WA) (Limpus, 2007). The management of the flatback turtle in Australia is broken up into five stocks currently described around Australia; eastern Queensland, Arafura Sea, Cape Domett, South-west Kimberley and Pilbara stocks (Commonwealth of Australia, 2017). The northern stock at Cape Domett breeds mainly in winter (July to September) (Commonwealth of Australia, 2017a). The South-west Kimberley stock is also characterised by summer nesting. Populations in western NT are thought to nest all year round with nesting density reaching its peak in July. Populations in northern Australia also nest all year round, with nesting density reaching its peak between June and August (Limpus, 2007).

The southern WA nesting population of flatback turtles occurs from Exmouth to the Lacepede Islands off the Kimberley coast (DSEWPaC, 2012c). NT populations are typically found in the Gulf of Carpentaria, western Torres Strait, Wellesley Islands Group and Sand Islet.

Flatback turtles nesting within the NT are from the Arafura Sea breeding and genetic stock, with unknown long-term trends for this stock (Commonwealth of Australia, 2017). Nesting has been recorded on the Tiwi Islands, with flatback turtles the predominant nesting species on the southern and south-western beaches that fall within the EMBA (Pendoley, 2023). The greatest proportion of activity occurs on the west coast of Bathurst Island (Chatto & Baker, 2008) with nesting females numbering around 11 to 100 per year, which is comparable to or smaller than other nesting sites of the Arafura Sea genetic stock. Nesting and internesting occurs year-round with a peak during June and August, and hatchling emergence peaking between July and September (Commonwealth of Australia, 2017).

Unlike other sea turtles, the flatback turtle lacks a wide oceanic dispersal phase and adults tend to be found in soft sediment habitats within the continental shelf of northern Australia (DSEWPaC, 2012b). Despite having geographically large foraging ranges (>1500 km), genetic differentiation suggests strong natal homing for both males and females (Turner Tomaszewicz et al., 2022). Little information is known on the diets of flatback turtles (DSEWPaC, 2012b); however, they are believed to forage on primarily soft-bodied invertebrates (Commonwealth of Australia, 2017a). Flatback turtles also differ from other species of sea turtles in maturing at a larger size and a likely younger age (<20 years) in comparison to other sea turtle species, indicating they may have a more rapid growth rate in their juvenile (similar to the leatherback turtle, a species with their own family) (Turner Tomaszewicz et al., 2022). This information from Turner Tomaszewicz et al., 2022 may provide valuable insight for ongoing population assessments and future recovery plans (Turner Tomaszewicz et al., 2022).

Figure 8 and **Figure 9** illustrates the BIAs and habitat critical (draft) for flatback turtles (as defined in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017a).

6.1.5. Leatherback Turtle

The leatherback turtle *(Dermochelys coriacea*) has the widest distribution of any marine turtle and can be found from tropical to temperate waters throughout the world (Márquez, 1990). There are no major leatherback turtle centres of nesting activity that have been recorded in Australia, although scattered isolated nesting (one to three nests per annum) occurs in southern Queensland and the Northern Territory (Limpus and McLachlin, 1994).

There have been several records of leatherback turtles off the coast of WA and NT, but no confirmed nesting sites (Limpus, 2009c). Turtle observations have mainly occurred south of the North West Shelf area and in open waters (>200 m deep) (Limpus, 2009c). Due to the lack of nesting sites around Australian coastal waters, it is presumed that leatherback turtles observed in Australian waters are migrating from neighbouring countries to utilise feeding grounds in Australia (Limpus, 2009c).

The leatherback turtle will feed at all levels of the water column and is carnivorous feeding mainly on pelagic, soft-bodied marine organisms such as jellyfish, which occur in greatest concentrations in areas of upwelling or convergence (DSEWPaC, 2012d). The leatherback turtle is a highly pelagic species with adults only going ashore to breed. Although the leatherback turtle is a highly pelagic species, they venture close to shore mainly during the nesting season and typically forage in waters <50 m deep, but this is dependent on the distribution of their prey (DCCEEW, 2023a; Eckert, 2006).

No BIAs for this species exists within the EMBA. The closest BIA was identified in the vicinity of Danger Point, Cobourg Peninsula, approximately 30 km east of the EMBA.

6.1.6. Olive Ridley Turtle

Olive ridley turtles (*Lepidochelys olivacea*) are the least common turtle species encountered with critical nesting habitat occurring near Vulcan Island, Darcy Island, Prior Point and Llanggi and Cape Leveque (Commonwealth of Australia, 2017). The greatest concentration of olive ridley turtles has been recorded around the northwest tip of Melville Island, on Seagull Island off the northwest coast of the Tiwi Islands, and from Lethbridge Bay to Brenton Bay on Melville Island (Chatto and Baker, 2008). The turtles found nesting on the Tiwi Islands is the NT genetic stock whereby the long-term trends of this genetic stock are currently unknown (Commonwealth of Australia, 2017). However, the number of females nesting on the Tiwi Islands are considered significant at the genetic stock, national and international level. Nesting of the NT genetic stock can occur year-round with a peak between April and June, and hatchling emergence peaking between June and August (Commonwealth of Australia, 2017). After nesting, female olive ridley turtles migrate to foraging grounds.

Internesting habitat, critical to the survival of the olive ridley turtle, encompasses nearshore waters along the north, west and east coasts of the Tiwi Islands. Satellite tracking on a small sample of internesting olive ridley turtles in the region recorded that the individuals remained close to shore (waters depths typically less than 55 m deep) and within 37 km of the nesting beach during the internesting interval (Whiting et al., 2007a,b; Whiting et al., 2005).

The species is known to forage within the shallow benthic habitats of northern WA, the NT and Timor Sea (Limpus, 2009), however, it displays unusual behaviour patterns compared to other sea turtles, in being capable of deeper (up to 140 m), benthic and exceptionally long (>2 hour) dives (McMahon et al., 2007). This trait, combined with their long-distance movement patterns (Polovina et al., 2004) is thought to be indicative of less specialist foraging (McMahon et al., 2007). Their extensive movements and variability in migration patterns suggest this species may be susceptible to a wide range of human activities (McMahon et al., 2007).

BIAs for this endangered species are known to occur in the vicinity of Joseph Bonaparte Depression (DSEWPaC, 2012b; Commonwealth of Australia, 2017a). See Figure 8 and **Figure 9** for identified olive ridley turtle BIAs and critical habitats (draft) within the combined EMBA (as defined in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017a).

6.2. Sea Snakes

Storr et al. (1986) estimate nine genera and 22 of the ~70 global species of sea snakes occur in WA waters, with 25 listed marine sea snake species being recorded in the search area of WA and NT waters (**Appendix A**). Little is known of the distribution of individual species, population sizes or aspects of their ecology. Sea snakes are essentially tropical in distribution, and habitats reflect influences of factors such as water depth, nature of seabed, turbidity and season (Heatwole and Cogger, 1993). Sea snakes are widespread throughout waters of the North West Shelf in offshore and nearshore habitats. They can be highly mobile and cover large distances or they may

be restricted to relatively shallow waters and some species must return to land to eat and rest. In the north-west region of Western Australia, no BIAs have been designated for sea snakes. However, both Ashmore Reef and Cartier Island are characterised for both a high density and high diversity of sea snakes (DSEWPaC, 2012b). The limited evidence available suggests that there are no sea snakes in at least the coastal waters of Cocos (Keeling) Islands, and few sea snake sightings in the waters of the Christmas Island territory (Brewer et al., 2009).

Three species of sea snakes listed as threatened under the EPBC Act were identified in the Protected Matters search within the combined EMBA (**Appendix A**):

- Short-nosed sea snake (*Aipysurus apraefrontalis*)
- Leaf-scaled sea snake (*Aipysurus foliosquama*).
- Dusky sea snake (*Aipysurus fuscus*)

6.2.1. Short-nosed Sea Snake

The short-nosed sea snake (*Aipysurus apraefrontalis*) is listed as critically endangered under the EPBC Act and the BC Act. It is a fully aquatic, small snake and is endemic to WA. It has been recorded from Exmouth Gulf, WA to the reefs of the Sahul Shelf, in the eastern Indian Ocean. This species is believed to show strong site fidelity to shallow coral reef habitats in less than 10 m of water, with most specimens having been collected from Ashmore and Hibernia reefs (Minton & Heatwole, 1975; Guinea and Whiting, 2005). However, no sightings of this species have been recorded at Ashmore and Hibernia Reefs since the late 1990's (Lukoschek et al., 2013).

The species prefers the reef flats or shallow waters along the outer reef edge in water depths to 10 m (McCosker, 1975; Cogger, 2000), as well as sandy bottom with pavement and occasional coral bommies, in up to 15 m depth (D'Anastasi et al., 2016). The species has been observed during daylight hours, resting beneath small coral overhangs or coral heads in 1–2 m of water (McCosker, 1975). Guinea and Whiting (2005) reported that very few short-nosed sea snakes moved even as far as 50 m away from the reef flat and are therefore unlikely to be expected in high numbers in offshore, deeper waters.

6.2.2. Leaf-scaled Sea Snake

The leaf-scaled sea snake *(Aipysurus foliosquama)* is listed as critically endangered under the EPBC Act and the BC Act. It occurs in shallow water (less than 10 m in depth), in the protected parts of the reef flat, adjacent to living coral and on coral substrates (DoE, 2014). The leaf-scaled sea snake forages by searching in fish burrows on the reef flat (DoE, 2014). This species was once very common yet found only on the reefs of the Sahul Shelf in WA, especially on Ashmore and Hibernia Reefs (Minton and Heatwole, 1975). No sightings of this species in the area have been reported since 2001 (Guinea, 2007; Lukoschek et al., 2013).

6.2.3. Dusky Sea Snake

The dusky sea snake (*Aipysurus fuscus*) is listed as endangered under the EPBC Act. It is restricted to the reefs of the Sahul Shelf in Western Australia, in particular Ashmore, Hibernia and Scott Reefs (Cogger, 1975, 2000; Guinea & Whiting, 2005; Guinea, 2007). The Dusky Sea snake inhabits reef flats, slopes and edges in habitats containing coral, coral rubble and sand at depths of less than 10 m (McCosker, 1975; Guinea, 2007). At Ashmore Reef, the dusky sea snake is more common on sandy areas of the reef flat at low tide and during the flooding tide, where it apparently searches for food in the sand (Guinea & Whiting, 2005). The dusky sea snake has been observed at Ashmore Reef digging into sand in shallow water, apparently in search of prey (Guinea & Whiting, 2005).

6.3. Crocodiles

The salt-water crocodile (*Crocodylus porosus*) is a migratory species under the EPBC Act and is also listed as a specially protected species (other specially protected fauna) under the BC Act. In WA, the species is found in most major river systems of the Kimberley, including the Ord, Patrick, Forrest, Durack, King, Pentecost, Prince Regent, Lawley, Mitchell, Hunter, Roe and Glenelg Rivers. The largest populations occur in the rivers draining into the Cambridge Gulf and the Prince Regent River and Roe River systems.

In the NT salt-water crocodile has been found in the Mary, Adelaide, Daly, Moyle, Victoria, Finniss, Wildman, West Alligator, East Alligator, South Alligator, Liverpool, Blyth, Glyde, Habgood, Baralminar, Goromuru, Cator and Peter John Rivers with a total 79 individuals per km identified in these river systems (Fukuda, 2007).

6.4. Biologically Important Areas/Habitat Critical – Marine Reptiles

Table 7 provides an overview of BIAs in the combined EMBA for marine reptiles, as identified by the DAWE (Commonwealth) and critical habitats identified in associated recovery plans. The DAWE may make recovery plans for threated fauna listed under the EPBC Act. The EPBC Act requires that 'habitat critical to the survival of the listed threatened species' is identified in recovery plans, relevant recovery plans are listed in **Section 13.2**.In addition, both the EPBC Act and WA BC Act and associated regulations (2018) provide for the listing of habitat critical - habitat 'critical to the survival of the threatened species. To date no habitat critical in WA has been listed under either Act. No provision is made under the TPWC Act for listing critical habitat.

Table 7: Biologically Important Areas/Habitat Critical and geographic locations - reptiles

Species	Scientific name	Aggregation area and use	BIAs within EMBA	Habitat Critical within EMBA
Loggerhead turtle	*Caretta caretta*	Foraging – islands and coastline of the Kimberley region and islands of the North West Shelf	Western Joseph Bonaparte Depression	No habitat critical to the survival of marine turtles overlapping the EMBA
Green turtle	*Chelonia mydas*	Nesting, foraging, and internesting – Offshore islands in the Kimberley coastlines	Ashmore Reef Browse Island Cartier Island Cassini Island Joseph Bonaparte Gulf Scott Reef Scott Reef - Sandy Islet Seringapatam Reef North-west of Melville Island	Mainland east of Mary Island to mainland adjacent to Murrara Island including all offshore islands. 20 km internesting buffer Ashmore Reef and Cartier Reef. 20 km internesting buffer Browse Island. 20 km internesting buffer Scott Reef. 20 km internesting buffer
Hawksbill turtle	*Eretmochelys imbricata*	Foraging, nesting and internesting – Offshore islands in the Browse Basin, North West Shelf and Kimberley /Pilbara coastlines	Ashmore Reef Cartier Island Scott Reef Greenhill Island	No habitat critical to the survival of marine turtles overlapping the EMBA
Flatback turtle	*Natator depressus*	Nesting, , foraging, and internesting buffer – Islands of the North West Shelf and the Pilbara/ Kimberley coastlines Mating, nesting – Barrow Island	Cape Domett Holothuria Zone (Northern Kimberley, Holothuria Banks) Lacepede Island The main nesting beach at Cape Domett is a 1.9-km-long north-west-facing sandy beach on the east of the Cambridge Gulf, East Kimberley, Western Australia (14 48.10S, 128 24.50E), located approximately 80 km north-north-east of the nearest town, Wyndham. Western Joseph Bonaparte Depression Melville Island, Cobourg Peninsula	Cape Domett and Lacrosse Island in the Cambridge Gulf. 60 km internesting buffer Lacepede Islands. 60 km internesting buffer Soldier Point to Pirlangimpi including Seafull Island. 60 km internesting buffer Brace point to One Tree Point, including all offshore islands. 60 km internesting buffer Waigait Beach to south of Point Blaze, including all offshore islands. 60 km internesting buffer. Waters between Melville Island and Vernon Islands. 60 km internesting buffer
Olive ridley turtle	*Lepidochelys olivacea*	Foraging, and internesting – Joseph Bonaparte Gulf – Kimberley region	Western Joseph Bonaparte Depression Northern Joseph Bonaparte Gulf Joseph Bonaparte Gulf Western Joseph Bonaparte Gulf – banks Fog Bay to Cox Peninsula Bathurst Island/Melville Island - North-west Greenhill Island	Soldier Point to Pirlangimpi including Seafull Island. 20 km internesting buffer Brace Point to One Tree Point, including all offshore islands. 20 km internesting buffer

7. Marine Mammals

Twenty-seven species of listed marine mammals are known to occur in Australian waters in the combined EMBA, according to the Protected Matters search (**Appendix A**). An examination of the species profile and threats database (DAWE, 2020a) showed that some listed mammal species are not expected to occur in significant numbers in the marine and coastal environments in the combined EMBA due to their terrestrial distributions. Hence, these species are not discussed further.

Of the remaining listed species, five are listed as threatened and migratory and six are listed as migratory under the Commonwealth EPBC Act (BIAs for marine mammals are discussed in **Table 9**. These species are shown in Table 8 long with their conservation listing under the WA BC Act and TPWC Act (as applicable).

The section below gives further details on marine mammal species listed as threatened and migratory and a summary is presented in **Figure 10**. Identified BIAs are presented in **Table 9**.

Table 8: Marine mammals listed as threatened or migratory under the EPBC Act

Species	Conservation Status				Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code	TPWC Act 1976		
Sei whale (*Balaenoptera borealis*)	Vulnerable Migratory	Endangered	-	-	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined
Blue whale (*Balaenoptera musculus*)	Endangered Migratory	Endangered	-	-	Foraging, feeding or related behaviour known to occur within area Migration route known to occur within area	Yes – Refer to Table 9
Fin whale (*Balaenoptera physalus*)	Vulnerable Migratory	Endangered	-	-	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined
Humpback whale (*Megaptera novaeangliae*)	Migratory	Special conservation interest and Migratory	-	Listed nationally	Breeding known to occur within area	Yes – Refer to Table 9
Sperm whale (*Physeter macrocephalus*)	Migratory	Vulnerable	-	-	Species or species habitat may occur within area	None - No BIA defined
Bryde's whale (*Balaenoptera edeni*)	Migratory	Migratory	-	-	Species or species habitat likely to occur within area	None - No BIA defined

Species	Conservation Status				Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code	TPWC Act 1976		
Killer whale (*Orcinus orca*)	Migratory	Migratory	-	-	Species or species habitat may occur within area	None - No BIA defined
Australian Humpback Dolphin (*Sousa sahulensis*)	Vulnerable Migratory (as *Sousa chinensis*)	Migratory	Priority 4	-	Breeding known to occur within area	Yes – Refer to Table 9
Spotted bottlenose dolphin (Arafura/Timor Sea populations) (*Tursiops aduncus*)	Migratory	Migratory	-	-	Species or species habitat known to occur within area	Yes – Refer to Table 9
Irrawaddy dolphin (Australian snubfin dolphin) (*Orcaella heinsohni*)	Vulnerable Migratory	Migratory	Priority 4	-	Breeding known to occur within area	Yes – Refer to Table 9
Dugong (*Dugong dugon*)	Migratory	Migratory	-	-	Species or species habitat known to occur within area	None - No BIA defined

7.1. Threatened and Migratory Species

7.1.1. Sei Whale

Sei whales have a worldwide, oceanic distribution and migrate between low-latitude tropical and subtropical regions during the winter and temperate and subpolar latitudes in summer (Leaper et al., 2008). Sei whales tend to be found further offshore than other species of large whales (Bannister et al., 1996).

Sei whales move between Australian waters and Antarctic feeding areas; however, they are only infrequently recorded in Australian waters (Bannister et al., 1996) and their movements and distribution in Australian waters is not well known (DAWE, 2020a). There are no known mating or calving areas in Australian waters (Parker, 1978 in DAWE, 2020a). The National Conservation Values Atlas currently record no BIAs for this species (DAWE, 2020b).

7.1.2. Pygmy Blue Whale

Two sub-species of blue whale are recorded in Australian waters: the southern (or true) blue whale (*Balaenoptera musculus intermedia*) and the pygmy blue whale (*Balaenoptera musculus brevicauda*). Southern blue whales are believed to occur in waters south of 60°S and pygmy blue whales occur in waters north of 55°S (i.e. not in the Antarctic) (DEWHA, 2008). By this definition all blue whales in waters overlapping the EMBA are assumed to be pygmy blue whales.

Pygmy blue whale populations are distinguishable only acoustically as they do not display morphological differences (Leroy et al., 2021). Prior to 2020 there were believed to be three populations of the pygmy blue whale (B. m. brevicauda), however, evidence for a fourth pygmy blue whale acoustic population were found by Cerchio, S. et al. (2020), and a fifth was identified by Leroy et al., (2021).

Pygmy blue whales have a southern hemisphere distribution, migrating from tropical water breeding grounds in winter to temperate and polar water feeding grounds in summer (Bannister et al. 1996; Double et al., 2014), such as the Perth Canyon and adjacent waters (Rennie et al., 2009) and the Great Southern Australian Coastal Upwelling System (Möller et al., 2020). The WA migration path takes pygmy blue whales down the WA coast to coastal upwelling areas along southern Australia (Gill, 2002) and south at least as far as the Antarctic convergence zone (Gedamke et al., 2007).

Tagging surveys have shown pygmy blue whales migrating northward relatively near to the Australian coastline (100 km) until reaching North West Cape after which they travelled offshore (240 km) to Indonesia (Double et al., 2014). Passive acoustic data documented pygmy blue whales migrating along the Western Australian shelf break (Woodside 2012). Tagging data collected by Gales et al., (2010) has provided the first definitive link between the blue whales that feed off the Perth Canyon and those that occur around Indonesia. This is movement is concordant with the proposed ‘Tasmania to Indonesia’ population described by Branch et al., (2007).

The northern migration passes the Perth Canyon from January to May and north bound animals have been detected off Exmouth and the Montebello Islands between April and August (Double et al., 2012a; McCauley & Jenner, 2010). A noise monitoring study conducted in 2014-15 recorded pygmy blue whales moving in a northward direction in August 2014 and between late-May to early July 2015 (JASCO Applied Sciences, 2016; McPherson et al., 2015). During the southern migration, pygmy blue whales pass south of the Montebello Islands and Exmouth from October to the end of January, peaking in late November to early December (Double et al., 2012b). No detections of the species were made during the period of their southward migration during the noise monitoring study.

Generally, they appear to travel as individuals or in small groups based on acoustic data. For example, analysis of pygmy blue whale calls from noise loggers deployed around Scott Reef (2006 to 2009) for the Woodside Browse project showed that 78% of the calls were from lone whales, 18% were from two whales and 4% were from three or more whales (McCauley, 2011; Woodside, 2014).

Pygmy blue whales appear to feed regularly along their migration route (i.e. at least once per week or more frequently) and are likely to have multiple food caches along their migratory route (e.g. Rowley Shoals and Ningaloo Reef) (ConocoPhillips, 2018).

No recognised feeding areas of significance to this species overlap the combined EMBA. Of the recognised feeding areas, one possible foraging area for pygmy blue whales is located within the EMBA at Scott Reef in WA (DoE, 2015a). Steep gradient features tend to stimulate upwelling and, therefore increased productivity (seasonally variable) (ConocoPhillips, 2018). Hence, they provide a favourable foraging area.

Breeding areas have not yet been identified; however, it is likely that pygmy blue whales calve in tropical areas of high localised production such as deep offshore waters of the Banda and Molucca Seas in Indonesia (Double et al., 2014; DAWE, 2020a). There are no known breeding areas of significance to blue whales in waters from Busselton to the NT.

The BIAs for pygmy blue whales are detailed in **Table 9** and depicted in **Figure 10.** However, a recent study by Thums et al., (2022) used a combination of passive acoustic monitoring of the Northwest Australian coast (46 instruments from 2006 to 2019) and satellite telemetry data (22 tag deployments from 2009 to 2021) to model the spatial extent of pygmy blue whale high use areas for foraging and migration and compared these areas to the BIAs. The synthesis of data indicated that pygmy blue whales extensively use the continental slope habitat rather than the continental shelf habitat off Western Australian coast compared to southern Australia.

Thums et al., (2022) described three important foraging (and/or resting/breeding) areas, including; The Perth Canyon and vicinity, the shelf edge off Geraldton and; the shelf edge from Ningaloo Reef to the Rowley Shoals (not continuous).

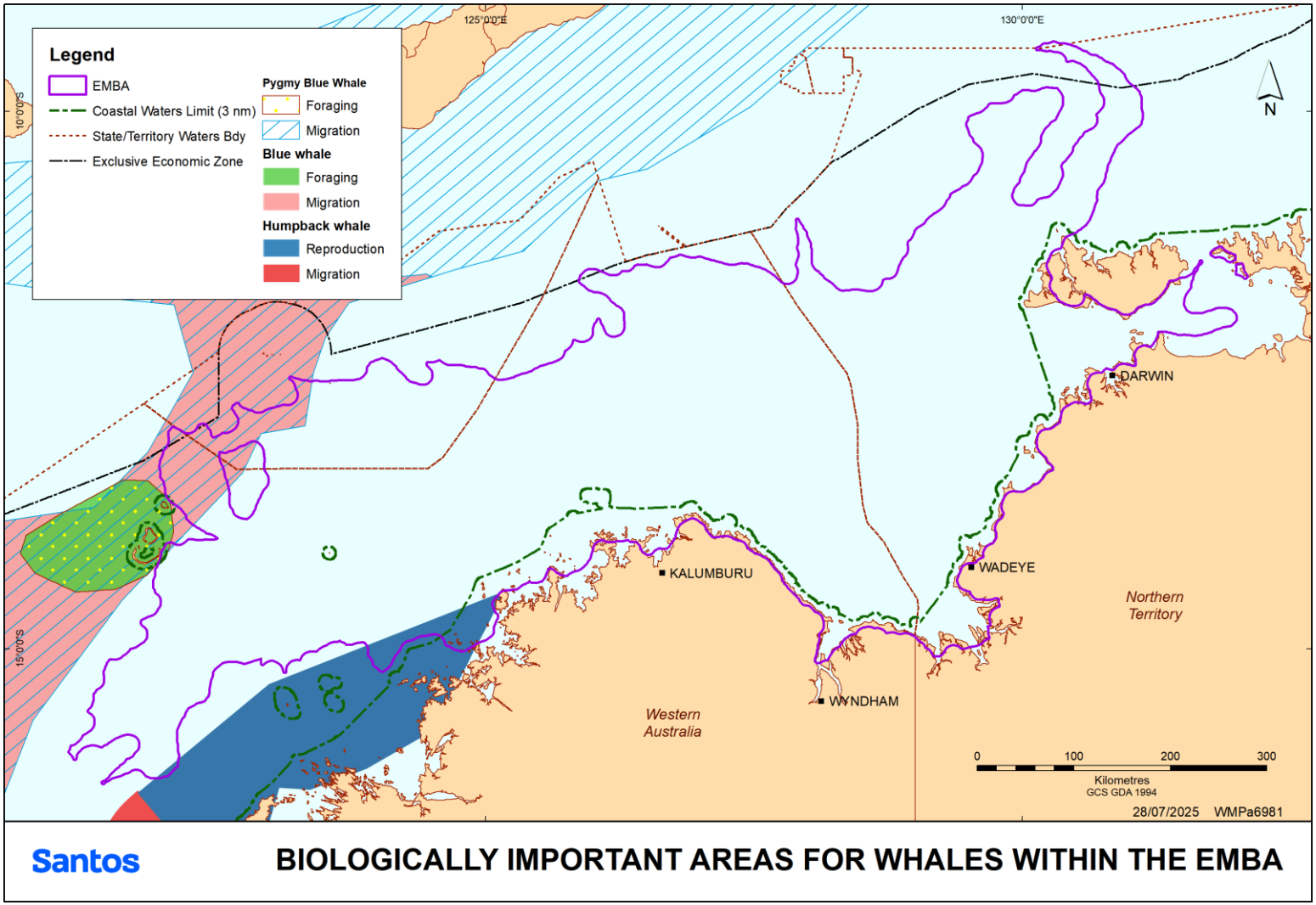


Figure 10: Biologically Important Areas – whales – Northern WA

7.1.3. Fin Whale

Fin whales have a worldwide distribution generally in deeper waters, with oceanic migrations between warm water breeding grounds and cold-water feeding grounds.

The fin whale distribution in Australia is not clear due to the sparsity of sightings. Information is known primarily from stranding events and whaling records. According to the Species Profile and Threats database (DAWE, 2020a); fin whales are thought to be present from Exmouth, along the southern coastline, to southern Queensland.

Migration paths are uncertain but are not thought to follow Australian coastlines (Bannister et al., 1996). There is insufficient data to prescribe migration times for fin whales. During summer and autumn this species has been recorded acoustically at the Rottnest Trench.

There are no known mating or calving areas in Australian waters (DoEE, 2015) and no BIAs for the fin whale are currently identified by the National Conservation Values Atlas (DAWE, 2020b).

7.1.4. Humpback Whale

Humpback whales have a worldwide distribution, migrating along coastal waters from polar feeding grounds to subtropical breeding grounds. Geographic populations are distinct and at least six southern hemisphere populations are thought to exist based on Antarctic feeding distribution and the location of breeding grounds on either side of each continent (Bannister et al., 1996). The population of humpback whales migrating along the WA coastline was recently estimated to be greater than 33,000 whales and likely increasing at exceptionally high growth rates between 10–12 % (Hedley et al., 2011; Salgado Kent et al., 2012).

Humpback whale populations have increased since being placed on the threatened species list for exploitation from whaling, resulting in a higher abundance of species off our Western Australian coastline. Effective from 26/02/2022, Humpback whales are no longer classed as vulnerable under the EPBC Act, however; they remain a Matter of National Environmental Significance as a listed Migratory Species and Cetacean under EPBC Act Division 3, where it is an offence to kill, injure, take, trade, keep, move or interfere with a cetacean. Humpback whales have been able to thrive and increase in numbers despite the heavy oil and gas exploration. A study presented by Bejder et al., (2016) has prompted a review of the species being down listed under Commonwealth legislation and regulations, as they are not eligible for listing as a threatened species under all statutory criteria. The west coast Australian humpback whale population migrates from Southern Polar Ocean ‘summer’ feeding grounds to their northern tropical ‘winter’ calving/ breeding grounds in coastal waters of the Kimberley. The northern migration tends to follow deeper waters of the continental shelf, whilst the southward migration concentrates whales closer to the mainland (Jenner et al., 2001; Irvine et al., 2018). Recent satellite tagging of southbound humpback whales indicate that whales generally migrated close to the coastline, within a few tens of kilometres of shore and in a corridor frequently less than 100 km (Double et al., 2010). Aerial surveys and noise logger recordings undertaken for Chevron’s Wheatstone Project indicated that the main distribution of humpback whales was sighted at an average distance of 50 km from the mainland during the northern migration and 35 km during the southbound migration (RPS, 2010a). Woodside have conducted aerial surveys that have confirmed that the reported distribution of migrating humpback whales off the North West Cape is consistent with baseline surveys first conducted in 2000 to 2001 (RPS, 2010 in Woodside, 2020).

The precise timing of the migration varies between years by up to six weeks, influenced by water temperature, sea ice distribution, predation risk, prey abundance and the location of feeding grounds (DEWR, 2007).

Peak northward migration across the North West Shelf is identified as from late July to early August, and peak southward migration from late August to early September (DoEE, 2015). Data collected between 1995 and 1997 by the Centre for Whale Research indicates that the period for peak northern migration into the calving grounds in the Kimberley is mid to late July. The peak for southern migration is in the first half of September (Jenner et al., 2001). Actual timing of annual migration may vary by as much as three weeks from year to year due to food availability in the Antarctic (DMP, 2003).

Satellite tagging data collected for migrating northbound humpback whales identified a consistent narrow inshore distribution, unlike the southward migration. There was little evidence that the whales tended to venture further from shore and into deeper water at any point on their northward migration. Whales were seen with calves off the North West Cape outside the ‘calving grounds; of Lacepede Islands to Camden Sound. This indicates some potential for this area being used as a ‘calving site’ as well as a migratory corridor. Consequently, the region from

the Lacepede Islands to Camden Sound should not be seen as the exclusive 'calving ground' for this population (Double et al., 2012b).

Details on the BIA for humpback whales are provided in Table 9 and depicted in Figure 10.

7.1.5. Sperm Whale

Sperm whales typically occur in WA along the southern coastline between Cape Leeuwin and Esperance (Bannister et al., 1996). Sperm whales are distributed worldwide in deep waters (greater than 400 m) off continental shelves and sometimes near shelf edges, averaging 20 to 30 nautical miles offshore (Hooker et al.,1999; Pirotta et al., 2011). The sperm whale is known to migrate northwards in winter and southwards in summer, however, detailed information on the distribution of sperm whales is not available for the timing of migrations. Sperm whales have been recorded in deep water off the North West Cape on the west coast of Western Australia (RPS, 2010b) and appear to occasionally venture into shallower waters in other areas (RPS, 2010b).

7.1.6. Bryde's Whale

Bryde's whales (*Balaenoptera edeni;* Migratory) are distributed year-round across tropical and warm temperate waters with individuals recorded in all Australian states, except the NT (Ceccarelli et al., 2011; Kato, 2002). The species typically moves between 40 °N and 40 °S, with these movements seeming to be primarily linked to prey availability (DoE, 2023). Two forms are recognised: inshore and offshore Bryde's whales. It appears that the inshore form is restricted to the 200 m depth isobar whilst the offshore form is found in deeper waters of 500-1,000 m (DoEE, 2019a). Both forms are expected to be found in zones of upwelling where they feed on shrimp like crustaceans (Bannister et al., 1996). Little is known about the population abundance of Bryde's whale, the location of exact breeding and calving grounds and large-scale migration patterns (DoEE, 2019a). It is however, suggested that the offshore form migrates seasonally, heading towards warmer tropical waters during the winter.

7.1.7. Killer Whale

The killer whale has a widespread global distribution and has been recorded in waters of all Australian states/territories (Bannister et al., 1996). Whilst more commonly found in cold, deeper waters, killer whales have been observed along the continental slope, shelf and shallower coastal areas. Killer whales are known to make seasonal movements and are most likely to follow the migratory routes of their prey, however, little is known about these movements (DoEE, 2019). They are more likely to be observed around seal colonies.

7.1.8. Indo-Pacific Humpback Dolphin

The Indo-pacific humpback dolphin is typically found in water less than 20 m deep but has been recorded in waters up to 40 m deep. This species is generally found in association with river mouths, mangroves, tidal channels and inshore reefs (DoEE, 2016a). This species of dolphin is known to have resident groups that forage, feed, breed and calve in multiple locations overlapping the combined EMBA, including Anjo Peninsula, Vansittart Bay and Napier Broome Bay (DoEE, 2016a).

The Indo-Pacific humpback dolphin BIA in the combined EMBA is detailed in Table 9 and shown on Figure 11.

7.1.9. Spotted Bottlenose Dolphin (Indo-Pacific bottlenose dolphin)

The spotted bottlenose dolphin (*Tursiops aduncus*) (Arafura/ Timor Sea populations) is generally considered to be a warm water subspecies of the spotted bottlenose dolphin, occurring in shallow (often <10 m deep) inshore waters (Bannister et al., 1996; Hale et al., 2000). The known distribution of the spotted bottlenose dolphin extends from Shark Bay north to the western edge of the Gulf of Carpentaria in Australia (DoEE, 2016b). The spotted bottlenose dolphin BIA in the combined EMBA is detailed in **Table 9** and shown on **Figure 11.**

7.1.10. Australian Snubfin Dolphin (Irrawaddy Dolphin)

The Australian snubfin dolphin (*Orcaella heinsohni*), also known as the Irrawaddy dolphin is known to occur within the waters off northern Australia, extending north from Broome in Western Australia to the Brisbane River in Queensland (DoEE, 2016c). Surveys have indicated that the species is typically found in protected shallow nearshore waters, generally less than 20 m deep, adjacent to river and creek mouths close to seagrass beds (DoEE, 2016c). The snubfin dolphin was not recorded during any of the aerial surveys undertaken along the

Dampier Peninsula coastline in the vicinity of James Price Point but were observed in Roebuck Bay from vessels on several occasions (RPS, 2010b). Based on the extensive survey effort and amenable conditions within the James Price Point coastal area during the survey, it is concluded that this species is seldom found outside of shallow and sheltered bays and inlets (DSD, 2010). The population in Australian waters is thought to be continuous with the Papua New Guinea species but separate from populations in Asia. Breeding is thought to occur throughout the year for this species.

The Irrawaddy dolphin BIA in the combined EMBA is detailed in Table 9 and shown on Figure 11.

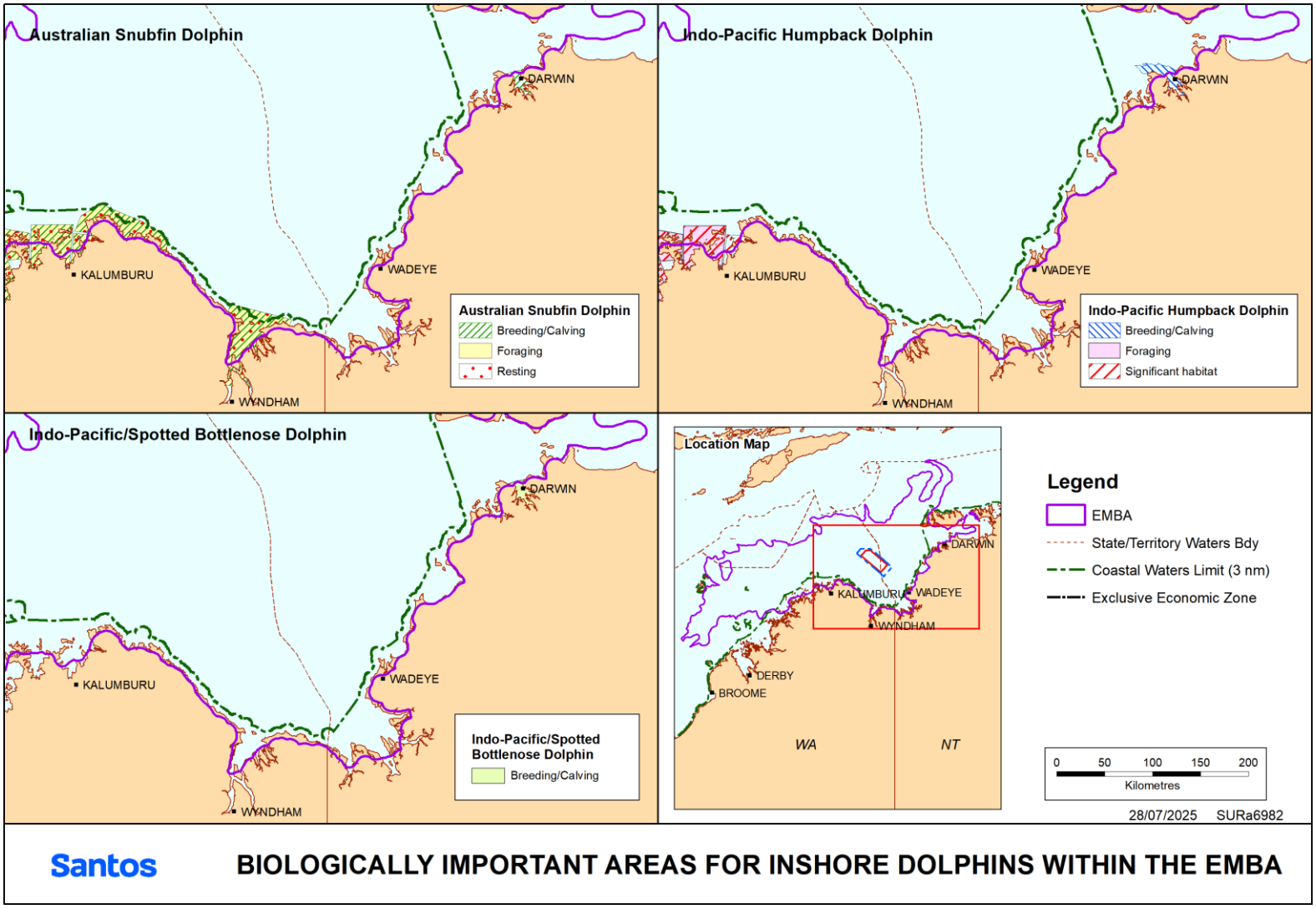


Figure 11: Biologically Important Areas – dolphins

7.1.11. Dugong

The dugong (*Dugong dugon*) is a large herbivorous marine mammal (up to 3 m) that feeds off seagrass and generally inhabits coastal areas. Key populations along the WA coast are principally located at: Shark Bay (the largest resident population in Australia), Ningaloo Marine Park and Exmouth Gulf, the Pilbara coast and offshore areas including Montebello/ Barrow/ Lowendal Islands, and further north at Eighty Mile Beach and off the Kimberley Coast, particularly Roebuck Bay and Dampier Peninsula (Marsh et al., 2002; DSEWPaC, 2012). Populations are also present at Ashmore Reef, and the north coast of the Tiwi Islands is recognised as a key site for the conservation of dugongs. A well-known major dugong aggregation of approximately 4,400 individuals occurs in waters seaward (within approximately 50 km) of the Tiwi Islands and ranks in the top eight of dugong populations in the world.

Dugong distribution and movement is based on the abundance, size and species of seagrass meadow. Dugongs can migrate hundreds of kilometres between seagrass habitats. Dugongs have been tracked moving long distances of up to 300 km between the Australia mainland and the Tiwi Islands (Whiting et al., 2009). Satellite-tracking data from dugongs tagged as part of the INPEX Ichthys Project baseline surveys observed that dugongs around the Vernon Islands, south of Melville Island, spent time in Darwin Harbour and around the Tiwi Islands (INPEX, 2010). Routine sightings occur in various locations along the NT coastline, including within Darwin Harbour, to the south of Melville Island.

Dugongs in the NT coastal waters have been observed foraging in intertidal rocky reef flats supporting sponges and algae as seagrass habitat is thought to be rare in the north marine region bioregion (INPEX, 2010; Whiting et al., 2009). However, seagrass communities are known to exist along the north coast of the Tiwi Islands.

There are no dugong BIAs overlapping the combined EMBA.

7.2. Biologically Important Areas / Critical Habitat – Marine Mammals

Table 9 below provides an overview of BIAs in the combined EMBA for marine mammals.

The DCCEEW may also make recovery plans for threated fauna listed under the EPBC Act. The EPBC Act requires that ‘habitat critical to the survival of the listed threatened species’ is identified in recovery plans, relevant recovery plans are listed in **Section 13.2**.

In addition, both the EPBC Act and WA BC Act and associated regulations (2018) provide for the listing of critical habitat - habitat ‘critical to the survival of the threatened species. To date no critical habitat in WA has been listed under either Act. No provision is made under the TPWC Act for listing critical habitat.

Table 9: Biologically Important Areas – marine mammals

Species	Scientific name	Aggregation area and use	BIAs within EMBA
Pygmy blue whales	*Balaenoptera musculus*	Migration – along the continental shelf edge off the WA coastline, extending offshore near Scott Reef and into Indonesian waters Foraging – along Ningaloo reef, around Scott Reef, around the Perth canyon	Augusta to Derby. Tend to pass along the shelf edge at depths of 500 m to 1000 m. Scott Reef
Humpback whale	*Megaptera novaeangliae*	Reproduction/calving/nursing/resting – Kimberley/Coastal North Lacepede Island, Campden Sound,	Kimberley/Coastal North Lacepede Island, Camden Sound The migration corridor extends from the coast to out to approximately 100 km offshore in the Kimberley region extending south to North West Cape. From North West Cape to south of Shark Bay the migration corridor is reduced to approximately 50 km.
Indo-Pacific humpback dolphin	*Sousa chinensis*	Breeding, calving, foraging – Kimberley coastal waters and islands Significant habitat – unknown behavior – Admiralty Gulf & Parry Harbour and Bougainville Peninsula Significant habitat - Vansittart Bay, Anjo Peninsula	Admiralty Gulf & Parry Harbour Bougainville Peninsula Camden Sound Area - Walcott Inlet, Doubtful Bay, Deception Bay, Augustus Island (Kuri Bay) Maret and Biggee Island Port Nelson, York Sound, Prince Frederick Harbour Vansittart Bay, Anjo Peninsula Darwin Harbour
Indo-Pacific/ spotted	*Tursiops aduncus*	Breeding– Kimberley coastal water Migration – Pender Bay	Darwin Harbour

Species	Scientific name	Aggregation area and use	BIAs within EMBA
bottlenose dolphin			
Irrawaddy dolphin (Australian snubfin dolphin)	*Orcella heinsohni*	Breeding, calving, foraging, resting– Kimberley coastal waters and islands	Admiralty Gulf and Parry Harbour Bougainville Peninsula Camden Sound Area - Walcott Inlet, Doubtful Bay, Deception Bay, Augustus Island (Kuri Bay) Cape Londonderry and King George River Maret and Biggee Island Port Nelson, York Sound, Prince Frederick Harbour Vansittart Bay, Anjo Peninsula Napier Broome Bay/Deep Bay

8. Birds

Marine waters and coastal habitats in the combined EMBA contain key habitats that are important to birds, including offshore islands, sandy beaches, tidal flats, mangroves, and coastal and pelagic waters. These habitats support a variety of birds which utilise the area in different ways and at different times of the year (DSEWPaC, 2012). Birds can be broadly grouped according to their preferred foraging habitat as seabirds and shorebirds.

Seabirds include those species whose primary habitat and food source is derived from pelagic waters. These species spend the majority of their lives at sea, ranging over large distances to forage over the open ocean. Seabirds present in the area include terns, noddies, petrels, shearwaters, tropicbirds, frigatebirds boobies and albatrosses (DEWHA, 2008a).

Shorebirds, including waders, inhabit the intertidal zone and adjacent areas. Some shorebird species, including oystercatchers are resident (Surman & Nicholson, 2013). Other shorebirds are migratory and include species that utilise the East Asian–Australasian Flyway, a migratory pathway for millions of migratory shorebirds that travel from Northern Hemisphere breeding grounds to Southern Hemisphere resting and foraging areas. Shorebirds that regularly migrate through the area include the Scolopacidae (curlews, sandpipers etc.) and Charadriidae (plovers and lapwings) families.

Surveys in the area by Santos and other agencies have built a picture of diverse avifauna. A summary of research is discussed below, followed by information on threatened and migratory birds. Wetlands of international importance are discussed in **Section 9.2**.

8.1. Threatened Species

A Protected Matters search of the combined EMBA identified 21 bird species (**Appendix A**) listed as threatened under the EPBC Act.

An examination of the Species Profile and Threats database (DAWE, 2020a) and The Action Plan for Australian Birds 2020 (Garnett & Baker, 2021) showed that some listed bird species are not expected to occur in significant numbers in the marine and coastal environments in the combined EMBA due to their terrestrial or southern distributions. Hence, these species are not discussed further.

EPBC Act threatened species expected to occur in the area are listed in **Table 10** along with their WA and NT conservation status (as applicable) and discussed below. There are an additional 51 migratory species listed under the EPBC Act, with these detailed in **Section 0** (**Table 12**). BIAs for birds are detailed in **Table 16** and depicted in **Figure 12.**

Table 10: Birds listed as threatened under the EPBC Act

Species	Conservation Status				Likelihood of occurrence in EMBA	BIAs in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code	TPWC Act 1976		
Shorebirds						
Red knot[8] (*Calidris canutus*)	Vulnerable, Migratory	Endangered	-	Endangered	Species or species habitat known to occur within area	None - No BIA defined
Curlew sandpiper[8] (*Calidris ferruginea*)	Critically endangered, Migratory	Critically endangered	-	Critically endangered	Species or species habitat known to occur within area	None - No BIA defined
Sharp-tailed sandpiper[8] (*Calidris acuminata*)	Vulnerable, Migratory	Specially protected (migratory)[4]	-	-	Roosting known to occur within area	None - No BIA defined
Terek sandpiper[8] (*Xenus cinereus*)	Vulnerable, Migratory	-	-	-	Roosting known to occur within area	None - No BIA defined
Great knot[8] (*Calidris tenuirostris*)	Vulnerable, Migratory	Critically endangered	-	Critically endangered	Roosting known to occur within area	None - No BIA defined
Greater sand plover[8] (*Charadrius leschenaultii*)	Vulnerable, Migratory	Vulnerable	-	Vulnerable	Species or species habitat known to occur within area	None - No BIA defined
Lesser sand plover[8] (*Charadrius mongolus*)	Endangered, Migratory	Endangered	-	Endangered	Roosting known to occur within area	None - No BIA defined
Grey plover[8] (*Pluvialis squatarola*)	Vulnerable, Migratory	Specially protected (migratory)[4]	-	-	Roosting known to occur within area	None - No BIA defined
Western Alaskan bar-tailed godwit[8] (*Limosa lapponica baueri*)	Endangered, Migratory[5]	Vulnerable, Specially protected (migratory)[4]	-	Vulnerable	Species or species habitat known to occur within area	None - No BIA defined
Northern Siberian bar-tailed godwit[8] (*Limosa lapponica menzbieri*)	Endangered, Migratory[5]	Critically endangered, Specially protected (migratory)[4]	-	Critically endangered	Species or species habitat known to occur within area	None - No BIA defined
Black-tailed godwit[8] (*Limosa limosa*)	Endangered, Migratory	Specially protected (migratory)[4]	-	-	Roosting known to occur within area	None - No BIA defined

[4] "Specially protected" species are defined as meeting one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection. Species that are listed as threatened species or extinct species under the BC Act 2016 cannot also be listed as specially protected species (DBCA, 2025).
[5] Listed as migratory at species level
[8] Listed under the East Asian – Australasian Flyway Partnership

Species	Conservation Status				Likelihood of occurrence in EMBA	BIAs in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code	TPWC Act 1976		
Eastern curlew[8] (*Numenius madagascariensis*)	Critically endangered, Migratory	Critically endangered	-	Critically endangered	Species or species habitat known to occur within area	None - No BIA defined
Australian painted snipe (*Rostratula australis*)	Endangered	Endangered	-	Endangered	Species or species habitat likely to occur within area	None - No BIA defined
Asian dowitcher[8] (*Limnodromus semipalmatus)*	Vulnerable, Migratory	-	-	-	Species or species habitat known to occur within area	None - No BIA defined
Common greenshank[8] (*Tringa nebularia*)	Endangered, Migratory	Specially protected (migratory)[4]	-	-	Species or species habitat known to occur within area	None - No BIA defined
Ruddy turnstone[8] (*Arenaria interpres*)	Vulnerable, Migratory	Specially protected (migratory)[4]	-	-	Roosting known to occur within area	None - No BIA defined
Seabirds						
Australian lesser noddy (*Anous tenuirostris melanops*)	Vulnerable	Endangered	-	-	Foraging, feeding or related behaviour known to occur within area	None - No BIA defined
Little tern (*Sternula albifrons*)	Vulnerable	Specially protected (migratory)[4]	-	Listed nationally	Breeding known to occur within area	Yes – refer to Table 16
Abbott's booby (*Papasula abbotti)*	Endangered	-	-	Endangered	Species or species habitat may occur within area	None - No BIA defined
Christmas Island white-tailed tropicbird (*Phaethon lepturus fulvus*)	Endangered	-	-	-	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined
Red-tailed tropicbird (Indian Ocean) (*Phaethon rubricauda westralis*)	Endangered		-	-	Breeding known to occur within area	None - No BIA defined

8.1.1. Shorebirds

Red Knot (New Siberian Islands and north-eastern Siberia)

The red knot is a migratory shorebird, and the species includes five subspecies, including two found in Australia, *Calidris canutus piersmai* and *Calidris canutus rogersi*. The red knot breeds in Siberia and spends the non-breeding season in Australia and New Zealand. During the non-breeding season, the species spends the majority of its time on tidal mudflats or sandflats where they feed on intertidal invertebrates, especially shellfish (Garnet et al., 2011).

Curlew Sandpiper

This species is a migratory shorebird that breeds in north Siberia and spends the non-breeding season from western Africa to Australia (Bamford et al., 2008). The curlew sandpiper occurs around coastal Australia and preferred habitats include coastal brackish lagoons, tidal mud and sand flats, estuaries, saltmarshes and less often inland. Their diet is mainly comprised of polychaete worms, molluscs and crustaceans (Higgins & Davies, 1996 in Garnet et al., 2011).

Great Knot

The great knot is a migratory shorebird with a global distribution, breeding in north-east Siberia and spending the non-breeding season along coasts from Arabia to Australia. Non-breeding birds migrate to inlets, bays, harbours, estuaries and lagoons with large intertidal mud and sand flats where they feed on bivalves, gastropods, crustaceans and other invertebrates (Higgins & Davies, 1996 in Garnet et al., 2011).

Greater Sand Plover and Lesser Sand Plover

The greater sand plover and lesser sand plover are congeners that breed in China, Mongolia and Russia. The greater sand plover spends the non-breeding season along coasts from Japan through southeast Asia to Australasia, while the lesser sand plover spends the non-breeding season along coasts from Taiwan to Australasia (Bamford et al., 2008). Non-breeding birds occur along all Australian coasts, especially in the north for the greater sand plover and in the east for the lesser sand plover (DAWE, 2020a).

Non-breeding birds forage on beaches, saltmarshes, coastal bays and estuaries, and feed on marine invertebrates including molluscs, worms, crustaceans and insects (Marchant & Higgins, 1993 in Garnet et al., 2011).

Bar-tailed Godwit (Western Alaskan and Northern Siberian Subspecies)

Two subspecies of the bar-tailed godwit exist, as determined by their breeding locations in Siberia and Alaska (Bamford et al. 2008). Non-breeding birds migrate to the coasts of Australia. The western Alaskan subspecies occurs especially on the north and east coasts of Australia whilst the northern Siberian subspecies occurs especially along the coasts of north Western Australia (DAWE, 2020a).

Non-breeding birds are found on muddy coastlines, estuaries, inlets, mangrove-fringed lagoons and sheltered bays, feeding on annelids, bivalves and crustaceans (Higgins & Davies, 1996 in Garnet et al., 2011).

Eastern Curlew

The eastern curlew is a migratory shorebird that breeds in Siberia, Kamchatka and Mongolia and migrates to coastal East Asia and Australia. The South Korean Yellow Sea is an important staging post for this species. Non-breeding birds occur around coastal Australia, are more common in the north and have disappeared or become much rarer at many sites along the south coast (Garnet, 2011).

Non-breeding birds are present at estuaries, mangroves, saltmarshes and intertidal flats, particularly those with extensive seagrass (Zosteraceae), where they feed on marine invertebrates, especially crabs and small molluscs (Higgins & Davies, 1996 in Garnet, 2011).

Australian Painted Snipe

The Australian painted snipe has been recorded at wetlands in all states of Australia (DoE, 2014g). The Australian painted snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. Typical sites include those with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire; often with scattered clumps of lignum Muehlenbeckia or

canegrass or sometimes tea-tree (*Melaleuca*). The Australian painted snipe sometimes utilises areas that are lined with trees, or that have some scattered fallen or washed-up timber (DoE, 2014g).

Sharp-tailed Sandpiper

The sharp-tailed sandpiper is a migratory shorebird that spends the non-breeding season in Australia. In WA, this species is around coastal and subcoastal plains of Pilbara Region to south-west and east Kimberley (Higgins & Davies, 1996). In the NT, the sharp-tailed sandpiper occurs in the north coast, generally east to Groote (Higgins & Davies, 1996). Approximately 85 000 sharp-tailed sandpipers occupy the EAAF (Hansen et al., 2016). During the non-breeding season approximately 91% of the EAAF population occurs in Australia and New Zealand, with 39 important sites identified in Australia, eight of which are in WA or the NT (Bamford et al., 2008).

Terek Sandpiper

The terek sandpiper is a migratory shorebird with a primarily coastal distribution. This species is widespread in the Kimberley. In the Northern Territory (NT), widespread records occur from Darwin, north to Melville Island, and east to the western section of the Gulf of Carpentaria. Sites of international significance in relevant to the EMBA include Chambers Bay, Joseph Bonaparte Bay and Fog Bay (Bamford et al., 2008). The EAAF population of the terek sandpiper is estimated to be around 60,000 of which approximately 23,000 spend the non-breeding season in Australia (Geering et al., 2007).

Grey Plover

The grey plover has been recorded in all Australian states, where it is found along the coasts. This species is most commonly found along western beaches of South Australia, and on coast of Western Australia between Albany and the northern Kimberley (Barrett et al., 2003; Lane, 1987). In the Northern Territory, small numbers of Grey Plovers are regularly recorded in the Top End. The key Australian population is likely the one which breeds north of the Arctic Circle in northern Siberia, as it is this population that is most likely to occur in Australia during the non-breeding season. Within Australia, two of the major staging areas are Eighty Mile Beach and Roebuck Bay, both near Broome, where large numbers of birds pass through on their arrival/departure in Australia (DCCEEW, 2025).

Black-tailed Godwit

The black-tailed godwit is a shorebird with a global distribution and nests in the Northern Hemisphere during the summer months (del Hoyo et al. 1996; Higgins & Davies, 1996). In Australia, this species is most commonly found in coastal regions on the North Coast around Darwin (Watkins, 1993). Fourteen important sites for the Black-tailed godwit have been identified in Australia, with 11 of these sites located in the NT and northern WA (Bamford et al., 2008).

Asian Dowitcher

The Asian dowitcher distribution in Australia is sporadic and sightings are quite rare, however in the this species can be found in sheltered coastal environments in Darwin and Arnhem Land, and in WA sightings have been recorded at Albany, Lake McLarty, Lake McLeod, north-east Pilbara and the south-west Kimberley division, the Port Hedland Saltworks, Roebuck Bay, Ashmore Reed and Eighty Mile Beach (Higgins & Davies, 1996).

Common Greenshank

The common greenshank is very widely distributed in Australia be found in wetlands in all states, however this species does not breed in Australia (Higgins & Davies, 1996). In WA, this species occurs around most of the coast. In the Kimberley it is recorded in the south-west and the north-east, with isolated records from the Bonaparte Archipelago, and has some scattered populations in the NT (Higgins & Davies, 1996). The EAAF population is thought to be approximately 110 000 (Hansen et al., 2016), of which approximately 17% spend the non-breeding season in Australia (Bamford et al., 2008; Clemens et al., 2008).

Ruddy Turnstone

During the non-breeding season, the ruddy turnstone has a wide distribution in Australia, found in coastal areas from Tasmania to Darwin (Higgins & Davies 1996; Bamford et al., 2008). The ruddy turnstone breeds on the coasts of Europe, Asia and North America, generally north of 60° latitude, with common breeding coasts including Norway, Denmark, the Baltic coasts of Sweden (Higgins & Davies, 1996), Finland, Spitsbergen and Estonia. During the non-breeding season approximately 73% of the EAAF population occurs in Australia and New Zealand, with 11 important sites identified in Australia (most of which occurring in northern WA (Bamford et al., 2008).

8.1.2. Seabirds

Australian Lesser Noddy

This species is usually found only around its breeding islands in the Houtman Abrolhos Islands in Western Australia (Storr et al., 1986). The Australian lesser noddy occupies coral-limestone islands that are densely fringed with white mangrove *Avicennia marina*, and it occasionally occurs on shingle or sandy beaches (Higgins & Davies, 1996 in DAWE, 2020a). This species is thought to be sedentary or resident, staying near to its breeding islands in the non-breeding season. It may leave nesting islands for short periods during the non-breeding season and probably forages widely (Higgins & Davies, 1996 in DAWE, 2020a).

Breeding apparently occurs only on Morley, Wooded and Pelsaert Islands at the Houtman Abrolhos Islands (Higgins & Davies, 1996 in DoE, 2014b). Mangrove stands support approximately 68,000 breeding pairs spread over the three islands (Surman & Nicholson 2006). Breeding may also occur on Ashmore Reef (Stokes & Hinchey, 1990). The breeding season extends from mid-August to early April (Higgins & Davies, 1996 in DoE, 2014b).

The National Conservation Values Atlas (DAWE, 2020b) does not identify any BIAs for this species within the combined EMBA.

Abbott's Booby

Currently, Abbott's booby is only known to breed on Christmas Island and to forage in the waters surrounding the island and south-east Asia (TSSC, 2020). Within Christmas Island, most nests are found in the tall plateau forest on the central and western areas of the island, and in the upper terrace forest of the northern coast.

The National Conservation Values Atlas (DAWE, 2020b) does not identify any BIAs for this species within the combined EMBA.

Christmas Island White-tailed Tropicbird

The Christmas Island white-tailed tropicbird is endemic to Christmas Island and leaves the island to forage in the warm waters of the Indian Ocean (Garnett, 2011). The white-tailed tropicbird roots at sea; only incubating or brooding adults remain on nests on the island at night (Stokes, 1988).

The National Conservation Values Atlas (DAWE, 2020b) does not identify any BIAs for this species within the combined EMBA.

Fairy Prion (southern)

The fairy prion is distributed off the cold-water coasts of Antarctica and southern Australia and New Zealand. The southern subspecies is known to breed on Macquarie Island, Langdon Point, Davis Point and Bishop and Clerk islands (Garnett & Crowley, 2000). It is estimated that the population of the fairy piron (southern) is a little over 50 pairs (Brothers, 1984).

The National Conservation Values Atlas (DAWE, 2020b) does not identify any BIAs for this species within the combined EMBA.

Little Tern

The little tern has two distinct breeding subpopulations in Australia, one being a northern subpopulation that breeds across northern Australia and the other an eastern subpopulation that breeds on the eastern and south-eastern coast of the mainland and Tasmania (DoE, 2025a).

There are BIAs for this species overlapping the EMBA, including breeding and resting BIA's off the Kimberley coast and islands including Ashmore Reef.

Red-tailed Tropicbird (Indian Ocean)

The red-tailed tropicbird (Indian Ocean) is a subspecies of the red-tailed tropicbird. In Australia, this subspecies has a small, restricted range on the coast of WA and only breeds on islands offshore of WA (DoE, 2025b).

The National Conservation Values Atlas (DAWE, 2020b) does not identify any BIAs for this species within the combined EMBA.

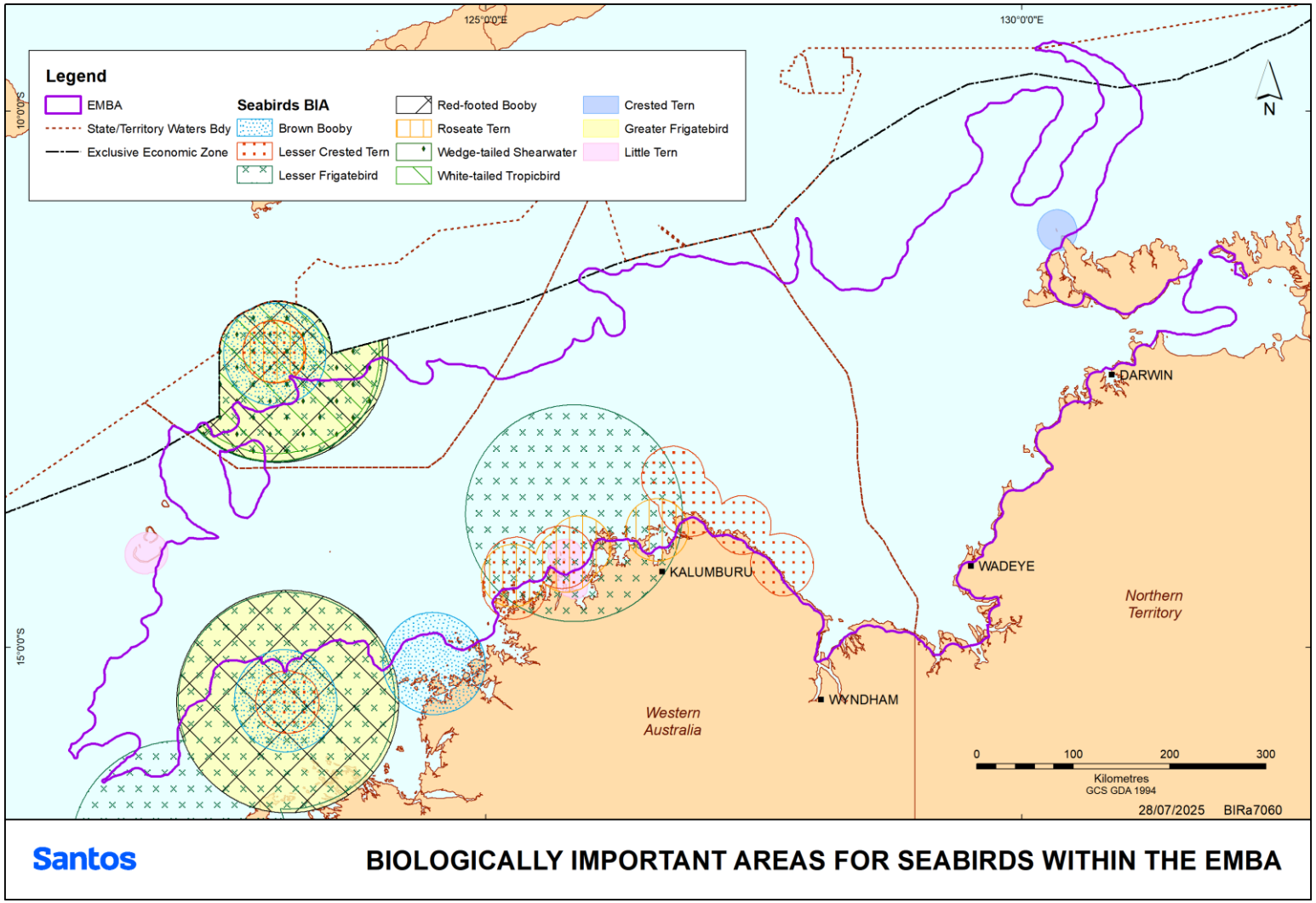


Figure 12: Biologically Important Areas – birds – Northern WA

Table 11: Summary of information for birds listed as threatened under the EPBC Act that may be in the combined EMBA

Species	Species Expected in EMBA	Breeding in the Area/ Seasonality	Foraging
Shorebirds			
Red knot[8]	Yes	No	Intertidal invertebrates
Curlew sandpiper[8]	Yes	No	Polychaete worms, molluscs and crustaceans taken from shorelines
Great knot[8]	Yes	No	Bivalves, gastropods, crustaceans and other invertebrates taken from shorelines
Greater sand plover/lesser sand plover	Yes	No	Marine invertebrates taken from shorelines
Bar-tailed godwit	Yes	No	Annelids, bivalves and crustaceans taken from shorelines
Eastern curlew[8]	Yes	No	Marine invertebrates associated with seagrass
Australian painted snipe	Yes	No	Seeds and small invertebrates
Western Alaskan bar-tailed godwit	Yes	No	Worms, molluscs, crustaceans, insects
Northern Siberian bar-tailed godwit	Yes	No	Worms, molluscs, crustaceans, insects and some plant material
Seabirds			
Australian lesser noddy	May forage from Kalbarri to Shark Bay	No	Small fish taken from marine and coastal waters (DoE, 2014b)
Fairy prion (southern)	Very low densities	No	Small pelagic crustaceans, small fish and squid
Abbott's booby	Low densities	No	Fish and squid
Christmas Island white-tailed tropicbird	Very low densities	No	Squid and flying fish

[8] Species listed under the East Asian-Australasian Flyway Partnership

8.2. Migratory Species

The EPBC PMST search identified an additional 35 species listed as migratory under the EPBC Act that may occur within the combined EMBA. These species are listed in **Table 12**. All of these species are also listed as migratory under the BC Act, with the exceptions of:

- the flesh-footed shearwater, which is listed as vulnerable under the BC Act.
- the grey-tailed tattler and red-tailed tropicbird which are listed as migratory under the EPBC Act and migratory and a Priority 4 under the BC Act.
- the rufous fantail and the wandering tattler, which are not listed under the BC Act.

Those species that are listed as both migratory and threatened under either the EPBC Act and/or BC Act are outlined in **Table 10** and are not repeated within **Table 12**.

Table 12: Summary of migratory birds that may occur within the combined EMBA

Species	Common Name	Likelihood of occurrence in EMBA
Limosa lapponica	Bar-tailed godwit[8]	Species or species habitat known to occur within area
Onychoprion anaethetus	Bridled tern	Breeding known to occur within area
Limicola falcinellus	Broad-billed sandpiper[8]	Roosting known to occur within area
Sula leucogaster	Brown booby	Breeding known to occur within area
Anous stolidus	Common noddy	Foraging, feeding or related behaviour known to occur within area
Actitis hypoleucos	Common sandpiper[8]	Species or species habitat known to occur within area
Apus pacificus	Fork-tailed swift	Species or species habitat likely to occur within area
Thalasseus bergii	Greater crested tern	Breeding known to occur within area
Fregata minor	Greater frigatebird	Species or species habitat known to occur within area
Tringa brevipes	Grey-tailed tattler[8]	Roosting known to occur within area
Fregata ariel	Lesser frigatebird	Breeding known to occur within area
Numenius minutus	Little curlew[8]	Roosting known to occur within area
Charadrius dubius	Little ringed plover[8]	Roosting known to occur within area
Calidris subminuta	Long-toed stint[8]	Roosting known to occur within area
Tringa stagnatilis	Marsh sandpiper/ Little greenshank[8]	Roosting known to occur within area
Charadrius veredus	Oriental plover[8]	Roosting known to occur within area

Species	Common Name	Likelihood of occurrence in EMBA
Glareola maldivarum	Oriental pratincole[8]	Roosting known to occur within area
Acrocephalus orientalis	Oriental reed-warbler	Species or species habitat known to occur within area
Pandion haliaetus	Osprey	Breeding known to occur within area
Pluvialis fulva	Pacific golden plover[8]	Roosting known to occur within area
Calidris melanotos	Pectoral sandpiper[8]	Species or species habitat known to occur within area
Gallinago stenura	Pin-tailed snipe[8]	Roosting likely to occur within area
Sula sula	Red-footed booby	Breeding known to occur within area
Calidris ruficollis	Red-necked stint[8]	Roosting known to occur within area
Cecropis daurica	Red-rumped swallow	Species or species habitat known to occur within area
Sterna dougallii	Roseate tern	Breeding known to occur within area
Calidris alba	Sanderling[8]	Roosting known to occur within area
Calonectris leucomelas	Streaked shearwater	Species or species habitat known to occur within area
Gallinago magala	Swinhoe's snipe[8]	Roosting known to occur within area
Tringa incana	Wandering tattler[8]	Roosting known to occur within area
Ardenna pacifica	Wedge-tailed shearwater	Breeding known to occur within area
Numenius phaeopus	Whimbrel[8]	Roosting known to occur within area
Phaethon lepturus	White-tailed tropicbird	Species or species habitat known to occur within area
Tringa glareola	Wood sandpiper[8]	Roosting known to occur within area
Calidris subminuta	Long-toed stint[8]	Roosting known to occur within area

[8] Listed under the East Asian- Australasian Flyway Partnership

Australia is signatory to three international treaties with China, Japan and the Republic of Korea to safeguard migratory bird species, predominantly shorebirds. To facilitate observance of the three agreements, 15 species of migratory shorebirds have been listed as specially protected under both the Commonwealth EPBC Act and the WA BC Act.

Two internationally recognised areas that can support shorebird migrations are protected as wetlands of international importance. These wetlands are discussed further in **Section 9.2**.

The EPBC Act Policy Statement 3.21 sets out criteria for determining the significance of sites to migratory shorebirds based on the number of migratory species and the proportion of a species population that is supported by the site (Commonwealth of Australia, 2017b). Site significance can be difficult to assess, particularly for

ephemeral inland wetlands. These areas may be used rarely, depending on weather conditions, but still provide important habitat for migratory shorebird species.

Migratory shorebirds require a particular conservation approach due to their migration patterns that take them across international boundaries (Bamford et al., 2008). These species and their habitats are sensitive to threats due to their high site fidelity, tendency to aggregate, high energy demands and the need for habitat networks containing both roosting and foraging sites (Commonwealth of Australia, 2017b). Migratory shorebirds are known to use networks of connected sites (also known as site complexes). They move within these networks depending on the time of day, availability of resources and environmental conditions at the site (Commonwealth of Australia, 2017b).

The types of habitat used by migratory shorebirds in Australia vary across the species identified in the PMST search. Migratory shorebirds use both coastal and inland habitats that most commonly include:

- Coastal habitats: coastal wetlands, estuaries, mudflats, rocky inlets, reefs and sandy beaches, sometimes supporting mangroves.
- Inland habitats: inland wetlands, floodplains and grassland areas, often with ephemeral water sources (Commonwealth of Australia, 2017b).

Feeding guilds provide an explanation for much of the shorebird distribution pattern in the north Western Australia. For example, Rogers (1999) classified shorebirds (and others) in Roebuck Bay as belonging to several guilds on the basis of prey choice and foraging method. These are summarised in **Table 13**.

Table 13: Feeding guilds based on prey choice and foraging method (Rogers 1999) adapted from Bennelongia (2008)

Feeding habitat	Feeding guild	Species
Sea edge	Tactile hunters of macrobenthos	Great knot, red knot, bar-tailed godwit, black-tailed godwit, Asian dowitcher
Along sandy sea edges or near tidal creeks	Tactile hunters of microbenthos	Curlew sandpiper, red-necked stint, broad-billed sandpiper, marsh sandpiper, sharp-tailed sandpiper
Reefs or mangrove fringes	Visual hunters of slow surface-dwelling prey	Common sandpiper, ruddy turnstone
Sandier parts often near-shore	Visual hunters of small fast prey	Grey plover, greater sand plover, lesser sand plover, grey-tailed tattler, terek sandpiper
Soft mudflats	Visual hunters of fast large prey	Eastern curlew, whimbrel, greenshank,

The Wildlife Conservation Plan for Migratory Shorebirds (DoE, 2015) provides a framework to guide the conservation of migratory shorebirds and their habitat in Australia and, in recognition of their migratory habits, outlines national activities to support their appreciation and conservation throughout the East Asian-Australasian Flyway.

The following migratory shorebird species are subject to the Wildlife Conservation Plan for Migratory Shorebirds 2015 (DoE, 2015).

Table 14: Birds subject to the Wildlife Conservation Plan for Migratory Shorebirds 2015

Migratory species	DCCEEW SPRAT information on distribution
Asian dowitcher[8]	The Asian dowitcher is a regular visitor to the north-west between Port Hedland and Broome. Elsewhere they are sporadic and rare. In the NT, the Asian dowitcher is found in Darwin and Arnhem Land. In WA, the species has been recorded at Albany, Lake McLarty, Lake McLeod, north-east Pilbara and the south-west Kimberley division. It has also been recorded at the Port Hedland Saltworks, Roebuck Bay, Ashmore Reef and Eighty Mile Beach. The Australian population is approximately 500 (Bamford et al., 2008).
Bar-tailed godwit	The bar-tailed godwit has been recorded in the coastal areas of all Australian states. In WA, it is widespread around the coast, from Eyre to Derby, with a few scattered records elsewhere in the Kimberley. In the NT populations have been recorded from Darwin and Melville Island. No sites of international importance from WA and the NT overlap the EMBA, but include: • Eighty Mile Beach, WA (110,290 individuals) • Roebuck Bay, WA (65,000 individuals) • Milingimbi coast, NT (7,000 individuals) • Elcho Island, NT (5,000 individuals).
Black-tailed godwit[8]	The black-tailed godwit is found in all states and territories of Australia; however, it prefers coastal regions and the largest populations are found on the north coast between Darwin and Weipa.
Broad-billed sandpiper	Individuals mostly occur on the coasts of the Pilbara and Kimberley between Onslow and Broome but are also recorded north to the mouth of Lawley River, and inland at Lake Daley.
Common greenshank	The common greenshank occurs around most of the coast from Cape Arid in the south to Carnarvon in the north-west. In the Kimberley region, it is recorded in the south-west and the north-east, with isolated records from the Bonaparte Archipelago. WA has three sites of international importance for the common greenshank, none of which overlap the EMBA but include: • Eighty Mile Beach (2,240 individuals) • Wilson Inlet (568 individuals) • Roebuck Bay (560 individuals). The NT does not have any sites of international importance.
Common sandpiper	The distribution of the common sandpiper in WA includes Roebuck Bay and the Nuytsland Nature Reserve, neither of which overlap the EMBA. In the NT distribution includes: Kakadu National Park and the greater Darwin area.
Great knot[8]	The great knot has been recorded around the entirety of the Australian coast, with a few scattered records inland. The greatest numbers are found in northern Australia; where the species is common on the coasts of the Pilbara and Kimberley, from the Dampier Archipelago to the Northern Territory border. • No sites of international importance for the Great Knot in WA overlap the EMBA, but include: Eighty Mile Beach (169,044 individuals) • Roebuck Bay (22,600 individuals).
Greater sand plover	In Australia, the greater sand plover occurs in coastal areas in all states, though the greatest numbers occur in northern Australia, especially the north-west. In northern Australia, the species is especially widespread between North West Cape and Roebuck Bay in Western Australia and are sparsely scattered records from the largely inaccessible area between Roebuck Bay and Darwin. No internationally important sites within Western Australia overlap the EMBA, but include: • Eighty Mile Beach (64,548 individuals) • Roebuck Bay (26,900 individuals) • Ashmore Reef (1,196 individuals) (15 km north of EMBA).
Grey plover	In Australia, the grey plover has been recorded in all states, where it is found along the coasts and are recorded frequently between Albany and the northern Kimberley coast. No internationally important sites that occur within WA overlap the EMBA, but include: • Eighty Mile Beach (1,650 individuals) • Roebuck Bay (1,300 individuals) • Peel Inlet (600 individuals) • Nuytsland Nature Reserve (409 individuals).
Grey-tailed tattler	A recent review of the species indicated an estimated 90% of the East Asian-Australasian Flyway population (approximately 45 000 individuals) spend the non-breeding season in Australia (Bamford et al. 2008). The grey-tailed tattler is widespread from Houtman Abrolhos and the mainland adjacent to the Kimberley Division. It has also been recorded inland at Lake Argyle and on islands off the coast.
Lesser sand plover	Within Australia, the lesser sand-plover is widespread in coastal regions and has been recorded in all states. It mainly occurs in northern and eastern Australia, in south-eastern parts of the Gulf of Carpentaria, western Cape York Peninsula and islands in Torres Strait, and along the entire east coast, though it occasionally also occurs inland. In Western Australia, no important sites overlap the EMBA but include: • Eighty Mile Beach (1,575 individuals) • Roebuck Bay (1,057 individuals) • Broome (745 individuals) • Port Hedland Saltworks (668 individuals).
Little curlew	Little Curlews generally spend the non-breeding season in northern Australia from Port Hedland in Western Australia to the Queensland coast. There are records of the species from inland Australia, and widespread but scattered records on the east coast. The species has also been recorded on Lord Howe Island, Cocos-Keeling Island and Christmas Island. The species is recorded in Australia between September and April and there are few winter records. Sites of international importance for the Little Curlew within Australia, with maximum counts, include (Bamford et al. 2008): • Kakadu National Park, Northern Territory (NT), 180 000 • Roebuck Plains, Western Australia (WA), 52 000 • Anna Plains, WA, 12 000 • Derby Sewage Ponds, WA, 5000

Migratory species	DCCEEW SPRAT information on distribution
	• Parry floodplain, Wyndham, WA, 3000 (may overlap the EMBA).
Little greenshank/ Marsh sandpiper	The marsh sandpiper is found on coastal and inland wetlands throughout Australia found mainly on the coast in Western Australia. No National sites of importance within Western Australia overlap the EMBA, but include: • Port Hedland Saltworks (500 individuals) • Peel inlet (276 individuals) • Eighty Mile Beach (140 individuals).
Little ringed plover	Discrete populations around Perth (WA) and Darwin (NT).
Long-toed stint	In Western Australia, the species is found mainly along the coast, with a few scattered inland records. It is widespread around the Pilbara region and the Kimberley Division between Karratha and Wyndham-Kununurra. On the south-west coast the species is known from the Vasse River estuary, Guraga Lake and the Namming Nature Reserve. The species has occasionally been recorded in the Gascoyne Region, around Lake Wooleen, Meeberrie Station and McNeill Claypan.
Oriental plover	Internationally important marine sites for the oriental plover include Eighty Mile Beach, WA (approximately 57 619 individuals) and Roebuck Bay, WA (Approximately 8 750 individuals), neither of which overlap the EMBA
Oriental pratincole	The species occurs at numerous and widespread sites in northern Australia, especially near the Pilbara and Kimberley coasts of northern WA, and throughout the entire coastline of the NT. There is an internationally important site at Eighty Mile Beach, WA (2.88 million birds) which does not overlap the EMBA.
Pacific golden plover	In Western Australia, the species is seldom recorded along the southern or south-western coasts but is more widespread along the Pilbara and Kimberley coasts between North-West Cape.
Pectoral sandpiper	In Australasia, the pectoral sandpiper prefers shallow fresh to saline wetlands. The species is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands. The species is usually found in coastal or near coastal habitat but occasionally found further inland. It prefers wetlands that have open fringing mudflats and low, emergent or fringing vegetation, such as grass or samphire.
Pin-tailed snipe	The Pin-tailed Snipe breeds in Russia from the northern Ural Mountains, south to the Yamal Peninsula, south-east to Transbaikalia and northern Mongolia (between Tannu-Ola and Lake Baikal. The species also breeds in the north-east, through southern Amur to the coast west of the sea of Okhotsk (it is absent from the Kamchatka Peninsula). The species breeding range also extends from north to west along the Chukotsky Peninsula as well as the Kolyma River delta. The non-breeding distribution occurs mostly in south and south-east Asia, from eastern Pakistan, through the Indian subcontinent and the Indian Ocean islands. It is also found east through Bangladesh, Burma, Thailand and Indochina, south through the Malay Peninsula through to Indonesia. The species is rare in the Philippines. The species is vagrant to east Africa and rare in Japan (Higgins & Davies, 1996)
Red knot[8]	The red knot large numbers are regularly recorded in north-west Australia, with 80 Mile Beach and Roebuck Bay being particular strongholds. The Australian population during the non-breeding period is estimated to be 135 000 (Hansen et al., 2016).
Red-necked stint	The red-necked stint has been recorded in all coastal regions and found inland in all states when conditions are suitable. The red-necked stint probably travels in flocks and has been observed to feed in dense flocks. The Australian population was estimated at 353,000. No internationally important sites overlap the EMBA, but include: • Eighty Mile Beach (60,000 individuals) • Port Hedland Salt Works (23,000 individuals) • Roebuck Bay (19,800 individuals) • Wilson Inlet (15,252 individuals) • Alfred Cove Nature Reserve (10,000 individuals) • Lake Macleod (8,312 individuals) • Peel Inlet (8,063 individuals).
Ruddy turnstone	The ruddy turnstone is widespread within Australia during its non-breeding period of the year. Australian sites of international importance include: • Eighty Mile Beach (3,480 individuals) • Ashmore Reef (2,230 individuals) (15 km north of EMBA) • Roebuck Bay (2,060 individuals) • Barrow Island (1,733 individuals) • Lacepede Islands (1,050 individuals).
Sanderling	Sanderlings occur on most of the coast from Eyre to Derby, and also around Wyndham. They are more often recorded on the south and southwest coasts, north to around southern Shark Bay, with more sparsely scattered records further north in Gascoyne and Pilbara Regions and the Kimberley Division. Important sites include: • Eighty Mile Beach (2,230 individuals) • Ashmore Reef (1,132 individuals) (15 km north of EMBA) • Roebuck Bay (1,510 individuals).
Sharp-tailed sandpiper	They are widespread from Cape Arid to Carnarvon, around coastal and subcoastal plains of Pilbara Region to south-west and east Kimberley Division (Higgins & Davies 1996). No internationally important sites overlap the EMBA, but include: • Eighty Mile Beach (25 000 individuals)Port Hedland Saltworks (20 000 individuals) • Lake Gregory (10 000 individuals) • Peel-Harvey system (4 030 individuals).

Migratory species	DCCEEW SPRAT information on distribution
Swinhoe's snipe	No conclusive records exist for this species in Australia so the number of individuals that appear in Western Australia are unknown. In WA the species has been recorded in parts of the Pilbara, the Kimberley, Mount Goldsworthy, Mount Blaize. It has also been found in the north west-regions around the Mitchell Plateau
Terek sandpiper	In Western Australia (WA), the terek sandpiper is widespread in the Pilbara region and Kimberley Division, from Dampier to Wyndham, with occasional records around Shark Bay. No internationally important sites overlap the EMBA, but include: • Eighty Mile Beach (8,000 individuals) • Roebuck Bay (1,840 individuals).
Wandering tattler	Discrete population in Darwin (NT).
Whimbrel	The whimbrel is common and widespread from Carnarvon to the north-east Kimberley Division, Western Australia. It is occasionally seen on the south coast of Western Australia and has occasionally been recorded in south-west Western Australia and further north to Shark Bay. Roebuck Bay (1,020 individuals) is an internationally important site for this species but does not overlap the EMBA.
Wood sandpiper	The wood sandpiper has its largest numbers recorded in north-west Australia, with all areas of national importance located in Western-Australia but not overlapping the EMBA: • Parry Floodplain (Wyndham) (355 individuals) • Camballin (185 individuals) • Lake Argyle (90 individuals) • Shark Bay area, (80 individuals) • Vasse-Wonnerup estuary (61 individuals) • Lake McLarty (64 individuals) • Kogolup Lakes (60 Individuals)

[8] Listed under the East Asian-Australasian Flyway Partnership (EAAFP)
NB Fork tailed swift and Streaked shearwater were not on the list of migratory bird subject to the Wildlife Conservation Plan for Migratory birds 2015 so were removed in Rev11 2023
Latham's Snipe was not included in this list as it does not occur within the combined EMBA

Shorebird migration patterns are seasonal and vary according to species (DSEWPaC, 2012). Generally, shorebirds migrate to northern Australia in August to November. Many birds remain in northern Australia, but others disperse southwards (Bennelongia, 2011). Migratory shorebird numbers on northern beaches peak in November then again in March as the majority of birds begin their return to the northern hemisphere between March and May. Most migratory shorebirds do not breed in Australia and juvenile birds may spend several years in Australia before reaching maturity and returning north to breed (DEWHA, 2009).

The Wildlife Conservation Plan for Migratory Seabirds (DoE, 2020) seeks to facilitate a nationally coordinated effort to protect and conserve EPBC Act listed seabirds and provides an over-arching framework for their research and management, while encouraging an effort to address threats to seabirds and their habitats.

The following seabird species found within the combined EMBA are subject to the Wildlife Conservation Plan for Migratory Shorebirds 2020 (DoE, 2020).

Table 15: Birds (migratory) subject to the Wildlife Conservation Plan for Seabirds 2020

Migratory species	DCCEEW SPRAT information on distribution within the area of interest
Red-tailed tropicbird	The Australian population is poorly known owing to the numerous breeding sites and protracted and asynchronous breeding season making an accurate census difficult. The largest population breeds on Christmas Island (>2,000 pairs) with additional key breeding locations on Cocos (Keeling) Group, islands of Ashmore Reef Marine Park, Lord Howe Island, Norfolk Island, Coral Sea Marine Park and two known islands and cays in the Great Barrier Reef Marine Park.
White-tailed tropicbird	In Australia, the white-tailed tropicbird (Indian Ocean) breeds in the Cocos-Keeling Islands, at Ashmore Reef and Rowley Shoals off the northern coast of Western Australia. Over the past few years, birds have been sighted with increased frequency on West Island and Home Island (also in the main atoll) in the Cocos-Keeling Islands. The White-tailed Tropicbird (Indian Ocean) ranges widely over the oceans surrounding its breeding locations (Marchant & Higgins 1990). The breeding population of the white-tailed tropicbird (Indian Ocean) in Australia is estimated at 120 birds.
Fairy prion	Two subspecies breed in Australia, *turtur* and *subantarctica*. The subspecies *subantarctica* has previously been detected breeding on two rock stacks off Macquarie Island in 1979 and Bishop and Clerk Island in 1993.
Wedge-tailed shearwater	The wedge-tailed shearwater breeds on the east and west coasts of Australia and on off-shore islands. The species is common in the Indian Ocean, the Coral Sea and the Tasman Sea (Lindsey 1986). In Western Australia breeding occurs on islands off the west coast of WA, consisting of at least one million breeding pairs.
Streaked shearwater	The streaked shearwater undergoes trans-equatorial migration traveling south during winter, to the coasts of Vietnam, New Guinea, the Philippines, Australia, southern India and Sri Lanka. The global population has been estimated to number 3 million individuals.
Lesser frigatebird	It has been suggested that lesser frigatebird roost at Weipa and survey data suggests Ashmore Reef Marine Park comprises significant numbers and is believed to account for ≥1% of the global population.
Great frigatebird	Important populations in Western Australian seas include those at North Keeling Island,the islands of Ashmore Reef Marine Park and Adele Island.

Migratory species	DCCEEW SPRAT information on distribution within the area of interest
Red-footed booby	This red-footed booby is found in tropical islands in most oceans, excluding the eastern Atlantic. It winters at sea in the same area, ranging north of the Tropic of Cancer and south of the Tropic of Capricorn. This species is largely pelagic occurring farther from land than other booby species. The most important breeding population in Australia occurs in Pulu Keeling National Park in the Indian Ocean, which regularly supports more than 30,000 pairs.
Brown booby	In Australia, the brown booby is found from Bedout Island in Western Australia, around the coast of the Northern Territory to the Bunker Group of islands in Queensland with occasional reports further south in New South Wales (NSW) and Victoria. The species is reported further south to Tweed Heads, NSW, and to near Onslow, Western Australia and may be becoming more common in these areas. Within Australian seas, including Christmas and Cocos-Keeling Islands in the eastern Indian Ocean, the total breeding population was 59 940–73 900 pairs in a 1996–97 survey. The global population estimate for the species is 200 000.
Common noddy	In Australia, the common noddy occurs mainly in ocean off the Queensland coast, but the species also occurs off the north-west and central Western Australia coast. The species is also rarely encountered off the coast of the Northern Territory, where only one breeding location with about 100-130 birds is known. In 1996, the total Australian population of the Common Noddy was estimated to be between 174 480 and 214 130 breeding pairs.
Bridled tern	In Western Australia, bridled terns are breeding at Cape Leeuwin (extending round the southern coast to Seal Rocks) north to Shark Bay and in Pilbara region and Kimberley Division. At sea, distribution extends from Cape Leeuwin north to Dirk Hartog Island, with isolated mainland coastal records at Point Maud and Ningaloo, and from Barrow Island to the Dampier Archipelago, and at sea off the Kimberley coast from waters west of the Dampier Peninsula to Ashmore Reef and Joseph Bonaparte Gulf. The total population in Western Australia is estimated to be at least 30 000–40 000 pairs and apparently increasing.
Little tern	The Australian breeding population can be divided into two major subpopulations (northern and eastern) with the northern subpopulation that breeds across northern Australia, from about Broome in north-western Western Australia through coastal Northern Territory to the Gulf of Carpentaria and eastern Cape York Peninsula.
Roseate tern	In Western Australia, the subspecies is regularly recorded north from Mandurah to around Eighty Mile Beach, in the Pilbara Region. Around the Kimberley coastline, the subspecies occurs at scattered sites, north to the Bonaparte Archipelago and possibly further. Records in south-west Western Australia indicate that the subspecies used to be a sporadic visitor to the region, but occurs regularly at present. In addition, breeding colonies have been established on Lancelin Island and Second Rock, off Western Australia (Higgins & Davies 1996). In the Northern Territory, the subspecies has a scattered occurrence along the north coast, mainly from Darwin to Gove Peninsula, though birds have been recorded west to North Peron Island and east to the Sir Edward Pellow Islands (Chatto 2001). The subspecies is more widespread in the west and south-west of the Gulf of Carpentaria (Higgins & Davies 1996).I
Osprey	The breeding range of the eastern osprey around the northern coast of Australia (including many offshore islands) extends from Albany in Western Australia to Lake Macquarie in NSW;

Migratory species	DCCEEW SPRAT information on distribution within the area of interest
	with a second isolated breeding population on the coast of South Australia. The species is most abundant in northern Australia, where high population densities occur in remote areas. A population on Barrow Island was estimated at 20 pairs in 1978.

Like many birds, seabirds often migrate after the breeding season. Several species undertake trans-equatorial trips, both from the north to the south, and from south to north (DoE, 2020).

Other species migrate shorter distances away from the breeding sites, their distribution at sea determined by the availability of food. If oceanic conditions are unsuitable, seabirds will immigrate to more productive areas, sometimes permanently if the bird is young (Oro et al., 2004). After fledging, juvenile birds often disperse further than adults, and to different areas, so are commonly sighted far from a species' normal range. Some species, such as some of the storm petrels, diving petrels and cormorants, rarely disperse at all, staying near their breeding colonies year-round (DoE, 2020).

8.3. Biologically Important Areas / Critical Habitat– Birds

Table 16 below provides an overview of BIAs in the combined EMBA for birds. The DCCEEW may make recovery plans for threated fauna listed under the EPBC Act. The EPBC Act requires that 'habitat critical to the survival of the listed threatened species' is identified in recovery plans, relevant recovery plans are listed in **Section 13.2**[6].

In addition, both the EPBC Act and WA BC Act and associated regulations (2018) provide for the listing of critical habitat - habitat 'critical to the survival of the threatened species. No provision is made under the TPWC Act for listing critical habitat.

[6] Further background information on BIA and identification of critical habitat in recovery plans is provided in Section 5.4.

Table 16: Critical habitat/ biologically important areas - birds

Species	Scientific name	Aggregation area and use	Specific geographic locations for species
Brown booby	*Sula leucogaster*	Breeding - Kimberley and northern Pilbara coasts and islands also Ashmore Reef.	Kimberley and northern Pilbara coasts and islands also Ashmore Reef.
Greater crested tern ("Crested tern")	*Thalasseus bergii*	Breeding	Seagull Island, off NW of Cape Van Diemen, Melville Island No. 2 Sandy Island (Cobourg)
Greater frigatebird	*Fregata minor*	Reproduction - Kimberley and Ashmore Reef	Kimberley and Ashmore Reef
Great-winged petrel	*Pterodroma macroptera*	Foraging - Offshore south of Shark Bay	Offshore south of Shark Bay, extending around south-west corner of WA and east past Kangaroo Island
Lesser crested tern	*Sterna bengalensis*	Breeding - Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef	Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef
Lesser frigatebird	*Fregata ariel*	Breeding – Kimberley coast and Ashmore Reef.	Kimberley Pilbara coast and Ashmore Reef.
Little tern	*Sternula albifrons*	Breeding and resting - Kimberley and islands including Ashmore Reef Resting - Roebuck Bay	Kimberley coast and islands including Ashmore Reef Roebuck Bay Ramsar site
Red-footed booby	*Sula sula*	Breeding - northwest Kimberley and Ashmore reef	Northwest Kimberley and Ashmore reef
Roseate tern	*Sterna dougallii*	Breeding – Islands and coastline in the Kimberley	Kimberley coast and islands including Ashmore Reef Low Rocks and Stern Island in Admiralty Gulf North-east and North-west Twin Islets near the mouth of King sound North-western and west coasts and islands from Sir Graham Moore Is (13º50'S), south to Mandurah (32º32'S) and as far offshore as Ashmore Reef.
Wedge-tailed shearwater	*Ardenna pacifica*	Breeding – west coast from Ashmore Reef to Carnac I. Kimberley coast, Ashmore reef	Breeding (in hundreds of thousands) off west coast from Ashmore Reef (12º15'S) to Carnac Island (32º07'S), and ranging in western seas between 12º00'S and 33º20'S. Kimberley coast and islands including Ashmore Reef
White-tailed tropic bird	*Phaethon lepturus*	Breeding - Kimberley, coast and islands including Ashmore Reef	Kimberley, coast and islands including Ashmore Reef

9. Protected Areas

A number of areas in the combined EMBA are protected under state and federal legislation. Protected areas include World Heritage Areas, Wetlands of International Importance (Ramsar), Wetlands of National Importance, National and Commonwealth Heritage Places, and terrestrial conservation reserves (National Parks, Nature Reserves and Conservation Parks) that bound marine waters. These areas are listed in **Table 17**, and shown in **Figure 13,** and discussed below. Other protected areas include Key Ecological Features (discussed in **Section 9.1**) and State and Commonwealth Marine Parks/Reserves (discussed in **Section 11** and **Section 12**). A Protected Matters search of the combined EMBA (**Appendix A**) identified several protected areas which were deemed to be irrelevant to Santos' petroleum activities due to their terrestrial location (e.g. Forrestdale and Thomsons Lakes – Ramsar wetland).

The Register of the National Estate (RNE) provides a listing of more than 13,000 natural, historic and indigenous sites of significance. However, in 2012 all references to the RNE were removed from the EPBC Act and the *Australian Heritage Council Act 2003*.The RNE is now maintained on a non-statutory basis as a publicly available archive and educational resource. The RNE places are not discussed further here but are listed in **Appendix A**.

Table 17: Summary of protected areas in waters within the combined EMBA

Area type	Title
Wetland of International Importance (Ramsar)	Cobourg Peninsula
National Heritage Place	The West Kimberley (Natural)
Commonwealth Heritage Place	Scott Reef and Surrounds - Commonwealth Area
	Bradshaw Defence Area
Terrestrial Conservation Reserves e.g. national parks, nature reserves, and conservation parks.	Numerous bounding marine waters – refer to Section 9.6.

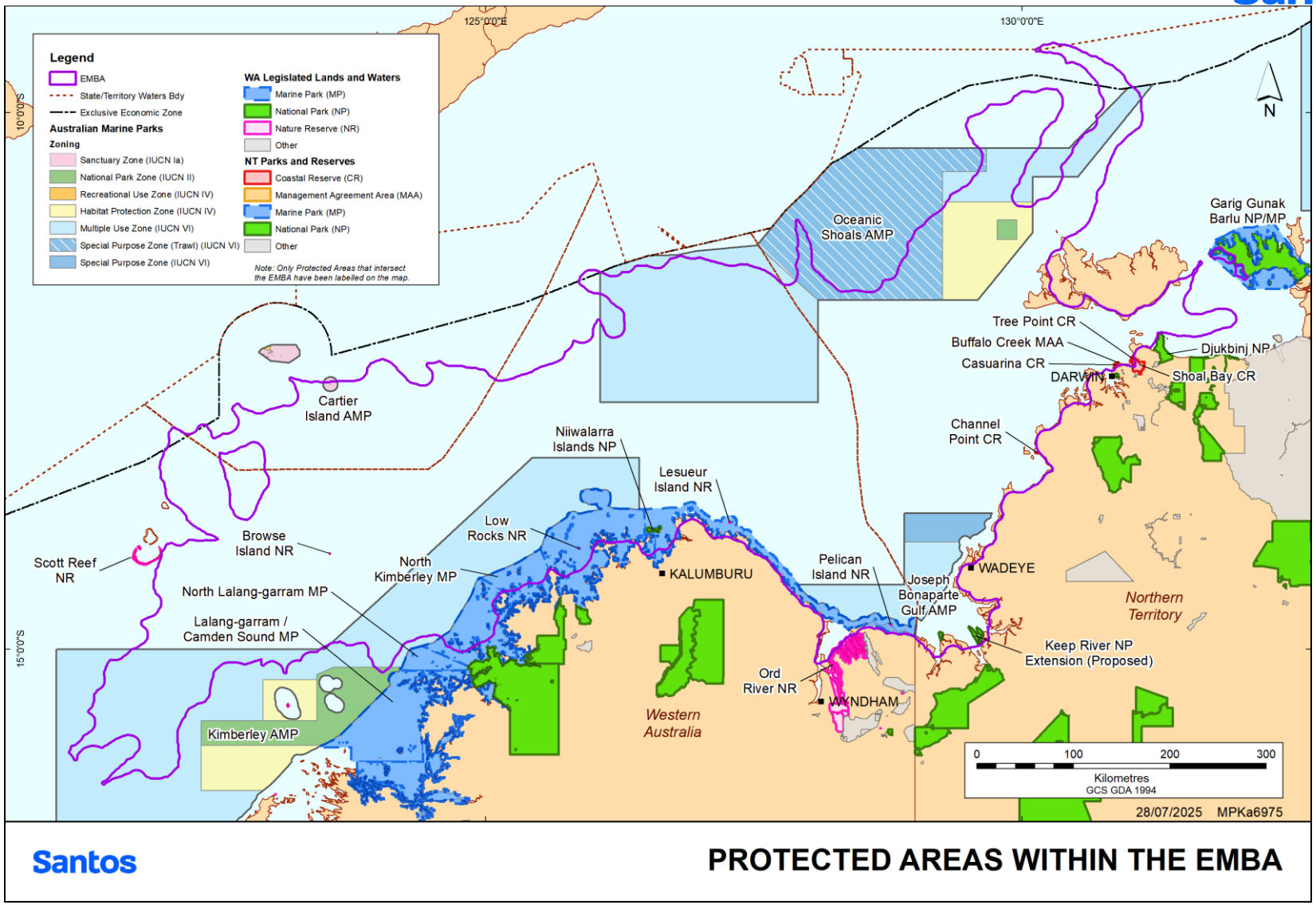


Figure 13: Protected areas

9.1. World Heritage Areas

There are no World Heritage Areas (WHA) located in marine waters that overlap the EMVA. The nearest WHA is located approximately 40 km east of the EMBA, although most of the area is terrestrial: Kakadu National Park.

The Australian World Heritage management principles are outlined under Schedule 5 of the EPBC regulations (2000). The objective is to ensure that any likely impact of an action on the World Heritage values of the property should be considered. Any action should be consistent with the protection, conservation, presentation or transmission to future generations of the World Heritage values of the property.

9.2. Wetlands of International Importance (Ramsar)

There are two wetlands of international importance (Ramsar wetlands) in waters that overlap the EMBA; all were listed in 1990 with the exception of the Cobourg Peninsula, which was listed in 1974.

9.2.1. Cobourg Peninsula

Under the Ramsar convention, the Cobourg peninsula site is listed as a Wetland of International Importance. The site is located 163 km north-east of Darwin within the Timor Sea Drainage Division. Within 220,700 ha, the site covers the entire peninsula and several nearby islands including the Sir George Hope Islands, Sandy Island No. I and II, Allaru Island, High Black Rock and Buford Island. Under the Cobourg Peninsula Aboriginal Land, Sanctuary and Marine act 1996, Cobourg peninsula and surrounding waters was declared a Nation Park (Garig Gunak Barlu National Park) (BMT WBM, 2011).

The Cobourg site is composed of a diverse coastal and inland wetland types. Wetland types present include intertidal forested wetlands and salt flats, seasonal freshwater marshes and permanent freshwater pools. Ramsar topology identifies ten coastal and ten inland types within the site. The site contains unique biodiversity and wildlife including terrestrial, riverine, freshwater, brackish and coastal/marine ecosystems. Identifiable wetland types include intertidal forested wetland and salt flats, seasonal freshwater marshes, and permanent freshwater pools.

Cobourg Peninsula is listed as a Wetland of International importance due to the diversity of coastal and inland wetland types that support population of threatened species, including a number of endangered turtles. The Cobourg site meets five of the current nine nomination criteria of the Ramsar Convention and is therefore recognised as a representative wetland habitat that is at bioregional level, support of populations of threatened species, support for key life-cycle functions such as marine turtle and waterbird breeding, refugia values, and its importance for supporting fish and nursery spawning habitats (BMT WBM, 2011). The Ramsar site is managed under the Cobourg Marine Park Plan of Management (DNREAS, 2011).

9.2.2. Ord River Flood Plains

Site lies within the Victoria-Bonaparte bioregion and contains a wide range of wetland types and includes all inland and marine components. This Ramsar site comprises of Parry Lagoons, Ord Estuary and the False Mouths of the Ord. Parry Lagoons includes both the permanent waterholes, such as Marglu Billabong, as well as the broader area of the flood plain within the Parry Lagoons Nature Reserve that are subject to periodic inundation. The area from the boundary near Adolphis Island to the Rocks is known as the Ord Estuary. The False Mouths of the Ord is an area of extensive intertidal creeks and flats in the north of the Ramsar site.

The Ord River Floodplain Ramsar site meets seven of the nine Nomination Criteria. The site represents the best example of wetlands associated with the floodplain, and estuary of a tropical river system in the Kimberley Region of Western Australia. Ord River contains extensive and diverse mangrove community containing 14 of the 18 species of mangrove known to occurs in Western Australia (Hale, 2008).

A number of threatened species including Freshwater Sawfish (*Pristis microdon*), the Green Sawfish (*Pristis zijsron*) and the Australian Painted Snipe (*Rostratula australis*), which are listed as vulnerable under the EPBC Act are supported in this area. The site also provides one of the two known habitats for the nationally endangered Northern River Shark (*Glypis* sp. C). The Ord River Floodplain Ramsar site provides an important nursery, breeding and feeding ground for at least 50 species of fish and a migratory route for 15 diadromous species.

There is sufficient evidence to suggest the sire regularly supports 20,000 birds in the site alone, although it should be acknowledged that there are difficulties associated with surveying the Ord River Floodplain. According to the

4th edition of Waterbird Population Estimates, the site regularly supports 1% of the population of Plumed Whistling Duck and Little Curlew (Hale, 2008). The Ramsar site is managed under the Ord River and Parry Lagoons Nature Reserves Management Plan (DEC, 2012c).

9.3. Wetlands of National Importance

9.3.1. Adelaide River Floodplain System

Several swamps, lakes, lagoons and dams are included in the 134,800-ha site. Four principal plant structural formations are present consisting of mangal low closed-forest (mangroves) mainly in the far north-west but extending along the river to south of the site, scattered chenopod low shrubland (samphire) in the far north, patches of melaleuca open-forest near the floodplain edges and missed closed grassland/sedgeland (seasonal floodplain) over most of the site (Jaensch, 1993).

The site is of particular significance as it contains one of the largest blocks of mangroves associated with the Top End floodplain as well as near-permanent marsh (Fogg Dam and Melacca Swamp), a rare wetland type in the Northern Territory. A rare species of the wetland plant *Goodenia quadrigida* also occurs within the floodplain. Surface inflow from the Adelaide-Margaret River System as well as numerous creeks (e.g. Hollands, Sunday and Buffalo Creeks) and Manton River provides a water supply for the area. The total volume of inflow is moderately high. The area provides a good example of the major floodplain-tidal wetland system typical of the Top End Region with substantial area of each component wetland type (Jaensch, 1993).

Adelaide River Floodplain system is a major breeding area for multiple species such as the Magpie Goose (*Anseranas semipalmata*), Saltwater Crocodile (*Crocodylus porosus*) and herons and allies. It is also a major dry season refuge area for waterbirds and a significant migration stop-over area for shorebirds (Jaensch, 1993).

9.3.2. Mary Floodplain System

Included in the 127,600-ha site is the entire floodplain of the Mary River, from near Bark Hit Inn downstream to Van Diemen Gulf (including intertidal mudflats) and including Swim Creek Plain. Three principal plant formations occur within the site. These include melaleuca open-forest (paperbark swamp), scattered chenopod low shrubland (samphire) in the north and centre-north; and the remainder, mixed closed- grassland/sedgeland (seasonal floodplain). Mangroves occur in the far north fringing the coast and at estuary mouths. The site includes some of the largest areas of wooded swamp in the Northern Territory. 21 of the 36 described floodplain flora communities occur in the Mary Floodplain system (Jaensch, 1993).

Water supply mainly occurs from the surface inflow form the Mary-McKinlay River system as well as many creeks. Mudflats, estuaries, and saline coastal flats are tidal. Tidal areas of mudflats and estuaries are inundated twice daily compared to the large parts of coastal flats that may be only periodically inundated. The floodplain water supply is seasonal, with near-permanent water in deeper channels and billabongs, as well as Eleocharis swamp. The site is a good example of a major floodplain-tidal wetland system typical of the Top End Region and features a complex network of channels and billabongs (Jaensch, 1993).

Mary Floodplain System provides a major breeding area for the Magpie Goose (*Anseranas semipalmata*) as well as refuge during dry season for waterbirds (geese, ducks and herons) and Saltwater Crocodiles (*Crocodylus porosus*). At least 75 species recorded within the area, of those 33 species were listed under treaties and 11 species were found breeding. The mudflat and coastal flats support at least several thousand migrant shorebirds at a time (Jaensch, 1993).

9.3.3. Cobourg Peninsula System

See Cobourg Peninsula Ramsar site (Section 9.2.1).

9.3.4. Daly-Reynolds Floodplain-Estuary System

The Daly-Reynold Floodplain-Estuary System includes the entire floodplain of the Daly River, entire floodplain of the Reynolds River and the tidal mudflats of north-east Anson Bay and is in the Darwin Coastal and Daly Basin biographical regions. Six principal plant formations exist within the 159,300-ha site. This includes mixed closed-grassland/sedgeland (seasonal floodplain) over most of the site; Melaleuca open-forest (paperbark swamp) in patches throughout, Coolibah/Gutta-percha low woodland over grassland in the far south-east; closed-forest (monsoon vine-thicket) around the Daly River in the far south-east; mangal low closed-forest (mangroves),

discontinuously along the Daly River estuary (to 1 km wide); and scattered chenopod low shrubland (samphire) at/near the coast and river mouth. The site provides a good example of a major floodplain-tidal wetlands system as it contains substantial areas of all the principal features of such a system in the Top End Region. It is also one of the largest floodplains in the Northern Territory (Jaensch, 1993).

Thirty-one of the 36 described floodplain flora communities occur on the Daly-Reynolds Floodplain. The Daly-Reynolds Floodplain-Estuary System plays an important ecological role by providing a top three breeding ground for Magpie goose (*Anseranas semipalmata*), as well as herons, allies and Saltwater Crocodiles. Additionally, the site is a major dry season refuge area for waterbirds and a significant migration stop-over area for shorebirds. The site also contains more than 80 fauna species, 30 of which are listed under treaties. Up to 2100 shorebirds are known to frequent this site as a migratory stop over (Jaensch, 1993).

9.3.5. Finniss Floodplain and Fog Bay Systems

The floodplain and bay systems provide a good example of a beach-fringed, curved bay with intertidal mudflats and intact floodplain with extensive paperback swamps. Plant structural formations within the area include mixed closed grassland/sedgeland and melaleuca open forests. Small areas of mangal and samphire occur near the estuaries and the south-west part of the bay. Surface inflow from the Finniss River, and several creeks supply the site with water (Jaensch, 1993).

At least 70 species of fauna are recorded in the area, 20 of which are listed under treaties. Finnis Floodplain and Fog Bay Systems are major breeding areas for Magpie goose and Saltwater Crocodile, a significant dry season refuge area for water birds and a major migration stop-over for over 25’000 shorebirds. 24 of the described floodplain flora communities along with the best floating mats in the Northern territory occur within this site (Jaensch, 1993).

9.3.6. Moyle Floodplain and Hyland Bay System

Plant structural formations of the area consist of closed grassland/sedgeland latiform arrangements, some fringing and scattered patches of melaleuca open-forests, and mangal low closed forest (mangroves) along the lower river. Surface inflow to floodplain areas from multiple creeks and Moyle River is the main source of water supply.

The Moyle Floodplain and Hyland Bay System is one of the least distributed examples of a Top End floodplain system associated with a small river a mudflat-fringed bay. The site is a major breeding area for magpie goose, a refuge for waterbirds (whistling duck) in the dry season, migration stop over area for shorebirds and a major breeding area for Saltwater Crocodiles. 27 of the described floodplain flora communities occur at this site. 47 fauna species are known to occur on the floodplain and adjacent coast, 26 of which are listed under treaties (Jaensch, 1993).

9.3.7. Ord Estuary System

See Ord River Flood Plains Ramsar site (Section 9.2.2).

9.3.8. Port Darwin

The entire Port Darwin site covers 48,800 ha. The whole site is tidal with mangal low closed-forest (mangroves) plant structural formations present. The site provides a good example of a shallow branching embayment of the Top End Region, supporting one of the largest discrete areas of mangrove swamp in the Northern Territory (Jaensch, 1993).

36 flora species, 23 of them trees and tall shrubs are present within the mangrove communities. Including Northern territory endemic *Avicennia integra*. The mangrove communities of this site are the most extensive and species rich of any Northern Territory embayment. The site is a major nursery for estuarine and offshore fish and crustaceans in the Beagle Gulf area. 48 fauna species, with 25 listed under treaties existing within this site. Rare species such as Red-necked Phalarope have also been recorded within the site. Furthermore, Woods Inlet is frequented by the uncommon dolphin *Orcaella brevirostris*. At least 72 fish species occur within the site as well as there being an unusual richness in sponges (220 species), soft and hard coral as well as invertebrates (Jaensch, 1993).

9.3.9. Shoal Bay - Micket Creek

Shoal bay is approximately 10 km immediately north-east of the City of Darwin and the site includes King Creek and Noogoo swamp within 1,600 ha. The site contains wetland marshes, mangrove woodlands, beaches, mudflats, creeks and estuaries and is a good example of a spring fed coastal wetland system. Micket Creek is a tidal estuary flowing into Shoal Bay while King Creek and water from Noogoo Swamp all flow into Shoal Bay. All areas contain remnants of monsoon forest interspersed with open woodland bounded by grassed backsoil plain (Hodgson, 1995).

Within the site there are some notable species. It has a bird habitat of over 200 species and provides a dry season refuge for waterfowl and birds of prey. Migratory birds regularly use the areas of mudflats with more than 15,000 wader species and 25 of them listed on international agreements with Japan and China. The Nationally endangered Littler Tern and two other uncommon species, the Eastern Grass Owl and Peregrin Falcon have been recorded within Shoal Bay – Micker Creek (Hodgson, 1995).

9.3.10. Legune Wetlands

The Legune Wetlands are located in the coastal floodplain of the Josef Bonaparte Bay. The area mostly consists of mudflats, swamps, grassy marshes and mangroves (BirdLife International, 2011). This system provides the main area of waterbird habitat in the Keep River drainage and has been identified by BirdLife International as an Important Bird Area (IBA) as it is thought to support at least 1% of the world population of pied herons (Jaensch, 1995; BirdLife International, 2011).

9.4. National Heritage Places

Natural, historic and indigenous places that are of outstanding heritage value to the Australian nation are recorded as National Heritage Places. One National Heritage Place is found in overlapping the EMBA.

9.4.1. The West Kimberley

The West Kimberley was included on the National Heritage List in 2011 and has numerous values which contribute to the significance of the property, including indigenous, historic, aesthetic, cultural and natural heritage values (DoE, 2014d). Of these values, the most relevant to the marine environment is Roebuck Bay as a migratory hub for shorebirds. The area is characterised by a diversity of landscapes and biological richness found in its cliffs, headlands, sandy beaches, rivers, waterfalls and islands.

9.5. Commonwealth Heritage Places

The Commonwealth Heritage Places List comprises natural, indigenous and historic heritage places which are either entirely within a Commonwealth area, or outside the Australian jurisdiction and owned or leased by the Commonwealth or a Commonwealth Authority. Three Commonwealth Heritage Places are found in or adjacent to the combined EMBA.

9.5.1. Scott Reef and Surrounds – Commonwealth Area

Scott Reef is a large, emergent shelf atoll located on the edge of the broad continental shelf, about 300 km from mainland north-western Australia. The listing comprises the areas of Scott Reef that are within Commonwealth waters to the 50 m BSL bathymetric contour. This includes North Reef, an annular reef, 16.3 km long and 14.4 km wide and parts of the lagoon of South Reef, a crescent shaped reef 17 km across (DoE, 2014d).

The place is regionally significant both because of its high representation of species not found in coastal waters off Western Australia and for the unusual nature of its fauna which has affinities with the oceanic reef habitats of the Indo-West Pacific as well as the reefs of the Indonesian region (DoE, 2014d).

9.5.2. Bradshaw Defence Area

The Bradshaw Defence Area is located in the Northern Territory and is bounded by the Fitzmaurice and Victoria Rivers on the shores of the Joseph Bonaparte Gulf and the Bradshaw Defence field training area.

The complex topography of the Bradshaw area results in a broad range of highly distinct environments and habitats that include lowland woodlands, heaths, grasslands, sandstone escarpments, monsoon rainforest patches and wetlands. Compared to surrounding areas, the vegetation within the Bradshaw area is more diverse and incorporates more than one fifth of the vegetation types that occur in the Top End of the Northern Territory and includes grassland, woodland flora that are restricted on a national level (DCCEEW, 2014b).

The topological complexity that results in a broad range of environments also contributes to the unusually rich vertebrate fauna. The species richness of frogs, reptiles and mammals is considered significant at a national level. Furthermore, it is also worth noting that the Bradshaw area supports many species that have declined elsewhere in Australia (DCCEEW, 2014b).

9.6. Coastal Terrestrial Conservations Reserves – bound by marine waters

Conservation reserves are created under the Land Administration Act 1997, and once reserved and set aside for conservation purposes are regulated under the *Conservation and Land Management Act (CALM) 1984*. Most conservation reserves in WA are vested in (owned) by the WA Conservation and Parks Commission, an independent statutory body established by the CALM Act 1984, and most are managed by the Department of Biodiversity, Conservation and Attractions – Parks and Wildlife Service. Most conservation areas in the NT are managed under the *Territory Parks and Wildlife Conservation Act*.

In WA there are three main types of terrestrial conservation reserves with legislative protection:

- Nature reserves – established for wildlife and landscape conservation; scientific study; and preservation of features of archaeological, historic or scientific interest.
- National parks – as above but also to be used for enjoyment by the public. Have national or international significance.
- Conservation parks – as above but have local or regional significance.

Nature reserves can have an extra classification applied to them and become ‘A class’ reserves, which generally require an Act of Parliament to alter.

In NT there are a number of types of terrestrial conservation reserves with legislative protection, those present within the combined EMBA include coastal reserves, national parks and conservation parks.

There are numerous terrestrial conservation reserves located adjacent to the coast in the combined EMBA. The oceanward boundary of the reserves varies. In some cases, the reserves extend to the low water mark, i.e. including the inter-tidal zone (particularly applicable to older gazetted reserves and terrestrial reserves not surrounded by a marine reserve). While in other cases, the terrestrial reserves extend to the high-water mark e.g. Lowendal Islands Nature Reserve (particularly applicable to terrestrial reserves adjacent to more recently gazetted marine parks). In other cases, the seaward boundary of the reserves is not defined. Management plans also contain the caveat for further consideration of the most appropriate tenure for intertidal areas and management arrangements.

Further information on coastal terrestrial reserves is provided below in **Section 9.6.1** (national parks) and **Section 9.6.2** (nature reserves and conservations parks).

9.6.1. Coastal National Parks

Protected coastal national parks managed under the CALM Act 1984 in the combined EMBA are listed in **Table 18**. The table also includes: any applicable management plan; whether the park includes the inter-tidal area; and the name of any adjacent state marine reserve. All WA National Parks are WA Class A reserves and IUCN Class 2.

Table 18: Coastal National Parks – coastal boundary in relation to inter-tidal zone

National Park	IBRA bioregion[7]	Management plan	Includes inter-tidal zone	Adjacent Marine Management Park (see Section 11)
Reserves of the Northern Territory (NT) – (see Figure 14)				
Djukbinj National Park	Darwin Coastal and Pine Creek	-	Yes[9]	-
Garig Gunak Barlu National Park	Tiwi Cobourg	Cobourg Marine Park Plan of Management (PAWCNT, 2011)	Yes[9]	Cobourg Marine Park

9.6.2. Coastal Nature Reserves and Conservation Parks

Protected coastal nature reserves and conservation parks managed under the CALM Act 1984 in the combined EMBA are listed in **Table 19** and shown in **Figure 15** for the north of WA. Protected lands in the NT are shown in **Figure 14** as gazetted under the (NT) Crown Lands Act 1992. The table also includes reserve class; IUCN classification; any applicable management plan; whether the reserve includes the inter-tidal area; and the name of any adjacent state marine reserve (may also describe inter-tidal areas values).

The CALM Act does not require management plans to be in place for conservation reserves at all times, instead they are required to be made as is reasonably practicable regarding resources. This means some conservation reserves do not have a management plan, or do not have a recent management plan.

[7] IBRA classifies Australia's landscapes into large geographically distinct bioregions based on common climate, geology, landform, native vegetation and species information (DoEE 2012).

Table 19: Nature Reserves (NR), Conservation Parks (CP), Regional Parks (RP) and Coastal Reserves (CR) in the combined EMBA

Reserve name and type	Reserve class	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 11)
Reserves of northern WA (see Figure 15)					
Ord River NR	-	1a	-	No [8]	North Kimberley Marine Park
Lesueur Island NR	A	1a			
Low Rocks NR	A	1a			
Browse Island NR	A	1a	-	Yes [9]	-
Scott Reef NR	-	1a	-	Yes [9]	-
Reserves of the Northern Territory (NT) – (see Figure 14)					
Channel Point Coastal Reserve	-	5	-	Yes[9]	-
Casuarina Coastal Reserve	1 and 3	5	Casuarina Coastal Reserve Management Plan (PAWCNT, 2016)	Yes[9]	-
Shoal Bay Coastal Reserve	-	6	-	Yes[9]	-
Tree Point Conservation Area	-	5	-	Yes[9]	-

[8] Inferred as adjacent marine park boundary is the high-water mark and dual tenure cannot exist.
[9] Conservatively inferred as no adjacent Marine Park.

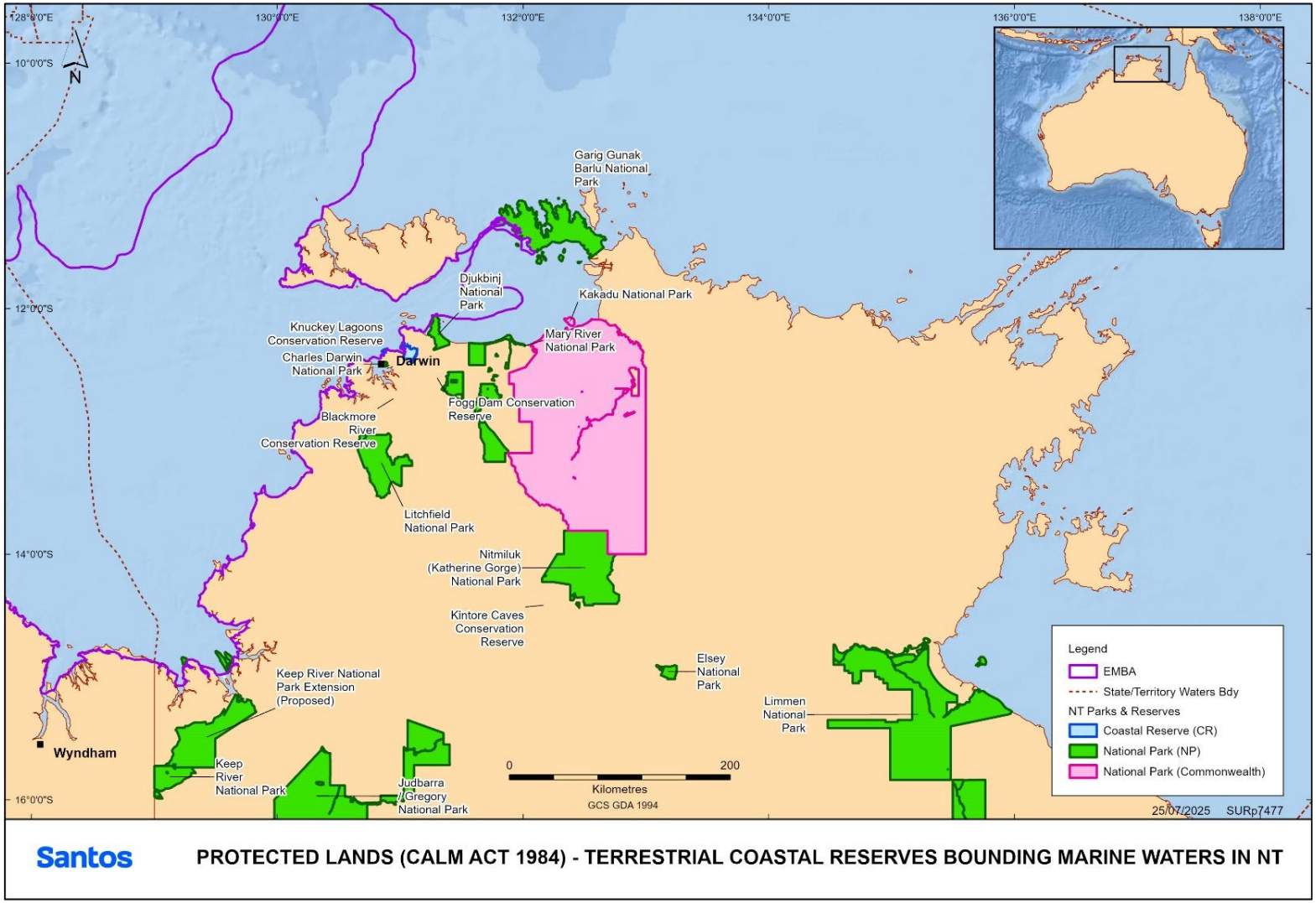


Figure 14: Protected Lands (CALM Act 1984) – terrestrial coastal reserves bounding marine waters in NT

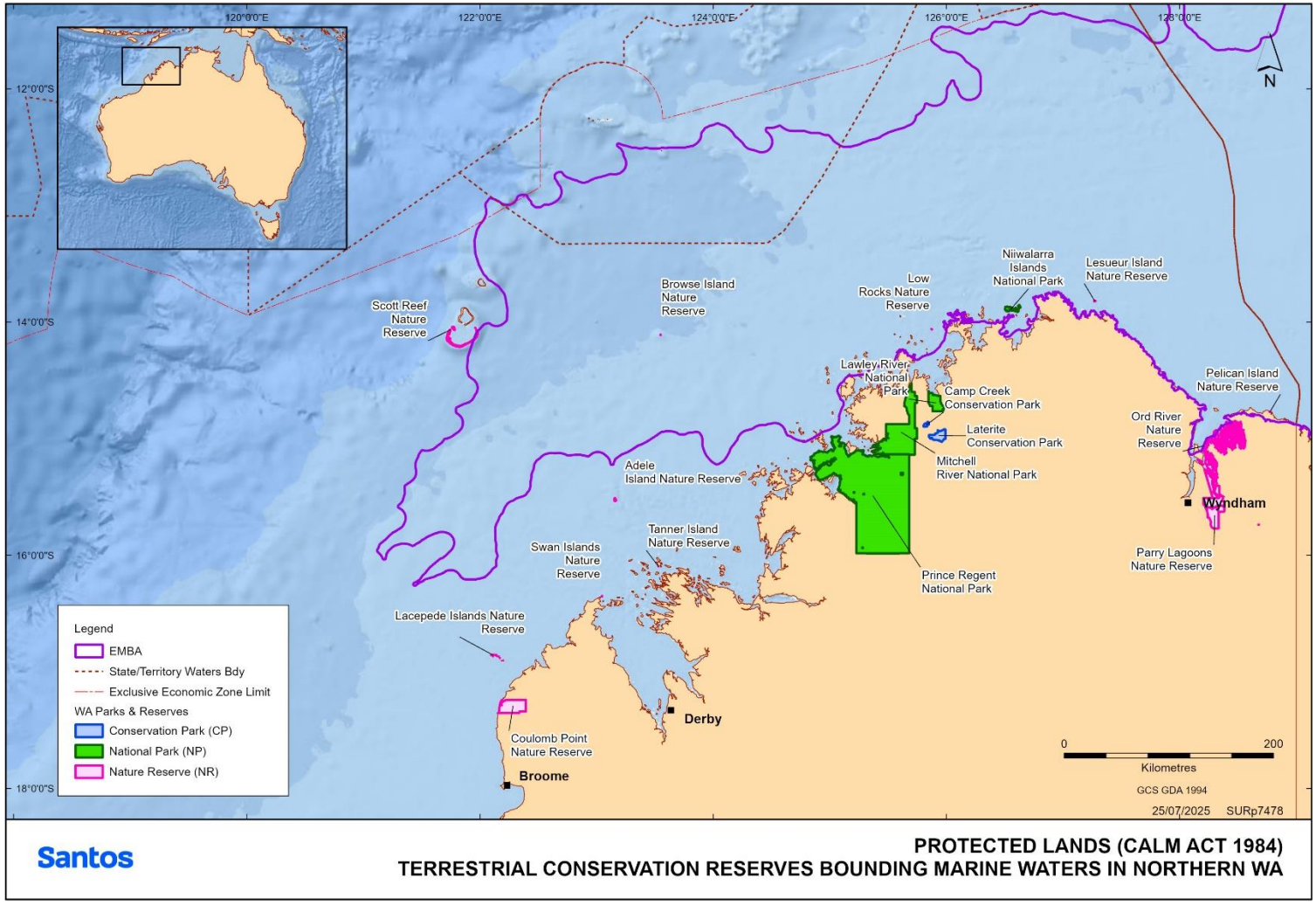


Figure 15: Protected Lands (CALM Act 1984) – terrestrial conservation reserves bounding marine waters in Northern WA

9.1. Threatened Ecological Communities

An ecological community is a naturally occurring group of plants, animals and other organisms interacting in a unique habitat. Ecological communities are listed under the EPBC Act as threatened if the community is at risk of extinction.

Similarly, ecological communities can be listed under the WA BC Act as threatened if facing a risk of becoming a collapsed ecological community. To date no ecological communities are listed as threatened under the WA Act, however several ecological communities are currently endorsed by the WA Minister of Environment as Threatened Ecological Communities (TECs) through the previous non-statutory process.

No TECs of relevance overlap or exist within the combined EMBA.

10. Key Ecological Features

10.1. Introduction

Key ecological features (KEFs) are elements of the Commonwealth marine environment that are considered to be of regional importance for either a region's biodiversity or its ecosystem function and integrity. KEFs meet one or more of the following criteria (DSEWPaC, 2012):

- A species, group of species or a community with a regionally important ecological role
- A species, group of species or a community that is nationally or regionally important for biodiversity
- An area or habitat that is nationally or regionally important for:
  - Enhanced or high biological productivity
  - Aggregations of marine life; or
  - Biodiversity and/or endemism
- A unique sea floor feature with ecological properties of regional significance.

Eight key ecological features of the Commonwealth waters in the combined EMBA (covering the NMR and the NWMR) have been identified in the protected matters search (**Figure 16**) and are discussed in this section. **Sections 1** and **2** provide an overview of the geomorphology and oceanography of the Indian Ocean. Individual EPs will describe specific ecological features outside of the Commonwealth waters that are within that activity's EMBA.

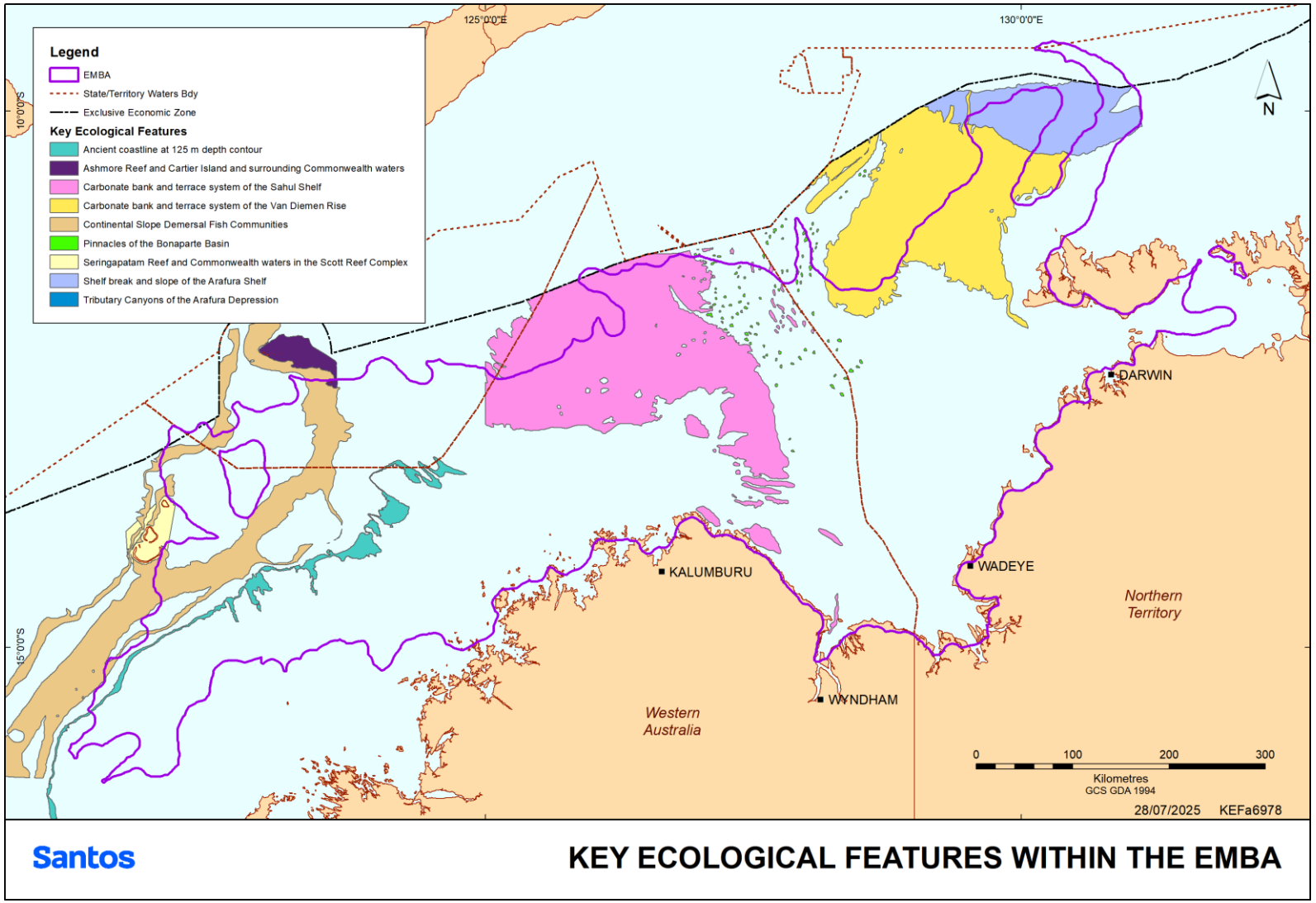


Figure 16: Key ecological features

10.1.1. Ancient Coastline at 125 m Depth Contour

The shelf of the North-west Marine Region contains several terraces and steps which reflect changes in sea level that occurred over the last 100,000 years. The most prominent of these features occurs at a depth of 125 m as an escarpment along the North West Shelf and Sahul Shelf (DSEWPaC, 2012). Where the ancient, submerged coastline provides areas of hard substrate it may contribute to higher biological diversity in areas otherwise dominated by soft sediments. Little detailed knowledge was available at the time of its designation, but it was thought that the hard substrate of the escarpment is likely to support sponges, crinoids, molluscs, echinoderms (DSEWPaC, 2012) and that changes in topography at these depths are critical points for the generation of internal waves (Holloway et al., 2001 cited in DEWHA, 2008a), playing a minor role in aiding localised upwelling or at least regional mixing associated with the seasonal changes in currents and winds. It was hypothesised that this prominent floor feature could be important as a migratory pathway for cetaceans and pelagic species such as the whale shark and humpback whale, as they move north and south between feeding and breeding grounds (DEWHA, 2008a). Enhanced productivity could potentially be attracting baitfish, which in turn provide food for the migratory species. The pressures of potential concern on the biodiversity value of this feature generally include ocean acidification as a result of climate change (DoEE, 2019b).

Currey-Randall et al. (2021) investigated drivers of fish species richness and assemblage composition spanning six degrees of latitude along sections of the ancient coastline, categorised as ‘on’ and ‘off’ the ancient coastline at 125m KEF (AC125) based on depth, across a range of habitats and seafloor complexity (~60–180 m depth). While some surveyed sections of the AC125 had hard bottom substrate and supported enhanced fish diversity, including over half of the total species observed, species richness and abundance overall were not greater on the AC125 than immediately adjacent to the AC125. Instead, depth, seafloor complexity and habitat type explained patterns in richness and abundance, and structured fish assemblages at both local and broad spatial scales. Fewer fishes were associated with deep sites characterized by negligible complexity and soft-bottom habitats, in contrast to shallower depths that featured benthic biota and pockets of complex substrate. Drivers of abundance of common species were species-specific and primarily related to sampling areas, depth and substrate. Fishes of the ancient coastline and adjacent habitats are representative of mesophotic fish communities of the region, included species important to fisheries and conservation, and several species were observed deeper than their currently known distribution.

Wakeford et al., (2023) investigated the bathymetry, sedimentology and benthic habitats at 5 locations across the AC125 using multibeam sonar, sediment samples and towed video imagery. Approximately 98% of the seabed surveyed was comprised of unconsolidated soft sediment habitat (mud/sand/silt) supporting negligible epibenthic biota. The prevalence of soft sediment suggests that post-glacial sediments have infilled parts of the ancient coastline), with cross-shelf, probably tidal currents in the northern section of the study area responsible for some of the sediment mobilisation and southern study areas more influenced by oceanic conditions. Within study areas, total biotic cover ranged from 0.02% to 1.07%. Of the biota encountered, most comprised filter feeder organisms (including gorgonians, sponges, and whip corals) whose distribution was associated with pockets of consolidated hard substrate. Benthic community composition varied with both study area and position in relation to the predicted AC125. In general, consolidated substrate was proportionally higher in water shallower than the AC125 compared to on the AC125 or deeper than the AC125. Spatially continuous maps of predicted benthic habitat classes (pre-determined benthic communities) in each study area were developed to characterise biodiversity. Spatial modelling corroborated depth and large-scale structural complexity of the seafloor as surrogates for predicting likely habitat class. The study provided an important assessment of the AC125 and concluded that if a distinct coastline exists in the areas surveyed, it is now largely buried and as such does not provide a unique hard substrate habitat.

10.1.2. Continental Slope Demersal Fish Communities

The Australian Continental Slope provides important habitat for demersal fish communities, characterised by high endemism and species diversity. Specifically, the continental slope between North West Cape and the Montebello Trough is the most diverse slope bioregion in Australia with more than 500 fish species, 76 of which are endemic (Last et al., 2005 in DSEWPaC, 2012).

The Continental Slope consists of two distinct community types, associated with the upper and mid slope, 225 – 500 m and 750 – 1000 m respectively. The Timor Province and Northwest Transition bioregions are the second-richest areas for demersal fish across the entire continental slope (DSEWPaC, 2012). The bacteria and fauna that is present in the system on the Continental Slope are the basis for the food web for demersal fish and higher order consumers in the system. Further information of this system has been poorly researched, though it has

been suggested that it is a detritus-based system, where infauna and epifauna become prey for a range of teleost fish, molluscs and crustaceans (Brewer et al., 2007). The higher order consumers supported by this system are likely to be carnivorous fish, deep water sharks, large squid and toothed whales (Brewer et al., 2007). The pelagic production is known to be phytoplankton based, with hotspots located around oceanic reefs and islands (Brewer et al., 2007).

It is believed that the loss of the benthic habitat along this continental shelf region would likely lead to a decline in the species diversity and endemism that this feature is associated with (DoEE, 2019). The endemism of the region is not supported by large data sets and is scarce. It is consequently not well understood what interactions exist between the physical processes and trophic structures that lead to this high diversity of fish and the suggested presence of endemic species in the region (DoEE, 2019).

10.1.3. Seringapatam Reef and Commonwealth Waters in the Scott Reef Complex

Scott and Seringapatam reefs are part of a series of submerged reef platforms that rise steeply from the sea floor between the 300–700 m contours on the north-west continental slope and lie in the Timor Province (Falkner et al., 2009). Scott Reef consists of two separate reef formations, North Reef and South Reef. The total area of the key ecological feature is approximately 2,418 km². As two of the few offshore reefs in the north-west, they provide an important biophysical environment in the region.

Scott and Seringapatam reefs and the waters surrounding them attract aggregations of marine life including humpback whales on their northerly migration, Bryde's whales, pygmy blue whales, Antarctic minke whales, dwarf minke whales, minke whales, dwarf sperm whales and spinner dolphins (Jenner et al., 2008; Woodside, 2009). Whale sharks and several species of sea snakes have also been recorded in this area (Donovan et al., 2008). Green and hawksbill turtles nest during the summer months on Sandy Islet on South Scott Reef. These species also internest and forage in the surrounding waters (Guinea, 2006). Scott Reef is a particularly biologically diverse system and includes more than 300 species of reef-building corals, approximately 400 mollusc species, 118 crustacean species, 117 echinoderm species and around 720 fish species (Woodside, 2009). Corals and fish at Scott Reef have higher species diversity than the Rowley Shoals (Done et al., 1994).

Scott Reef is listed as Commonwealth Heritage Places and is discussed in **Section 9.5.1**.

10.1.4. Ashmore Reef and Cartier Island and Surrounding Commonwealth Waters

Ashmore Reef and Cartier Island are situated on the shallow upper slope of the Sahul Shelf, north of Scott and Seringapatam reefs. Rising from a depth of more than 100 m, the reef platform is at the edge of the North West Shelf and covers an area of 239 km². Ashmore Reef Commonwealth Marine Reserve encloses an area of about 583 km² of seabed (EA, 2002). Cartier Island lays about 350 km off Australia's Kimberley coast, 115 km south of the Indonesian island of Roti and 45 km south-east of Ashmore Reef Commonwealth Marine Reserve. Cartier Island Commonwealth Marine Reserve covers 167 km² (EA, 2002). Species at Ashmore Reef and Cartier Island include more than 225 reef-building corals, 433 molluscs, 286 crustaceans, 192 echinoderms, and the most diverse variety of fish of any region in Western Australia with 709 species (EA, 2002).

Sandy beaches provide important habitat for nesting green and hawksbill turtles throughout the year. Seagrass present at Ashmore Reef provides critical breeding (April–May) and foraging (throughout the year) habitat for a genetically distinct population of dugong with their range probably extending to other submerged shoals within the area (Brown & Skewes, 2005; Whiting, 1999). The emergent habitat at Ashmore also provides important nesting sites for seabirds, many of which are migratory. Ashmore's islands are regarded as supporting some of the most important seabird rookeries on the North West Shelf seasonally supporting up to 50,000 seabirds (26 species) and up to 2,000 waders (30 species, representing almost 70 % of wader species that regularly migrate to Australia) (Milton, 2005). Large colonies of sooty terns, crested terns, bridled terns and common noddies breed on the east and middle islands. Smaller breeding colonies of little egrets, eastern reef egrets, black noddies and possibly lesser noddies also occur. Migratory wading birds include eastern curlews, ruddy turnstones, whimbrels, bar-tailed godwits, common sandpipers, Mongolian plovers, red-necked stints and tattlers, during October–November and March–April as part of the migration between Australia and the Northern Hemisphere (Milton, 2005).

This KEF only overlaps the combined EMBA within the surrounding deep Commonwealth waters.

10.1.5. Carbonate Bank and Terrace System of the Sahul Shelf

The Carbonate Banks and Terrace System of the Sahul Shelf are located in the western Joseph Bonaparte Gulf and to the north of Cape Bougainville and Cape Londonderry. The banks consist of a hard substrate and flat tops at depths of 150–300 m. Each bank occupies an area generally less than 10 km^2 and is separated from the next bank by narrow sinuous channels with depths up to 150 m. The origin of the banks is uncertain, though the area contains predictably high levels of productivity, in comparison to the generally low productivity of the region (DSEWPaC, 2012).

The banks are foraging areas for loggerhead, olive ridley and flatback turtles and provide habitat for humpback whales, and green and freshwater sawfish (Donovan et al., 2008 in DSEWPaC, 2012). The hard substrate of the banks is thought to support diverse organisms including sessile benthic invertebrates such as sponges, soft and hard corals, gorgonians, bryozoans, ascidians and associated reef fish and elasmobranchs (Brewer et al., 2007). Cetaceans, green and fresh sawfish are also likely to occur in the area, as well as possibly the Australian snubfin dolphin, a migratory species occurring mostly on the northern extent of the Sahul Shelf (DSEWPaC, 2012).

According to DSEWPaC (2012), the carbonate banks and terrace system of the Sahul Shelf are regionally important because of their role in enhancing productivity relative to their surrounds. Little is known about the banks, terraces and associated channels but they are believed to be areas of enhanced productivity and biodiversity due to the upwellings of cold nutrient-rich water at the heads of the channels and the availability of hard substrate (Brewer et al., 2007).

10.1.6. Pinnacles of the Bonaparte Basin

The limestone Pinnacles of the Bonaparte Basin are located in the mid-outer shelf of the western Joseph Bonaparte Gulf and comprise of 61 % of the limestone pinnacles in the Northwest Marine Region and 8 % of the total limestone pinnacles found within the Australian Exclusive Economic Zone (Baker et al., 2008). The pinnacles range from water depths of 30 to 80 m providing hard substrate in a relatively sparse soft sediment habitat for sessile species. The pinnacles are thought to be remnants of the calcareous shelf and coastal features from previous low sea level stands and have been recorded to be up to 50 m in height and range from 50 to 100 km long (Baker et al., 2008; Heyward et al., 1997).

Diverse communities of sessile benthic invertebrates including hard and soft corals, sponges, whips, fans, bryozoans and aggregations of demersal fish species such as snappers, emperors and groupers have been recorded (Brewer et al., 2007; Nichol et al., 2013). Foraging and general use has been recorded within the pinnacles by marine turtles and the area has also been suggested to be used by freshwater and green sawfish as well as humpback whales (Donovan et al., 2008). The pinnacles have been recognised as a sponge biodiversity hotspot which has recorded greater diversity and communities than that of the surrounding sea floor (NERP MBH, 2014).

According to DSEWPaC (2012), the Pinnacles of the Bonaparte Basin are regionally important because of its biodiversity values (unique sea-floor feature with ecological properties of regional significance), which apply to both the benthic and pelagic habitats. The hard substrate of the pinnacles are likely to support a high number of species, although a better understanding of the species richness and diversity associated with these structures is required.

10.1.7. Carbonate Bank and Terrace System of the Van Diemen Rise

The bank and terrace system of the Van Diemen Rise covers approximately 31,278 km^2 and forms part of the larger system associated with the Sahul Banks to the north and Londonderry Rise to the east. The feature is characterised by carbonate terrace, banks, channels and valleys, with variability in water depth and substrate composition considered to contribute to the presence of unique ecosystems in the channels. The variability in water depth and substrate composition across the feature may contribute to the presence of unique ecosystems in the channels. The carbonate banks and shoals found within the Van Diemen Rise make up 80 % of the banks and shoals, 79 % of the cannels and valleys, and 63 % of the terrace found across the North Marine Region. The carbonate banks and shoals rise from depths of 100 m- 200 m to withing 10 m -40 m of the sea surface (Anderson et al., 2011).

The feature provides habitat for a high diversity of sponges, soft corals and other sessile filter feeders; epifauna and infauna; and olive ridley turtles, sea snakes and sharks. Rich sponge gardens and octocorals have been identified on the eastern Joseph Bonaparte Gulf along the banks, ridges and some terraces. Plains in deep hole/valleys are characterised by scattered epifauna and infauna that include polychaetes and ascidians.

Epibenthic communities such as the sponges found in the channels are likely to support fish and second-order consumers. Pelagic fish such as mackerel, red snapper and a distinct gene pool of gold band snapper are found in the Van Diemen Rise.

10.1.8. Shelf Break and Slope of the Arafura Shelf

The Shelf Break and Slope of the Arafura Shelf is an important ecological feature that creates a unique sea floor which enhances biological productivity on the edge of the shelf and attracts feeding aggregations of pelagic marine organisms. The productivity of this area has been recognised as nationally and/or regionally important (Last et al., 2005).

Although the ecosystem processes in this area are largely unknown it is thought that the oceanographic processes associated with the Indonesian Throughflow current and monsoonal winds are strong influence (DEWHA, 2007).

The physical characteristics of the Shelf Break and Slope of the Arafura Shelf comprise of continental slope, patch reefs and hard substrate pinnacles (Harris et al., 2005).

Phytoplankton and invertebrates have been sampled at this KEF and the primary production of phytoplankton is thought to be the basis for offshore food webs in the area (DEWHA, 2007). Records show approximately 284 demersal fish species in the area (Last et al., 2005) and other marine species that have been recorded include marine turtles, whale sharks and predatory fish species including sharks (DEWHA, 2008b).

11. State Marine Conservation Reserves

11.1. Introduction

Marine parks and reserves have been progressively established in Western Australia since 1987 and the Northern Territory since 1983. The Conservation and Parks Commission (CPC) is the vesting authority for marine parks and reserves under the provisions of the *Conservation and Land Management Act 1984*. Parks and Wildlife, within the Department of Biodiversity, Conservation and Attractions (DBCA), is responsible for day-to-day management of the parks.

There are three categories of state marine conservation reserves: marine parks; marine management areas; and marine nature reserves.

Marine parks are created to protect natural features and aesthetic values while allowing recreational and commercial uses that do not compromise conservation values. There are currently three marine parks wholly or partially within the combined EMBA (refer **Figure 13**).

Marine parks are multiple-use reserves that cater for a wide range of activities. Within marine parks there may be four types of management zones: recreation zones: general use zones; no-take areas known as sanctuary zones; and special purpose zones.

Each marine park has a ‘management plan’ that contains strategies to protect the high value assets in the park, as well as permitted activities tables. These tables provide explicit regulatory management.

Sanctuary zones are ‘no-take' areas created primarily for conservation and scientific research and are designed to protect a particular significant ecosystem or habitat. Low-impact tourism may be permitted, but no recreational or commercial fishing, aquaculture, pearling, petroleum drilling or production is allowed.

Marine management areas provide an integrated management structure over areas that have high conservation value and intensive multiple-use. There are two marine management areas within the combined EMBA (described below).

There is currently only one state marine nature reserve: Scott Reef Nature Reserve, 270 km off the Kimberley Coast, WA.

Within the NT component of the combined EMBA, there are no marine based conservation reserves. There is one coastal reserve (Casuarina Coastal Reserve) and one national park (Djukbinj National Park) identified in the PMST report as being situated adjacent to the combined EMBA and likely have coastline within the reserves. The above coastal reserves should be considered if the individual EP’s EMBA extends to the coastline. Garig Gunak

Barlu National Park was also identified and has an adjoining terrestrial and marine park overlapping the combined EMBA, as such it has been included below. Kakadu National Park was identified in the PMST search and extends to the coastline. Three more were identified as being present (Mary River National Park, Keep River National Park, Charles Darwin National Park) in the combined EMBA. However, these are all terrestrial based reserves with no coastline zone so have not been discussed in further detail.

11.1.1. Lalang-gaddam Marine Park

The Lalang-gaddam Marine Park is an amalgamation of the Lalang-garram / Camden Sound, Lalang-garram / Horizontal Fall and the North Lalang-garram Marine Park, and the proposed Maiyalam Marine Park. The *Lalang-gaddam amended Joint Management Plan for the Lalang-garram / Camden Sound, Lalang-garram / Horizontal Falls and North Lalang-garram Marine Parks and Indicative Joint Management Plan for the Proposed Maiyalam Marine Park* (DBCA, 2020a; DBCA, 2020b) states the amalgamation is intended to:

- Provide clearer direction for joint management and governance outcomes
- Aid in communication and engagement with the Dambeemangardee Community and other park users.

The amendment to the plan is expected to come into effect in 2024 and is intended to be in effect for 10 years. The strategic objective of the amendment is to protect and conserve the value of the land for the culture and heritage of Dambeemangardee people.

The Lalang-gaddam Marine Park has a range of physical and biological environmental values. The Lalang-gaddam amended Joint Management Plan for the Lalang-garram / Camden Sound, Lalang-garram / Horizontal Falls and North Lalang-garram Marine Parks and Indicative Joint Management Plan for the Proposed Maiyalam Marine Park (DBCA, 2020a; DBCA, 2020b) identifies the same physical and biological environmental values as described above for the Lalang-gaddam Marine Park. The plan also recognises tourism, recreational fishing, commercial fishing and aquaculture as important values within the park, which are also identified as sources of risk that require management.

Lalang-gaddam marine park is located wholly within the combined EMBA.

Lalang-garram/Camden Sound Marine Park

The Lalang-garram/Camden Sound Marine Park was created on 19 June 2012 under Section 13 of the Conservation and Land Management Act 1984 (CALM Act). It is a multiple zone marine park that includes Sanctuary, Special Purpose, and General Use zones (DPaW, 2013). The marine park falls within the west Kimberley, which was recently added to the Australian National Heritage List because of its natural, indigenous and historic values to the nation.

The marine park is located about 150 km north of Derby (or 300 km north of Broome) and lies within the traditional country of three Aboriginal native title groups. The Dambimangari people's determination overlies the majority of the marine park. A section of the Wunambal Gaambera people's Uunguu determination includes a small portion of St George Basin, while a small section of the Mayala people's determination overlies the southwest corner of the marine park (DPaW, 2013; DBCA, 2022).

The marine park covers an area of approximately 705,000 ha. It recognises and provides special management arrangements for this area of the Kimberley, which is a principal calving habitat of the humpback whale (*Megaptera novaeangliae*) population that migrates annually along Western Australia's coast. The marine park also conserves a range of species listed as having special conservation status including marine turtles, snubfin and Indo-Pacific humpback dolphins, dugong, saltwater crocodiles, and several species of sawfish. The park also includes a wide range of marine habitats and associated marine life, such as coral reef communities, rocky shoals, and the extensive mangrove forests and marine life of the St George Basin and Prince Regent River (DPaW, 2013).

Lalang-garram/ Horizontal Falls and North Lalang-garram Marine Park

The Lalang-garram/ Horizontal Falls and North Lalang-garram Marine Parks were established in 2016 under the State Government's *Kimberley Science and Conservation Strategy* and are jointly managed by Dambimangari Traditional Owners and the Department of Parks and Wildlife (DPaW, 2016). The marine parks fall within the west Kimberley region, included in the Australian National Heritage List for its nationally significant natural, indigenous and historic values (DoEE, 2019).

The Lalang-garram/ Horizontal Falls Marine Park extends from Talbot Bay (*Ganbadba*) in the west to Walcott Inlet (*Iledda*) and Glenelg River (*Molor Moloiyn*) in the east and covers approximately 353,000 ha (DPaW, 2016). The

marine park protects the internationally recognised Horizontal Falls and is important for the region's tourism. The North Lalang-garram Marine Park lies between the Lalang-garram / Camden Sound and North Kimberley Marine Parks and covers approximately 110,000 ha (DPaW, 2016).

The area's large tidal range results in extensive intertidal areas with diverse ecosystems such as fringing coral reefs, mangroves and mudflat communities. Subtidal habitats and communities common to the marine parks include filter feeding communities of sponges and hard and soft corals. These intertidal and subtidal habitats provide critical foraging and nursery areas for dugong, marine turtles, estuarine crocodiles, snubfin and Indo-Pacific humpback dolphins, several species of sawfish and migratory seabirds. The marine parks are also a principal calving habitat for humpback whales (DPaW, 2016).

11.1.2. North Kimberley Marine Park

The North Kimberley Marine Park was established in December 2016 as a Class A marine park under the CPC (DPaW, 2016a). The marine park comprises four separate management areas including, Uunguu, Balanggarra, Miriuwung Gajerrong, and Wilinggin. It is a multiple zone marine park that includes: eight sanctuary zones, nine special purpose zones (recreation and conservation), two special use zone (cultural heritage), and general use areas (DPaW, 2016a). The marine park is managed in accordance with the provisions of the CALM Act with joint management between the Department of Parks and Wildlife and Traditional Owners of the area.

The area within the marine park is recognised for its natural values including coral reefs, marine turtle species, dugongs, seagrass and macroalgal communities, mangroves and saltmarshes, finfish, and water and sediment quality, as well as for its social values (i.e. recreation, tourism and community values) and commercial values and resource use (e.g. commercial fishing). The marine park lies within the Indian Ocean and Timor Sea of Western Australia's Kimberley region, covering an area of approximately 1,845,000 ha (DPaW, 2016a). The south-western boundary is approximately 270 km north-east of Derby.

11.1.3. Garig Gunak Barlu National Park

Garig Gunak Barlu National Park includes the entire Cobourg Peninsula, the surrounding waters of the Arafura Sea and Van Diemen Gulf including some of the neighbouring islands. The park covers 4,500 km^2 and is one of two parks in the NT that contain adjoining terrestrial and marine parks. The park consists of sandy beaches, dunes, coastal grasslands, mangroves, rainforest patches, swamps, lagoons, corals reefs, seagrass meadows and rich marine life. It provides protection for rare species including dugongs and turtles (green, loggerhead, leatherback, olive ridley, hawksbill and flatback.

12. Australian Marine Parks

12.1. Introduction

In agreement with the states and NT governments, the Australian Commonwealth government committed to establish Commonwealth marine parks as a component of the National Representative System of Marine Protected Areas (DoE, 2014) (**Figure 13**). In November 2012, the Commonwealth Marine Reserves Network was proclaimed with the purpose of protecting the biological diversity and sustainable use of the marine environment (Director of National Parks, 2012). Commonwealth Marine Reserves were renamed as Australian Marine Parks in October 2017. Seven marine regions are included in the Australian Marine Parks Network, including the Coral Sea, the South-west, the Temperate East, the South-east, the North, the North-west and Indian Ocean Marine Territories. The South-east network 10-year Management Plan came into effect on 1 July 2013. The remaining networks 10-year Management Plans were approved and came into effect on 1 July 2018. The Indian Ocean Marine Territories draft management plans were open for public consultation from 6 July to 17 August 2023 after Christmas Island Marine Park and Cocos (Keeling) Islands Marine Park were declared in March 2022.The new management plans establish the management and zoning of the designated marine parks. The marine park networks pertinent to (i.e. marine parks wholly or partially within) the combined EMBA include the:

- North-West Marine Parks Network
- North Marine Parks Network.

The North-West Marine Parks Network comprises 13 marine parks, two of which occur in West Australian waters pertinent to the combined EMBA:

- Kimberley Marine Park
- Cartier Island Marine Park

The Northern Marine Parks Network comprises eight marine parks. Two of these occur in Western Australian or Northern Territory waters within the combined EMBA:

- Oceanic Shoals Marine Park
- Joseph Bonaparte Gulf Marine Park

The sizes of these marine parks range from 300—152,000 km^2, and the water depths within the marine parks vary from approximately 15—1,500 m deep. The EPBC Act requires that each management plan assign an International Union for the Conservation of Nature (IUCN) category to each marine park. Additionally, the Act also allows for the management plan to divide a marine park into zones and to assign a category to each zone, which may differ from the overall category of the marine park. Zoning considers the purposes for which the marine parks were declared, the objectives of the relevant management plans, the values of the marine park and requirements of the EPBC Act and EPBC Regulations.

The North-West Marine Parks Network includes six different types of zoning:

- Sanctuary Zone (IUCN Category Ia)
- National Park Zone (IUCN Category II)
- Recreational Use Zone (IUCN Category IV)
- Habitat Protection Zone (IUCN Category IV)
- Multiple Use Zone (IUCN Category VI)
- Special Purpose Zone (Trawl) (VI).

The South-west Marine Parks Network includes six different types of zoning:

- National Park Zone (IUCN Category II)
- Habitat Protection Zone (IUCN Category IV)
- Multiple Use Zone (IUCN Category VI)
- Special Purpose Zone (Mining Exclusion) (IUCN Category VI)
- Special Purpose Zone (IUCN Category VI)
- Special Purpose Zone (Trawl) (IUCN Category VI).

Five types of zones are represented within the North Marine Parks Network:

- National Park Zone (IUCN Category II)
- Habitat protection zone (IUCN Category IV)
- Multiple use zone (IUCN Category VI)
- Special Purpose Zone (Trawl) (IUCN Category VI)
- Special Purpose Zone (IUCN Category VI)

A summary of the North-West and North Marine Parks Networks is provided below.

12.2. North-West Marine Park Network

The North-West Marine Parks Network is aligned to the North-west Marine Region. The network covers 335, 341 km^2 and includes 13 marine parks (Director of National Parks, 2018a). Broad values of the North-west Commonwealth Marine Reserves Network include:

- Natural values
- Cultural values
- Heritage values
- Socio-economic values.

Further detail on each of the relevant marine parks within the combined EMBA is provided below. See **Section 12.1** for extent of marine parks (wholly or partially) within the combined EMBA.

12.2.1. Kimberley Marine Park

The Kimberley Marine Park (zones within EMBA: Multiple Use Zone – IUCN Category VI, Habitat Protection Zone - IUCN Category VI and National Park Zone - IUCN Category II) is located approximately 100 km north of Broome, Western Australia, and extends from the Western Australian state water boundary north from the Lacepede Islands to the Holothuria Banks offshore from Cape Bougainville. It is adjacent to the Western Australian Lalanggarram / Camden Sound Marine Park and the North Kimberley Marine Park. It covers an area of 74,469 km², and protects the following conservation values (Director of National Parks, 2018a):

- Northwest Shelf Province
  - Diverse benthic and pelagic fish communities
  - Ancient coastline thought to be an important sea floor feature
  - Migratory pathway for humpback whales
- Northwest Shelf Transition
  - High levels of species diversity
  - Endemism occurs among demersal fish communities on the continental slope
- Timor Province
  - Reefs and islands of the bioregion are regarded as biodiversity hotspots
  - Endemism in demersal fish communities of the continental slope is high (two distinct communities have been identified on the upper and mid slopes)
  - Ancient coastline at the 125 m depth contour where rocky escarpments are thought to provide biologically important habitats in areas otherwise dominated by soft sediments
  - Continental slope demersal fish communities characterised by high diversity of demersal fish assemblages
  - Breeding and foraging habitat for seabirds
  - Internesting and nesting habitat for marine turtles
  - Breeding, calving and foraging habitat for inshore dolphins
  - Calving, migratory pathway and nursing habitat for humpback whales
  - Migratory pathway for pygmy blue whales
  - Foraging habitat for dugong and whale sharks
  - More than 40 known shipwrecks listed under the *Underwater Cultural Heritage Act 2018*.

Tourism, commercial fishing, mining, recreation, (e.g. fishing), and traditional use are important activities in the Marine Park (Director of National Parks, 2018a).

12.2.2. Cartier Island Marine Park

The Cartier Island Marine Park (Sanctuary Zone – IUCN Category Ia) is located approximately 45 km south-east of Ashmore Reef Marine Park and 610 km north of Broome, Western Australia. Both Marine Parks are in Australia's External Territory of Ashmore and Cartier Islands and are also within an area subject to a Memorandum of Understanding (MoU) between Indonesia and Australia, known as the MoU Box. The Marine

Park covers an area of 172 km² and protects the following conservation values (Director of National Parks, 2018a):

- Ashmore Reef and Cartier Island and surrounding Commonwealth waters
- Areas of enhanced productivity in an otherwise low-nutrient environment
- Regional importance for feeding and breeding aggregations of birds and marine life
- Continental slope demersal fish communities
- Area of high diversity in demersal fish assemblages
- Area of high diversity and abundance of hard and soft corals, gorgonians (sea fans), sponges and a range of encrusting organisms
- Breeding and foraging habitat for seabirds
- Internesting, nesting and foraging habitat for marine turtles
- Foraging habitat for whale sharks
- Internationally significant for its abundance and diversity of sea snakes
- One known shipwreck listed under the *Underwater Cultural Heritage Act 2018*: the Ann Millicent (wrecked in 1888).
- Scientific research is an important activity in the Marine Park (Director of National Parks, 2018a).

12.3. North Marine Park Network

The North Marine Parks Network is aligned to the North Marine Region. The network covers 157,480 km^2 (Director of National Parks, 2018b). Broad values of the North Network include:

- Natural values
- Cultural values
- Heritage values
- Socio-economic values.

Further detail on the applicable Oceanic Shoals Marine Park is provided below.

12.3.1. Oceanic Shoals Marine Park

The Oceanic Shoals Marine Park (zones within EMBA: Multiple Use Zone - IUCN Category VI- 32,488 km^2; Special Purpose Zone – IUCN VI-24,443 km^2). The marine park also includes a National Park Zone (IUCN Category II, 406 km2) and Habitat Protection Zone (Category IV, 6,929 km2).

The marine park protects the following conservation values (DoE, 2014):

- Important resting area for turtles between egg laying (internesting area) for the threatened flatback turtle and olive ridley turtle
- Important foraging area for the threatened loggerhead turtle and olive ridley turtle
- Examples of the ecosystems of two provincial bioregions: the Northwest Shelf Transition Province (which includes the Bonaparte, Oceanic Shoals, and Tiwi meso-scale bioregions) and the Timor Transition Province
- KEFs represented in the park are (Director of National Parks, 2018b):
  - Carbonate bank and terrace system of the Van Diemen Rise (unique sea-floor feature)
  - Carbonate banks and terrace system of the Sahul Shelf (unique sea-floor feature)
  - Pinnacles of the Bonaparte Basin (enhanced productivity, unique sea-floor feature)
  - Shelf break and slope of the Arafura Shelf (unique sea-floor feature).

No heritage listings apply to the marine park Commercial fishing and mining are important socio-economic values for the park (Director of National Parks, 2018b).

A spatial predictive benthic habitat model of the Oceanic Shoals Marine Park has been developed by AIMS, as part of the Australian National Environmental Science Programme, to determine the spatial heterogeneity of the benthic environment and key classes of organisms within the reserve. The benthic habitat model maps the 10 broad classes of benthic organisms; alcyons, gorgonians, soft corals, hard corals, *Halimeda*, macroalgae, seagrass, filterers (e.g. sponges), burrowers (e.g. sea urchins) and no biota detected (Radford & Puotinen, 2016).

12.3.2. Joseph Bonaparte Marine Park

The Joseph Bonaparte Gulf Marine Park is located approximately 15 km west of Wadeye, Northern Territory, and approximately 90 km north of Wyndham, Western Australia, in the Joseph Bonaparte Gulf. It is adjacent to the Western Australian North Kimberley Marine Park. The marine park covers an area of 8597 km² and water depth ranges between less than 15 m and 100 m and is wholly contained within the combined EMBA. The marine park is comprised of two zones; Special Purpose Zone (VI) and Multiple Use Zone (VI) (Director of National Parks, 2018b).

The Joseph Bonaparte Marine Park has been deemed significant because “it contains habitats, species and ecological communities associated with the Northwest Shelf Transition bioregion. It includes one key ecological feature: the carbonate bank and terrace system of the Sahul Shelf (valued as a unique sea floor feature with ecological properties of regional significance). The Marine Park contains a number of prominent shallow sea floor features including an emergent reef system, shoals, and sand banks. It is near an important wetland systems including the Ord River floodplain Ramsar site and provides connectivity between the nearshore and sea environments. The Marine Park includes habitats connecting to and complementing the adjacent Western Australian North Kimberley Marine Park” (Director of National Parks, 2018b).

The Joseph Bonaparte Marine Park has both cultural and natural values.

The marine park protects the following natural values (Director of National Parks, 2018b):

- Ecosystems representative of the Northwest Shelf Transition
- BIAs for Marine Turtles
- BIA for the Australian Snubfin Dolphin
- KEFs represented in the park are:
  - Carbonate bank and terrace system of the Sahul Shelf (unique sea-floor feature)

No heritage listings apply to the marine park; however, the marine park is adjacent to the West Kimberley National Heritage Place. Tourism, commercial fishing, mining and recreation (e.g. fishing) are important socio-economic values for the park (Director of National Parks, 2018b).

Table 20: Summary of marine network values, pressures, management programs and actions applicable to the combined EMBA

Marine network	Values	Pressures	Management programs and actions
North-west	• Eight bioregions • Key ecological features • EPBC listed species • Biologically important areas • Sea country indigenous values • Native title determinations • Traditional Indonesian fishers • World Heritage Properties (Ningaloo Coast, Shark Bay) • Eighty-Mile Beach Ramsar site • Shipping and port activities • Commercial fishing, pearling, aquaculture • Marine tourism • Scientific research	• Climate change • Hydrological changes from coastal development and agriculture (increase sediment loads and pollutants) • Illegal/unregulated/ unreported fishing • Bycatch of non-target species • Habitat modification from mining • Human presence • Invasive species • Marine pollution	• Communication, education and awareness programs • Promote suitable tourism experience • Facilitate partnerships between tourism operators and Indigenous operators • Indigenous engagement program • Marine monitoring programs • Park management via assessments / authorisation program for marine park activities • Marine Park management and development of suitable infrastructure • Compliance planning and surveillance
North	• One bioregion • Key ecological features • EPBC listed species • Biologically important areas • Historic shipwrecks	• Climate change • Hydrological changes reliance upon the large number of estuaries and waterways that feed into the Gulf of Carpentaria and the waters adjacent to the Northern Territory coastline • Illegal/unregulated/ unreported fishing • Bycatch of non-target species • Physical Habitat modification • Marine pollution	• Communication, education and awareness programs • Promote suitable tourism experience • Facilitate partnerships between tourism operators and Indigenous operators • Indigenous engagement program • Marine monitoring programs • Park management via assessments / authorisation program for marine park activities • Marine park management and development of suitable infrastructure • Compliance planning and surveillance

13. Conservation Management Plans

In order to protect, maintain and enhance recovery of certain threatened species and ecological communities the DAWE may prepare conservation management plans in the form of Conservation Advice or Recovery Plans.

13.1. Conservation Advice

When a native species or ecological community is listed as threatened under the EPBC Act, conservation advice is developed to assist its recovery. Conservation advice provides guidance on immediate recovery and threat abatement activities that can be undertaken to ensure the conservation of a newly listed species or ecological community.

13.2. Recovery Plans

The Australian Government Minister for the Environment may make or adopt and implement recovery plans for threatened fauna, threatened flora (other than conservation dependent species) and threatened ecological communities listed under the Commonwealth EPBC Act. Recovery plans set out the research and management actions necessary to stop the decline of, and support the recovery of, listed threatened species or threatened ecological communities. The aim of a recovery plan is to maximise the long-term survival in the wild of a threatened species or ecological community (DCCEEW, 2024a).

Table 21: Summary of EPBC Act recovery plans applicable to the combined EMBA

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
Bird	Australian lesser noddy	Approved Conservation Advice for *Anous tenuirostris melanops* (Australian lesser noddy) (TSSC, 2015)	Habitat modification by pied cormorants (Houtman Abrolhos)
			Catastrophic destruction of habitat by cyclones
	Migratory species within the combined EMBA: • Bar-tailed godwit • Black-tailed godwit • Broad-billed sandpiper • Common greenshank • Common sandpiper • Curlew Sandpiper • Eastern Curlew • Grey plover • Grey-tailed tattler • Long-toed stint • Little curlew • Little greenshank/ marsh sandpiper • Little ringed plover • Oriental plover • Oriental pratincole • Pacific golden plover • Pectoral sandpiper • Red-necked stint • Red knot • Ruddy turnstone • Sanderling • Sharp-tailed sandpiper • Terek sandpiper • Wandering tattler	Wildlife Conservation Plan for Migratory Shorebirds (Commonwealth of Australia, 2015a)	Habitat loss and degradation
			Pollution and Contaminants
			Invasive species
			Anthropogenic disturbance
			Climate change and variability
			Overharvesting of shorebird prey
			Fisheries bycatch
			Direct mortality (hunting)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
	• Whimbrel • Wood sandpiper.		
	Asian dowitcher	Conservation Advice for Asian dowitcher (DCCEEW, 2024b) Wildlife Conservation Plan for Migratory Shorebirds (Commonwealth of Australia, 2015a)	Habitat loss, fragmentation and degradation
			Climate change
			Invasive species
			Exploitation
			Pollution
	Migratory and/or marine species within the combined EMBA • Red-tailed tropicbird • White-tailed tropicbird • Wedge-tailed shearwater • Streaked shearwater • Lesser frigatebird • Great frigatebird • Red-footed booby • Brown booby • Common noddy • Bridled tern • Little tern • Roseate tern • Osprey	Wildlife Conservation Plan for Migratory Seabirds (DoE, 2020)	Habitat loss and modification
			Climate variability and change
			Geological processes (volcanism, earthquake, tsunami and landslips)
			Invasive species
			Native wildlife
			Fisheries interactions and by-catch
			Prey depletion
			Resource extraction
			Renewable energy (collision/limited foraging)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Anthropogenic disturbance
			Direct mortality (hunting)
			Transport
			Drones
			Pollution and contaminants
			Aquaculture
			Disease
	Red knot	Approved Conservation Advice for *Calidris canutus* (red knot) (DCCEEW, 2024c) Wildlife Conservation Plan for Migratory Shorebirds (Commonwealth of Australia, 2015a)	Habitat loss and habitat degradation
			Over-exploitation of shellfish
			Pollution/contamination impacts
			Disturbance
			Direct mortality (hunting)
			Diseases
			Extreme weather events
			Climate change impacts
	Curlew sandpiper		Ongoing human disturbance

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
		Approved Conservation Advice for *Calidris ferruginea* (curlew sandpiper) (DCCEEW, 2023a)	Habitat loss, fragmentation and degradation
			Changes to the water regime
			Invasive plants
			Climate change impacts
	Great knot	Approved Conservation Advice for *Calidris tenuirostriss* (Great knot) (DCCEEW, 2024d) Wildlife Conservation Plan for Migratory Shorebirds (Commonwealth of Australia, 2015a).	Habitat loss, fragmentation and degradation
			Pollution/contaminants
			Disturbance
			Diseases
			Direct mortality (hunting)
			Climate change impacts
	Greater sand plover	Approved Conservation Advice for *Charadrius leschenaultii* (greater sand plover) (DCCEEW, 2023b) Wildlife Conservation Plan for Migratory Shorebirds (Commonwealth of Australia, 2015a)	Habitat loss, fragmentation anddegradation
			Pollution/contamination impacts
			Anthropogenic disturbance
			Exploitation
			Climate change impacts
	Lesser sand plover		Habitat loss and habitat degradation

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
		Approved Conservation Advice for *Charadrius mongolus* (Lesser sand plover) (TSSC, 2016) Wildlife Conservation Plan for Migratory Shorebirds (Commonwealth of Australia, 2015a)	Pollution/contamination impacts
			Disturbance
			Direct mortality (hunting)
			Diseases
			Climate change impacts
	Western Alaskan bar-tailed godwit	Approved Conservation Advice for *Limosa lapponica baueri* (Bar-tailed godwit (western Alaskan)) (DCCEEW, 2024e)	Habitat loss, fragmentation and degradation
			Anthropogenic disturbance
			Pollution
			Exploitation
			Climate change
	Northern Siberian bar-tailed godwit	Approved Conservation Advice for *Limosa lapponica menzbieri* (Yakutian bar-tailed Godwit) (DCCEEW, 2024f)	Habitat loss, fragmentation and degradation
			Anthropogenic disturbance
			Pollution
			Exploitation
			Climate change
	Eastern curlew		Habitat loss, fragmentation and degradation

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
		Approved Conservation Advice *for Numenius madagascariensis* (far eastern curlew) (DCCEEW, 2023c)	Anthropogenic disturbance
			Pollution
			Exploitation
			Climate change
	Abbott's booby	Conservation Advice for the Abbott's booby *Papasula abbotti* (TSSC, 2020)	Vegetation clearing – edge effects from previous clearing and new vegetation clearing
			Climate change – severe storm events and prey depletion
			Introduction of a new disease
			Invasive weeds
			Yellow crazy ants – habitat modification
			Fisheries – prey depletion
			Marine debris - plastics
	Christmas Island white-tailed tropicbird	Conservation Advice for *Phaethon lepturus fulvus* white-tailed tropicbird (Christmas Island) (DoE, 2014a)	Introduced predators on Christmas Island
			Crazy ants
	Red-tailed tropicbird (Indian Ocean)	Conservation Advice for *Phaethon rubricauda westralis* (Indian Ocean	Introduced predators (cats and black rats)
			Crazy ants

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
		red-tailed tropicbird) (DCCEEW, 2023d)	Climate change – severe storm events and changing ocean temperatures
	Little tern	Conservation Advice for *Sternula albifrons* (little tern) (DCCEEW, 2025a) Wildlife Conservation Plan for Migratory Seabirds (DoE, 2020)	Introduced predators (cats, dogs and foxes)
			Anthropogenic disturbance
			Habitat loss, fragmentation and degradation
			Climate change
	Sharp-tailed sandpiper	Conservation Advice for *Calidris acuminata* (sharp-tailed sandpiper) (DCCEEW, 2024g)	Habitat loss, fragmentation and degradation
			Anthropogenic disturbance
			Climate change
	Terek sandpiper	Conservation Advice for *Xenus cinereus* (terek sandpiper) (DCCEEW, 2024h)	Habitat loss, fragmentation and degradation
			Anthropogenic disturbance
			Climate change
	Grey plover	Conservation Advice for *luvialis squatarola* (grey plover) (DCCEEW, 2024i)	Pollution
			Anthropogenic disturbance
			Introduced and invasive plants
	Black-tailed godwit		Habitat loss, fragmentation and degradation

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
		Conservation Advice for *Limosa limosa* (black-tailed godwit) (DCCEEW, 2024j)	Anthropogenic disturbance
	Common greenshank	Conservation Advice for *Tringa nebularia* (common greenshank) (DCCEEW, 2024k) Wildlife Conservation Plan for Migratory Shorebirds (Commonwealth of Australia, 2015a)	Habitat loss, fragmentation and degradation
			Silt, pollution, weeds or pest invasion
			Anthropogenic disturbance
			Introduced species
	Ruddy turnstone	Conservation Advice for *renaria interpres* (ruddy turnstone) (DCCEEW, 2024l) Wildlife Conservation Plan for Migratory Shorebirds (Commonwealth of Australia, 2015a)	Habitat loss, fragmentation and degradation
			Anthropogenic disturbance
	Australian painted snipe	Commonwealth Conservation Advice on *Rostratula australis* (Australian painted snipe) (DSEWPaC, 2013a)	Loss and degradation of wetlands, through drainage and the diversion of water for agriculture and reservoirs
			Grazing and associated trampling of wetland vegetation/nests, nutrient enrichment and disturbance to substrate by livestock
			Climate change
			Predation by feral animals
			Introduction of weeds

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
Mammals	Sei whale	Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (TSSC, 2015b)	Climate and oceanographic variability and change
			Anthropogenic noise and acoustic disturbance
			Habitat degradation including pollution (increasing port expansion and coastal development)
			Pollution (persistent toxic pollutants)
			Vessel strike
			Prey depletion due to fisheries (potential threat)
			Resumption of commercial whaling (potential threat)
	Pygmy blue whale	Blue Whale Conservation Management Plan 2015 - 2025 (DoE, 2015)	Whaling
			Climate Variability and Change
			Noise Interference
			Habitat Modification
			Vessel Disturbance
			Overharvesting of prey
	Fin whale	Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (TSSC, 2015c)	Climate and oceanographic variability and change
			Anthropogenic noise and acoustic disturbance

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Habitat degradation including coastal development, port expansion and aquaculture
			Pollution (persistent toxic pollutants)
			Fisheries catch, entanglement and bycatch
			Vessel strike
			Resource depletion due to fisheries (potential threat)
			Resumption of commercial whaling (potential threat)
	Australian snubfin dolphin	Approved Conservation Advice for *Orcaella heinsohni* (Australian snubfin dolphin) (DCCEEW, 2025b)	Habitat degradation and destruction including coastal development
			Fisheries catch, entanglement and bycatch
			Pollution (persistent toxic pollutants)
			Pathogens
			Vessel Disturbance
	Australian humpback dolphin	Approved Conservation Advice for *Sousa sahulensis* (Australian humpback dolphin) (DCCEEW, 2025c)	Habitat loss and degradation including pollution
			Fisheries catch, entanglement and bycatch
			Noise Interference
			Vessel Disturbance

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Overharvesting of prey
			Wildlife tourism
Reptiles	Short-nosed sea snake	Approved Conservation Advice on *Aipysurus apraefrontalis* (Short-nosed sea snake) (DSEWPaC, 2011a)	Degradation of reef habitat, primarily as a result of coral bleaching (primary threat)
			Oil and gas exploration
			Incidental catch and death in commercial prawn trawling fisheries
	Leaf-scaled sea snake	Approved Conservation Advice on *Aipysurus foliosquama* (Leaf-scaled sea snake) (DSEWPaC, 2011b)	Degradation of reef habitat, primarily as a result of coral bleaching (primary threat)
			Oil and gas exploration
			Incidental catch and death in commercial prawn trawling fisheries (north-west marine area)
			Unsustainable and illegal fishing practices (currently the most significant threat in the Ashmore region)
	Loggerhead turtle	Recovery Plan for Marine Turtles in Australia 2017 – 2027 (Commonwealth of Australia, 2017) Loggerhead turtle – WA genetic stock	Fisheries bycatch – international (moderate), domestic (high)
			Indigenous take (moderate)
			Terrestrial predation (moderate)
			Habitat modification – infrastructure/coastal development (moderate), dredging/trawling (moderate)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Chemical and terrestrial discharge – acute (high), chronic (low)
			Marine debris – entanglement and ingestion (moderate; unknown)
			Climate change and variability (high)
			International take – outside Australia's jurisdiction (moderate), within Australia's jurisdiction (low)
			Light pollution (moderate)
			Vessel disturbance (moderate)
			Noise interference – acute (moderate), chronic (moderate; unknown)
			Recreational activities (low)
			Diseases and pathogens (low; unknown)
			Fisheries bycatch – international (moderate), domestic (high)
			Cumulative impacts of threats
	Green turtle	Recovery Plan for Marine Turtles in Australia 2017 – 2027 (Commonwealth of Australia, 2017)	Fisheries bycatch – international (moderate), domestic (moderate)
			Indigenous take (moderate)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
		Green turtle – NWS genetic stock (NWS), Scott-Browse genetic stock (ScBr), Ashmore genetic stock (AR)	Terrestrial predation NWS – moderate, AR –high; unknown, ScBr – moderate; unknown)
			Habitat modification – infrastructure/coastal development (NWS – moderate, AR – low, ScBr – high), dredging/trawling (NWS – moderate, AR – low, ScBr – low)
			Chemical and terrestrial discharge – acute (NWS, AR, ScBr –high), chronic (NWS – moderate, AR – high, ScBr – high)
			Marine debris – entanglement (NWS – moderate, AR – very high, ScBr – moderate; unknown) and ingestion (NWS – low; unknown, AR – moderate, ScBr – moderate)
			Climate change and variability (NWS – moderate, AR – very high, ScBr – high)
			International take – outside Australia's jurisdiction (moderate; unknown for NWS and ScBr), within Australia's jurisdiction (moderate; unknown for NWS and ScBr)
			Light pollution (NWS – high, AR – moderate, ScBr – moderate)
			Vessel disturbance (moderate)
			Noise interference – acute (NWS – moderate; unknown, AR – low, ScBr – moderate), chronic (NWS – moderate; unknown, AR – low, ScBr – moderate; unknown)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Recreational activities
			Diseases and pathogens (low; unknown for AR and ScBr)
			Cumulative impacts of threats
	Leatherback turtle	Approved Conservation Advice on *Dermochelys coriacea* (DEWHA, 2008a) Recovery Plan for Marine Turtles in Australia 2017 – 2027 (Commonwealth of Australia, 2017)	Incidental capture in commercial fisheries
			Harvest of eggs and meat
			Ingestion of marine debris
			Boat strike
			Predation on eggs by wild dogs, pigs and monitor lizards
			Degradation of foraging areas
			Changes to breeding sites
			Fisheries bycatch – international (high), domestic (high)
			Indigenous take (low)
			Terrestrial predation (moderate; unknown)
			Habitat modification – infrastructure/coastal development (moderate), dredging/trawling (low)
			Chemical and terrestrial discharge – acute (low), chronic (low; unknown)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Marine debris – entanglement (moderate) and ingestion (high)
			Climate change and variability (high)
			International take – outside Australia's jurisdiction (high), within Australia's jurisdiction (low)
			Light pollution (low)
			Vessel disturbance (moderate)
			Noise interference – acute (low; unknown), chronic (low; unknown)
			Recreational activities (low)
			Diseases and pathogens (low; unknown)
			Fisheries bycatch – international (high), domestic (high)
			Cumulative impacts of threats
	Hawksbill turtle	Recovery Plan for Marine Turtles in Australia 2017 – 2027 (Commonwealth of Australia, 2017) Hawksbill turtle – WA genetic stock	Fisheries bycatch – international (moderate), domestic (moderate)
			Indigenous take (moderate)
			Terrestrial predation (moderate)
			Habitat modification – infrastructure/coastal development (moderate), dredging/trawling (moderate)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Chemical and terrestrial discharge – acute (moderate), chronic (moderate)
			Marine debris – entanglement (moderate) and ingestion (low; unknown)
			Climate change and variability (high)
			International take – outside Australia's jurisdiction (very high), within Australia's jurisdiction (moderate)
			Light pollution (high)
			Vessel disturbance (moderate)
			Noise interference – acute (moderate), chronic (moderate; unknown)
			Recreational activities (low)
			Diseases and pathogens (low; unknown)
			Cumulative impacts of threats
	Olive ridley turtle	Recovery Plan for Marine Turtles in Australia 2017 – 2027 (Commonwealth of Australia, 2017) Olive ridley turtle – Northern Territory genetic stock	Fisheries bycatch – international (moderate), domestic (high)
			Indigenous take (moderate)
			Terrestrial predation (moderate; unknown)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Habitat modification – infrastructure/coastal development (low), dredging/trawling (low)
			Chemical and terrestrial discharge – acute (high), chronic (moderate)
			Marine debris – entanglement (very high) and ingestion (moderate; unknown)
			Climate change and variability (very high)
			International take – outside Australia's jurisdiction (moderate), within Australia's jurisdiction (moderate)
			Light pollution (moderate)
			Vessel disturbance (moderate)
			Noise interference – acute (low), chronic (low; unknown)
			Recreational activities (low)
			Diseases and pathogens (low; unknown)
			Cumulative impacts of threats
	Dusky sea snake	Conservation Advice for *Aipysurus fuscus* (dusky sea snake) (DCCEEW, 2024m)	Fisheries bycatch (Prawn trawling)
	Flatback turtle		Fisheries bycatch – international (low), domestic (moderate)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
		Recovery Plan for Marine Turtles in Australia 2017 – 2027 (Commonwealth of Australia, 2017) Flatback turtle – Pilbara coast genetic stock (Pil), South-west Kimberley coast genetic stock (swKim) and Cape Domett (CD)	Indigenous take (moderate)
			Terrestrial predation (moderate)
			Habitat modification – infrastructure/coastal development (Pil – high, swKim – moderate), dredging/trawling (moderate)
			Chemical and terrestrial discharge – acute (high), chronic (moderate)
			Marine debris – entanglement (moderate) and ingestion (low)
			Climate change and variability (Pil – high, swKim – moderate)
			International take – outside Australia's jurisdiction (low), within Australia's jurisdiction (low)
			Light pollution (Pil – high, swKim – moderate)
			Vessel disturbance (moderate)
			Noise interference – acute (moderate), chronic (moderate; unknown)
			Recreational activities (Pil – low, swKim – moderate)
			Diseases and pathogens (low; unknown)
			Cumulative impacts of threats

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
Sharks and fish	Grey nurse shark	Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*) (DoE, 2014b)	Mortality due to incidental capture by commercial and recreational fisheries
			Mortality due to shark control programs
			Ecotourism
			Public aquarium trade
			Pollution and disease
			Ecosystem effects - habitat modification and climate change
	Great white shark	Recovery plan for the White Shark (*Carcharodon carcharias*) (DSEWPac, 2013b)	Mortality related to being caught accidentally (bycatch) or illegally (targeted) by commercial and recreational fisheries, including issues of post release mortality
			Mortality related to shark control activities such as beach meshing or drumlining (east coast population)
			Illegal trade in white shark products
			Ecosystem effects as a result of habitat modification and climate change
			Ecotourism
	Northern river shark	Approved Conservation Advice for *Glyphis garricki* (northern river shark) (DoE, 2014c)	Commercial fishing activities
			Recreational fishing

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Indigenous fishing
			Illegal, unreported and unregulated fishing
			Habitat degradation and modification
			Marine debris
			Collection of animals for display in public aquaria (no known occurrences to date)
		Sawfish and River Sharks Multispecies Recovery Plan (Commonwealth of Australia, 2015b)	Fishing activities including being caught as by-catch in the commercial and recreational sectors; through indigenous fishing; and illegal, unreported and unregulated fishing
			Habitat degradation and modification
	Dwarf sawfish	Approved Conservation Advice on *Pristis clavata* (dwarf sawfish) (DEWHA, 2009)	Being caught as bycatch in commercial and recreational net fishing
			Illegal, unreported and unregulated fishing
			Habitat degradation due to increasing human development
		Sawfish and River Sharks Multispecies Recovery Plan (Commonwealth of Australia, 2015b)	Fishing activities including being caught as by-catch in the commercial and recreational sectors; through indigenous fishing; and illegal, unreported and unregulated fishing
			Habitat degradation and modification

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
	Freshwater sawfish	Approved Conservation Advice for *Pristis pristis* (largetooth sawfish) (DoE, 2014d)	Commercial fishing activities
			Recreational fishing
			Indigenous fishing
			Illegal, unreported and unregulated fishing
			Habitat degradation and modification
			Marine debris
			Collection of animals for display in public aquaria
		Sawfish and River Sharks Multispecies Recovery Plan (Commonwealth of Australia, 2015b)	Fishing activities including being caught as by-catch in the commercial and recreational sectors; through indigenous fishing; and illegal, unreported and unregulated fishing
			Habitat degradation and modification
	Green sawfish	Approved Conservation Advice for *Pristis zijsron* (green sawfish) (DEWHA, 2008b)	Capture as bycatch and byproduct in gillnet and trawl fisheries
			Illegal capture for fins and rostra
			Habitat degradation through coastal development
		Sawfish and River Sharks Multispecies Recovery Plan (Commonwealth of Australia, 2015b)	Fishing activities including being caught as by-catch in the commercial and recreational sectors; through indigenous fishing; and illegal, unreported and unregulated fishing

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Habitat degradation and modification
	Whale shark	Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015d)	Intentional and unintentional mortality from fishing outside of Australian waters
			Boat strike from large vessels
			Habitat disruption from mineral exploration, production and transportation
			Disturbance from domestic tourism operations
			Marine debris
			Climate change
	Speartooth shark	Approved Conservation Advice for *Glyphis glyphis* (speartooth shark) (DoE, 2014e)	Habitat degradation and modification
			Fishing activities including being caught as by-catch in the commercial and recreational sectors; and illegal, unreported and unregulated fishing

14. Social and Economic Features

14.1. Industry

In 2020/21, Western Australia's petroleum industry was worth $23 billion. The petroleum sector accounted for 10.4 % of the total value of WA's mineral and petroleum sales in 2020/21, with 7.5 % of all mineral and petroleum sales coming from Liquefied Natural Gas (LNG). This is a 37 % decrease in prices compared to 2018/19. The decrease was accounted for by a drop in oil prices due to excess supply from the COVID-19 pandemic and related economic shutdowns, operation issues at Gorgon, Prelude remaining offline until January 2021 along with maintenance shutdowns at the North West Shelf and Wheatstone. Currently Western Australia has five operating LNG projects; the North West Shelf, Gorgon, Pluto, Wheatstone and Prelude. There are also a number of Floating Production and Storage Offtake (FPSO) facilities in the Timor Sea and North West Shelf, as denoted on **Figure 17**. Offshore development is focussed on the Carnarvon Basin, Browse Basin and on the North West Shelf (DMP, 2014). The Bonaparte Basin is an established hydrocarbon province with a number of commercial operations, including the Blacktip production platform and pipeline operated by Eni Australia B.V.

There are several exploration and production permits and leases throughout WA and Commonwealth waters in the combined EMBA. Existing petroleum infrastructure, permits and licences are shown in **Figure 17.**

14.2. Other Infrastructure

The Jasuraus submarine communication cable links Australia with Indonesia. The cable was installed as a link from Australia to provide telephone services connection to the world in 1995-1996. Travelling north out of Port Hedland for approximately 210 km the cable then heads north-west toward Jakarta, Indonesia. Its capacity and major role was overtaken in 2000 by other subsea cables out of Australia. However, Telstra continues to manage the cable as it remains an emergency backup link out of Australia. The cable includes two submerged repeaters in the wider region.

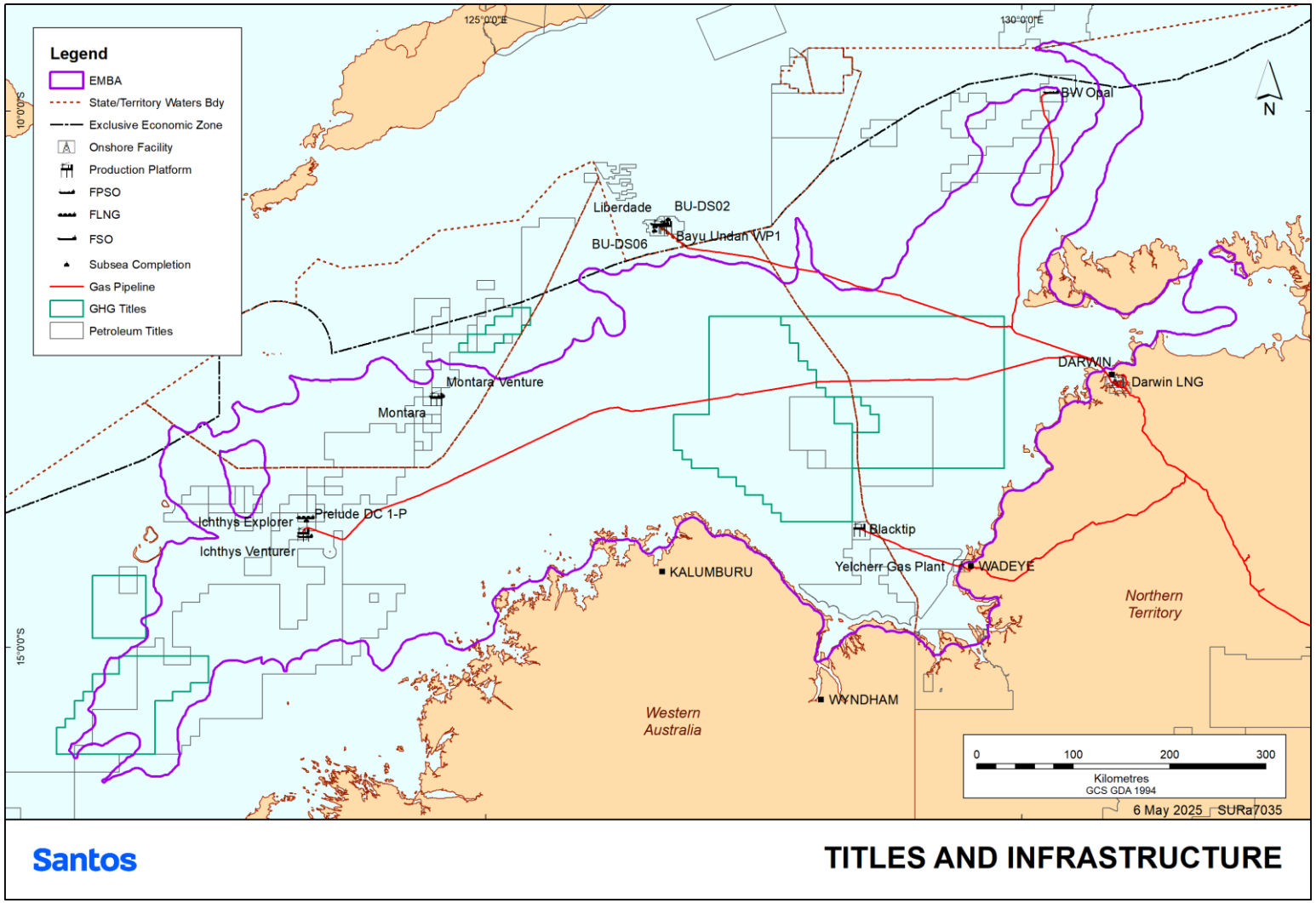


Figure 17: Existing petroleum infrastructure, permits and licences – Northern WA

14.3. Shipping

The Western Australian coastline supports 12 ports including the major ports of Dampier, Port Hedland and Broome in the north, which are operated by their respective port authorities. Large cargo vessels transit along the coastline to and from Fremantle. Commercial shipping also moves to and from marine terminals associated with the oil and gas industry (see **Section 14.1**). Darwin Port is also a major service centre for the mining and energy sectors in northern Australia. Closer proximity shipping also includes construction vessels/barges/dredges, domestic support vessels, and offshore survey vessels.

The Australian Maritime Safety Authority (AMSA) has established a network of shipping fairways off the north-west coast of Australia to manage traffic patterns (AMSA, 2013). The Shipping Fairways are designed to keep shipping traffic away from offshore infrastructure and aims to reduce the risk of collision (AMSA, 2013).

Use of the fairways is strongly recommended but not mandatory. The International Regulations for *Preventing Collisions at Sea 1972* apply to all vessels navigating within or outside the shipping fairways. The use of these fairways does not give vessels any special right of way (AMSA, 2012).

Under the *Commonwealth Navigation Act 2012*, certain vessels operating in Australian waters are required to report their location on a daily basis to the Rescue Coordination Centre (RCC) in Canberra. This Australian Ship Reporting System (AUSREP) is an integral part of the Australian Maritime Search and Rescue system and is operated by AMSA through the RCC. Traffic data (provided by Australian Maritime Safety Authority [AMSA]) within and surrounding the Operational Area between May 2024 and April 2025 is illustrated in **Figure 18.**

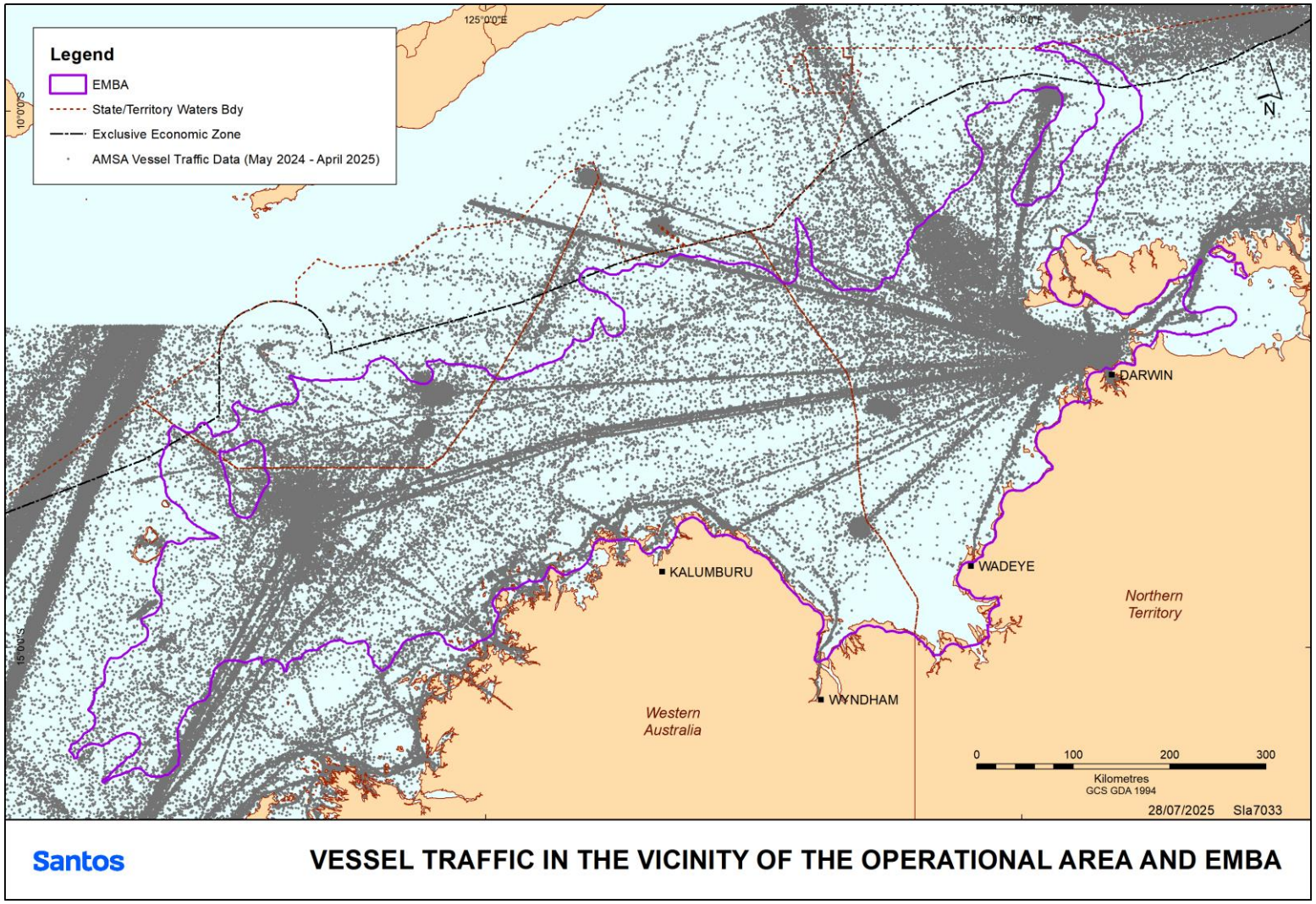


Figure 18: Vessel traffic

14.4. Defence Activities

Australian Border Force and Australian Defence Force vessels undertake civil and maritime surveillance within the region with the primary purpose of monitoring the passage of illegal entry vessels and illegal fishing activity within these areas. Refugees seeking asylum in Australia are also known to utilise the area, travelling between Indonesia and Australia.

The EMBA overlaps with practice and training areas that comprise the North Australian Exercise Area (NAXA), a maritime military zone administered by the Australian Defence Force, as well as restricted airspace. The NAXA is used by the Royal Australian Air Force and the Royal Australian Navy for military operations including live weapons and missile firings. The NAXA is the primary location of the KAKADU training exercise that operates biennially. The exercise involves numerous naval ships from various countries participating in the waters off Darwin and Northern Australia. Exercise KAKADU is Australia's premier international maritime exercise bringing together navies and air forces from the Asian, Pacific and Indian Ocean regions to test integration and war fighting abilities. During Exercise KAKADU, access may be restricted to all vessels and aircraft. Defence advised Santos during consultation that early advice of progress may enable compatible activities with minimal disruption to both parties.

Key defence bases and facilities are illustrated in **Figure 19.** Designated military exercise areas occur over waters and airspace of the north west of WA and may be activated following the required notifications.

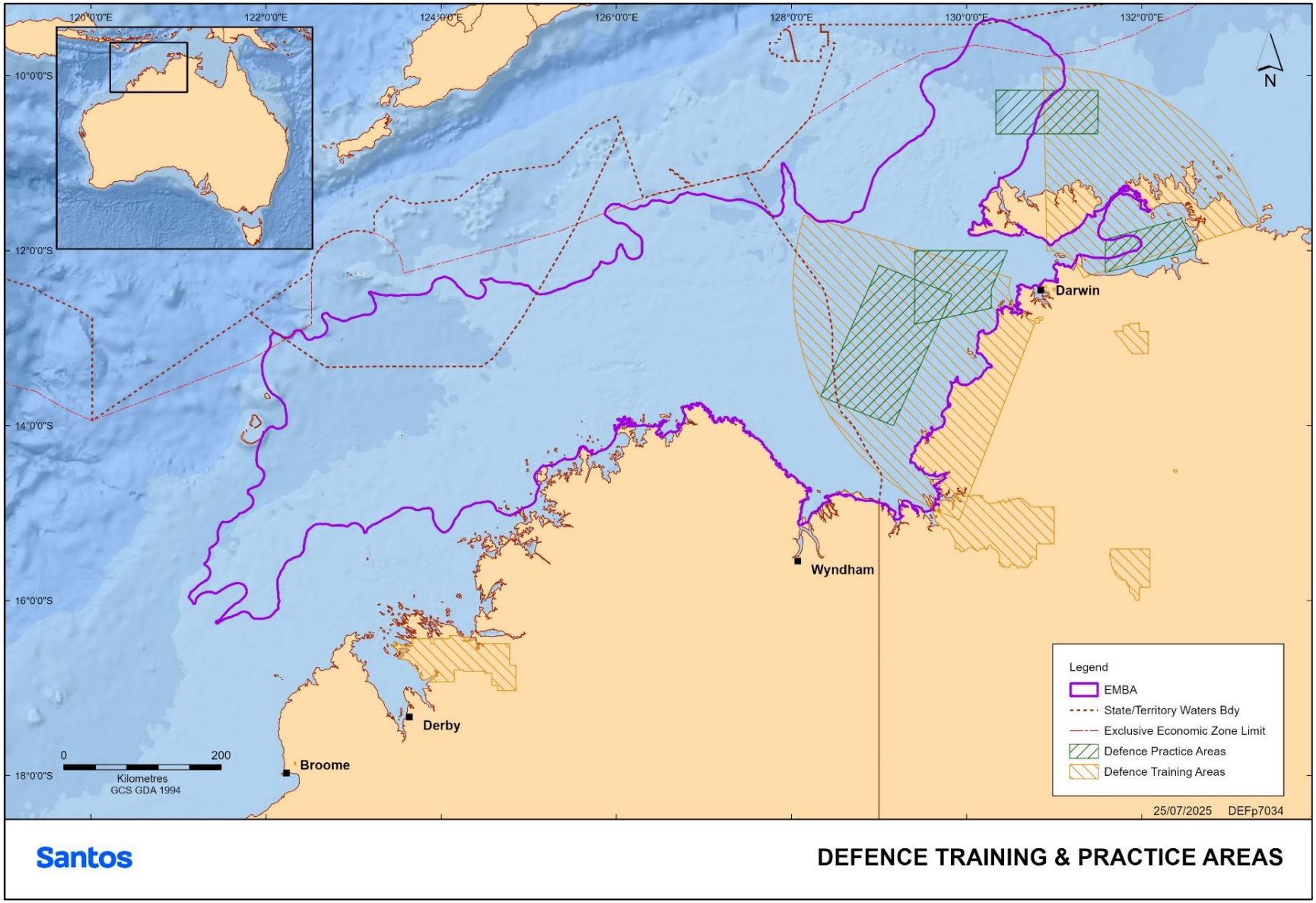


Figure 19: Defence activities

14.5. Tourism

The Kimberley region and Darwin are popular visitor destination for Australian and international tourists. Tourism contributes to local economies in terms of both income and employment and tourists include local, interstate and international visitors. Popular water-based activities include fishing, swimming, snorkelling/ diving, surfing/windsurfing/kiting and boating, while popular land-based activities include bushwalking, camping, bird watching and four-wheel driving.

Tourism in the region typically peaks during the dry season (May to October), which includes activities such as recreational fishing, diving, snorkelling, wildlife watching and boating (DEWHA, 2008a). Approximately 400,000 tourists visit the Kimberley region per annum, 11% of which travel internationally (RDA Kimberley, 2020). A number of luxury cruise operators access Kimberley coastal waters, including Kimberley Quest, Silversea and True North, which operate from late February/March to October/early November to avoid the wet season. Some Kimberley cruises extend to the coastal waters of the JBG, sailing from Wyndham and visiting coastal locations such as Cambridge Gulf, Berkeley River, Reveley Island, King George River and Cape Bernier. Cruise itineraries do not include offshore waters, although operators may occasionally transit within the EMBA between Darwin and the Kimberley coastline (Silversea, 2021; True North, 2021). Darwin is a popular destination for cruise and expedition ships, with 105 vessels and approximately 44,000 passengers having arrived in the 2023/24 season (Tourism NT, 2025).

No scuba diving or snorkelling sites or dive shops or clubs have been identified in the JBG or adjacent townsites. The presence of saltwater crocodiles and other potentially dangerous fauna generally makes these waters unsuitable for such activities and some tourism operators clearly specify this on their websites. Swimming tends to be limited to guided excursions to freshwater pools and waterfalls on land. Known dive sites in the wider Kimberley region are near Broome, the Lacepede Islands and the Rowley Shoals.

14.6. Maritime Heritage

Details of recorded shipwreck sites are available on the Australian National Shipwreck Database are managed by the DCCEEW although precise locations of the wrecks are sometimes unknown. Key shipwrecks in the combined EMBA are shown in **Figure 20** and **Figure 21**. Under the Commonwealth *Underwater Culture Heritage Act 2018* all shipwrecks older than 75 years are protected, while those dated pre-1900 are protected by WA law under the *Maritime Archaeology Act 1973*. Within the combined EMBA, there are 54 shipwrecks known to be in excess of 75 years old as of April 2025.

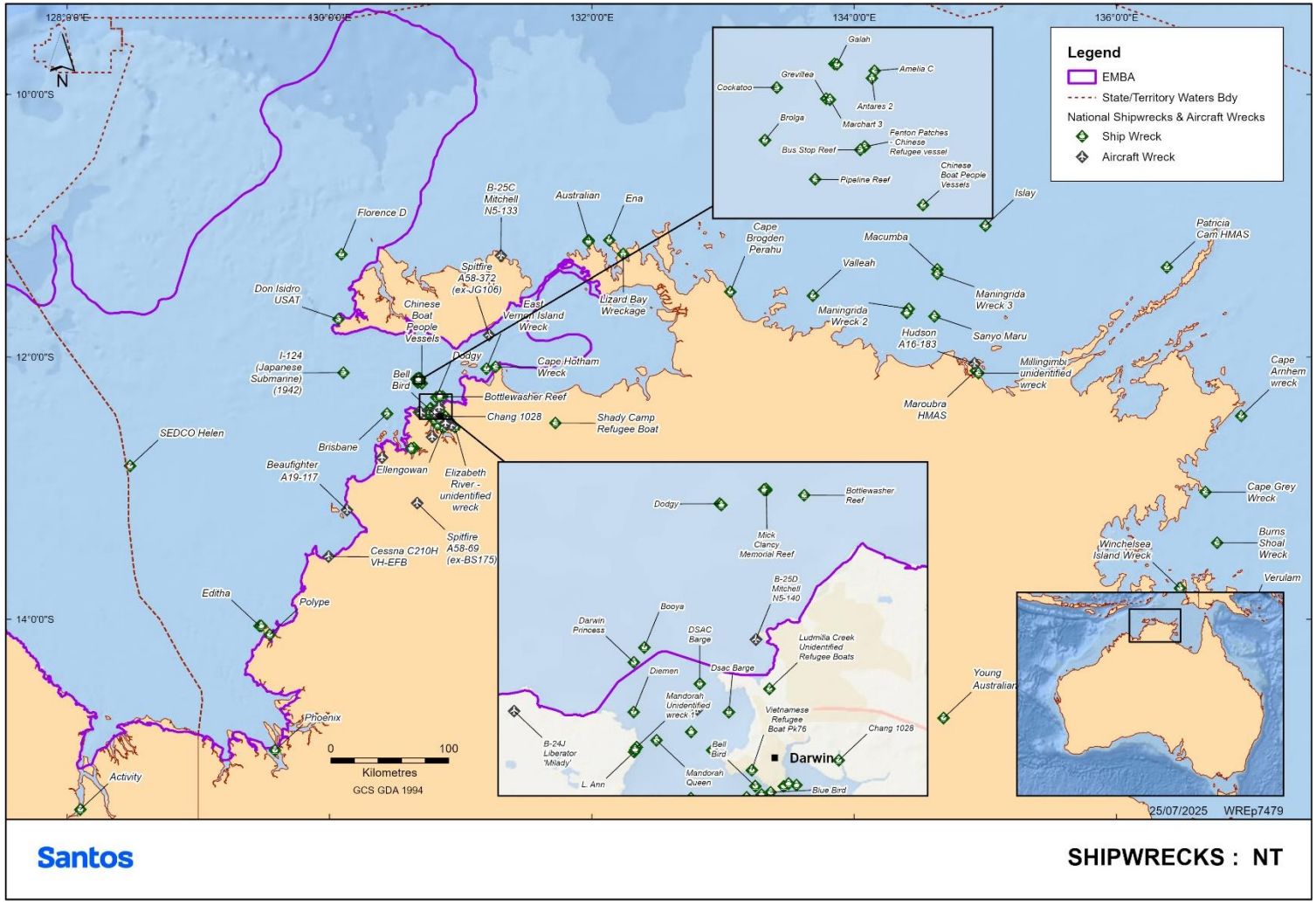


Figure 20: Shipwrecks –NT

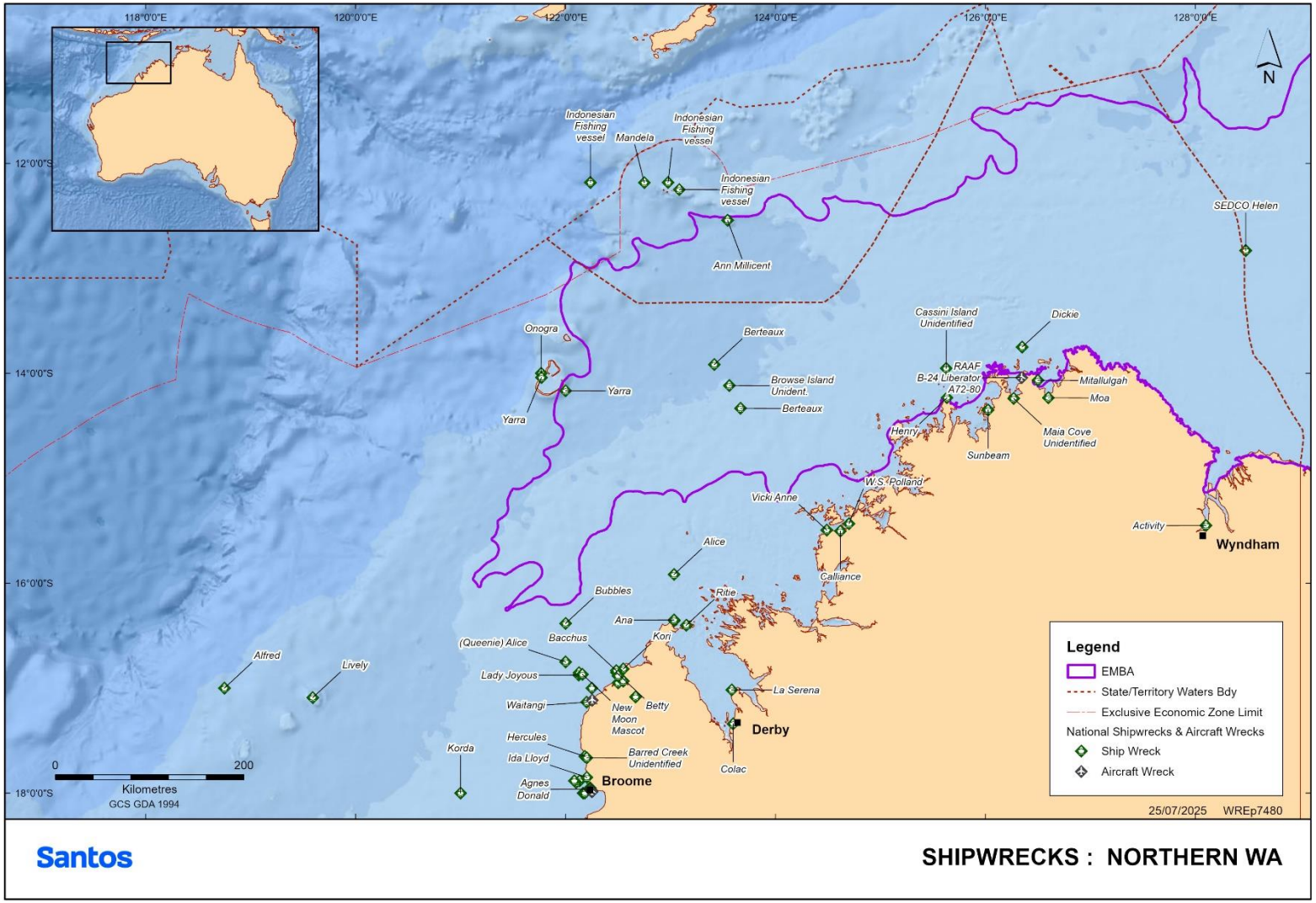


Figure 21: Shipwrecks – Northern WA

14.7. Commercial Fisheries

A valuable and diverse commercial fishing industry is supported by both the offshore and coastal waters in the North Coast Bioregions between the WA and NT. The major fisheries in this area target tropical finfish, large pelagic fish species, crustaceans (prawns and scampi), and pearl oysters (Fletcher & Santoro, 2013).

14.7.1. State Fisheries

State fisheries are managed by the WA Department of Primary Industries and Regional Development (DPIRD) (formerly Department of Fisheries (DoF)) with specific management plans, regulations and a variety of subsidiary regulatory instruments under the *Fish Resources Management Act 1994* (WA). The information on State managed fisheries has been derived from '*The State of the Fisheries'* Report 20 (Newman et al. 2023) and direct consultation with DPIRD. Santos consults regularly with State fisheries relevant to activity operational areas, mainly by distribution of an Annual Consultation Update by post (as well as conducting further consultation in preparing an EP under s 25 of the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023.

State commercial fisheries that exist between Kalbarri (WA) and the NT border are shown in Figure 23. Fisheries in the Northern Territory are shown in **Figure 22.**

A summary of all commercial fisheries wholly or partially operating in the combined EMBA is also provided in **Table 22**. These are:

North Coast Bioregion

- Abalone Managed Fishery
- Broome Prawn Managed Fishery (BPMF)
- Kimberley Prawn Managed Fishery (KPMF)
- Kimberley Gillnet & Barramundi Managed Fishery (KGBF)

- Kimberley Developing Mud Crab Fishery[10]
- Northern Demersal Scalefish Managed Fishery (NDSF)
- Marine Aquarium
- Specimen Shell
- South West Coast Salmon Fishery
- West Coast Deep Sea Crustacean Fishery
- Western Australian Sea Cucumber Fishery
- Mackerel Managed Fishery
- Pearl Oyster Managed Fishery
-

Northern Territory

- Coastal Line Fishery
- Aquarium Fishery
- Trepang Fishery

[10] Not shown in

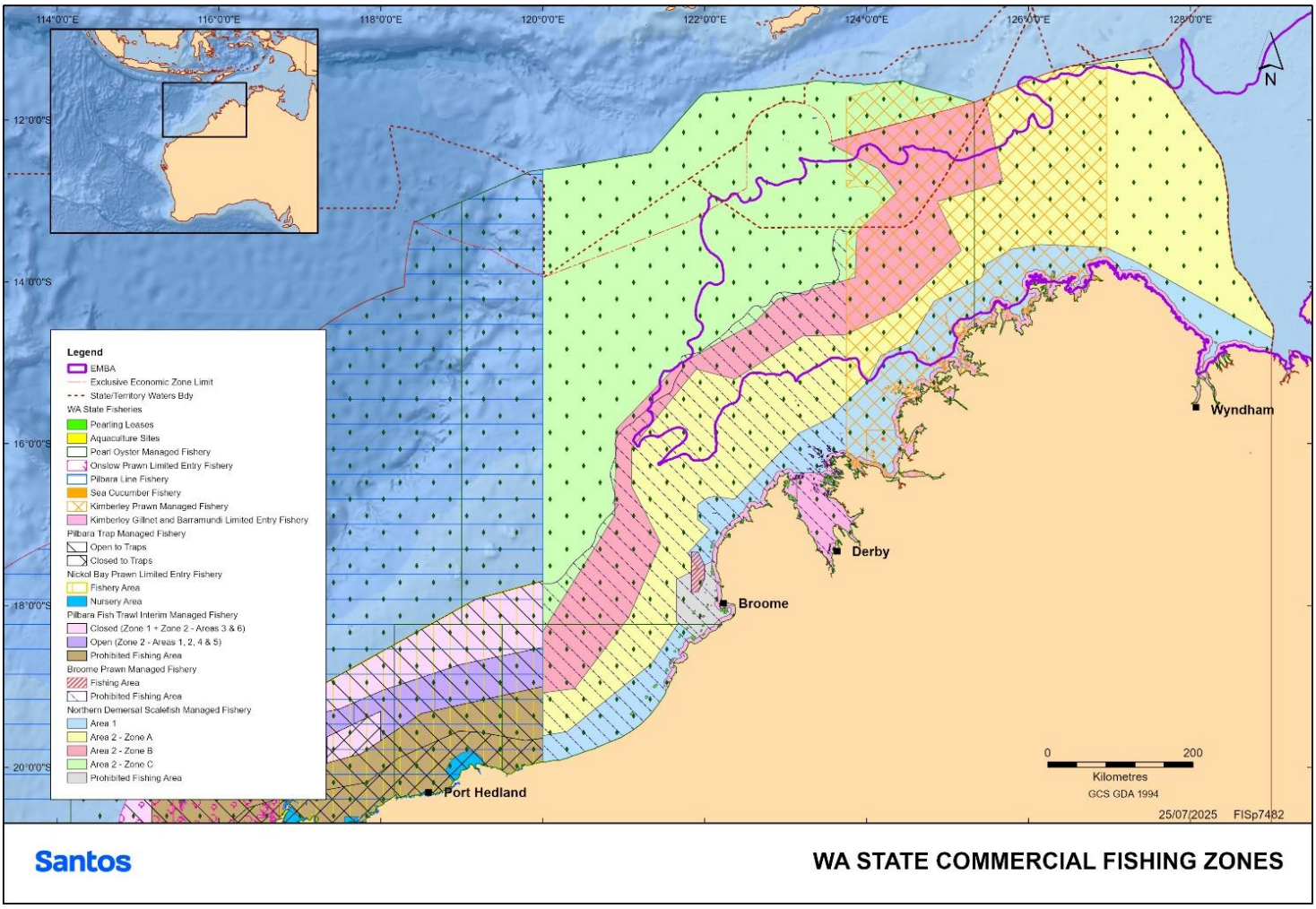


Figure 23: WA state commercial fishing zones

- Development Small Pelagic Fishery
- Coastal Net Fishery
- Spanish Mackerel Fishery
- Offshore Net and Line Fishery
- Timor Reef Fishery
- Demersal Fishery
- Barramundi Fishery.
-

Whole of State Fisheries

- Marine Aquarium Fish Managed Fishery (MAFMF)
- Specimen Shell Managed Fishery
- Hermit Crab Fishery (HCF) [10].

Some of the fisheries listed above will be more susceptible to impacts than others, particularly fisheries without the ability to escape impacts. For example, above average water temperatures over the last three years will have had an impact on prawns, scallops and blue swimmer crabs which have previously been significantly affected by heat wave events (Caputi et al., 2014).

14.7.2. Commonwealth Fisheries

Commonwealth fisheries are those within the 200 nautical mile Australian Fishing Zone (AFZ) managed by Australian Fisheries Management Authority (AFMA) and are, on the high seas, and, in some cases, by agreement with the States and Territory, to the low water mark. Information on Commonwealth managed fisheries has been derived from '*Fishery Status'* Report 2019 (Department of Agriculture, 2019)

Commonwealth fisheries who have permits to operate in the combined EMBA include as shown in **Figure 24:**

- North West Slope Trawl (NWST)
- Northern Prawn Fishery (NPF)
- Southern Bluefin Tuna Fishery (SBFTF)
- Western Tuna and Billfish Fishery (WTBF) (including Southern Tuna and Billfish Fishery)
- Skipjack Tuna Fishery (STF) (referred to as Western Skipjack Tuna Fishery in **Figure 24.**
- Commonwealth commercial fisheries overlapping the EMBA are shown Figure 24 and summarised in Table 22.

Table 22: Commercial fisheries with permits to operate within the combined EMBA

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
State Managed Fisheries				
Aquarium Fishery	Multi-species catch including; invertebrates (hermit crabs, various snails, whelks and hard and soft corals) and finfish (rainbowfish, catfishes and scats).	Unknown	Dive-based method of collection, using barrier, cast, scoop, drag and skimmer nets, hand pumps, freshwater pumps and handheld instruments.	The Aquarium fishery is a small-scale, multi-species fishery that prospects freshwater, estuarine and marine habitats to the outer boundary of the AFZ. Most of the harvest occurs within 100 km of Darwin, though one licence holder does collect from two offshore locations; Evans Shoal and Lynedoch Bank. Fishing activities may occur year-round. Partially within the combined EMBA
Barramundi Fishery	Barramundi and king threadfin	The fishery is restricted to 14 licences all of which are currently allocated to fishers.	Gill nets	The annual commercial barramundi fishing season in the NT is from 1 February to 30 September. Fishing is allowed from the high-water mark to three nautical miles seaward of the low water mark. The area is restricted to waters seaward from the coast, river mouths and legislated closed lines
Broome Prawn Managed Fishery (BPMF)	Western king prawns (*Penaeus latisulcatus*) and coral prawns (a combined category of small penaeid species).	Extremely low fishing effort occurred as only two boats undertaking fishing activities in 2023/24. This resulted in negligible landings of western king prawns	Otter trawl	The BPMF operates in a designated trawl zone off Broome. The boundaries of the BPMF are ‘all Western Australian waters of the Indian Ocean lying east of 120° east longitude and west of 123°45' east longitude on the landward side of the 200 m isobath’. The actual trawl area is

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
		with no byproduct recorded.		contained within a delineated small area north west of Broome. Partially within the combined EMBA
Coastal Line Fishery	Black jewfish Golden snapper	Fishery is restricted to 52 licences, all of which are allocated.	Lines, nets and traps	Fishing occurs along the NT coast between high water marks and 15 nm from low water mark. Majority of activity is concentrated around rocky reefs along the coastline within 100 km from Darwin. Fishing activities occur year-round. Partially within the combined EMBA
Coastal Net Fishery	Mullet	This fishery is restricted to five licences, all of which are allocated.	Nets	The fishery extends from the high-water mark to three nautical miles out from the low water mark. The fishery is divided into regions including: Darwin – from Cape Hotham to Native Point and Cape Ford to Cape Dooley Gove – between Cape Arnhem and Cape Wilberforce Borroloola – from Bing Bong Creek and Pelican Spit. Only the Darwin region overlaps the combined EMBA
Demersal Fishery	Red snappers Goldband snappers	There are currently 16 licences issued for the fishery, and seven boats	Baited trap, line or trawl Fish traps Although essentially	This fishery extends from waters 15nm from the coastal waters mark to the outer limit of the AFZ, excluding the area of the Timor Reef Fishery.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
			trap-based since 2002	
Abalone Managed Fishery	Greenlip abalone (*Haliotis laevigata*) Brownlip abalone (*H. conicopora*)	2022/2023: Commercial: 40.1t Recreational: 11.6-17.2t 2023/2024 Commercial: 27t Recreational: 14.4t	Dive fishery The principal harvest method is a diver working off 'hookah' (surface supplied breathing apparatus) or SCUBA using an abalone 'iron' to prise the shellfish off rocks – both commercial and recreational divers employ this method.	Shallow coastal waters off the south-west and south coasts of Western Australia Covers all Western Australian coastal waters, which are divided into eight management areas. Commercial fishing for greenlip/brownlip abalone is managed in three separate areas. Partially within the EMBA
Hermit Crab Fishery (HCF)	Australian land hermit crab (*Coenobita variabilis*)	2017/2018: 58,643 (lowest reported in the last 10 years (2008-2017; catch range 58,643-118,203). In the 2023/24 season, less than three licences operated in the HCF	Land based hand collection typically using four-wheel drives to access remote beaches	Operates in Western Australian waters north of the Exmouth Gulf (22°30'S) Partially within the EMBA
Kimberley Developing Mud Crab Managed Fishery	Mud crab (*Scylla serrata*)	2017/2018: 60 tonnes (also includes catch data from Pilbara Developmental crab fishery)	Mud Crab traps	This fishery operates between Broome and Cambridge Gulf. Three commercial operators are permitted to fish from King Sound to the Northern Territory border, with closed areas around

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
		In the 2023/24 season, the total catch from the fishery was 0.45 t		communities and fishing camps. One Aboriginal Corporation is permitted to fish in King Sound, with the other Aboriginal Corporation permitted to fish in a small area on the western side of the Dampier peninsula, north of Broome. Notices issued under the Fish Resources Management Act 1994 prohibit all commercial fishing for mud crabs in Roebuck Bay and an area of King Sound near Derby. Partially within the EMBA
Kimberley Gillnet and Barramundi Managed Fishery (KGBF)	Barramundi (*Lates calcarifer*), King threadfin (*Polydactylus macrochir*), Blue threadfin (*Eleutheronema tetradactylum*)	The fishery is restricted to four licences. In 2023/24, four vessels fished in the KGBF and total commercial catch was 86.8 t	Gill net in inshore waters	Nearshore and estuarine zones of the North Coast Bioregion from the WA/NT border (129ºE) to the top end of Eighty Mile Beach, south of Broome (19ºS). The annual commercial barramundi fishing season in the NT is from February to November. Fishing is allowed from the high-water mark to three nautical miles seaward of the low water mark. The area is restricted to waters seaward from the coast, river mouths and legislated closed lines The waters of the KGBF are defined as 'all Western Australian waters north of 19° south latitude and west of 129° east longitude and within three nautical miles of the high-water mark of the mainland of Western Australia and the waters of King Sound south of 16°21.47´ south latitude. Partially within the EMBA

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
Kimberley Prawn Managed Fishery (KPMF)	Banana prawns (*Penaeus merguiensis*) Tiger prawns (Penaeus esculentus) Endeavour prawns (*Metapenaeus endeavouri*) Western king prawns *(Penaeus latisulcatus*)	In 2022/23, commercial catch was 131 t more (239 t) than in the 2023/24 season (108 t). This is due to fewer vessels fishing as low rainfall in the season implied lower catch.	Otter trawl	The KPMF operates off the north of the state between Koolan Island and Cape Londonderry. The boundaries of the KPMF are 'all Western Australian waters of the Indian Ocean lying east of 123°45´ east longitude and west of 126°58´ east longitude'. It abuts the western boundary of the Commonwealth Northern Prawn Fishery (NPF). Partially within the EMBA
Marine Aquarium Fish Managed Fishery (MAFMF)	The MAFMF potentially includes over 1,500 species of aquarium fish, including corals, live rock, algae, aquatic plants and invertebrates under the *Marine Aquarium Fish Managed Fishery Management Plan 2018*. The main fish species landed in 2023/24 were scribbled angelfish (*Chaetodontoplus duboulayi*) and black-axil chromis (C*hromis atripectoralis*). Invertebrates were dominated by gastropods, anemones and crabs, and the The main coral species landed were zoanthid anemones.	2022/23: Commercial: total catch 19,710 individuals (fish) 77,287 invertebrates Eleven licences were active in the MAFMF in the 2023/24 season. Total catch included 107,786 fish and invertebrates, 10 t coral, live rock and sand, and 272 L of marine plant and live feed.	Hand harvest while diving or wading. Hand held nets	Dive based fishery operating all year throughout WA waters but restricted by diving depths. The MAFMF is able to operate in all State waters (between the Northern Territory border and South Australian border). The fishery is typically more active in waters south of Broome with higher levels of effort around the Capes region, Perth, Geraldton, Exmouth and Dampier. Operators in the MAFMF are also permitted to take coral, live rock, algae, seagrass and invertebrates under the Prohibition on Fishing (Coral, 'Live Rock' and Algae) Order 2007 and by way of Ministerial Exemption (Gaughan & Santoro, 2018). Partially within the combined EMBA
Northern Demersal Scalefish Managed	Red emperor (*Lutjanus sebae*) Goldband snapper (*Pristipomoides multidens*)	2017/2018:1317 t (total) Goldband snapper (not including other jobfish): 473 tonnes.	The permitted means of operation within the fishery include handline, dropline and fish traps, but	The Northern Demersal Scalefish Managed Fishery (NDSF) operates off the northwest coast of Western Australia in the waters east of 120° E longitude. These waters extend out

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
Fishery (NDSMF)		Red emperor: 34 – 47 t 2022/2023: Commercial: 1458 t Recreational:41-63 t In the 2023/34 season, the NDSMF had a commercial catch of 1,450 t and a recreational catch of 66 t,	since 2002 it has essentially been a trap-based fishery which uses gear time access and spatial zones as the primary management measures (State of the Fisheries 2014-15).	to the edge of the Australian Fishing Zone (200 nautical miles). The Fishery consists of three zones; Zone A is an inshore area; Zone B comprises the area with most historical fishing activity and Zone C is an offshore deep slope developmental area. The fishery is further divided into two fishing areas: an inshore sector and an offshore sector. The inshore waters in the vicinity of Broome are closed to commercial fishing. Partially within the EMBA
WA North Coast Shark Fisheries	Sandbar (*Carcharhinus plumbeus*), hammer head (Sphyrnidae), blacktip (*Carcharhinus melanopterus*) and lemon sharks (*Negaprion brevirostris*).	This fishery has been closed since 2008/2009	Gill net, longline	Comprised of the State-managed WA North Coast Shark Fishery in the Pilbara and western Kimberley, and the Joint Authority Northern Shark Fishery in the eastern Kimberley.
Offshore Net and Line Fishery	Blacktip sharks Grey mackerel	This fishery has no restrictions on the number of licences issued.	Pelagic lines and nets	The fishery covers an area of over 522,000 km^2 and extends from the NT high water mark to the boundary of the AFZ. Majority of the fishing effort is in the coastal zone (within 12 nm of the coast) and immediately offshore in the Gulf of Carpentaria. Partially within the combined EMBA
Specimen Shell Managed Fishery (SSF)	Shells (cowries, cones) The Specimen Shell Managed Fishery (SSF) is based on the collection of individual shells for the purposes of display, collection, cataloguing,	Total catch in 2023/24 was 5,807 shells distributed over 140 species. The total catch of 2023/24 was	Hand harvest while diving or wading along coastal beaches below the high-	Dive based fishery operating all year throughout WA waters but restricted by diving depths.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
	classification and sale. Approximately 200 species of specimen shell are collected on average each year, using a variety of methods.	733 shells more than the total catch in the 2022/23 season (5,074)	water mark and by use of remotely operated underwater vehicles	The fishing area includes all Western Australian waters between the high-water mark and the 200 m isobath. Partially within the combined EMBA
South West Coast Salmon Managed Fishery (SWCSMF)	WA salmon (*Arripis truttaceus*)	This fishery is restricted to five licences, with four currently active (DPIRD, 2024)	Beach seine nets	The SWCSMF extends from the eastern state boundary of WA with the Northern Territory (NT) on the north coast to Cape Beaufort on the south-west coast. Licencees are permitted to operate throughout all open areas of the fishery. There is no specified season for salmon fishing however fishers target the species as they migrate around the west coast from February through to the end of April.
Spanish Mackerel Fishery	Narrow-barred Spanish mackerel	The Spanish mackerel fishery is restricted to 15 licences, all of which are currently allocated.	Troll lines, floating hand lines and rods.	The fishery extends from the NT waters seaward off the coast and river mouths to the outer limit of the AFZ. The majority of the fishing effort occurs coastal areas around reefs, shoals and headlands. The majority of the catch is taken in the Kimberley Area and north of Port Hedland. Wholly within the combined EMBA
Trepang Fishery	Sea cucumber (sandfish species)	The fishery is restricted to six licences, all of which are currently allocated.	Trepang are harvested by hand, either on foot or by diving.	Commercial fishing for sea cucumber is allowed from the high-water mark to three nautical miles seaward from the territorial sea baseline. Most sea cucumbers are collected along the Arnhem Land coast, mainly around the Cobourg Peninsula and Groote Eylandt Partially within the combined EMBA

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
Timor Reef Fishery	Goldband snapper	There are 16 licences issued and seven boats nominated for fishing.	Drop lines primarily in the 100 m–200 m depth range. Vertical lines, finfish long-lines and baited fish traps are also used.	Operates in remote offshore waters in the Timor Sea in a defined area approximately 370 km north-west of Darwin.
West Coast Deep Sea Crustacean (Interim) Managed Fishery	Crystal (Snow) crabs (*Chaceon albus*), Giant (King) crabs (P*seudocarcinus gigas*) and Champagne (Spiny) crabs (*Hypothalassia acerba*).	In the 2023/24 season there were seven licence holders and three vessels. The total catch was 123.1 t of crystal crab, 1.7 t of champagne crab and 0.13 t of giant crab.	Baited pots operated in a longline formation in the shelf edge waters (>150 m)	North of latitude 34° 24' S (Cape Leeuwin) and west of the Northern Territory border on the seaward side of the 150 m isobath out to the extent of the AFZ, mostly in 500 to 800 m of water.
Mackerel Managed Fishery	Spanish mackerel (*Scomberomorus commerson*) and grey mackerel (*S. semifasciatus*)	In the 2023/24 season, total commercial catch was 225 t of Spanish mackerel and 16 t for grey mackerel. Total recreational catch was 35-78 t of Spanish mackerel and 1-3 t of grey mackerel	Trolling or handline Near-surface trolling gear from vessels in coastal areas around reefs, shoals and headlands. Jig fishing is also used to capture grey mackerel (*S.semifasciatus*)	The Fishery extends from the West Coast Bioregion to the WA/NT border, to the 200 nautical mile AFZ with most effort and catches recorded north of Geraldton, especially from the Kimberley and Pilbara coasts of the Northern Bioregion. Restricted to coastal and shallower waters. Catches are reported separately for three Areas: Area 1 – Kimberley (121º E to WA/NT border) Area 2 -Pilbara (114º E to 121º E) Area 3 – Gascoyne (27º S to 114º E) and West Coast (Cape Leeuwin to 27º S).

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
				Area 1 overlaps the EMBA
Western Australian Pearl Oyster Managed Fishery	Indo- Pacific silver-lipped pearl oyster (*Pinctada maxima*).	In the 2023/24 season, total commercial catch was 798,217 shells.	Drift diving restricted to shallow diveable depths. The collection of pearl oysters for the Pearl Oyster Managed Fishery is restricted to shallow diving depths below 35 m. Divers are attached to large outrigger booms on a vessel and towed slowly over the pearl oyster beds, harvesting legalised oysters by hand as they are seen.	The fishery is separated into four zones: Pearl Oyster Zone 1: NW Cape (including Exmouth Gulf) to longitude 119°30'E. There are five licensees in this zone. No fishing in this zone since 2008 Pearl Oyster Zone 2: East of Cape Thouin (118°20´ E) and south of latitude 18°14´ S. The 9 licensees in this zone also have full access to Zone 3. This zone is the mainstay of the fishery. Pearl Oyster Zone 3: West of longitude 125°20´ E and north of latitude 18°14´ S. The 2 licensees in this zone also have partial access to Zone 2. Pearl Oyster Zone 4: East of longitude 125°20´ E to the Western Australia/Northern Territory border. Although all licensees have access to this zone, exploratory fishing has shown that stocks in this area are not economically viable. However, pearl farming does occur. Wholly within the combined EMBA
Western Australian Sea Cucumber Fishery (formerly known as Beche-de-mer)	Sandfish (*Holothuria scabra*) and deepwater redfish (*Actinopyga echinites*).	Total catch in 2023/24 was 126.1 t, which was well above the 2022/23 catch of 56.5 t due to increased fishing effort around the Montebello Islands. Three commercial vessels	Hand-harvest fishery, with animals caught principally by diving, and a smaller amount by wading.	The Western Australian Sea Cucumber Fishery is permitted to operate throughout WA waters with the exception of a number of specific closures around the Dampier Archipelago, Cape Keraudren, Cape Preston and Cape Lambert, the Rowley Shoals and the Abrolhos Islands.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
		fished in the 2023/24 season.		The fishery is primarily based in the northern half of the State, from Exmouth Gulf to the Northern Territory border.
Commonwealth Managed Fisheries				
North West Slope Trawl	Scampi (crayfish): velvet scampi (*Metanephrops velutinus*) and boschmai scampi *(Metanephrops boschmai)*. Deepwater prawns (penaeid and carid): pink prawn (*Parapenaeus longirostris)*, red prawn (*Aristaeomorpha foliacea*), striped prawn (*Aristeus virilis)*, giant scarlet prawn (*Aristaeopsis edwardsiana*), red carid prawn (*Heterocarpus woodmasoni*) and white carid prawn (*Heterocarpus sibogae*). Snapper.	In the 2022/23 season, there were seven fishing permits allocated and three active vessels. Fishing effort was 218 days. Total catch was 85.4 t	Demersal crustacean trawl seaward of the 200 m isobath.	Extends from 114° E to approximately 125° E off the WA coast between the 200 m isobath and the outer limit of the Australian Fishing Zone (AFZ). Partially within the combined EMBA
Northern Prawn Fishery (NPF)	Tiger (brown – *Penaeus esculentus*, and grooved – *P. semisulcatus*) and banana (white – *Penaeus merguiensis*, and redleg – *P. indicus*) prawns.	In the 2022/23 season total catch was 309 t (redleg banana), 6,470 t (white banana), 321 t (brown tiger) and 921 (groved tiger). 52 fishing permits were in use and 53 vessels were active.	Otter trawl	The NPF extends from the JBG across the Top End to the Gulf of Carpentaria.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
Western Skipjack Tuna Fishery	Skipjack tuna (*Katsuwonus pelamis*)	No catch since 2008/09 fishing season	Purse seine	The Skipjack Tuna Fishery is split into two sectors; east and west. The Western Skipjack Tuna Fishery is located in all Australia waters west of 142° 30' 00°E, out to 200 nm from the coast. There has been no fishing effort in the Skipjack Tuna Fishery since the 2008-09 season. Partially within the combined EMBA
Southern Bluefin Tuna Fishery	Southern bluefin tuna (*Thunnus maccoyii*).	In the 2022/23 season, total catch was 6,034 t	Purse seine vessels primarily in Great Australian Bight all year round and longline off southern NSW in winter. Around 98% of Australia's SBT quota is taken by 5–10 purse seine vessels fishing for 13–25 kg southern bluefin tuna.	Fishery includes all waters of Australia, out to 200 nm from the coast. No current effort on the North West Shelf, as fishing activity is concentrated in the Great Australian Bight and off South-east Australia (Department of Agriculture 2019). Partially within the combined EMBA
Western Tuna and Billfish Fishery	Broadbill swordfish (*Xiphias gladius*), albacore tuna (*Thunnus alalunga)*, striped marlin (*Kajikia audax*), bigeye tuna (*T. obesus)* and yellowfin tuna (*T. albacares*).	In the 2022/23 seaosn, total catch was 196 t	Pelagic, longline, minor line and purse seine.	Extends westward from Cape York Peninsula (142°30' E) off Queensland to 34° S off the WA west coast. It also extends eastward from 34° S off the west coast of WA across the Great Australian Bight to 141° E at the South Australian–Victorian border. In recent years, fishing effort has concentrated off south-west Western Australia and South

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
				Australia with no current effort on the North West Shelf (Department of Agriculture 2019). Partially within the combined EMBA

Source: Apache (2008); Australian Fisheries Management Authority (2011); Department of Fisheries (2013), Stakeholder consultation.
[1]Sources for catch data: Department of Agriculture, 2019; Gaughan et al., 2019; DPIRD, 2018; DPIRD, 2023; Newman et al., 2024

14.8. Aquaculture

14.8.1. North Coast Bioregion

Aquaculture development in this region is dominated by the production of pearls from the species *Pinctada maxima*. Pearl farm sites are located mainly along the Kimberley coast, particularly in the Buccaneer Archipelago, in Roebuck Bay and at the Montebello Islands. Developing marine aquaculture initiatives in this region include growing trochus and barramundi. The Fishery of Western Australia operates in shallow coastal waters (DoF, 2006). All the leases are within the 35m diving depth, with commercial diving predominantly occurring in nearshore habitats of 8-15 m depths (sourced from Fisheries Research and Development Cooperation in Thomas & Miller, 2022). Thomas and Miller (2022) demonstrated high levels of gene flow among inshore (8-15 m water depth) and offshore sites (35 m water depth) and no differences in genetic diversity between depths indicating high levels of dispersal and connectivity among inshore and offshore fishing grounds

The Pearl Producer's Association (PPA) assert that spawning stock for pearl oysters occur out to the 100 m depth contour, however, evidence for this is lacking. Condie et al., (2006) modelled oyster larva transport in the Eighty Mile Beach region and found that while some larvae travelled more than 60 km, most were transported less than 30 km. The model results suggested that spawning in the Eighty Mile Beach region is concentrated around the 8 to 15m depth range, with potential smaller contributions from the northeast. These spawning events are likely to lead to successful recruitment locally and alongshore to the southwest.

However, spat abundances seem to be low in these areas, suggesting that recruitment is strongly limited by habitat availability and possibly high mortality rates in shallow water. High local abundances of broodstock and spat observed occasionally in deeper water (<30 m) seem to be supported by intermittent larval transport from inshore populations. Spawning in this area seems to contribute little to recruitment in the inshore populations.

Further aquaculture in this region mainly focuses on barramundi farming within Cone Bay, with two aquaculture licences granted in this area located about 200 km north-east of Broome (Gaughan & Santoro, 2020).

Further aquaculture operations have expanded in the region with the establishment of the Kimberley Aquaculture Development zone, which encompasses almost 2,000 ha of coastal waters within Cone Bay supporting the production of up to 20,000 t of finfish annually (Gaughan & Santoro, 2020).

14.8.2. Northern Territory

The Northern Territory boasts a diverse and vibrant aquaculture industry. An extensive range of commercial activity includes barramundi farming, trepang (sea cucumber), pearling and the collection of marine fish and coral for the tropical aquarium market. A pond-based barramundi farm on the Adelaide River produces more than 1,000 tonnes of Barramundi a year (Northern Territory Government, 2016). Giant clams are also farmed with trials on Groote Eylandt and Goulburn Island growing sea clams in sea-based cages. The silver-lipped pearl oyster is farmed in four main areas of the NT: Bynoe Harbour, Beagle Gulf, Cobourg Peninsula and Croker Island around the islands north west of Nhulunbuy (NT Government, 2023).

The NT Government, via the Darwin Aquaculture Centre (DAC), is also encouraging the development of aquaculture of other species, including barramundi, sea cucumber, blacklip oysters, and giant clams. The DAC is based on Channel Island in Darwin Harbour, approximately 3.5 km south of the DLNG facility and 1.5 km south of the Operational Area. Barramundi is currently grown in ponds on the Adelaide River, and trials on Groote Eylandt and Goulburn Island are looking at growing clams in sea-based cages (NT Government, 2023).

14.9. Recreational Fisheries

14.9.1. North Coast Bioregion

The North Coast Bioregion (Pilbara/Kimberley) runs from the Ashburton River to the Western Australia/Northern Territory border (WAFIC, 2016). The oceanography of this region includes waters of Pacific Ocean origin that enter through the Indonesian archipelago bringing warm, low salinity waters polewards via the Indonesian throughflow and Holloway currents which flow seasonally and interact with Indian ocean waters. Recreational fishing is experiencing a significant growth in this region, with a distinct seasonal peak in winter when the local

population increases by significant numbers of metropolitan and inter-state tourists. This has been added to by the increased recreational fishing by those involved in the construction or operation of major developments in this region. Owing to the high tidal range, much of the angling activity is boat-based with beach fishing limited to periods of flood tides and high water. Numerous creek systems, mangroves, rivers and ocean beaches provide shore and small boat fishing for a variety of species including barramundi, tropical emperors, mangrove jack, trevallies, sooty grunter, threadfin, mud crabs and cods. Offshore islands, coral reef systems and continental shelf waters provide species of major recreational interest including saddletail snapper and red emperor, cods, coral and coronation trout, sharks, trevally, tuskfish, mackerels and billfish (WAFIC, 2016).

14.9.2. Northern Territory

Available data on recreational fishing in the Greater Darwin area indicates that line fishing (using bait, lures or flies) was the most common fishing method used, accounting for 72 % of the total effort, followed by Mud Crab potting (23 %). The use of cast nets and other fishing methods was far less common. Approximately 70% of all recreational fishing effort occurred in estuarine waters (Matthews et al., 2019). The Darwin Harbour region and its associated arms and creeks supported 40 % of the total fishing effort, followed by Bynoe Harbour (14 %) and Shoal Bay (6 %). The offshore regions seaward of Bynoe Harbour and Dundee were the most popular sites for those fishers venturing beyond estuarine waters. Most of the catch (84 %) comprised of fish species (i.e. bony fish and sharks/rays) with the bulk of the remaining catch consisting of crabs and prawns.

In the NT, 95 % of recreational fishing occurs in in areas <5 km from the coastline, and offshore waters (West et al., 2022). The peak fishing effort between October to December and April to June (West et al., 2022). Several shoals and banks may be visited by small numbers of recreational fishers/charter vessels targeting fish inhabiting these shallower offshore features.

The Tiwi Islands are a popular tourist destination offering cruises, fishing, sailing and water tours among other cultural activities. Access and fishing are not permitted at the locations on the west coast of Bathurst Island that are intersected by the EMBA (Tiwi Land Council, 2023b).

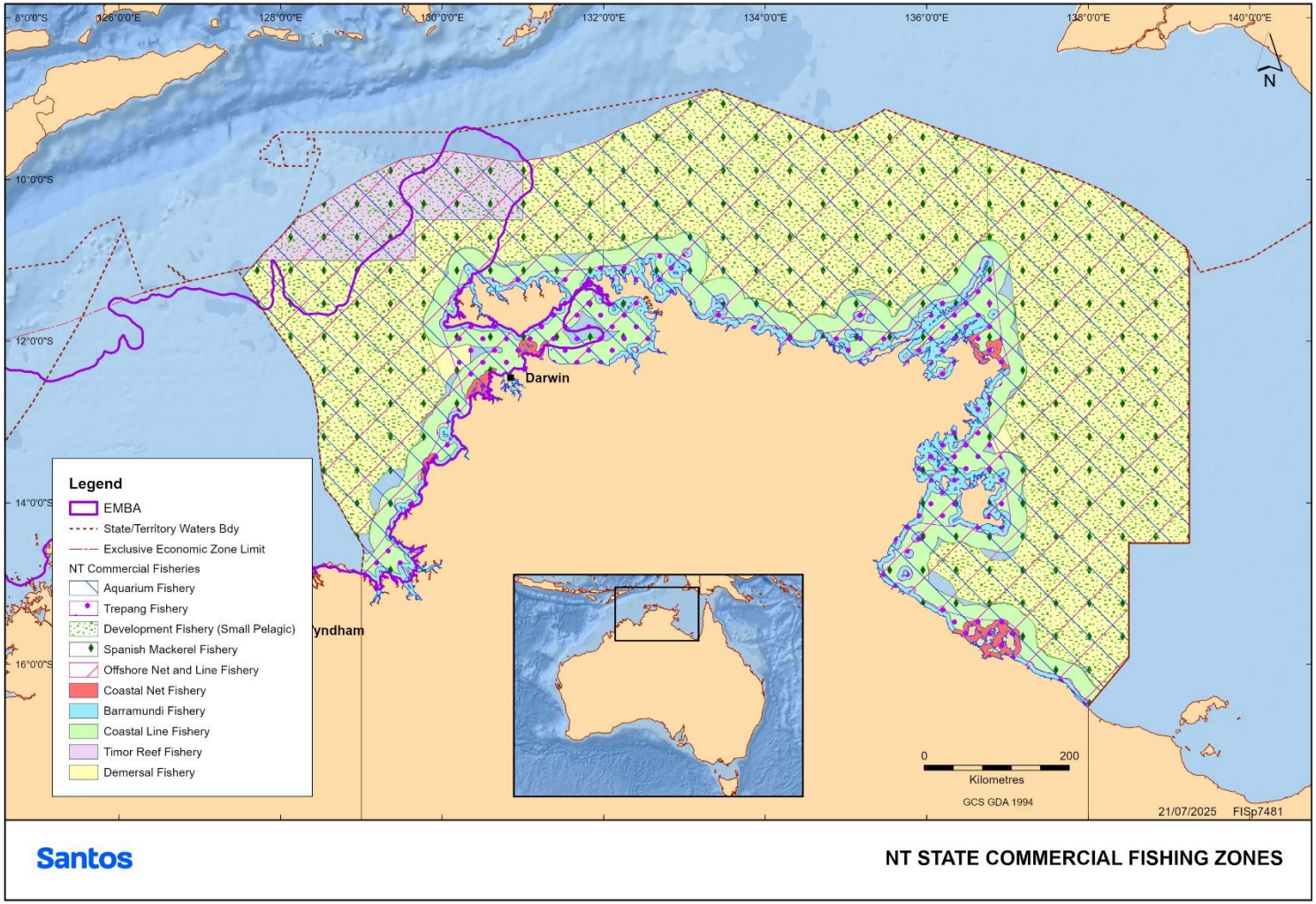


Figure 22: NT state commercial fishing zones

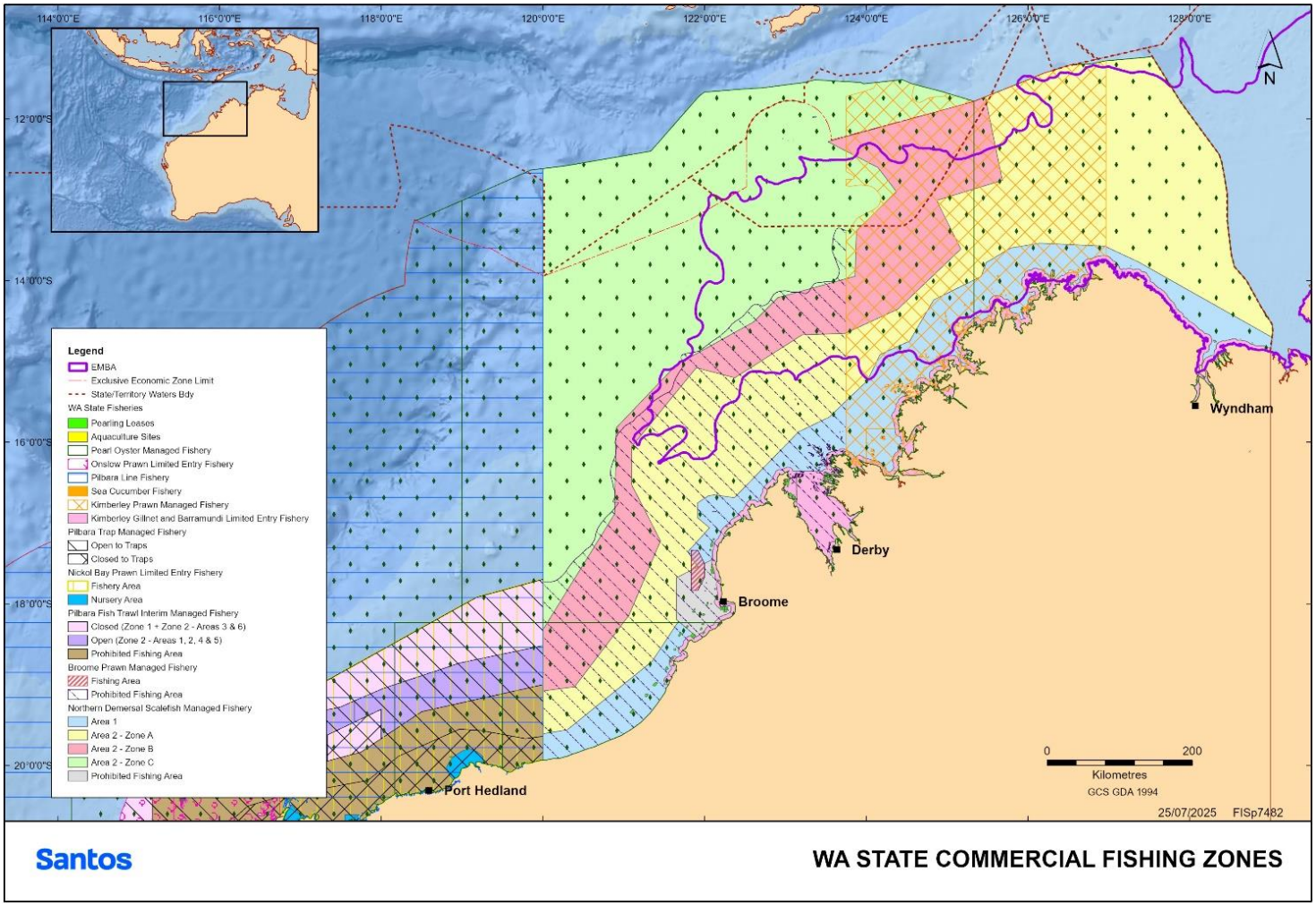


Figure 23: WA state commercial fishing zones

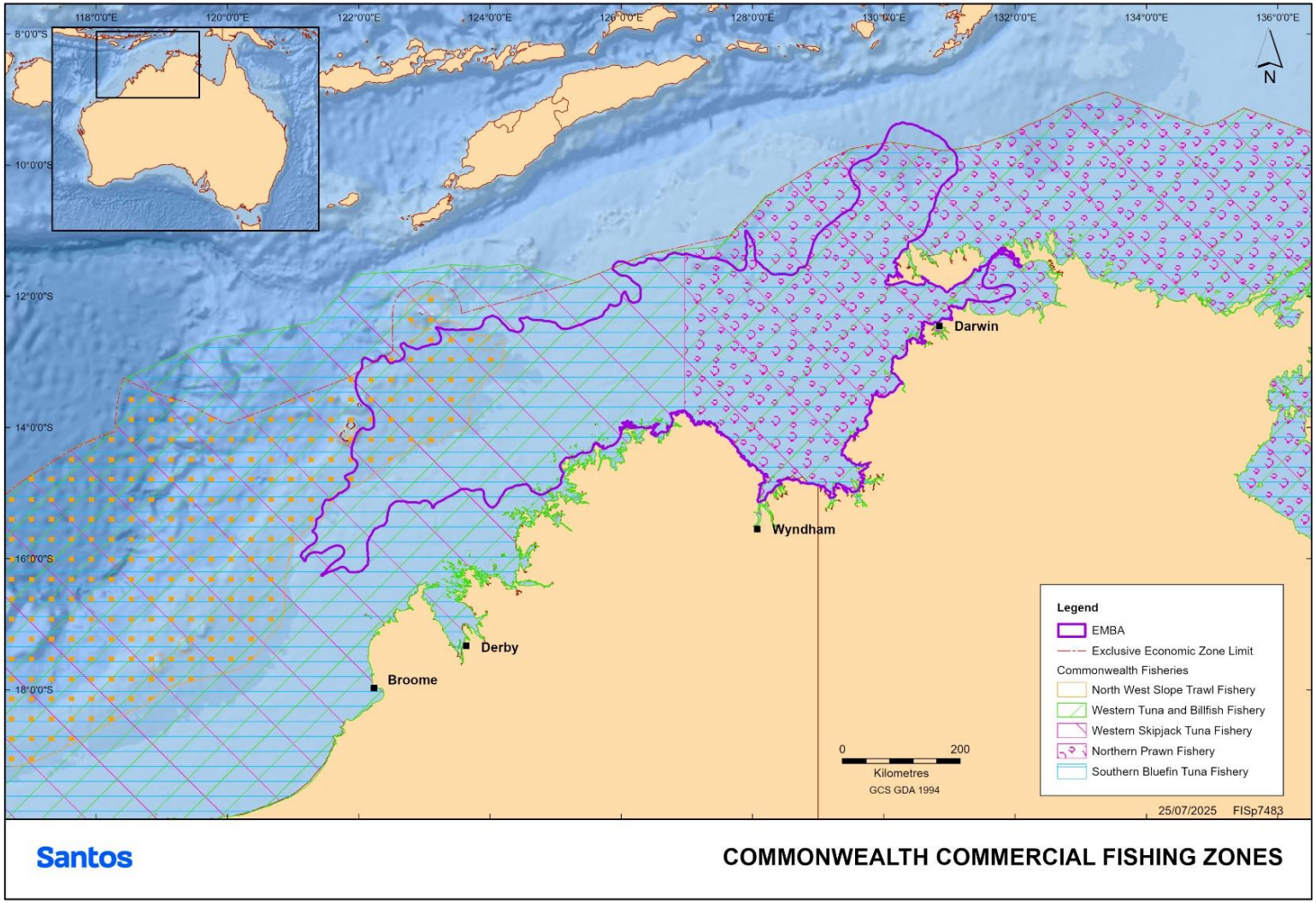


Figure 24: Commonwealth commercial fishing zones

15. Document Review

This document is to be reviewed annually at a minimum. The review and revision will consider any changes to the spatial scope of the document, i.e. the Environment that May be Affected (EMBA), as well as any changes to EPBC Act Matters of National Environmental Significance (MNES) from one review year to the next, regardless of any changes to the spatial extent of the combined EMBA. A review of changes to MNES shall consider at a minimum any changes to EPBC Act species lists, species management/recovery plans and MNES spatial layers.

16. References

16.1. Physical Environment

Brewer DT, Lyne V, Skewes TD and Rothlisberg P 2007. Trophic Systems of the North West Marine Region Prepared for the Department of the Environment, Water, Heritage and the Arts by CSIRO Marine and Atmospheric Research, Cleveland, Queensland

Bureau of Meteorology, 2019. Climatology of Tropical Cyclones in Western Australia. Available at: http://www.bom.gov.au/cyclone/climatology/. Viewed on 8 October 2019.

[BoM] Bureau of Meteorology, 2024. Monthly climate statistics. Barrow Island Airport. http://www.bom.gov.au/climate/averages/tables/cw_005094.shtml

[BoM] Bureau of Meteorology, 2025a. Australian tropical cyclone season long-range forecast. Australian Government. Available at: http://www.bom.gov.au/climate/cyclones/australia/#tabs=About

[BoM] Bureau of Meteorology, 2025b. Climate statistics for Australian locations – Port Keats. Australian Government. Available at: http://www.bom.gov.au/climate/averages/tables/cw_014948.shtml

[BoM] Bureau of Meteorology, 2025c. Climate statistics for Australian locations – Channel Point. Australian Government. Available at: http://www.bom.gov.au/climate/averages/tables/cw_014253.shtml

[BoM] Bureau of Meteorology, 2025d. Climate statistics for Australian locations – Dum In Mirrie Airstrip. Australian Government. Available at: http://www.bom.gov.au/climate/averages/tables/cw_014277.shtml

[BoM] Bureau of Meteorology, 2025e. Climate statistics for Australian locations – Truscott. Australian Government. Available at: http://www.bom.gov.au/climate/averages/tables/cw_001020.shtml

Commonwealth of Australia, 2022. Annual Climate Change Statement 2022, Australian Government Department of Climate Change, Energy, the Environment and Water

Condie, S., Andrewartha, J., Mansbridge, J, and Waring, J., 2006. Modelling circulation and connectivity on Australia's North West Shelf. North West Shelf Joint Environmental Management Study: Technical Report No. 6. CSIRO Marine and Atmospheric Research, Hobart, Tasmania

[DEWHA] Department of the Environment, Water, Heritage and the Arts, 2008a. The North-west Marine Bioregional Plan: Bioregional profile: A Description of the Ecosystems, Conservation Values and Uses of the North-West Marine Region. Department of the Environment Water, Heritage and the Arts, Canberra, Australian Capital Territory

[DEWHA] Department of the Environment, Water, Heritage and the Arts, 2008b. The North Marine Bioregional Plan: Bioregional profile: A Description of the Ecosystems, Conservation Values and Uses of the North Marine Region. Department of the Environment Water, Heritage and the Arts, Canberra, Australian Capital Territory

[DSEWPaC] Department of Sustainability, Environment, Water, Population and Communities, 2012. Marine Bioregional Plan for the North Marine Region. Department of Sustainability, Environment, Water, Population and Communities, Canberra, Australian Capital Territory.

ENI Australia, 2021. Blacktip Offshore Environment Plan Summary. Available at: https://docs.nopsema.gov.au/A706151 Accessed 26/10/2021.

Fugro, 2015. Barossa Field Meteorological, Current Profile, Wave and CTD Measurements – Final Report. Reporting Period: 8 July 2014 to 16 July 2015. Report prepared for ConocoPhillips Australia Pty Ltd., Perth, Western Australia

Holloway, P.E., 1983. Tides on the Australian north west shelf. *Australian Journal of Marine and Freshwater Research*, 34(1): 213–230

Holloway, P.E. and Nye, H.C., 1985 Leeuwin current and wind distributions on the southern part of the Australian North West Shelf between January 1982 and July 1983. *Australian Journal of Marine and Freshwater Research* 36(2): 123–137

McKinnon, AD, Meekan, MG, Carleton, JH, Furnas, MJ, Duggan, S and Skiring, W., 2003. Rapid changes in shelf water and pelagic communities on the southern Northwest Shelf, Australia, following a tropical cyclone. *Continental Shelf Research* 23: 93–111

NSR, 1995. Wandoo full field development. Public Environmental Report for Ampolex Ltd, NSR Environmental Consultants Pty Ltd. November 1995

Przeslawski, R., Daniell, J., Anderson, T., Barrie, J.V., Battershill, C., Heap, A., Hughes, M., Li, J., Potter, A., Radke, R., Siwabessy, J., Tran, M, Whiteway, T., Nichol, S., 2011. Seabed Habitats and Hazards of the Joesph Bonaparte Gulf and Timor Sea, Northern Australia. Geoscience Australia, record 2011/40. Geoscience Australia, Canberra, Australian Capital Territory.

[SSE] Steedman Science and Engineering, 1991. Normal and extreme environmental design criteria. Campbell and Sinbad locations, and Varanus Island to Mainland Pipeline. Volume 1. Prepared for Hadson Energy Limited by Steedman Science and Engineering. Report E486. March 1991

[SSE] Steedman Science and Engineering, 1993. Review of oceanography of North West Shelf and Timor Sea regions pertaining to the environmental impact of the offshore oil and gas industry. Vol I prepared for Woodside Offshore Petroleum and the APPEA Review Project of Environmental Consequences of Development Related to the Petroleum Production in the Marine Environment: Review of Scientific Research, Report E1379, October 1993

WNI, 1995. Preliminary report on ambient and non-cyclonic design criteria for the Stag location. WNI Science & Engineering. December 1995

WNI, 1996. Metocean Conditions on the North West Shelf of Australia, Cape Lambert to the North West Cape Relating to Jack-up Drilling Operation. (DR-50-ED-001). July 1996

16.2. Benthic and Pelagic Habitats

AIMS (Australian Institute of Marine Science). 2014. Benthic habitat characterisation of Montgomery Reef, Kimberley region, Western Australia. Available at http://data.aims.gov.au/metadataviewer/uuid/b4175af1-e213-4ac7-a7e8-baa121f709b2 [Accessed April 2014]

AIMS (Australian Institute of Marine Science). (2021). Hawksbill and green turtle distribution and important areas. As part of the Northwest Shores to Shoals Research Program, supported by Santos. Available at: https://northwestatlas.org/nwa/nws2s-megafauna#green_bia Australian Ocean Data Network 2017, Australian Phytoplankton Database, Integrated Marine Observing System. Available from: https://portal.aodn.org.au/ [Accessed: 20/11/2017]

BHPBIO, 2011. Proposed Outer Harbour Development, Port Hedland Public Environmental Review/Draft Environmental Impact Statement. BHP Billiton Iron Ore, Perth, Western Australia

Brewer, D.T., Lyne, V., Skewes, T.D. and Rothlisberg, P., 2007. Trophic Systems of the North West Marine Region Prepared for the Department of the Environment, Water, Heritage and the Arts by CSIRO Marine and Atmospheric Research, Cleveland, Queensland

Brooke, B.P., 1997. Geomorphology of the islands and reefs of the central western Kimberley coast In: Marine Biological Survey of the Central Kimberley Coast, Western Australia, Ed DI Walker, University of Western Australia, Western Australia

Brown, K. & Skewes, T., 2005. A preliminary assessment of the ecology of seagrasses at Ashmore Reef. In: Understanding the Cultural and Natural Heritage Values and Management Challenges of the Ashmore Region, Proceedings of a Symposium organised by the Australian Marine Sciences Association and the Museum and Art Gallery of the Northern Territory, Darwin, 4-6 April 2001. Edited *by* B Russell, H Larson, CJ Glasby, RC Willan, and J Martin. Museum and Art Galleries of the Northern Territory & Australian Marine Sciences Association, Darwin, Northern Territory. pp. 143–152

CALM, MPRA, 2005a. Management Plan for the Ningaloo Marine Park and Muiron Islands Marine Management Area 2005–2015. Management Plan No. 52. Department of Conservation and Land Management and Marine Parks and Reserves Authority, Perth, Western Australia

Calnan, T., 2006. An assessment of the conservation values of the Gunn Peninsula/Vernon Islands area and the impacts of the proposed Glyde Point heavy industry and residential estate. Prepared for ECNT and AMCS, Darwin.

Ceccarelli, D.M., Richards, Z.T., Pratchett M.S, and Cvitanovic, C., 2011. Rapid increase in coral cover on an isolated coral reef, the Ashmore Reef National Nature Reserve, north-western Australia. Marine and Freshwater Research 62(10): 1214

ConocoPhillips, 2018. Barossa Area Development Offshore Project Proposal. ConocoPhillips, Perth, Western Australia

[DEC and MPRA] Marine Parks and Reserves Authority, 2007. MPRA Marine Parks and Reserves Authority Annual Report 1 July 2006 - 30 June 2007. Department of Environment and Conservation, Fremantle, pp 1-30

[DEWHA] Department of the Environment, Water, Heritage and the Arts, 2008a. The North-west Marine Bioregional Plan Bioregional profile: A Description of the Ecosystems, Conservation Values and Uses of the North-west Marine Region. Department of the Environment, Water, Heritage and the Arts, Canberra, Australian Capital Territory

[DEWHA] Department of the Environment, Water, Heritage and the Arts, 2008b. The North Marine Bioregional Plan Bioregional profile: A Description of the Ecosystems, Conservation Values and Uses of the North Marine Region. Department of the Environment, Water, Heritage and the Arts, Canberra, Australian Capital Territory

[DSEWPaC] Department of Sustainability, Environment, Water, Population and Communities, 2012. Marine Bioregional Plan for the North Marine Region. Department of Sustainability, Environment, Water, Population and Communities, Canberra, Australian Capital Territory

[DPAW] Department of Parks and Wildlife, 2013. Lalang-garram/ Camden Sound Marine Park Management Plan 73 2013–2023. Department of Parks and Wildlife, Perth, Western Australia

Gilmour, J., Smith, L., Cook, K. and Pincock, S., 2013. Discovering Scott Reef: 20 years of exploration and research. Australian Institute of Marine Science, Perth, Western Australia.

Gilmour, J.P., Cook, K.L., Ryan, N.M., Puotinen, M.L., Green, R.H., Heyward, A.J., 2021. A tale of two reef systems: Local conditions, disturbances, coral life histories, and the climate catastrophe. Ecological Applications e2509. https://doi.org/10.1002/eap.2509

Griffith, J.K., 1997. The Corals Collected During September/October at Ashmore Reef, Timor Sea. Parks Australia

Hale, J. and Butcher, R., 2013. Ashmore Reef Commonwealth Marine Reserve Ramsar Site Ecological Character Description. A report to the Department of the Environment, Canberra, Australian Capital Territory

Heyward, A.J., Pincerato, E.J., and Smith, L. (eds). 1997. Big Bank Shoals of the Timor Sea: An Environmental Resource Atlas. BHP Petroleum, Melbourne, Victoria

Heyward, A., Revill, A. and Sherwood, C., 2006. Review of research and data relevant to marine environmental management of Australia's North West Shelf North West Shelf Joint Environmental Management Study: Technical Report No. 1. CSIRO Marine and Atmospheric Research, Hobart, Tasmania

Heyward, A., Radford, B., Burns, K., Colquhoun, J., Moore, C., 2010. Montara Surveys: Final report on Benthic Surveys at Ashmore, Cartier and Seringapatam Reefs. Australian Institute of Marine Science, Crawley Western Australia

Heyward, A., Jones, R., Meeuwig, J., Burns, K., Radford, B., Colquhoun, J., Cappo, M., Case, M., O'Leary, R., Fisher, R., Meekan, M. and Stowar, M., 2011. Monitoring Study S5 Banks & Shoals, Montara: 2011 Offshore banks Assessment Survey. Report for PTTEP Australasia (Ashmore Cartier) Pty. Ltd. Australian Institute of Marine Science, Townsville. (253pp.).

Heyward, A., Jones, R., Travers, M., Burns, K., Suosaari, G., Colquhoun, J., Case, M., Redford, B., Meekan, M., Markey, K., Schenk, T., O'Leary, R.A., Brooks, K., Tinkler, P., Cooper, T., Emslie, M., 2012. Montara: 2011 shallow reef surveys at Ashmore, Cartier and Seringapatam reefs (Monitoring Study No. S6B Coral Reefs). Australian Institute of Marine Science, Townsville

Heyward, A., Case, M., Colquhoun, J., Depczynski, M., Fisher, R., Gilmour, J., Meekan, M., Radford, B., Rogers, S., Speed, C.W. and Suosaari, G., 2013. *Seringapatam Reef Baseline Surveys 2012-2013.* Report prepared by the Australian Institute of Marine Science for ConocoPhillips, Perth, Western Australia.

Heyward, A., Radford, B., Cappo, M., Wakeford, M., Fisher, R., Colquhoun, J., Case, M., Stowar, M. and Miller K., 2017. Barossa Environmental Baseline Study, Regional Shoals and Shelf Assessment 2015 Final Report. A report for ConocoPhillips Australia Exploration Pty Ltd by the Australian Institute of Marine Science, Perth 2017

Huisman, J., 2004. Marine benthic flora of the Dampier Archipelago, Western Australia. pages 61–68 In: D.S. Jones (ed.) Marine Biodiversity of the Dampier Archipelago, Western Australia 1998–2002, Report of the Western Australian Museum, 2004, 401 pp., Western Australian Museum, Perth

Huisman JM, Leliaert F, Verbruggen H, Townsend RA 2009. Marine Benthic Plants of Western Australia's Shelf Edge Atolls. Records of the Western Australian Museum Supplement No. 77: 50–87

Huisman, J.M., Dixon, R.R.M., Townsend, R.A. and Belton, G.S., 2021. Diversity and distribution of marine benthic algae and seagrasses in the tropical Kimberley, Western Australia. Records of the Western Australian Museum Supplement. 85,185-200.

[IMCRATG] Interim Marine and Coastal Regionalisation for Australia Technical Group. (1998). Interim Marine and Coastal Regionalisation for Australia: an ecosystem-based classification for marine and coastal environments. Version 3.3. Environment Australia, Commonwealth Department of the Environment. Canberra.

INPEX, 2008. Presentation at the Northern Development Taskforce Site Evaluation Workshop. Broome, WA, 24 July 2008

Lanyon, J.M. & Marsh, H., 1995. Temporal changes in the abundance of some tropical intertidal seagrasses in North Queensland. Aquatic Botany 49:217–237

Last, P., Lyne, V., Yearsley, G., Gledhill, D., Gomon, M., Rees, T. & White, W., (2005) Validation of National Demersal Fish Datasets for the Regionalisation of the Australian Continental Slope and Outer Shelf (>40 m depth), Department of Environment and Heritage and CSIRO Marine

LEC, Astron, 1993. Griffin Gas Pipeline Development Consultative Environmental Review. Prepared for BHP Petroleum and Doral Resources by LeProvost Environmental Consultants and Astron Engineering, Perth, Western Australia

Marsh, L.M., 1993. Cnidaria, other than reef-building corals of Ashmore Reef and Cartier Island. In Marine and Faunal Surveys of Ashmore Reef and Cartier Island North-western Australia. Edited by P.F. Berry. Western Australian Museum, Perth, Western Australia. pp. 21–23.Masini R, Sim C, Simpson C 2009. Protecting the Kimberley: a synthesis of scientific knowledge to support conservation management in the Kimberley region of Western Australia, Part A. Department of Environment and Conservation, Perth, Western Australia

Mellbrand, K., Lavery, P.S., Hyndes, G. and Hamback, P.A., 2011. Linking Land and Sea: Different Pathways for Marine Subsidies. Ecosystems 14, 732–744. https://doi.org/10.1007/s10021-011-9442-x

NT Government, 2011. Cobourg Marine Park Plan of Management (expired). Cobourg Peninsula Sanctuary and Marine Park Board and Parks and Wildlife Service of the Northern Territory, Department of Natural Resources, Environment, The Arts and Sport. Available from: https://depws.nt.gov.au/__data/assets/pdf_file/0006/249045/Cobourg-Marine-Park.pdf, accessed April 2023

Orr, M., Zimmer, M., Jelinski, D.E., & Mews, M., 2005. Wrack deposition on different beach types: spatial and temporal variation in the pattern of subsidy. Ecology 86(6), 2005, pp. 1496–1507

Pezner, A.K., Courtney, T.A., Barkley, H.C., Chou, W., Chu, H., Clements, S.M., Cyronak, T., DeGrandpre, M.D., Kekuewa, S.A.H. ,Kline, D.I., Liang, Y., Martz, T.R., Mitarai, S., Page, H.N., Rintoul, M.S., Smith, J.E., Soong, K., Takeshita, Y., Tresguerres, Wei, Y., Yates, K.K. and Andersson, A.J., 2023. Increasing hypoxia on global coral reefs under ocean warming. *Nat. Clim. Chang.* **13**, 403–409. https://doi.org/10.1038/s41558-023-01619-2

Pike, G. & Leach, G.J., 1997. Handbook of Vascular Plants of Ashmore and Cartier Islands. Parks and Wildlife Commission of the Northern Territory and Parks Australia, Canberra, Australian Capital Territory

Pratchett, M.S., Munday, P., Wilson, S.K., Graham, N.A., Cinner, J.E., Bellwood, D.R., Jones, G.P., Polunin, & McClanahan, T.R., 2008. Effects of climate-induced coral bleaching on coral-reef fishes. Ecological and economic consequences. Oceanography and Marine Biology: Annual Review 46: 251-296

Przeslawski, R., Daniell, J., Anderson, T., Barrie, J.V., Battershill, C., Heap, A., Hughes, M., Li, J., Potter, A., Radke, R., Siwabessy, J., Tran, M, Whiteway, T. & Nichol, S. (2011). Seabed Habitats and Hazards of the Joseph Bonaparte Gulf and Timor Sea, Northern Australia. Geoscience Australia, record 2011/40. Geoscience Australia, Canberra, Australian Capital Territory

Richards ZT, Bryce M, Bryce C (2013) New records of atypical coral reef habitat in the Kimberley, Australia. Journal of Marine Biology 2013, 363894

Richardson AJ, Eriksen RS & Rochester W (2015). Plankton 2015: state of Australia's oceans, CSIRO, Hobart.

Rio Tinto, 2009. Cape Lambert port B Development. Public Environmental Review and Draft Public Environmental Review, 2009

RPS Environmental 2008. INPEX environmental impact assessment studies – Technical appendix: Marine Ecology. Prepared for INPEX Browse LTD by RPS Environmental, Perth, Western Australia

Russell BC, Hanley JR 1993. History and Development. In: Survey of the Marine Biological and Heritage Resources of Cartier and Hibernia Reefs, Timor Sea. Northern Territory Museum of Arts and Sciences, Darwin

Seagrass-Watch 2019. Kimberley Region. Available at http://www.seagrasswatch.org/WA.html [Accessed December 2019]

Skewes, T., Dennis, D., Jacobs, D., Gordon, S., Taranto, T., Haywood, M., Pitcher, C., Smith, G., Milton, D., Poiner, I., 1999a. Survey and Stock Size Estimates of the Shallow Reef (0-15 M Deep) and Shoal Area (15-50 M Deep) Marine Resources and Habitat Mapping Within the Timor Sea MOU74 Box. Volume 1: Stock Estimates and Stock Status. CSIRO Marine Research, Hobart

Skewes, T., Gordon, S., McLeod, I., Taranto, T., Dennis, D., Jacobs, D., Pitcher, C., Haywood, M., Smith, G., Poiner, I., Milton, D., Griffin, D., Hunter, C., 1999b. Survey and Stock Size Estimates of the Shallow Reef (0-15 m Deep) and Shoal Area (15-50 m Deep) Marine Resources and Habitat Mapping within the Timor Sea MOU74 Box. Volume 2: Habitat Mapping and Coral Dieback. CSIRO Marine Research, Hobart.

[SKM] Sinclair Knight Merz, 2009. Browse Kimberley LNG DFS#10 – Intertidal Survey. Prepared for Woodside Energy Limited by Sinclair Knight Merz Pty Ltd, Perth, Western Australia

Smit, N., Billyard R. and Ferns L. (2000). Beagle Gulf Benthic Survey: Characterisation of Soft Substrates. Parks and Wildlife Commission of the NT, Parks and Wildlife Commission of the NT

Trebilco R, Fischer M, Hunter C, Hobday AJ, Thomas L, Evans K (2021). Marine: Marine ecosystem processes. In: Australia State of the environment 2021, Australian Government Department of Agriculture, Water and the Environment, Canberra, https://soe.dcceew.gov.au/marine/environment/marine-ecosystem-processes, DOI: 10.26194/nvaa-rf92

Udyawer, V., Radford, B., Galaiduk, R., Brinkman, R., and Streten, C. (2021). Chapter 5. Predictive modelling of Darwin Harbour's benthic community. Pp 43-70 In: Streten, C. (editor). Revised predic□ve benthic habitat map for Darwin Harbour. Report prepared for Department of Environment, Parks and Water Security. Australian Institute of Marine Science [AIMS], Darwin, 127 pp.

URS, 2006. Report on Environmental Surveys Undertaken at Scott Reef in February 2006. Prepared for Woodside Energy Limited by URS Australia Pty Ltd, Perth, Western Australia

URS, 2009. Report Annual Marine Monitoring – Macroalgae. Prepared for Apache Energy Ltd by URS Australia Pty Ltd, Perth, Western Australia, August 2009

URS, 2010a. Ichthys Gas Field Development Project Studies of the Offshore Marine Environment. Prepared for INPEX Browse Ltd, Perth Western Australia, INPEX Document No. C036-AH-REP-0023

van Keulen M, Langdon MW 2011. Ningaloo Collaboration Cluster: Biodiversity and ecology of the Ningaloo Reef lagoon. Ningaloo Collaboration Cluster Final Report No. 1c

Vergès A., Vanderklift M. Doropoulos C. and Hyndes G. 2011. Spatial Patterns in Herbivoury on a Coral Reff Are Influenced by Structural Complexity but not by Algal Traits. PloS one. 6. e17115. 10.1371/journal.pone.0017115.

Veron, J.E.N., 1993. Hermatypic corals of Ashmore Reef and Cartier Island. In: Marine Faunal Surveys of Ashmore Reef and Cartier Island, North-western Australia, ed. P.F. Berry. Western Australian Museum, Perth

Walker DI 1989. Seagrass in Shark Bay – the foundations of an ecosystem. In: Seagrasses: A Treatise on the Biology of Seagrass with Special Reference to the Australian Region, eds A W D Larkum, A J McComb, S A Shepherd, Elsevier, Amsterdam, pp.182-210

Walker, D.I., 1995. Seagrasses and macroalgae. In FE Wells, R Hanley and DI Walker (Eds) Marine Biological Survey of the Southern Kimberley, Western Australia. Western Australian Museum, Perth, Western Australia

Walker, D.I., Wells FE & Hanley R 1996. Survey of the marine biota of the eastern Kimberley, Western Australia. University of Western Australia, Western Australian Museum and the Museum and Art Gallery of the Northern Territory

Walker, D.I., 1997. Marine Biological survey of the central Kimberley coast, Western Australia. University of Western Australia, Perth, Western Australia

Walker, D.I. & Prince, R.I.T., 1987. Distribution and biogeography of seagrass species on the northwest coast of Australia. Aquatic Botany 29:19–32

Waples K & Hollander E 2008. Ningaloo Research Progress Report: Discovering Ningaloo – latest findings and their implications for management. Ningaloo Research Coordinating Committee, Department of Environment and Conservation, WA

[WAM] Western Australian Museum, 2009. A Marine Biological Survey of Mermaid Reef (Rowley Shoals), Scott and Seringapatam Reefs, Western Australia 2006. Edited by C Bryce. Records of the Western Australian Museum Supplement 77.

Whiting S 1999. Use of the remote Sahul Banks, North-western Australia, by dugongs, including breeding females. Marine Mammal Science 15: 609–615

Williams A, Dunstan P, Althaus F, Barker B, McEnnulty F, Gowlett-Holmes K & Keith G (2010) Characterising the seabed biodiversity and habitats of the deep continental shelf and upper slope off the Kimberley coast, NW Australia. Report produced for Woodside Energy Ltd. CSIRO, pp. 95

Wilson, D.F., 2005. Arafura Sea Biological Survey Report on RV Southern Surveyor Expedition 05/2005., A National Oceans Office, Australian Museum and CSIRO project, Hobart.

Woodside, 2011. Browse LNG Development Draft Upstream Environmental Impact Statement. EPBC Referral 2008/4111. Woodside Energy Ltd, Perth, Western Australia, November 2011

Woodside Energy Limited, Australian Institute of Marine Science, Western Australian Museum 2010. Scott Reef Status Report 2010.

16.3. Shoreline and Intertidal Habitats

Alongi, D.M., 2002. Present state and future of the world's mangrove forests. Environmental Conservation 29, 331–349. doi:10.1017/S0376892902000231

Alongi, D.M., 2009. The Energetics of Mangrove Forests. Springer.

Ayukai, T., 1998. Introduction: carbon fixation and storage in mangroves and their relevance to the global climate change – a case study in Hinchinbrook Channel in North-eastern Australia. Mangroves and Salt Marshes V2 No 4, Kluwer Academic Publishers.

Chatto, R. and Baker, B., 2008. The Distribution and Status of Marine Turtle Nesting in the Northern Territory, Technical Report 77. Parks and Wildlife Commissiong of the Northern Territory, Darwin, Northern Territory.

Cresswell, I. and Semeniuk, V., 2011. Mangroves of the Kimberley coast: ecological patterns in a tropical ria coast setting. Journal of the Royal Society of Western Australia 94, 213–237.

ConocoPhillips, 2020. Barossa Gas Export Pipeline Installation Environment Plan. ConocoPhillips, Western Australia.

[DEWHA] Department of the Environment, Water, Heritage and the Arts 2008. The North Marine Bioregional Plan Bioregional profile: A Description of the Ecosystems, Conservation Values and Uses of the North Marine Region. Department of the Environment, Water, Heritage and the Arts, Canberra, Australian Capital Territory

[DPAW] 2013. Lalang-garram/ Camden Sound Marine Park Management Plan 73 2013–2023. Department of Parks and Wildlife, Perth, Western Australia

Duke, N.C., Ball, M.C., Ellison, J.C., 1998. Factors influencing biodiversity and distributional gradients in mangroves. Global Ecology and Biogeography Letters 7, 27–47.

Duke, N., Wood, A., Hunnam, K., Mackenzie, J., Haller, A., Christiansen, N., Zahmel, K. and Green, T., 2010. Shoreline ecological assessment aerial and ground surveys 7-19 November 2009.

Garnet S.T. and Crowley, G.M., 2000. The action plan for Australian birds 2000. Environment Australia, Canberra.

Gibson, L. and Wellbelove, A., 2010. Protecting critical marine habitats: The key to conserving our threatened marine species: a Humane Society International and WWF-Australia Report.

Hanley, J.R. and Morrison, P.F., 2012. A Guide to the intertidal flora and fauna of the Point Samson Fish Reserve. Sinclair Knight Merz and Rio Tinto Australia Pty Ltd.

Johnstone, R., 1984. Intergradation between Lemon-breasted Flycatcher *Microeca flavigaster* Gould and Brown-tailed Flycatcher *Microeca tormenti* Mathews in Cambridge Gulf, Western Australia. Records of the Western Australian Museum 11, 291–295.

Jones, D.S., 2004. Marine biodiversity of the Dampier Archipelago Western Australia 1998-2002.

Kathiresan, K., Bingham, B.L., 2001. Biology of mangroves and mangrove ecosystems. Advances in marine biology 40, 81–251.

Kenyon, R., Loneragan, N., Manson, F., Vance, D. and Venables, W., 2004. Allopatric distribution of juvenile red-legged banana prawns (*Penaeus indicus* H. Milne Edwards, 1837) and juvenile white banana prawns (*Penaeus merguiensis* De Man, 1888), and inferred extensive migration, in the Joseph Bonaparte Gulf, northwest Australia. Journal of Experimental Marine Biology and Ecology 309, 79–108.

Masini. R., Sim, C. and Simpson, C., 2009. Protecting the Kimberley: A synthesis of scientific knowledge to support conservation management in the Kimberley region of Western Australia.

Nagelkerken I, van der Velde G, Gorissen MW, Meijer GJ, Van't Hof T, den Hartog C, 2000. Importance of Mangroves, Seagrass Beds and the Shallow Coral Reef as a Nursery for Important Coral Reef Fishes, Using a Visual Census Technique. Estuarine, Coastal and Shelf Science 51, 31–44. doi:10.1006/ecss.2000.0617

NOAA, 2010. Oil Spills in Mangroves, Planning and Response. National Oceanic and Atmospheric Administration. US Department of Commerce, Office of Response and Restoration.

Pedretti, Y.M. and Paling, E.I., 2001. WA Mangrove Assessment Project 1999-2000. Marine and Freshwater Research Laboratory, Murdoch University, Perth, Western Australia.

Robertson, A.I., 1988. Decomposition of mangrove leaf litter in tropical Australia. Journal of Experimental Marine Biology and Ecology 116, 235–247. doi:10.1016/0022-0981(88)90029-9

Robson BJ, Burford M, Gehrke P, Revill A, Webster I, Palmer D (2008) Response of the lower Ord River and estuary to changes in flow and sediment and nutrient loads (Water for a Healthy Country Flagship Report). CSIRO.

[SKM] Sinclair Knight Merz, 2009. Browse Kimberley LNG DFS#10 – Intertidal Survey. Prepared for Woodside Energy Limited by Sinclair Knight Merz Pty Ltd, Perth, Western Australia

[SKM] Sinclair Knight Merz, 2011. *Port Headland Outer Harbour Development. Benthic Primary Producer Assessment: Intertidal.* Appendix 13, Port Headland Outer Harbour Development Project Referral to the EPA. Report prepared for BHP Billiton, October 2011.

Semeniuk V (1993) The mangrove systems of Western Australia: 1993 Presidential Address. Journal of the Royal Society of Western Australia 76:99-122.

URS, 2010. Ichthys Gas Field Development Project Studies of the Offshore Marine Environment. Prepared for INPEX Browse Ltd, Perth Western Australia, INPEX Document No. C036-AH-REP-0023

Wade, S. and Hickey, R., 2008. Mapping Migratory Wading Bird Feeding Habitats using Satellite Imagery and Field Data, Eighty-Mile Beach, Western Australia. Journal of Coastal Research 243, 759–770. doi:10.2112/05-0453.1

Wildsmith, M.D., Potter, I.C., Valesini, F.J. and Platell, M.E., 2005. Do the assemblages of benthic Macroinvertebrates in nearshore waters of Western Australia vary among habitat types, zones and seasons? Journal of Marine Biology 85: 217-232.

Wilson, B., 1994. A representative Marine Reserve System for Western Australia.

Wilson, B., 2013. The Biogeography of the Australian North West Shelf: Environmental Change and Life's Response. Elsevier.

Zell, L., 2007. Kimberley Coast. Wild Discovery.

16.4. Fish and Sharks

Allen, J., C. Gosden, R. Jones, and J.P. White, 1988. Pleistocene dates for human occupation of New Ireland, northern Melanesia. Nature 331 :707-9.

Allen, GR. 1989. Fishes. In Survey of the Marine Fauna of Cocos (Keeling) Islands, Indian Ocean. (Ed. P.F. Berry). (Western Australian Museum: Perth, Western Australia).

[BBG] Bowman Bishaw Gorham, 1994. Dampier Port Authority, Environmental Management Plan. Report prepared by Bowman Bishaw Gorham Perth, for the Dampier Port Authority, Dampier.

Borrell A, Aguilar A, Gazo M, Kumarran RP, Cardona L 2011. Stable isotope profiles in whale shark (Rhincodon typus) suggest segregation and dissimilarities in the diet depending on sex and size. Environmental Biology of Fishes, 92: 559-567.

Brewer DT, Lyne V, Skewes TD and Rothlisberg P 2007. Trophic Systems of the North West Marine Region. Prepared for the Department of the Environment, Water, Heritage and the Arts by CSIRO Marine and Atmospheric Research, Cleveland, Australia.

Cailliet, G.M. (1996). An Evaluation of Methodologies to Study the Population Biology of White Sharks. In: Klimley, A.P. & D.G. Ainley, eds. Great White Sharks The biology of Carcharodon carcharias. Page(s) 415-416. United States of America: Academic Press Limited.

Castro, J. I., Woodley, C. M. and Brudek, R. L. (1999). A preliminary evaluation of the status of shark species. FAO Fish. Tech. Paper., 380: 1-72.

Chen C-T, Liu K-M, Joung S-J (1997) Preliminary report on Taiwan's whale shark fishery. Traffic Bulletin, 17: 53-57.

Chidlow J, Gaughan D and McAuley RB (2006) Identification of Western Australian Grey Nurse Shark aggregation sites. Final report to the Australian Government, Department of the Environment and Heritage. Fisheries research report No. 155. Department of Fisheries, Western Australia, 48p.

[CITES] Convention on International Trade in Endangered Species, 2004. Convention of International Trade in Endangered Species of Wild Fauna and Flora - Appendix II Listing of the White Shark (revision 1). Available from: https://www.environment.gov.au/system/files/resources/2a4abfb5-236c-43bf-ad9d-b6d29c507f04/files/great-white-cites-appendix2-english.pdf [accessed February 2020].

Clark, E and Nelson, D., 1997. Young whale sharks, *Rhincodon typus*, feeding on a copepod bloom near La Paz, Mexico. Environmental Biology of Fishes. 50. 63-73. 10.1023/A:1007312310127.

Commonwealth of Australia, 2015. Sawfish and River Sharks Multispecies Recovery Plan. Available from: http://www.environment.gov.au/system/files/resources/062794ac-ef99-4fc8-8c18-6c3cd5f6fca2/files/sawfish-river-sharks-multispecies-recovery-plan.pdf. [Accessed 24 February 2020].

Compagno, L.J.V. & Last, P.R., 1999. Order Pristiformes. Pristidae: sawfishes, in KE Carpenter & VH Niem (eds), FAO species identification guide for fishery purposes – the living marine resources of the western central Pacific, vol. 3, Batoid fishes, chimaeras and bony fishes, part 1 (*Elopidae* to *Linophyroidae*), FAO, Rome, pp. 1410–1417.

Compagno, L.J., 2001. Sharks of the World: An Annotated and Illustrated Catalogue of Shark Species Known to Date. Vol. 2, Bullhead, Mackerel and Carpet Sharks (Heterodontiformes, Lamniformes and Orectolobiformes) (Vol. 2, No. 1). Food & Agriculture Org.

Compagno L.J.V., Cook, S.F., Oetinger, M.I. and Fowler, S.L., 2006. *Anoxypristis cuspidata*. In: 2011 IUCN Red List of Threatened Species. Version 2011.2. www.iucnredlist.org. on 30 January 2012.

Couturier, LIE, Rohner, CA, Richardson, AJ, Pierce, SJ, Marshall, AD, Jaine, FRA, Townsend, KA, Bennett, MB, Weeks, SJ, & Nichols, PD., 2013. Unusually high levels of n-6 polyunsaturated fatty acids in whale sharks and reef manta rays. *Lipids,* 48(10):1029-1034.

[DBCA] Department of Biodiversity, Conservation and Attractions, 2014. Eighty Mile Beach Marine Park Management Plan 2014-2024. https://maps.northwestatlas.org/files/montara/links_to_plans/WA/1.%20EIGHTY_MILE_BEACH_MGT_PLAN_V12%20Ngarla-Nyanguarta-Karajarri.pdf

[DCCEEW] Department of Climate Change, Energy, the Environment and Water, 2024. Listing Advice for *Sphyrna lewini* (scalloped hammerhead). https://www.environment.gov.au/biodiversity/threatened/species/pubs/85267-listing-advice-27022024.pdf

[DEH] Department of the Environment and Heritage, 2006. A Guide to the Integrated Marine and Coastal Regionalisation of Australia Version 4.0. Department of the Environment and Heritage, Canberra, Australia.

[DEWHA] Department of the Environment, Water, Heritage and the Arts (2008a) The north-west marine region bioregional profile: a description of the ecosystems, conservation values and uses of the north-west marine region, Australian Government Department of the Environment, Water, Heritage and the Arts (DEWHA), Canberra.

[DEWHA] Department of the Environment, Water, Heritage and the Arts 2008c. The North Marine Bioregional Plan: Bioregional profile: A Description of the Ecosystems, Conservation Values and Uses of the North Marine Region. Department of the Environment Water, Heritage and the Arts, Canberra, Australian Capital Territory

[DEWHA] Department of the Environment, Water, Heritage and the Arts (2009) DEWHA Fact Sheet – Three sharks listed as migratory species under the EPBC Act. Department of the Environment, Water, Heritage and the Arts, Canberra, Australia.

[DEWHA] Department of the Environment, Water, Heritage and the Arts (2012a) Species group report card – bony fishes. Supporting the marine bioregional plan for the North-west Marine Region. Australian Government Department of the Environment, Water, Heritage and the Arts (DEWHA), Canberra.

[DEWHA] Department of the Environment, Water, Heritage and the Arts (2012b) Species group report card – sharks and saw fishes. Supporting the marine bioregional plan for the North-west Marine Region. Australian Government Department of the Environment, Water, Heritage and the Arts (DEWHA), Canberra.

DoE (2014) Aipysurus foliosquama in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id= 1118. Accessed 23 July 2014

DoE (Department of Environment) (2014a) World Heritage Places - The Ningaloo Coast Western Australia. Available at: http://www.environment.gov.au/node/19787 [Accessed April 2014]

[DoE] Department of the Environment, 2014b. *Pristis clavata* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed 18 Mar 2014

[DoE] Department of the Environment, 2014c. *Pristis pristis* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed 25 Mar 2014

[DoE] Department of the Environment, 2014c. *Pristis zijsron* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed 25 Mar 2014

[DoE] Department of the Environment, 2015. Approved Conservation Advice *Rhincodon typus* (whale shark). Threatened Species Scientific Committee, Department of the Environment, Canberra, Australian Capital Territory

[DoEE] Department of Energy and the Environment, 2015. 'Sawfish and River Sharks Multispecies Recovery Plan, Commonwealth of Australia 2015.

[DSEWPaC] Department of Sustainability, Environment, Water, Population and Communities, 2012. Marine Bioregional Plan for the North-west Marine Region. Prepared under the Environment Protection and Biodiversity Conservation Act 1999. Department of Sustainability, Environment, Water, Population and Communities, Canberra, Australian Capital Territory

Eckert, S.A, and Stewart, B. S., 2001. Telemetry and satellite tracking of whale sharks, *Rhincodon typus*, in the sea of Cortez, Mexico, and the north Pacific Ocean. Environmental Biology of Fishes 60: 299-308.

Fletcher, WJ. and Santoro, K. 2013. Status Reports of the Fisheries and Aquatic Resources of Western Australia 2012/13(eds). The State of the Fisheries. Department of Fisheries, Western Australia.

Fourmanoir, P., 1961. Requins de la Côte Ouest de Madagascar. Memoires de L'Institut Scientifique de Madagascar. Série F. Oceanographie. ORSTOM. Tome IV.

Fox, N.J. and Beckley, L.E., 2005. Priority areas for conservation of Western Australian coastal fishes: A comparison of hotspot, biogeographical and complementarity approaches. Biological Conservation, 125: 399-410.

Gaughan, D.J., Molony, B. and Santoro, K. (eds). 2019. Status Reports of the Fisheries and Aquatic Resources of Western Australia 2017/18: The State of the Fisheries. Department of Primary Industries and Regional Development, Western Australia.

Gelsleichter J, Musick, J.A. & Nichols, S., 1999. Food habits of the smooth dogfish, *Mustelus canis*, dusky shark, *Carcharhinus obscurus*, Atlantic sharpnose shark, *Rhizoprionodon terraenovae*, and the sand tiger, *Carcharias taurus*, from the northwest Atlantic Ocean, Environmental Biology of Fishes, vol. 54, pp. 205–217.

Heyman, W. D., Graham, R. T., Kjerfve, B. & Johannes, R. E. 2001. Whale sharks, *Rhincodon typus*, aggregate to feed on fish spawn in Belize. *Marine Ecology Progress Series* 215, 275–282.

IUCN 2019. The IUCN Red List of Threatened Species. Version 2019-3. http://www.iucnredlist.org. Accessed 16 December 2019.

Kospartov, M., Beger, M., Ceccarelli, D., and Richards, Z., 2006. An assessment of the distribution and abundance of sea cucumbers, trochus, giant clams, coral, fish and invasive marine species at Ashmore Reef National Nature Reserve and Cartier Island Marine Reserve: 2005. Report prepared by UniQuest Pty Ltd for the Department of the Environment and Heritage, Canberra, ACT.

Last, P., Lyne, V., Yearsley, G., Gledhill, D., Gomon, M., Rees, T. and White, W., 2005. Validation of national demersal fish datasets for the regionalisation of the Australian continental slope and outer shelf (>40 m depth). Department of Environment and Heritage and CSIRO Marine Research, Australia. 99pp

Last, P.R., & Stevens J.D., 2009. Sharks and rays of Australia, 2nd edn, CSIRO Publishing, Collingwood.

Marcus, L., Virtue, P, Pethybridge, HR,. Meekan, MG, Thums, M & Nichols, PD. (2016).Intraspecific Variability in Diet and Implied Foraging Ranges of Whale Sharks at Ningaloo Reef, Western Australia, from Signature Fatty Acid Analysis. Marine Ecology Progress Series554: 115–28

McAuley, R. 2004. Western Australian Grey Nurse Shark Pop Up Archival Tag Project. Final Report to Department of Environment and Heritage. Page(s) 55.

Meekan MG, Jarman SN, McLean C, Schultz MB (2009) DNA evidence of whale sharks (*Rhincodon typus*) feeding on red crab (*Gecarcoidea natalis*) larvae at Christmas Island, Australia. Marine and Freshwater Research 60: 607-609

Meekan, M.G., Virtue, P., Marcus, L., Clements, K.D., Nichols, P.D. & Revill, A.T., 2022. The world's largest omnivore is a fish. *Ecology* (Durham) e3818.

Meenakshisundaram, A., Thomas, L., Kennington, W. J., Thums, M., Lester, E. and Meekan, M. 2021.Genetic markers validate photo-identification and uniqueness of spot patterns in whale sharks. *Marine Ecology Progress Series*, 668:177– 183.

Newman, S.J., Wise, B.S., Santoro, K.G. and Gaughan, D.J. (eds). 2023. Status Reports of the Fisheries and Aquatic Resources of Western Australia 2021/22: The State of the Fisheries. Department of Primary Industries and Regional Development, Western Australia.

Norman, B (2005) *Rhincodon typus*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. <www.iucnredlist.org>. Accessed 31 May 2013.

Otway, N.M., & Parker, P.C., 2000. The Biology, Ecology, Distribution, Abundance and Identification of Marine Protected Areas for the Conservation of Threatened Grey Nurse Sharks in South-east Australian Waters. NSW Fisheries Office of Conservation.

Peverell, S.C., 2005. Distribution of sawfishes (Pristidae) in the Queensland Gulf of Carpentaria, Australia, with notes on sawfish ecology, Environmental Biology of Fishes, vol. 73, pp. 391–402.

Peverell, S.C., 2007. Dwarf Sawfish *Pristis clavata*. Marine Education Society of Australasia. Available at: http://www.mesa.edu.au/seaweek2008/info_sheet05.pdf

Pierce, SJ., Pardo, SA., Rohner, CA., Matsumoto, R., Murakumo, K., Nozu, R. & Meekan, M.G., 2021. Whale Shark Reproduction, Growth, and Demography. Whale Sharks: Biology, Ecology, and Conservation.

Pogonoski, J.J., Pollard, D.A. & Paxton, J.R., 2002. Conservation Overview and Action Plan for Australian Threatened and Potentially Threatened Marine and Estuarine Fishes. [Online]. Canberra, ACT: Environment Australia. Available from: https://www.environment.gov.au/system/files/resources/ca415225-5626-461c-a929-84744e80ee36/files/marine-fish.pdf [Accessed February 2020].

Pollard, D.A., Lincoln-Smith, M.P. & Smith, A.K., 1996. The biology and conservation of the grey nurse shark (*Carcharias taurus* Rafinesque 1810) in New South Wales, Australia. Aquatic Conservation: Marine and Freshwater Ecosystems. 6.

Rowat, D. & Brooks, K.S., 2012. A Review of the Biology, Fisheries and Conservation of the Whale Shark Rhincodon Typus. *Journal of fish biology*, 80(5).

Russell, B., Larson, H., Hutchins, J., and Allen, G.R., 2005. Reef Fishes of the Sahul Shelf. In Understanding the Cultural and Natural Heritage Values and Management Challenges of the Ashmore Region, Proceedings of a Symposium organised by the Australian Marine Sciences Association and the Museum and Art Gallery of the Northern Territory, Darwin, 4-6 April 2001. Edited by B. Russell, H. Larson, C.J. Glasby, R.C. Willan, and J. Martin. Museum and Art Galleries of the Northern Territory & Australian Marine Sciences Association, Darwin, Northern Territory. pp. 83–105.

Smale, M.J., 2005. The diet of the ragged-tooth shark *Carcharias taurus* Rafinesque 1810 in the Eastern Cape, South Africa, African Journal of Marine Science, vol. 27, pp. 331–335.

Stevens, J.D., Pillans, R.D. and Salini, J., 2005. Conservation Assessment of *Glyphis sp.* A (Speartooth Shark), *Glyphis sp.* C (Northern River Shark), *Pristis microdon* (Freshwater Sawfish) and *Pristis zijsron* (Green Sawfish). [Online]. Hobart, Tasmania: CSIRO Marine Research. Available from: https://www.environment.gov.au/system/files/resources/d1696b5b-6a2e-4920-a3e2-16e5a272349a/files/assessment-glyphis.pdf [Accessed February 2020].

Stevens JD, McAuley RB, Simpfendorfer CA & Pillans RD (2008) Spatial distribution and habitat utilisation of sawfish (Pristis spp) in relation to fishing in northern Australia, report to the Australian Government Department of Environment and Heritage, Canberra.

Thorburn, DC, Morgan, DL, Rowland, AJ & Gill HS (2004) The northern river shark (*Glyphis sp*. C) in Western Australia, Report to the National Trust

Thorburn DC, DL Morgan, AJ Rowland & HS Gill (2007) Freshwater sawfish *Pristis microdon* Latham, 1794 (Chondrichthyes: Pristidae) in the Kimberley region of Western Australia. *Zootaxa*. 1471:27-41.

Thorburn, DC, Morgan, DL, Rowland, AJ, Gill, HS & Paling, E (2008) Life history notes of the critically endangered dwarf sawfish, *Pristis clavata*, Garman 1906 from the Kimberley region of Western Australia', Environmental Biology of Fishes, vol. 83, pp. 139–145

Tyminski, John P et al. (2015). Vertical Movements and Patterns in Diving Behavior of Whale Sharks as Revealed by Pop-Up Satellite Tags in the Eastern Gulf of Mexico: *PloS one*, 10(11).

Wilson, S Polovina, J Stewart, B & Meekan, M (2006) Movements of whale sharks (*Rhincodon typus*) tagged at Ningaloo Reef. Marine Biology, vol. 147, pp. 1157-1166.

Womersley, Freya C et al. (2022) Global Collision-Risk Hotspots of Marine Traffic and the World's Largest Fish, the Whale Shark. Proceedings of the National Academy of Sciences, 119(20).

16.5. Marine Reptiles

[AIMS] Australian Institute of Marine Science, 2021. Hawksbill and green turtle distribution and important areas. As part of the Northwest Shores to Shoals Research Program, supported by Santos. Available at: https://northwestatlas.org/nwa/nws2s-megafauna#green_bia

Baldwin, R., Hughes, G.R. and Prince, R.I.T., 2003. Loggerhead turtles in the Indian Ocean. In: AB Bolten and BE Witherington (eds) Loggerhead Sea Turtles, Smithsonian Books, Washington.

Brewer, D.T., Potter, A., Skewes, T.D, Lyne, V., Andersen, J., Davies, C., Taranto, T. Heap, A. D., Murphy, N. E., Rochester, W. A., Fuller, M., Donovan, A., 2009. Conservation values in Commonwealth waters of the Christmas and Cocos (Keeling) Islands remote Australian Territories. Report to Department of Environment and Water Resources. CSIRO, Cleveland. 216

CALM, MPRA, 2005a. Management Plan for the Ningaloo Marine Park and Muiron Islands Marine Management Area 2005–2015. Management Plan No. 52. Department of Conservation and Land Management and Marine Parks and Reserves Authority, Perth, Western Australia

Chaloupka, M. and Prince, R.I.T., 2012. Estimating demographic parameters for a critically endangered marine species with frequent reproductive omission: Hawksbill turtles nesting at Varanus Island, Western Australia. Marine Biology 159(2): 355-363.

Chatto, R., 1997. Marine turtles in the Northern Territory: a brief overview of nesting. **In:** Noor, Y. R., I. R. Lubis, R. Ounsted, S. Troeng, & A. Abdullah, eds. *Proceedings of the Workshop on Marine Turtle Research and Management in Indonesia*. Bogor, Wetlands International /PHPA/ Env. Aust.

Chatto, R., 1998. A preliminary overview of the locations of marine turtle nesting in the Northern Territory. **In:** Kennett, R., A. Webb, G. Duff, M. Guinea & G. Hill, eds. *Proceedings of a Workshop held at the Northern Territory University, 3-4 June 1997*. Centres for Indigineous Natural Culture Resource Management/Tropical Wetland Management. Darwin, Northern Territory University.

Chatto, Ray & Baker, Bryan., 2008. The distribution and status of marine turtle nesting in the Northern Territory. Chevron (2005) Environmental Impact Statement/Environmental Review and Management Programme for the proposed Gorgon Development. Chevron Australia Pty Ltd, Perth, Western Australia.

Chevron (2008) Gorgon Gas Development Revised and Expanded Proposal Public Environmental Review Operated by Chevron Australia in joint venture with Gorgon Project. EPBC Referral 2008/4178Assessment No. 1727. Chevron Australia Pty Ltd, Perth, Western Australia, September 2008.

Cogger, H.G. (1975). Sea snakes of Australia and New Guinea. **In:** Dunson, W.A., ed. *The Biology of Sea Snakes*. Page(s) 59-139. Baltimore: University Park Press

Cogger HG (2000) Reptiles and Amphibians of Australia - 6th edition. Sydney, NSW: Reed New Holland

Commonwealth of Australia (2017a), Recovery Plan for Marine Turtles in Australia 2017 – 2027.

D'Anastasi, B. R., van Herwerden, L, Hobbs, J. A., Simpfendorfer, C. A. and Lukoschek, V. (2016) Habitat and behavioural associations of Aipysurus group sea snakes in Western Australia. Interim report to Marine Species Conservation, Department of the Environment, Australian Government. DCCEEW, 2023a

[DoE] Department of the Environment, 2014. *Aipysurus foliosquama* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1118. Accessed 23 July 2014

[DoEE] Department of the Environment and Energy, 2017. Recovery Plan for Marine Turtles in Australia. Available at: http://www.environment.gov.au/system/files/resources/46eedcfc-204b-43de-99c5-4d6f6e72704f/files/recovery-plan-marine-turtles-2017.pdf.

[DoEE] Department of Energy and the Environment, 2019. Species Profile and Threats Database [Online] Department of Environment and Energy Canberra, Commonwealth of Australia Available from: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl

[DSEWPaC] Department of Sustainability, Environment, Water, Population and Communities, 2012a. *Eretmochelys imbricata* – Hawksbill Turtle. Available from: http://www.environment.gov.au/cgibin/sprat/public/publicspecies.pl?taxon_id=1766. Department of Sustainability, Environment, Water, Population and Communities.

[DSEWPaC] Department of Sustainability, Environment, Water, Population and Communities, 2012b. Marine bioregional plans. Department of Sustainability, Environment, Water, Population and Communities, Canberra, ACT. Available at http://www.environment.gov.au/marine/marine-bioregional-plans/about

[DSEWPaC] Department of Sustainability, Environment, Water, Population and Communities, 2012c. *Natator depressus* – Flatback Turtle. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=59257. Department of Sustainability, Environment, Water, Population and Communities.

[DSEWPaC] Department of Sustainability, Environment, Water, Population and Communities, 2012d. Species Group Report Card – Reptiles. Supporting the draft marine bioregional plan for the North-west Marine Region. Department of Sustainability, Environment, Water, Populations and Communities, Canberra, Australia.

Eckert, S. A., 2006. High-use oceanic areas for Atlantic leatherback sea turtles (*Dermochelys coriacea*) as identified using satellite telemetered location and dive information. *Marine Biology* 149: 1257–1267.

Ferreira, Luciana, C & Thums, Michele & Fossette, Sabrina & Wilson, Phillipa & Shimada, Takahiro & Tucker, Anton & Pendoley, Kellie & Waayers, Dave & Guinea, Michael & Loewenthal, Graham & King, Joanne & Speirs,

Marissa & Rob, Dani & Whiting, Scott. (2020). Multiple satellite tracking datasets inform green turtle conservation at a regional scale. Diversity and Distributions. 27. 249-266. 10.1111/ddi.13197.

Fossette, S, Ferreira, LC, Whiting, SD, Pendoley, JKK, Shimada, T, Speirs, M, Tucker, AD, Wilson, P & Thums, M. (2021). Movements and distribution of hawksbill turtles in the Eastern Indian Ocean. *Global Ecology and Conservation,* 29. e01713.

Fukuda, Y., P. Whitehead & G. Boggs (2007). Broad-scale environmental influences on the abundance of saltwater crocodiles (Crocodylus porosus). Australia. Wildlife Research. 34:167-176.

Guinea ML & SD Whiting (2005) Insights into the distribution and abundance of sea snakes at Ashmore Reef. The Beagle (Supplement 1). Page(s) 199-206

Guinea, M.L., 2007. Survey March 16 - April 2 2007: Sea snakes of Ashmore Reef, Hibernia Reef and Cartier Island with comments on Scott Reef. Final Report to the Department of the Environment and Water Resources, Canberra. Darwin: Charles Darwin University.

Guinea, M.L., 2009. Long Term Marine Turtle Monitoring at Scott Reef. Report prepared for Woodside Pty Ltd.

Heatwole H and Cogger HG (1993). *Family Hydrophiidae*, in: Glasby CG, Ross GJB and Beesley PL (eds) Fauna of Australia Volume 2A: Amphibia and Reptilia. AGPS Canberra. 439pp

Kendall WL and Bjorkland R., 2001. Using open robust design models to estimate temporary emigration from capture - recapture data. Biometrics: 57,1113 – 1122.

Limpus, C.J., 2007. A biological review of Australian marine turtle species. 5. Flatback turtle*, Natator depressus* (Garman). The State of Queensland. Environmental Protection Agency, Brisbane, Queensland.

Limpus, C.J., 2008a. A biological review of Australian marine turtle species. 2. Green turtle*, Chelonia mydas* (Linneaus). The State of Queensland. Environmental Protection Agency, Brisbane, Queensland.

Limpus, C.J., 2008b. A biological review of Australian marine turtle species. 1. Loggerhead turtle*, Caretta caretta* (Linneaus). The State of Queensland. Environmental Protection Agency, Brisbane, Queensland.

Limpus, C.J., 2009a. A biological review of Australian marine turtle species.3. Hawksbill turtle, *Eretmochelys imbricata* (Linneaus). The State of Queensland. Environmental Protection Agency, Brisbane, Queensland.

Limpus, C.J., 2009b. *A Biological Review of Australian Marine Turtles*, Queensland Environmental Protection Agency, Queensland.

Limpus, C.J., 2009c. A biological review of Australian marine turtle species. 6. Leatherback turtle, *(Dermochelys coriacea*). The State of Queensland. Environmental Protection Agency, Brisbane, Queensland.

Limpus, C.J. and McLachlin, N. 1994. The conservation status of the Leatherback Turtle, *Dermochelys coriacea*, in Australia. In: James R (ed.) Proceedings of the Australian Marine Turtle Conservation Workshop, Gold Coast 14-17 November 1990. pp. 63-67. Queensland Department of Environment and Heritage. Canberra: ANCA.

Limpus, C. and N. Nicholls, 1994. Progress report on the study of the interaction of the El Nino Southern Oscillation on annual Chelonia mydas numbers at the Southern Great Barrier Reef rookeries. Australian Marine Turtle Conservation Workshop. Queensland Dept of Environment and Heritage Australian Nature Conservation Agency, Sea World, Nara Resort, Gold Coast.

Limpus, C. J. and N. Nicholls, 1988. The Southern Oscillation Regulates the Annual Numbers of Green Turtles (Chelonia-Mydas) Breeding Around Northern Australia. Wildlife Research 15: 157- 161.

Lukoschek, V., M. Beger, D. Ceccarelli, Z. Richards & M. Pratchett (2013). Enigmatic declines of Australia's sea snakes from a biodiversity hotspot. *Biological Conservation*. 166:191-202. Marquez 1990

McCosker, J.E., 1975. Feeding behaviour of Indo-Australian Hydrophiidae. In: Dunson W A (eds.) The Biology of Sea Snakes. Page(s) 217-232. Baltimore: University Park Press

McMahon, C.R., Bradshaw, J.A. & Hays, G.C., 2007. Satellite tracking reveals unusual diving characteristics for a marine reptile, the olive ridley turtle *Lepidochelys olivacea*. Marine Ecology Progress Series. 329:239-252.

Minton, S.A. & Heatwole, H., 1975. Sea snakes from three reefs of the Sahul Shelf. In: Dunson, W. A., ed. The Biology of Sea Snakes. Page(s) 141-144. Baltimore: University Park Press.

Morris, K., 2004. Regional significance of marine turtle rookeries on the Lowendal Islands. Unpublished information provided to Apache Energy Ltd.

Northern Territory Government (n.d.) Threatened Species of the Northern Territory Green Turtle Chelonia mydas. The Northern Territory Government, Northern Territory.

Pendoley, K.L., 2005. Sea Turtles and the Environmental Management of Industrial Activities in North West Western Australia, PhD Thesis, Murdoch University, Australia. 310pp.

Pendoley Environmental, 2011. Varanus Island Marine Turtle Tagging Programme 2009 - 2010. Report to Apache Energy Ltd.

Pendoley (2023). Desktop Study Tiwi Turtle Programs. Pendoley Environmental for Santos, June 2023

Perez, M.A., Limpus, C.J., Hofmeister, K., Shimada, T., Strydom, A., Webster, E. & Hamann, M., 2022. Satellite tagging and flipper tag recoveries reveal migration patterns and foraging distribution of loggerhead sea turtles (Caretta caretta) from eastern Australia. Mar Biol 169: 80.

Polovina, JJ, Balazs, GH, Howell, EA, Parker, DM, Seki, MP & Dutton, PH. (2004). Forage and migration habitat of logger-head (Caretta caretta) and olive ridley (Lepidochelys olivacea) sea turtles in the central North Pacific Ocean. *Fish Oceanogr,* 13:36–51.

Prince, R.I.T., 1994. Status of the Western Australian Marine Turtle Populations: The Western Australian Marine Turtle Project 1986–1990. Report prepared for the Queensland Department of Environment and Heritage and Australian Nature Conservation Agency.

Solow, Andrew & Bjorndal, Karen & Bolten, Alan (2002). Annual Variation in Nesting Numbers of Marine Turtles: The Effect of Sea Surface Temperature on Re-migration Intervals. Ecology Letters. 5. 742 – 746. 10.1046/j.1461-0248.2002.00374.x.

Storr, G.M., Smith, L.A. and Johnstone, R.E., 1986. Snakes of Western Australia. First edition. Perth: Western Australian Museum.

Tucker, A.D., Pendoley, K.L., Murray, K. et al. (2021). Regional Ranking of Marine Turtle Nesting in Remote Western Australia by Integrating Traditional Ecological Knowledge and Remote Sensing. Remote Sens. 13: 4696.

Turner Tomaszewicz CN, Avens L, LaCasella EL, Eguchi T, Dutton PH, LeRoux RA, et al. Mixed-stock aging analysis reveals variable sea turtle maturity rates in a recovering population. *J Wildl Manag*. 2022; https://doi.org/10.1002/jwmg.22217

Whiting, S.D., Long, J., Hadden, K. and Lauder, A. 2005., Identifying the Links Between Nesting and Foraging Grounds for the Olive Ridley (*Lepidochelys olivacea*) Sea Turtles in Northern Australia. Final Report to the Department of the Environment, Water and Resources. June 2005.

Whiting, S.D., Hadden, K., Long, J.L., Lauder, A.D.K., Kleidon, A. & Cook, K. 2007a. *Sea Turtle Conservation and Education on the Tiwi Islands. Final Natural Heritage Report*. Canberra. Australian Government.

Whiting S.D., Long J.L, and Coyne, M., 2007b. Migration routes and foraging behavior of olive ridley 446 turtles *Lepidochelys olivacea* in northern Australia. *Endanger Species Res* 3:1-9. 447 DOI:10.3354/esr003001

Woodside, 2002. WA-271-P Field Development: Environmental Impact Statement. Woodside Energy Ltd., Perth.

16.6. Marine Mammals

Bannister, J.L., C.M. Kemper & R.M. Warneke, 1996. *The Action Plan for Australian Cetaceans*. Canberra: Australian Nature Conservation Agency. Available from: http://www.environment.gov.au/resource/action-plan-australian-cetaceans.

Bejder M, Johnston D.W., Smith J, Friedlaender A, Bejder L., 2016. Embracing conservation success of recovering humpback whale populations: Evaluating the case for downlisting their conservation status in Australia. Marine Policy 66 (2016) 137–141.

Branch TA, Stafford KM, Palacios DM, Allison C, Bannister JL, Burton CLK, Cabrera E, Carlson CA, Galletti vernazzani B, Gill PC, Hucke-gaete R, Jenner KC, Jenner M-N, Matsuoka K, Mikhalev YA, Miyashita MG, Morrice S, Nishiwaki VJ, Sturrock D, Tormosov RC, Anderson AN, Baker PB, Best P, Borsa T, Brownell Jr. RL, Childerhouse SK, Findlay P, Gerrodette, T, Ilangakoon, AD, Joergensen, M, Kahn, B, Ljungblad, DK, Maughan, B, Mccauley, RD, Mckay, S, Norris, TF, Oman whale and Dolphin research group, Rankin, S, Samaran, F, Thiele, D, Van Waerebeek K & Warneke RM (2007) Past and present distribution, densities and movements of blue

whales *Balaenoptera musculus* in the Southern Hemisphere and Northern Indian Ocean. Mammal Rev. 37(2):116–175

Ceccarelli, D., McCrea, I., Collis, M. & Nicoll, R., 2011. Australia's last great whale haven Cetacean distribution and conservation needs in the north-west marine region. International Fund for Animal Welfare, 1–68.Cerchio, S. et al. (2020). A new blue whale song-type described for the Arabian sea and western Indian Ocean. Endanger. Species Res. 43, 495–515

ConocoPhillips, 2018. Barossa Area Development Offshore Project Proposal. ConocoPhillips, Perth, Western Australia

[DAWE] Department of Agriculture, Water and the Environment, 2020a. Species Profile and Threats Database [Online]. Department of Agriculture, Water and the Environment. Canberra, Commonwealth of Australia. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl

[DAWE] Department of Agriculture, Water and the Environment, 2020b. National Conservation Values Atlas [Online]. Department of Agriculture, Water and the Environment. Canberra, Commonwealth of Australia. Available from: http://www.environment.gov.au/webgis-framework/apps/ncva/ncva.jsf

[DEWHA] Department of the Environment, Water, Heritage and the Arts (2008) The South-West Marine Bioregional Plan: Bioregional Profile: A Description of the Ecosystems, Conservation Values and Uses of the South-West Marine Region. [Online] Canberra: DEWHA Available from: https://parksaustralia.gov.au/marine/pub/scientific-publications/archive/south-west-marine-bioregional-plan.pdf

DEWR (Department of Environment and Water Resources) (2007) Whales and dolphins identification guide. Department of Environment and Water Resources, Canberra. http://www.environment.gov.au/system/files/resources/9c058c02-afd1-4e5d-abff-11cac2ebc486/files/blue-whale-conservation-management-plan.pdf.

[DoE] Department of the Environment, 2015. Conservation Management Plan for the Blue Whale. A Recovery Plan under the *Environment Protection and Biodiversity Conservation Act 1999*. Department of the Environment. Canberra.

[DoE] Department of the Environment, 2023. *Balaenoptera edeni* — Bryde's Whale. Species Profile and Threats Database. Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?showprofile=Y&taxon_id=35

[DoEE] Department of Energy and the Environment, 2015. 'Sawfish and River Sharks Multispecies Recovery Plan, Commonwealth of Australia 2015.

[DoEE] Department of Energy and the Environment, 2015. Conservation Advice *Balaenoptera physalus* fin whale.

[DoEE] Department of Energy and the Environment, 2016a. *Sousa sahulensis*— Indo-Pacific Humpback Dolphin. Species Profile and Threats Database. Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=50 [Accessed on 3 August 2016]

[DoEE] Department of Energy and the Environment, 2016b. *Tursiops aduncus* — Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin. Species Profile and Threats Database. Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=68418 [Accessed on 3 August 2016]

[DoEE] Department of Energy and the Environment, 2016c. *Orcaella heinsohni* — Australian Snubfin Dolphin. Species Profile and Threats Database. Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=81322 [Accessed on 3 August 2016]

[DoEE] Department of Energy and the Environment, 2019a. Species Profile and Threats Database [Online] Department of Environment and Energy Canberra, Commonwealth of Australia Available from: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl

[DoEE] Department of Energy and the Environment, 2019b, Australia's National Heritage List. Available from: http://www.environment.gov.au/heritage/places/national-heritage-list [Accessed 16 December 2019].

[DMP] Department of Mines and Petroleum, 2003. Location and Estimated Period of Humpback Whale Activity in WA. Available at: http://www.washarkattacks.net/humpback-activity.pdf

Double MC, Andrews-Goff V, Jenner KCS, Jenner M-N, Laverick SM, Branch TA & Gales N., 2014. Migratory movements of pygmy blue whales (*Balaenoptera musculus brevicauda*) between Australia and Indonesia as revealed by satellite telemetry. PLOS one, April 2014 9(4)

Double MC, Gales N, Jenner KCS & Jenner M-N (2010) Satellite tracking of south-bound female humpback whales in the Kimberley region of Western Australia. Final report to the Australian Marine Mammal Centre, Tasmania, September 2010

Double MC, Jenner KCS, Jenner M-N, Ball I, Laverick S, Gales N (2012a) Satellite tracking of northbound humpback whales (*Megaptera novaeangliae*) off Western Australia. Final report to the Australian Marine Mammal Centre, Tasmania May 2012.

Double MC, Jenner KCS, Jenner M-N, Ball I, Laverick S, Gales N (2012b) Satellite tracking of pygmy blue whales (*Balaenoptera musculus brevicauda*) off Western Australia. Final report to the Australian Marine Mammal Centre, Tasmania, May 2012. DSEWPaC (Department of Sustainability, Environment, Water, Population and Communities) (2012) Conservation Management Plan for the Southern Right Whale. [Online] Department of Sustainability, Environment, Water, Population and Communities Canberra, Commonwealth of Australia Available from: http://www.environment.gov.au/biodiversity/threatened/recovery-plans

[DSD] Department of State Development, 2010. Browse Liquified Natural Gas Precinct – Strategic Assessment Report. Part 3 – Environmental Assessment - Marine Impacts. December 2010

Gales N, Double MC, Robinson S, Jenner C, Jenner M, King E, Gedamke J, Childerhouse S & Paton D (2010) Satellite tracking of Australian humpback (*Megaptera novaeangliae*) and pygmy blue whales (*Balaenoptera musculus brevicauda).* Report number SC/62/SH21 presented to the Scientific Committee of the International Whaling Commission, June 2010, Morocco

Gedamke J, Gales N, Hildebrand J & Wiggins S (2007) Seasonal occurrence of low frequency whale vocalisations across eastern Antarctic and southern Australian waters, February 2004 to February 2007. IWC SC/59/SH5

Gill PC (2002) A blue whale (*Balaenoptera musculus*) feeding ground in a southern Australian coastal upwelling zone. J. Cetacean Res. Manage. 4(2):179—184

Hale, P.T., Barreto, A.S., Ross, G.J.B. (2000) Comparative morphology and distribution of the *aduncus* and *truncatus* forms of bottlenose dolphin Tursiops in the Indian and Western Pacific Oceans. Aquatic Mammals 26, 101–110.

Hedley, SL, Bannister, JL & Dunlop, RA 2011 Abundance estimates of Southern Hemisphere Breeding Stock 'D' Humpback Whales from aerial and land-based surveys off Shark Bay, Western Australia, 2008. J. Cetacean Res. Manage. (special issue 3): 209—221

Hooker, S. K., Whitehead, H., and Gowans, S. (1999). Marine protected area design and the spatial and temporal distribution of Cetaceans in a Submarine Canyon. Conserv. Biol. 13, 592–602.

INPEX Browse. 2010. Icthys Gas Field Development Project: draft environmental impact statement. INPEX Browse, Perth.

Irvine, L. and Kent, C.S. (2018) The distribution and relative abundance of marine mega-fauna, with a focus on humpback whales (Megaptera novaeangliae), in Exmouth Gulf, Western Australia

JASCO Applied Sciences, 2016. Underwater Acoustics: Boise and the Effects on Marine Mammals. Compiled by Christine Erbe, Perth, Western Australia.

Jenner, KCS, Jenner, M-N & McCabe, KA, 2001 Geographical and temporal movements of humpback whales in Western Australian waters. APPEA Journal Vol 41(2001), pp 749—765

Kato, H. (2002). Bryde's Whales *Balaenoptera edeni* and *B. brydei*. **In:** Perrin W.F., B. Wrsig & H.G.M. Thewissen, eds. *Encyclopedia of Marine Mammals*. Page(s) 171-177. Academic Press.

Leaper, R, Bannister, J. L., Branch, T. A., Clapham, P. J., Donovan, G. P., Matsuoka, K., Reilly, S., and Zerbini, A. N. (2008). A review of abundance, trends and foraging parameters of baleen whales in the Southern Hemisphere, CCAMLR-IWC-WS-08/04 presented to IWC/CCAMLR workshop, Hobart, 2008.

Leroy, E.C., Royer, J., Alling, A., Maslen, B. and Rogers, T.L. 2021. Multiple pygmy blue whales acoustic populations in the Indian Ocean: whale song identifies a possible new population. *Scientific Reports.* 11:8762.

Marsh, H, Eros, C, Penrose, H & Hugues, J 2002, Dugong - Status Report and Action Plans for countries and territories, UNEP Early Warning and Assessment Report Series 1.

McCauley, R.D., 2011. Woodside Kimberley sea noise logger program, Sept-2006 to June-2009: Whales, fish and man-made noise. Report prepared for Woodside Energy Ltd., Perth, Western Australia.

McCauley, R.D. & Jenner, C., 2010. Migratory patterns and estimated population size of pygmy blue whales (*Balaenoptera musculus brevicauda*) traversing the Western Australian coast based on passive acoustics. SC/62/SH26 in Proceedings of the 62nd IWC Annual Meeting, Agadir, Morocco (June 21–25). Available as SC-62-SH26.pdf in archive at https://iwc.int/document_1453 (Accessed February 2020).

McPherson, C, Kowarski, K, Delarue, Whitt, C, MacDonnell, Martin, B. (2015). Passive Acoustic Monitoring of Ambient Noise and Marine Mammals – Barossa Field: Juley 2014 to July 2015 (No. JASCO Document 00997, Version 1.0). Technical report by JASCO Applied Sciences (Australia) Pty Ltd. For Jacobs.

Möller, L.M. et al. (2020) Movements and behaviour of blue whales satellite tagged in an Australian upwelling system, *Scientific Reports*, 10(1): 21165f

Pirotta, E., Matthiopoulos, J., Mackenzie, M.L., Scott-Hayward, L.A.S. and Rendell, L. 2011. Modelling Sperm Whale Habitat Preference: A Novel Approach Combining Transect and Follow Data. *Marine Ecology Progress Series.* 436:257-272.

Rennie, S, Hanson, C.E, McCauley, R.D, Pattiaratchi, C, Burton, C, Bannister, J, Jenner, C, Jenner, M.N, (2009). Physical properties and processes in the Perth Canyon, Western Australia: links to water column production and seasonal pygmy blue whale abundance. In: J. Mar. Syst., 77, pp. 21–44.

RPS, 2010a. Technical Appendix – Marine Mammals. Wheatstone Project EIS/ERMP. Unpublished report for Chevron Australia Pty Ltd, March 2010

RPS, 2010b. Marine Megafauna Report Browse MMFS 2009. Prepared for Woodside Energy Ltd.

Salgado Kent, C, Jenner, C, Jenner, M, Bouchet, P & Rexstad, E. 2012 Southern Hemisphere Breeding Stock D humpback whale population estimates from North West Cape, Western Australia. J. Cetacean Res. Manage. 12(1): 29—38

Thums, M, Ferreira, L.C, Jenner, C, Jenner, M, Harris, D, Davenport, A, Andrews-Goff, V, Double, M, Moller, L, Attard, C.R.M, Bilgmann, K, Thomson, P.G, McCauley, R. (2022) Pygmy blue whale movement, distribution and important areas in the Eastern Indian Ocean. Global Ecology and Conservation 35, e02054.

Whiting, A.U., Thomson, A., Chaloupka, M., Limpus, C. J., 2009. Seasonality, abundance and breeding biology of one of the largest populations of nesting flatback turtles, *Nataor depressus*: Cape Domett, Western Australia. Australian Journal of Zoology 56, 297-303.

Woodside, 2012. Rosebud 3D Marine Seismic Survey Environment Plan Summary. Available online at: https://docs.nopsema.gov.au/A251121

Woodside Energy, 2014. Browse FLNG Development Draft Environmental Impact Statement, EPBC Referral 2013/7079, November 2014.

Woodside, 2020. WA-49-L Gemtree Anchor Hold Testing. NOPSEMA Reference 5049. Accessed at https://info.nopsema.gov.au/activities/406/show_public.

16.7. Birds

Bamford, M., Watkins, D., Bancroft, W., Tischler, G. & Wahl, J., 2008. Migratory Shorebirds of the East Asian - Australasian Flyway; Population Estimates and Internationally Important Sites. Wetlands International – Oceania, Canberra, Australia

Barrett, G., A. Silcocks, S. Barry, R. Cunningham & R. Poulter, 2003. *The New Atlas of Australian Birds*. Melbourne, Victoria: Birds Australia.

Bennelongia, 2008. Report on shorebird numbers and shorebird values at Cape Preston. Prepared for Citic Pacific Mining by Bennelongia Environmental Consultants, Report 2008/52

Bennelongia, 2011. Port Hedland Migratory shorebird survey report and impact assessment. Prepared for BHP Billiton Iron Ore by Bennelongia Environmental Consultants, Report 2011/124

Birdlife Australia, 2017. Australasian Bittern [Online]. Available from: http://birdlife.org.au/bird-profile/australasian-bittern. [Accessed November 2017].

Brothers, N.P., 1984. Breeding, distribution and status of burrow-nesting petrels at Macquarie Island. *Australian Wildlife Research* **11**, 113–131.

Chatto, R., 2001. The distribution and status of colonial breeding seabirds in the Northern Territory. Parks & Wildlife Commission of the NT Technical Report. 70pp.

Clemens, R.S., A. Haslem, J. Oldland., L. Shelley, M.A. Weston & M.A.A. Diyan, 2008. Identification of Significant Shorebird Areas in Australia: Mapping, Thresholds and Criteria. Birds Australia report the Australian Government. Canberra, ACT: Department of the Environment, Water, Heritage, and the Arts.

Commonwealth of Australia, 2017b. EPBC Act Policy Statement 3.21—Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species. Commonwealth of Australia.

[DAWE] Department of Agriculture, Water and the Environment, 2020a. Species Profile and Threats Database [Online]. Department of Agriculture, Water and the Environment. Canberra, Commonwealth of Australia. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl

[DAWE] Department of Agriculture, Water and the Environment, 2020b. National Conservation Values Atlas [Online]. Department of Agriculture, Water and the Environment. Canberra, Commonwealth of Australia. Available from: http://www.environment.gov.au/webgis-framework/apps/ncva/ncva.jsf

[DBCA] Department of Biodiversity, Conservation and Attractions, 2023. Conservation Category Definitions for Western Australian Flora and Fauna. Government of Western Australia. Available at: conservation_codes_for_western_australian_flora_and_fauna (1).pdf

[DCCEEW] Department of Climate Change, Energy, the Environment and Water, 2025. *Pluvialis squatrola* – Grey Plover. Species Profile and Threats Database (SPRAT). Available at: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=865

del Hoyo, J., A. Elliott & J. Sargatal, eds. (1996). *Handbook of the Birds of the World. Volume 3, Hoatzin to Auks*. Barcelona: Lynx Edicions.

[DEWHA] Department of the Environment, Water, Heritage and the Arts, 2008a. The North-West Marine Bioregional Plan: Bioregional Profile: A Description of the Ecosystems, Conservation Values and Uses of the South-West Marine Region. [Online]. Canberra: DEWHA. Available from: https://parksaustralia.gov.au/marine/pub/scientific-publications/archive/north-west-bioregional-plan.pdf

[DEWHA] Department of the Environment, Water, Heritage and the Arts, 2009. EPBC Act Policy Statement 3.21 – Significant Impact Guidelines for 36 Migratory Shorebird Species. Commonwealth Department of the Environment, Water, Heritage and Arts, Canberra.

DoE (2014g) *Papasula abbotti* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=59297. Accessed 23 July 2014

[DoE] Department of the Environment, 2015. Wildlife Conservation Plan for Migratory Shorebirds, Commonwealth of Australia. Available at: https://www.dcceew.gov.au/sites/default/files/documents/widlife-conservation-plan-migratory-shorebirds.pdf

[DoE] Department of the Environment, 2020. Wildlife Conservation Plan for Seabirds. Commonwealth of Australia. Available at: https://www.dcceew.gov.au/sites/default/files/documents/wildlife-conservation-plan-for-seabirds.pdf

[DoE] Department of the Environment, 2025a. *Sternula albifrons* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: https://www.environment.gov.au/sprat. Accessed Mon, 28 Apr 2025 11:36:12 +1000

[DoE] Department of the Environment, 2025b. *Phaethon rubricauda westralis* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: https://www.environment.gov.au/sprat. Accessed Mon, 28 Apr 2025 12:01:15 +1000.

[DSEWPaC] Department of Sustainability, Environment, Water, Population and Communities, 2012. Species group report card- seabirds. Supporting the marine bioregional plan for the North-west Marine Region. Commonwealth of Australia, 2012

[EAAFP] The East Asian-Australasian Flyway Partnership, 2018. Home - Eaaflyway. [Accessed 8 April 2024]

Garnett, S.T. & G.M. Crowley 2000. The Action Plan for Australian Birds 2000. Canberra, ACT: Environment Australia and Birds Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications action/birds2000/index.html. [Accessed 21/11/2017]Garnet ST, Szabo JK, Dutson G (2011) The Action Plan for Australian Birds 2010. CSIRO Publishing, Melbourne

Garnett, S.T. and Baker, G.B., (Eds), 2021. *The Action Plan for Australian Birds 2020*. CSIRO Publishing, Melbourne.

Geering, A., L. Agnew & S. Harding, eds., 2007. *Shorebirds of Australia*. Melbourne: CSIRO Publishing.

Hansen, B.D., Fuller, R.A., Watkins, D., Rogers, D.I., Clemens, R.S., Newman, M., Woehler, E.J. and Weller, D.R., 2016. Revision of the East Asian-Australasian Flyway Population Estimates for 37 listed Migratory Shorebird Species. Unpublished report for the Department of the Environment. BirdLife Australia, Melbourne.

Higgins PJ & Davies SJJF eds 1996. Handbook of Australian, New Zealand and Antarctic Birds. Volume Three - Snipe to Pigeons. Melbourne, Victoria: Oxford University Press

Lane, B.A., 1987. *Shorebirds in Australia*. Sydney, NSW: Reed.

Lindsey, T.R., 1986. The Seabirds of Australia. North Ryde, NSW: Angus and Robertson

Marchant S & Higgins PJ eds. 1990. Handbook of Australian, New Zealand and Antarctic Birds. Volume One - Ratites to Ducks. Melbourne, Victoria: Oxford University Press

Marchant S & Higgins PJ (Eds) 1993. Handbook of Australian, New Zealand and Antarctic Birds. Volume Two - Raptors to Lapwings. Oxford University Press, Melbourne

Oro, D., Cam, E., Pradel, R. and Martinetz-Abrain, A., 2004. Influence of food availability on demography and local population dynamics in a long-lived seabird. Proceedings of the Royal Society B. 271 (1537): 387–396

Rogers, D., 1999. What determines shorebird feeding distribution in Roebuck Bay? Chapter 9, 145-174. In Pepping, M., Piersma, T., Pearson, G. and Lavaleye, M. (eds) 1999. Intertidal sediments and benthic animals of Roebuck Bay, Western Australia. Netherlands Institute for Sea Research Report 3, Texel, Netherlands, 1-214

Stokes, T., 1988. A review of the birds of Christmas Island, Indian Ocean. Australian National Parks & Wildlife Service Occasional Paper 16.

Stokes, T. & Hinchey, M., 1990. Which small Noddies breed at Ashmore Reef in Eastern Indian Ocean? Emu. 90:269-271

Storr, G.M., Johnstone, R.E. & Griffin, P., 1986. Birds of the Houtman Abrolhos, Western Australia. Records of the Western Australian Museum Supplement. 24

Surman, C.A. & Nicholson, L.W., 2006. 'Seabirds,' in S McClatchie, J Middleton, C Pattiaratchi, D Currie & G Kendrick (eds), The South-west Marine Region: ecosystems and key species groups, Australian Government Department of the Environment and Water Resources, Hobart

Surman, C.A. & Nicholson, L.W., 2013. Monitoring of annual variation in seabird breeding colonies throughout the Lowendal Group of islands: 2013 Annual Report. Lowendal Island Seabird Monitoring Program (LISMP). Unpublished report prepared for Apache Energy Ltd. by Halfmoon Biosciences. 59pp.

[TSSC] Threatened Species Scientific Committee, 2020. Conservation Advice the Abbott's booby *Papasula abbotti*. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/59297-conservation-advice-19102020.pdf. In effect under the EPBC Act from 19-Oct-2020.

[TSSC] Threatened Species Scientific Committee, 2016. Conservation Advice Gallirallus philippensis andrewsi Cocos buff-banded rail. Canberra: Department of the Environment and Energy. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/64439-conservation-advice-07122016.pdf. In effect under the EPBC Act from 15-Jul-2016.

Watkins, D., 1993. A national plan for shorebird conservation in Australia. *RAOU Report Series*. 90.

16.8. Protected Areas

BirdLife International., 2011. Important Bird Areas factsheet: Legune (Joseph Bonaparte Bay). Available at: http://www.birdlife.org

BMT WBM, 2011. Ecological Character Description for Cobourg Peninsula Ramsar Site. Prepared for the Australian Government, Canberra. https://www.environment.gov.au/system/files/resources/21746527-9ee4-44eb-a2a6-aa08463d985b/files/1-ecd_0.pdf [Accessed June 2021].

Brewer DT, Lyne V, Skewes TD, Rothlisberg, P., 2007. Trophic systems of the North West Marine Region. Report to the Australian Government Department of the Environment and Water Resources, CSIRO, Cleveland

Brown, K & Skewes, T, 2005. A preliminary assessment of the ecology of seagrasses at Ashmore Reef. The Beagle, Records of the Museums and Art Galleries of the Northern Territory, Sup 1: 143-152.

[DAWE] Department of Agriculture, Water and the Environment, 2020a. Australian Wetlands Database, Important Wetlands, Exmouth Gulf East Wetland.

[DCCEEW] Department of Environment. 2014b. Bradshaw Defence Area. Available at http://www.environment.gov.au/cgi-bin/ahdb/search.pl?mode=place_detail;place_id=105655 [Accessed June 2023]

[DEC] WA Department of Environment and Conservation, 2012c. Ord River and Parry Lagoons Nature Reserves Management Plan. Available from: https://www.dpaw.wa.gov.au/images/documents/parks/management-plans/decarchive/ord-river-and-parry-lagoons-nature-reserves-management-plan-2012_webversion.pdf [Accessed July 2021].

[DNREAS] Department of Natural Resources, Environment, The Arts and Sport, 2011. Cobourg Marine Park Plan of Management. Available from: https://dtc.nt.gov.au/__data/assets/pdf_file/0006/249045/Cobourg-Marine-Park.pdf [Accessed July 2021]

[DoE] Department of the Environment, 2014. Australian Heritage Database. Available at http://www.environment.gov.au/cgi-bin/ahdb/search.pl [Accessed April 2014]

[DoEE] Department of Energy and the Environment, 2012. Australia's bioregions (IBRA), Version 7. Available at: http://www.environment.gov.au/land/nrs/science/ibra

Hale, J., 2008. Ecological Character Description of the Ord River Floodplain Ramsar Site, Report to the Department of Environment and Conservation, Perth, Western Australia. Available online: https://www.dpaw.wa.gov.au/images/documents/conservation-management/wetlands/ramsar/ord-floodplain-ecd_final-with-disclaimer.pdf [Accessed June 2021].

Hale, J., Butcher, R., 2013. Ashmore Reef Commonwealth Marine Reserve Ramsar Site ecological character description (A report to the Department of the Environment). Department of the Environment, Canberra.

Hodgson, P., 1995. Directory of Important Wetlands in Australia - Information sheet (Shoal Bay – Micket Creek NT032). Compiled by Wetlands Unit, Australian Nature Conservation Agency. Minor additions by S. J. Moore of Moore Environmental Consulting and L. N. Lloyd of Lloyd Environmental Consultants in 1999. DEO-NT update 1999. Available online: https://www.environment.gov.au/cgi-bin/wetlands/report.pl [Accessed June 2021].

Jaensch, R.P., 1995. Oceania Program of Wetlands International, GPO Box 636, Canberra ACT 2601, November 1995.

16.9. Key Ecological Features

Anderson, T.J., Nichol, S., Radke L., Heap, A.D., Battershill C., Hughes, M., Siwabessy, P.J., Barrie, V., Alvarez de Glasby, B., Tran, M., Daniell, J. and Shipboard Party., 2011. Seabed Environments of the Eastern Joesph Bonaparte Gulf, Norther Australia GA0325/Sol5117 – Post-Survey Report. GeoScience Australia, Canberra, Australian Capital Territory.

Baker, C., Potte,r A., Tran, M., Heap, A.D., 2008. Geomorphology and sedimentology of the North-west Marine Region of Australia. Record 2008/07, Geoscience Australia, Canberra

Brewer, D.T., Lyne, V., Skewes, T.D., Rothlisberg, P., 2007. Trophic systems of the North West Marine Region. Report to the Australian Government Department of the Environment and Water Resources, CSIRO, Cleveland

Brown, K. & Skewes, T., 2005. A preliminary assessment of the ecology of seagrasses at Ashmore Reef. The Beagle, Records of the Museums and Art Galleries of the Northern Territory, Sup 1: 143-152.

Currey-Randall, M, Galaiduk, R, Stowar, M, Vaughan, B.I and K. J. Miller, 2021. Mesophotic fish communities of the ancient coastline in Western Australia. PLoS ONE 16(4): e0250427. https://doi.org/10.1371/journal.pone.0250427Dambacher, JM, Rochester, W & Dutra, L, (2009). Addendum to ecological indicators for the exclusive economic zone waters of the South-west Marine Region., report for the Australian Government Department of the Environment, Water, Heritage and the Arts, Canberra.

[DEWHA] Department of the Environment, Water, Heritage and the Arts (2007). Characterisation of the marine environment of the north marine region: outcomes of an expert workshop convened in Darwin., Northern Territory, 2-3 April 2007, DEWHA, Canberra. http://www.environment.gov.au/resource/characterisation-marine-environment-north-marine-region-outcomes-expert-workshop-2-3-april

[DEWHA] Department of the Environment, Water, Heritage and the Arts (2008a) A characterisation of the marine environment of the North-west Marine Region: Perth workshop report. A summary of an expert workshop convened in Perth, Western Australia. 5-6 September 2007, DEWHA, Hobart

[DEWHA] Department of the Environment, Water, Heritage and the Arts (2008b). The North Marine Bioregional Plan: Bioregional Profile: A Description of the Ecosystems, Conservation Values and Uses of the North Marine Region. Canberra: DEWHA.

Done TJ, Williams DMcB, Speare PJ, Davidson J, DeVantier LM, Newman SJ, Hutchins JB (1994) Surveys of coral and fish communities at Scott Reef and Rowley Shoals. Australian Institute of Marine Science, Townsville

Donovan A, Brewer D, van der Velde T, Skewes T (2008) Scientific descriptions of four selected key ecological features in the North-west Bioregion: final report. Report to the Australian Government Department of Environment, Water, Heritage and the Arts, CSIRO Marine and Atmospheric Research, Cleveland

[DSEWPaC] Department of Sustainability, Environment, Water, Population and Communities, 2012. Commonwealth marine environment report card. Commonwealth of Australia

[EA] Environment Australia, 2002. Ashmore Reef National Nature Reserve and Cartier Island Marine Reserve (Commonwealth waters) management plans. EA, Canberra

Falkner, I., Whiteway, T., Przeslawski, R. and Heap, A.D., 2009. Review of ten key ecological features in the Northwest Marine Region. Record 2009/13, Geoscience Australia, Canberra

Guinea, M., 2006. Sea turtles, sea snakes and dugongs of Scott Reef, Seringapatam Reef and Browse Island with notes on West Lacepede Island., Report submitted to the Australian Government Department of the Environment, Water, Heritage and the Arts, Canberra.

Harris, P, Heap, A, Passlow, V, Sbaffi, L, Fellows, M, Porter-Smith, R, Buchanan, C & Daniell, J , (2005). Geomorphic Features of the Continental Margin of Australia., Report to the National Oceans Office on the production of a consistent, high-quality bathymetric data grid and definition and description of geomorphic units for part of Australia'a marine jurisdiction. Geoscience Australia, Record 2003/30.

Heyward A, Pinceratto E, Smith L, 1997. Big bank shoals of the Timor Sea: an environmental resource atlas. Australian Institute of Marine Science, Melbourne

Jenner C, Jenner M, Pirzl R, 2008. A study of cetacean distribution and oceanography in the Scott Reef/Browse Basin development areas during the austral winter of 2008. Centre for Whale Research (WA), Perth

Last, P., Lyne, V., Yearsley, G., Gledhill, D., Gomon, M., Rees, T. and White, W., 2005. Validation of national demersal fish datasets for the regionalisation of the Australian continental slope and outer shelf (>40 m depth). Australian Government Department of the Environment and Heritage & CSIRO Marine and Atmospheric Research, Hobart

Milton, D.A., 2005. Birds of Ashmore Reef National Nature Reserve: an assessment of its importance for seabirds and waders. The Beagle, Records of the Museums and Art Gallery of the Northern Territory, suppl. 1: 133–141

[NERP MBH] National Environmental Research Program Marine Biodiversity Hub, 2014. Exploring the Oceanic Shoals Commonwealth Marine Reserve., NERP MBH, Hobart.

Nichol, SL, Howard, FJF, Kool, J, Stowar, M, Bouchet, P, Radke, L, Siwabessy, J, Przeslawski, R, Picard, K, Alvarez de Glasby, B, Colquhoun, J, Letessier, T & Heyward, A, 2013. Oceanic Shoals Commonwealth Marine Reserve (Timor Sea) Biodiversity Survey: GA0339/SOL5650 - Post Survey Report., Record 2013/38, Geoscience Australia, Canberra.

Wakeford M, Puotinen M, Nicholas W, Colquhoun J, Vaughan BI, Whalan S, et al, (2023. Mesophotic benthic communities associated with a submerged palaeoshoreline in Western Australia. PLoS ONE 18(8): e0289805. https://doi.org/10.1371/journal.pone.0289805

Whiting, S., 1999. Use of the remote Sahul Banks, northwestern Australia, by dugongs, including breeding females. Marine Mammal Science 15: 609–615

Woodside, 2009. Reef status report 2008., Australian Institute of Marine Science, Western Australian Museum & Woodside, Perth.

16.10. State Marine Parks

[DBCA] Department of Biodiversity, Conservation and Attractions, 2020a. Proposed Mayala Marine Park Indicative Joint Management Plan 2020. Department of Biodiversity, Conservation and Attractions, Perth, Western Australia. Accessible from: https://www.dpaw.wa.gov.au/images/documents/conservation-management/managementplans/Proposed%20Mayala%20Marine%20Park%20indicative%20joint%20management%20plan.pdf

[DBCA] Department of Biodiversity, Conservation and Attractions, 2020b. Lalang-gaddam amended Joint Management Plan for the Lalang-garram / Camden Sound, Lalang-garram / Horizontal Falls and North Lalang-garram Marine Parks and Indicative Joint Management Plan for the Proposed Maiyalam Marine Park. Department of Biodiversity, Conservation and Attractions, Perth, Western Australia. Accessible from: https://www.dpaw.wa.gov.au/images/documents/conservationmanagement/managementplans/Lalang-gaddam%20marine%20park%20amended%20and%20indicative%20joint%20management%20plan.pdf

[DBCA] Department of Biodiversity, Conservation and Attractions, 2022. Mayala Marine Park Joint Management Plan 2022 Management Plan 100. Department of Biodiversity, Conservation and Attractions, Perth, Western Australia. Accessible from: Mayala Marine Park | Department of Biodiversity, Conservation and Attractions (dbca.wa.gov.au)

[DoEE] Department of Energy and the Environment, 2019, Australia's National Heritage List. Available from: http://www.environment.gov.au/heritage/places/national-heritage-list [Accessed 16 December 2019].

[DPaW] Department of Parks and Wildlife, 2013. Lalang-garram/ Camden Sound Marine Park Management Plan 73 2013–2023. Department of Parks and Wildlife, Perth, Western Australia

[DPaW] Department of Parks and Wildlife, 2016. Lalang-garram/ Horizontal Falls and North Lalang-garram marine parks joint management plan 2016. Management Plan 88. Department of Parks and Wildlife, Perth.

16.11. Australian Marine Parks

Director of National Parks, 2012. Concerning the Proposed Proclamation of 40 Commonwealth marine reserves (and the related revocation of seven existing Commonwealth reserves and the revocation of the Coral Sea Conservation Zone); and the amendment of the names of four existing Commonwealth marine reserves. Report to the Director of National Parks under the Environment Protection and Biodiversity Conservation Act 1999 Section 351.

Director of National Parks, 2018a. North-west Marine Parks Network Management Plan 2018, Director of National Parks, Canberra.

Director of National Parks, 2018b. North Marine Parks Network Management Plan 2018, Director of National Parks, Canberra.

[DoE] Department of the Environment, 2014. Australian Heritage Database. Available at http://www.environment.gov.au/cgi-bin/ahdb/search.pl [Accessed April 2014]

Heyward, A., Radford, B., Burns, K., Colquhoun, J., Moore, C. 2010. Montara Surveys: Final report on Benthic Surveys at Ashmore, Cartier and Seringapatam Reefs. Australian Institute of Marine Science, Crawley Western Australia

Radford, B. and Puotinen, M. 2016. Spatial benthic model for the Oceanic Shoals CMR. Australian Institute of Marine Science, Perth, Western Australia.

16.12. Conservation Management Plans

Commonwealth of Australia, 2015a. *Wildlife Conservation Plan for Migratory Shorebirds*.

Commonwealth of Australia, 2015b. *Sawfish and River Sharks - Multispecies Recovery Plan 2015*. Canberra, ACT.

Commonwealth of Australia, 2017. Recovery Plan for Marine Turtles in Australia 2017 – 2027.

[DCCEEW] Department of Climate Change, Energy, the Environment and Water, 2023a. Conservation Advice for *Calidris ferruginea* (curlew sandpiper), Canberra.

[DCCEEW] Department of Climate Change, Energy, the Environment and Water, 2023b. Conservation Advice for *Charadrius leschenaultii* (greater sand plover), Canberra.

[DCCEEW] Department of Climate Change, Energy, the Environment and Water, 2023c. Conservation Advice for *Numenius madagascariensis* (far eastern curlew), Canberra.

[DCCEEW] Department of Climate Change, Energy, the Environment and Water, 2023d. Conservation Advice for *Phaethon rubricauda westralis* (Indian Ocean red-tailed tropicbird), Canberra.

[DCCEEW] Department of Climate Change, Energy, the Environment and Water, 2024a. DCCEEW Recovery Plans Website. Accessible at: https://www.dcceew.gov.au/environment/biodiversity/threatened/recovery-plans#:~:text=listed%20under%20the%20Commonwealth%20Environment,species%20or%20threatened%20ecological%20communities. [accessed on 17 April 2024]

[DCCEEW] Department of Climate Change, Energy, the Environment and Water, 2024b. Conservation Advice for *Limnodromus semipalmatus* (Asian dowitcher), Canberra.

[DCCEEW] Department of Climate Change, Energy, the Environment and Water, 2024c. Conservation Advice for *Calidris canutus* (red knot), Canberra.

[DCCEEW] Department of Climate Change, Energy, the Environment and Water, 2024d. Conservation Advice for *Calidris tenuirostriss* (great knot), Canberra.

[DCCEEW] Department of Climate Change, Energy, the Environment and Water, 2024e. Conservation Advice for *Limosa lapponica baueri* (Alaskan bar-tailed Godwit), Canberra.

[DCCEEW] Department of Climate Change, Energy, the Environment and Water, 2024f. Conservation Advice for *Limosa lapponica manzbieri* (Yakutan bar-tailed Godwit), Canberra.

[DCCEEW] Department of Climate Change, Energy, the Environment and Water, 2024g. Conservation Advice for *Calidris acuminata* (sharp-tailed sandpiper), Canberra.

[DCCEEW] Department of Climate Change, Energy, the Environment and Water, 2024h. Conservation Advice for *Xenus cinereus* (Terek Sandpiper), Canberra.

[DCCEEW] Department of Climate Change, Energy, the Environment and Water, 2024i. Conservation Advice for *Pluvialis squatarola* (grey plover), Canberra.

[DCCEEW] Department of Climate Change, Energy, the Environment and Water, 2024j. Conservation Advice for Limosa limosa (black-tailed godwit), Canberra.

[DCCEEW] Department of Climate Change, Energy, the Environment and Water, 2024k. Conservation Advice for *Tringa nebularia* (common greenshank), Canberra.

[DCCEEW] Department of Climate Change, Energy, the Environment and Water, 2024l. Conservation Advice for *Arenaria interpres* (ruddy turnstone), Canberra.

[DCCEEW] Department of Climate Change, Energy, the Environment and Water, 2024m. Conservation Advice for *Aipysurus fuscus* (dusky sea snake), Canberra.

[DCCEEW] Department of Climate Change, Energy, the Environment and Water, 2025a. Conservation Advice for *Sturnula albifrons* (little tern), Canberra.

[DCCEEW] Department of Climate Change, Energy, the Environment and Water, 2025b. Conservation advice for *Orcaella heinsohni* (Australian snubfin dolphin),

[DCCEEW] Department of Climate Change, Energy, the Environment and Water, 2025c. Conservation advice for *Sousa sahulensis* (Australian humpback dolphin), Canberra.

[DEWHA] Department of the Environment, Water, Heritage and the Arts, 2008a. Approved Conservation Advice for *Dermochelys coriacea* (Leatherback Turtle). Canberra: Department of the Environment, Water, Heritage and the Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/1768-conservation-advice.pdf. In effect under the EPBC Act from 08-Jan-2009.

[DEWHA] Department of the Environment, Water, Heritage and the Arts, 2008b. Approved Conservation Advice for Green Sawfish. Canberra: Department of the Environment, Water, Heritage and the Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/68442-conservation-advice.pdf. In effect under the EPBC Act from 07-Mar-2008.

[DEWHA] Department of the Environment, Water, Heritage and the Arts, 2009. Approved Conservation Advice for *Pristis clavata* (Dwarf Sawfish). Canberra, ACT: Department of the Environment, Water, Heritage and the Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/68447-conservation-advice.pdf. In effect under the EPBC Act from 20-Oct-2009.

[DoE] Department of the Environment, 2014a. Conservation Advice *Phaethon lepturus fulvus* white-tailed tropicbird (Christmas Island). Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/26021-conservation-advice.pdf. In effect under the EPBC Act from 06-Nov-2014.

[DoE] Department of the Environment, 2014b. *Recovery plan for the Grey Nurse Shark (Carcharias taurus)*.

[DoE] Department of the Environment, 2014c. Approved Conservation Advice for *Glyphis garricki* (northern river shark). Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/82454-conservation-advice.pdf. In effect under the EPBC Act from 11-Apr-2014.

[DoE] Department of the Environment, 2014d. Approved Conservation Advice for *Pristis pristis* (largetooth sawfish). Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/60756-conservation-advice.pdf. In effect under the EPBC Act from 11-Apr-2014.

[DoE] Department of the Environment, 2014e. *Approved Conservation Advice for* Glyphis glyphis *(speartooth shark)*. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/82453-conservation-advice.pdf.

DoE] Department of the Environment, 2015. Conservation Management Plan for the Blue Whale—A Recovery Plan under the Environment Protection and Biodiversity Conservation Act 1999, Canberra, CT: Commonwealth of Australia.

[DoE] Department of the Environment, 2020. Wildlife Conservation Plan for Seabirds. Commonwealth of Australia. Available at: https://www.dcceew.gov.au/sites/default/files/documents/wildlife-conservation-plan-for-seabirds.pdf

[DSEWPaC] Department of Sustainability, Environment, Water, Population and Communities, 2011a. Approved Conservation Advice for *Aipysurus apraefrontalis* (Short-nosed Sea Snake). Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/1115-conservation-advice.pdf. In effect under the EPBC Act from 15-Feb-2011.

[DSEWPaC] Department of Sustainability, Environment, Water, Population and Communities, 2011b. Approved Conservation Advice for *Aipysurus foliosquama* (Leaf-scaled Sea Snake). Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/1118-conservation-advice.pdf. In effect under the EPBC Act from 15-Feb-2011.

[DSEWPaC] Department of Sustainability, Environment, Water, Population and Communities, 2013a. Approved Conservation Advice for *Rostratula australis* (Australian painted snipe). Canberra: Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/77037-conservation-advice.pdf. In effect under the EPBC Act from 15-May-2013.

[DSEWPaC] Department of Sustainability, Environment, Water, Population and Communities, 2013b. *Recovery Plan for the White Shark (Carcharodon carcharias)*. Available from: http://www.environment.gov.au/biodiversity/threatened/recovery-plans/recovery-plan-white-shark-carcharodon-carcharias.

[TSSC] Threatened Species Scientific Committee, 2015a. Conservation Advice *Anous tenuirostris melanops* Australian lesser noddy, Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/26000-conservation-advice-01102015.pdf. In effect under the EPBC Act from 01-Oct-2015.

[TSSC] Threatened Species Scientific Committee, 2015b. Conservation Advice *Balaenoptera borealis* sei whale. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/34-conservation-advice-01102015.pdf. In effect under the EPBC Act from 01-Oct-2015.

[TSSC] Threatened Species Scientific Committee, 2015c. Conservation Advice *Balaenoptera physalus* fin whale. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/37-conservation-advice-01102015.pdf. In effect under the EPBC Act from 01-Oct-2015.

[TSSC] Threatened Species Scientific Committee, 2015d. Conservation Advice *Rhincodon typus* whale shark. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/66680-conservation-advice-01102015.pdf. In effect under the EPBC Act from 01-Oct-2015.

[TSSC] Threatened Species Scientific Committee, 2016. Conservation Advice *Charadrius mongolus* Lesser sand plover. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/879-conservation-advice-05052016.pdf. In effect under the EPBC Act from 05-May-2016.

[TSSC] Threatened Species Scientific Committee, 2020. Conservation Advice the Abbott's booby *Papasula abbotti*. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/59297-conservation-advice-19102020.pdf. In effect under the EPBC Act from 19-Oct-2020.

16.13. Commercial and Recreational Fisheries

Apache, 2008. Van Gogh Oil Development Draft Public Environmental Report (EPBC Referral 2007/3213). Apache Energy Ltd, Perth, Western Australia, February 2008.

[AFMA] Australian Fisheries Management Authority, 2011. Annual Report 2010/2011. Australian Government, Canberra.

Caputi, N., Jackson, G. and Pearce, A., 2014. The marine heat wave off Western Australia during the summer of 2010/11 – 2 years on. Fisheries Research Report No. 250. Department of Fisheries, Western Australia. 40pp.

Condie SA, Mansbridge JV, Hart AM and Andrewartha JR, 2006. Transport and Recruitment of Silver-lip Pearl Oyster Larvae on Australia's North West Shelf. In Journal of Shellfish Research, Vol. 25, No. 1. pp 179 – 185.

Department of Agriculture, 2019. Fishery Status Reports 2019. Department of Agriculture, Canberra, Australian Capital Territory.

[DPIRD] Department of Primary Industries and Regional Development, 2018. Annual Report 2018. Government of Western Australia.

[DPIRD] Department of Primary Industries and Regional Development, 2020. Aquaculture. Development Plan for Western Australia. Government of Western Australia.

[DPIRD] Department of Primary Industries and Regional Development, 2024. Western Australian South West Coast Salmon Managed Fishery and South Coast Salmon Managed FisheryWildlife Trade Operation Application. Prepared for the consideration of the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW). Available at: https://www.dcceew.gov.au/sites/default/files/documents/western-australian-salmon-fisheries-agency-application-2024.pdf

Fletcher, W J and Santoro, K., 2013. Status Reports of the Fisheries and Aquatic Resources of Western Australia 2012/13 (eds).: The State of the Fisheries. Department of Fisheries, Western Australia.

Gaughan, D.J., Molony, B. and Santoro, K. (eds), 2019. Status Reports of the Fisheries and Aquatic Resources of Western Australia 2017/18: The State of the Fisheries. Department of Primary Industries and Regional Development, Western Australia.

Gaughan, D.J. and Santoro, K. (eds), 2020. Status Reports of the Fisheries and Aquatic Resources of Western Australia 2018/19: The State of the Fisheries. Department of Primary Industries and Regional Development, Western Australia.

Matthews, S. R., Penny, S. S and Steffe A., 2019. A Survey of Recreational Fishing in the Greater Darwin Area 2015. Northern Territory Government, Australia. Fishery Report No 121

Newman, S.J., Santoro, K.G. and Gaughan, D.J. (eds), 2023. Status Reports of the Fisheries and Aquatic Resources of Western Australia 2022/23: The State of the Fisheries. Department of Primary Industries and Regional Development, Western Australia.

Northern Territory Government, 2016. Status of Key Northern Territory Fish Stocks Report 2016. Northern Territory Government. Department of Primary Industry and Resources. Fishery Report No. 119

NT Government, 2023. Aquaculture Species. Available at: https://nt.gov.au/marine/aquaculture/commercial/aquaculture-species

Thomas, L and K.J. Miller, 2022. High gene flow in the silverlip pearl oyster *Pinctada maxima* between inshore and offshore sites near Eighty Mile Beach in Western Australia. PeerJ 10:e13323 https://doi.org/10.7717/peerj.13323

Tiwi Land Council, 2003. Natural Resource Management Strategy. Tiwi Land Council. Available at http://www.tiwilandcouncil.com/publications/land.htm (accessed 22/01/2017)

[WAFIC] Western Australia Fishing Industry Council Incorporated, 2016. Available at: http://www.wafic.org.au/region/west-coast/ [Accessed August 2016]

West, L.D., Stark, K.E., Dysart, K., Lyle, J.M., 2022. Survey of recreational fishing in the Northern Territory: 2018 to 2019. Northern Territory Government, Australia.

16.14. Social and Economic Features

[AMSA] Australian Marine Safety Authority, 2012. Marine Notice 15/2012, Shipping Fairways off the north-west coast of Australia. Australian Maritime Safety Authority, Australian Government

[AMSA] Australian Marine Safety Authority, 2013. North West Shipping Management. Australian Maritime Safety Authority. Canberra.

[DEWHA] Department of the Environment, Water, Heritage and the Arts, 2008a. The North-West Marine Bioregional Plan: Bioregional Profile: A Description of the Ecosystems, Conservation Values and Uses of the North-West Marine Region. [Online]. Canberra: DEWHA. Available from: https://www.environment.gov.au/system/files/resources/2e286b1a-c6e2-4e3d-95cf-c98a8dea60fd/files/bioregional-profile.pdf

[DMP] Department of Mines and Petroleum, 2014. Petroleum in Western Australia. East Perth, Western Australia, April 2014.

[RDA] Regional Development Australia Kimberley, 2020. Business in the Kimberley Report. Tourism Industry. Available at: https://www.rdakimberley.com.au/wp-content/uploads/2020/03/Tourism-Industry_web.pdf

Silversea, 2021. Australia and New Zealand. Available at: https://www.silversea.com/destinations/australia-new-zealand-cruise.html Accessed 6/10/2021

Tourism NT, 2025. Northern Territory's Tourism Industry Strategy 2030, Annual Report Card 2023-2024. Available at: https://tourismnt.com.au/system/files/uploads/files/2025/NT%20Tourism%20Industry%20Strategy%202030%20-%20Annual%20Report%20Card%202023-24_2.PDF

True North, 2021. Departure dates. Available at: https://truenorth.com.au/departure-dates/. Accessed 6/10/21

Appendix I Values and sensitivities of the marine and coastal environment

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 04-Apr-2025

Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat
Acknowledgements

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	1
Wetlands of International Importance (Ramsar	3
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	10
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	85
Listed Migratory Species:	81

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	55
Commonwealth Heritage Places:	9
Listed Marine Species:	134
Whales and Other Cetaceans:	27
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	11
Habitat Critical to the Survival of Marine Turtles:	4

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	17
Regional Forest Agreements:	None
Nationally Important Wetlands:	10
EPBC Act Referrals:	176
Key Ecological Features (Marine):	9
Biologically Important Areas:	51
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

National Heritage Places		[Resource Information]
Name	State	Legal Status
Natural		
The West Kimberley	WA	Listed place

Wetlands of International Importance (Ramsar Wetlands)	[Resource Information]
Ramsar Site Name	Proximity
Ashmore reef national nature reserve	Within 10km of Ramsar site
Cobourg peninsula	Within Ramsar site
Ord river floodplain	Within Ramsar site

Commonwealth Marine Area	[Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)

Listed Threatened Species	[Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text

Scientific Name	Threatened Category	Presence Text
BIRD		
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Arenaria interpres Ruddy Turnstone [872]	Vulnerable	Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Vulnerable	Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Chloebia gouldiae listed as Erythrura gouldiae Gouldian Finch [90091]	Endangered	Species or species habitat known to occur within area
Epthianura crocea tunneyi Alligator Rivers Yellow Chat, Yellow Chat (Alligator Rivers) [67089]	Endangered	Species or species habitat may occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Endangered	Species or species habitat known to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Falcunculus frontatus whitei Crested Shrike-tit (northern), Northern Shrike-tit [26013]	Vulnerable	Species or species habitat likely to occur within area
Geophaps smithii blaauwi Partridge Pigeon (western) [66501]	Vulnerable	Species or species habitat likely to occur within area
Geophaps smithii smithii Partridge Pigeon (eastern) [64441]	Vulnerable	Species or species habitat known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica baueri Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380]	Endangered	Species or species habitat known to occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit [86432]	Endangered	Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]	Endangered	Roosting known to occur within area
Melanodryas cucullata melvillensis Tiwi Islands Hooded Robin, Hooded Robin (Tiwi Islands) [67092]	Critically Endangered	Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Phaethon lepturus fulvus		
Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Phaethon rubricauda westralis		
Red-tailed Tropicbird (Indian Ocean), Indian Ocean Red-tailed Tropicbird [91824]	Endangered	Breeding known to occur within area
Pluvialis squatarola		
Grey Plover [865]	Vulnerable	Roosting known to occur within area
Rostratula australis		
Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Sternula albifrons		
Little Tern [82849]	Vulnerable	Breeding known to occur within area
Tringa nebularia		
Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area
Tyto novaehollandiae kimberli		
Masked Owl (northern) [26048]	Vulnerable	Species or species habitat known to occur within area
Tyto novaehollandiae melvillensis		
Tiwi Masked Owl, Tiwi Islands Masked Owl [26049]	Endangered	Species or species habitat known to occur within area
Xenus cinereus		
Terek Sandpiper [59300]	Vulnerable	Roosting known to occur within area
FROG		
Uperoleia daviesae		
Howard River Toadlet, Davies's Toadlet [85375]	Vulnerable	Species or species habitat known to occur within area
MAMMAL		
Antechinus bellus		
Fawn Antechinus [344]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Conilurus penicillatus Brush-tailed Rabbit-rat, Brush-tailed Tree-rat, Pakooma [132]	Vulnerable	Species or species habitat known to occur within area
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat known to occur within area
Isoodon auratus auratus Golden Bandicoot (mainland) [66665]	Vulnerable	Species or species habitat likely to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat known to occur within area
Mesembriomys gouldii gouldii Black-footed Tree-rat (Kimberley and mainland Northern Territory), Djintamoonga, Manbul [87618]	Endangered	Species or species habitat known to occur within area
Mesembriomys gouldii melvillensis Black-footed Tree-rat (Melville Island) [87619]	Vulnerable	Species or species habitat known to occur within area
Orcaella heinsohni Australian Snubfin Dolphin [81322]	Vulnerable	Breeding known to occur within area
Petrogale concinna canescens Nabarlek (Top End) [87606]	Endangered	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Petrogale concinna concinna		
Nabarlek (Victoria River District) [87605]	Critically Endangered	Species or species habitat likely to occur within area
Petrogale concinna monastria		
Nabarlek (Kimberley) [87607]	Endangered	Species or species habitat known to occur within area
Phascogale pirata		
Northern Brush-tailed Phascogale [82954]	Vulnerable	Species or species habitat known to occur within area
Phascogale tapoatafa kimberleyensis		
Kimberley brush-tailed phascogale, Brush-tailed Phascogale (Kimberley) [88453]	Vulnerable	Species or species habitat likely to occur within area
Saccolaimus saccolaimus nudicluniatus		
Bare-rumped Sheath-tailed Bat, Bare-rumped Sheathtail Bat [66889]	Vulnerable	Species or species habitat likely to occur within area
Sminthopsis butleri		
Butler's Dunnart [302]	Vulnerable	Species or species habitat known to occur within area
Sousa sahulensis		
Australian Humpback Dolphin [87942]	Vulnerable	Breeding known to occur within area
Trichosurus vulpecula arnhemensis		
Northern Brushtail Possum [83091]	Vulnerable	Species or species habitat known to occur within area
Xeromys myoides		
Water Mouse, False Water Rat, Yirrkoo [66]	Vulnerable	Species or species habitat known to occur within area
PLANT		
Burmannia championii listed as Burmannia sp. Bathurst Island (R.Fensham 1021)		
[93461]	Endangered (listed as Burmannia sp. Bathurst Island	Species or species habitat likely to occur within area
Elaeocarpus miegei		
[65147]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Hoya australis subsp. oramicola a vine [55436]	Vulnerable	Species or species habitat known to occur within area
Mitrella tiwiensis a vine [82029]	Vulnerable	Species or species habitat likely to occur within area
Stylidium ensatum a triggerplant [86366]	Endangered	Species or species habitat known to occur within area
Tarennoidea wallichii [65173]	Endangered	Species or species habitat known to occur within area
Typhonium jonesii a herb [62412]	Endangered	Species or species habitat likely to occur within area
Typhonium mirabile a herb [79227]	Endangered	Species or species habitat likely to occur within area
Xylopia monosperma a shrub [82030]	Endangered	Species or species habitat known to occur within area
REPTILE		
Acanthophis hawkei Plains Death Adder [83821]	Vulnerable	Species or species habitat known to occur within area
Aipysurus apraefrontalis Short-nosed Sea Snake, Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area
Aipysurus foliosquama Leaf-scaled Sea Snake, Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat may occur within area
Aipysurus fuscus Dusky Sea Snake [1119]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Carettochelys insculpta Pig-nosed Turtle, Pitted Shell Turtle [1762]	Vulnerable	Species or species habitat may occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Tiliqua scincoides intermedia Northern Blue-tongued Skink [89838]	Critically Endangered	Species or species habitat known to occur within area
Varanus mertensi Mertens' Water Monitor, Mertens's Water Monitor [1568]	Endangered	Species or species habitat known to occur within area
Varanus mitchelli Mitchell's Water Monitor [1569]	Critically Endangered	Species or species habitat known to occur within area
SHARK		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Glyphis garricki Northern River Shark, New Guinea River Shark [82454]	Endangered	Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Glyphis glyphis Speartooth Shark [82453]	Critically Endangered	Species or species habitat known to occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Breeding known to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sphyrna lewini Scalloped Hammerhead [85267]	Conservation Dependent	Species or species habitat known to occur within area

Listed Migratory Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Foraging, feeding or related behaviour known to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat known to occur within area
Onychoprion anaethetus Bridled Tern [82845]		Breeding known to occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Species or species habitat known to occur within area
Sterna dougallii Roseate Tern [817]		Breeding likely to occur within area
Sternula albifrons Little Tern [82849]	Vulnerable	Breeding known to occur within area
Sula leucogaster Brown Booby [1022]		Breeding known to occur within area
Sula sula Red-footed Booby [1023]		Breeding known to occur within area
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat known to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat may occur within area
Carcharias taurus Grey Nurse Shark [64469]		Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Dugong dugon Dugong [28]		Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Megaptera novaeangliae Humpback Whale [38]		Breeding known to occur within area
Mobula alfredi as Manta alfredi Reef Manta Ray, Coastal Manta Ray [90033]		Species or species habitat known to occur within area
Mobula birostris as Manta birostris Giant Manta Ray [90034]		Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Orcaella heinsohni Australian Snubfin Dolphin [81322]	Vulnerable	Breeding known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Breeding known to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sousa sahulensis as Sousa chinensis Australian Humpback Dolphin [87942]	Vulnerable	Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
[Tursiops aduncus (Arafura/Timor Sea populations)](#)		
Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Migratory Terrestrial Species		
[Cecropis daurica](#)		
Red-rumped Swallow [80610]		Species or species habitat known to occur within area
[Cuculus optatus](#)		
Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat known to occur within area
[Hirundo rustica](#)		
Barn Swallow [662]		Species or species habitat known to occur within area
[Motacilla cinerea](#)		
Grey Wagtail [642]		Species or species habitat known to occur within area
[Motacilla flava](#)		
Yellow Wagtail [644]		Species or species habitat known to occur within area
Migratory Wetlands Species		
[Acrocephalus orientalis](#)		
Oriental Reed-Warbler [59570]		Species or species habitat known to occur within area
[Actitis hypoleucos](#)		
Common Sandpiper [59309]		Species or species habitat known to occur within area
[Arenaria interpres](#)		
Ruddy Turnstone [872]	Vulnerable	Roosting known to occur within area
[Calidris acuminata](#)		
Sharp-tailed Sandpiper [874]	Vulnerable	Roosting known to occur within area
[Calidris alba](#)		
Sanderling [875]		Roosting known to occur within area

Scientific Name	Threatened Category	Presence Text
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris subminuta Long-toed Stint [861]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Vulnerable	Roosting known to occur within area
Charadrius dubius Little Ringed Plover [896]		Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Roosting known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting known to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Glareola maldivarum Oriental Pratincole [840]		Roosting known to occur within area

Scientific Name	Threatened Category	Presence Text
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]	Endangered	Roosting known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting known to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]	Vulnerable	Roosting known to occur within area
Thalasseus bergii Greater Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area

Scientific Name	Threatened Category	Presence Text
Tringa incana		
Wandering Tattler [831]		Roosting known to occur within area
Tringa nebularia		
Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area
Tringa stagnatilis		
Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Xenus cinereus		
Terek Sandpiper [59300]	Vulnerable	Roosting known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Lands [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Commonwealth Land Name	State
Attorney-General - Australian Customs Service	
Commonwealth Land - Australian Customs Service [70998]	NT
Attorney-General - Australian Government Solicitor	
Commonwealth Land - Australian Government Solicitor [70092]	NT
Commonwealth Land - Australian Government Solicitor [71135]	NT
Commonwealth Land - Australian Government Solicitor [70996]	NT
Commonwealth Land - Australian Government Solicitor [70332]	NT
Commonwealth Land - Australian Government Solicitor [70208]	NT
Commonwealth Land - Australian Government Solicitor [70450]	NT
Commonwealth Land - Australian Government Solicitor [70089]	NT
Commonwealth Land - Deputy Crown Solicitor [70333]	NT
Commonwealth Land - Deputy Crown Solicitor [70994]	NT
Commonwealth Land - Deputy Crown Solicitor [70334]	NT
Defence	
Defence - AUSTRALIAN ARMY BAND - DARWIN [70042]	NT

Commonwealth Land Name	State
Defence - BRADSHAW FIELD TRAINING AREA [70043]	NT
Defence - DARWIN - AP10 RADAR SITE - LEE POINT [70021]	NT
Defence - DARWIN - AP3 RECEIVING STATION - LEE POINT [70044]	NT
Defence - DARWIN RELOCATIONS CENTRE [70045]	NT
Defence - DEFENCE FORCE CAREERS REFERENCE CENTRE [70046]	NT
Defence - Esanda Builidng [70048]	NT
Defence - LARRAKEYAH BARRACKS [70061]	NT
Defence - LEANYER BOMBING RANGE [70023]	NT
Defence - LEANYER BOMBING RANGE [70024]	NT
Defence - LEANYER BOMBING RANGE [70022]	NT
Defence - MT GOODWIN RADAR SITE [70063]	NT
Defence - Patrol Boat Base (DARWIN NAVAL BASE) [70041]	NT
Defence - QUAIL ISLAND BOMBING RANGE [70003]	NT
Defence - RAAF BASE DARWIN [70073]	NT
Defence - SHOAL BAY RECEIVING STATION [70037]	NT
Defence - STOKES HILL OIL FUEL INSTALLATION [70035]	NT
Defence - WINNELLIE TWO [70077]	NT
Defence - Defence Housing Authority	
Commonwealth Land - Director of Property Services Defence Estate [70855]	NT
Commonwealth Land - Director of Property Services Defence Estate [70856]	NT
Family and Community Services - Department of Community Services & Health	
Commonwealth Land - Department of Community Services & Health [70720]	NT
Finance and Administration	
Commonwealth Land - Department of Administrative Services [70091]	NT
Commonwealth Land - Department of Administrative Services [70590]	NT
Commonwealth Land - Department of Administrative Services [70210]	NT

Commonwealth Land Name	State
Immigration and Multicultural and Indigenous Affairs - Department of Immigration Local Government and Ethnic Affairs	
Commonwealth Land - Department of Immigration Local Government & Ethnic Affairs [70336]	NT
Transport and Regional Services	
Commonwealth Land - Department of Transport & Regional Development [70207]	NT
Unknown	
Commonwealth Land - [70327]	NT
Commonwealth Land - [70090]	NT
Commonwealth Land - [70580]	NT
Commonwealth Land - [70206]	NT
Commonwealth Land - [70203]	NT
Commonwealth Land - [70591]	NT
Commonwealth Land - [70593]	NT
Commonwealth Land - [70204]	NT
Commonwealth Land - [70205]	NT
Commonwealth Land - [70447]	NT
Commonwealth Land - [70993]	NT
Commonwealth Land - [70995]	NT
Commonwealth Land - [70594]	NT
Commonwealth Land - [70337]	NT
Commonwealth Land - [70595]	NT
Commonwealth Land - [70999]	NT
Commonwealth Land - [70338]	NT
Commonwealth Land - [70335]	NT

Commonwealth Heritage Places		[Resource Information]
Name	State	Status
Historic		
Larrakeyah Barracks Headquarters Building	NT	Listed place
Larrakeyah Barracks Precinct	NT	Listed place

Name	State	Status
Larrakeyah Barracks Sergeants Mess	NT	Listed place
RAAF Base Commanding Officers Residence	NT	Listed place
RAAF Base Precinct	NT	Listed place
RAAF Base Tropical Housing Type 2	NT	Listed place
RAAF Base Tropical Housing Type 3	NT	Listed place
Natural		
Bradshaw Defence Area	NT	Listed place
Scott Reef and Surrounds - Commonwealth Area	EXT	Listed place

Listed Marine Species [Resource Information]

Scientific Name	Threatened Category	Presence Text
Bird		
Acrocephalus orientalis Oriental Reed-Warbler [59570]		Species or species habitat known to occur within area overfly marine area
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus Common Noddy [825]		Foraging, feeding or related behaviour known to occur within area
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area overfly marine area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Arenaria interpres Ruddy Turnstone [872]	Vulnerable	Roosting known to occur within area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area overfly marine area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area overfly marine area
Calidris subminuta Long-toed Stint [861]		Roosting known to occur within area overfly marine area
Calidris tenuirostris Great Knot [862]	Vulnerable	Roosting known to occur within area overfly marine area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Cecropis daurica as Hirundo daurica		
Red-rumped Swallow [80610]		Species or species habitat known to occur within area overfly marine area
Chalcites osculans as Chrysococcyx osculans		
Black-eared Cuckoo [83425]		Species or species habitat known to occur within area overfly marine area
Charadrius dubius		
Little Ringed Plover [896]		Roosting known to occur within area overfly marine area
Charadrius leschenaultii		
Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus		
Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius ruficapillus		
Red-capped Plover [881]		Roosting known to occur within area overfly marine area
Charadrius veredus		
Oriental Plover, Oriental Dotterel [882]		Roosting known to occur within area overfly marine area
Chroicocephalus novaehollandiae as Larus novaehollandiae		
Silver Gull [82326]		Breeding known to occur within area
Fregata ariel		
Lesser Frigatebird, Least Frigatebird [1012]		Breeding known to occur within area
Fregata minor		
Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat known to occur within area
Gallinago megala		
Swinhoe's Snipe [864]		Roosting known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area overfly marine area
Glareola maldivarum Oriental Pratincole [840]		Roosting known to occur within area overfly marine area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Roosting known to occur within area overfly marine area
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area overfly marine area
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area overfly marine area
Limnodromus semipalmatus Asian Dowitcher [843]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]	Endangered	Roosting known to occur within area overfly marine area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Motacilla cinerea Grey Wagtail [642]		Species or species habitat known to occur within area overfly marine area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area overfly marine area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting known to occur within area overfly marine area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Onychoprion anaethetus as Sterna anaethetus Bridled Tern [82845]		Breeding known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Species or species habitat known to occur within area
Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area

Scientific Name	Threatened Category	Presence Text
Pluvialis squatarola Grey Plover [865]	Vulnerable	Roosting known to occur within area overfly marine area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area overfly marine area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area overfly marine area
Sterna dougallii Roseate Tern [817]		Breeding likely to occur within area
Sternula albifrons as Sterna albifrons Little Tern [82849]	Vulnerable	Breeding known to occur within area
Stiltia isabella Australian Pratincole [818]		Roosting known to occur within area overfly marine area
Sula leucogaster Brown Booby [1022]		Breeding known to occur within area
Sula sula Red-footed Booby [1023]		Breeding known to occur within area
Thalasseus bengalensis as Sterna bengalensis Lesser Crested Tern [66546]		Breeding known to occur within area
Thalasseus bergii as Sterna bergii Greater Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes as Heteroscelus brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
[Tringa incana as Heteroscelus incanus](#) Wandering Tattler [831]		Roosting known to occur within area
[Tringa nebularia](#) Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area overfly marine area
[Tringa stagnatilis](#) Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area overfly marine area
[Xenus cinereus](#) Terek Sandpiper [59300]	Vulnerable	Roosting known to occur within area overfly marine area
Fish		
[Bhanotia fasciolata](#) Corrugated Pipefish, Barbed Pipefish [66188]		Species or species habitat may occur within area
[Campichthys tricarinatus](#) Three-keel Pipefish [66192]		Species or species habitat may occur within area
[Choeroichthys brachysoma](#) Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
[Choeroichthys suillus](#) Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
[Corythoichthys amplexus](#) Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area
[Corythoichthys flavofasciatus](#) Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
[Corythoichthys haematopterus](#) Reef-top Pipefish [66201]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish [66202]		Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Festucalex cinctus Girdled Pipefish [66214]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus dunckeri Red-hair Pipefish, Duncker's Pipefish [66220]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys cyanospilos Blue-speckled Pipefish, Blue-spotted Pipefish [66228]		Species or species habitat may occur within area
Hippichthys parvicarinatus Short-keel Pipefish, Short-keeled Pipefish [66230]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
[Solegnathus hardwickii](#) Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
[Solegnathus lettiensis](#) Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
[Solenostomus cyanopterus](#) Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
[Syngnathoides biaculeatus](#) Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
[Trachyrhamphus bicoarctatus](#) Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
[Trachyrhamphus longirostris](#) Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammal		
[Dugong dugon](#) Dugong [28]		Species or species habitat known to occur within area
Reptile		
[Aipysurus apraefrontalis](#) Short-nosed Sea Snake, Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area
[Aipysurus duboisii](#) Dubois' Sea Snake, Dubois' Seasnake, Reef Shallows Sea Snake [1116]		Species or species habitat may occur within area
[Aipysurus foliosquama](#) Leaf-scaled Sea Snake, Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat may occur within area
[Aipysurus fuscus](#) Dusky Sea Snake [1119]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Aipysurus laevis Olive Sea Snake, Olive-brown Sea Snake [1120]		Species or species habitat may occur within area
Aipysurus mosaicus as Aipysurus eydouxii Mosaic Sea Snake [87261]		Species or species habitat may occur within area
Aipysurus tenuis Brown-lined Sea Snake, Mjoberg's Sea Snake [1121]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Crocodylus johnstoni Freshwater Crocodile, Johnston's Crocodile, Johnstone's Crocodile [1773]		Species or species habitat may occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Emydocephalus annulatus Eastern Turtle-headed Sea Snake [1125]		Species or species habitat may occur within area
Ephalophis greyae as Ephalophis greyi Mangrove Sea Snake [93738]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Hydrelaps darwiniensis Port Darwin Sea Snake, Black-ringed Mangrove Sea Snake [1100]		Species or species habitat may occur within area
Hydrophis atriceps Black-headed Sea Snake, Banded Sea Snake [1101]		Species or species habitat may occur within area
Hydrophis coggeri Cogger's Sea Snake, Black-headed Sea Snake [25925]		Species or species habitat may occur within area
Hydrophis elegans Elegant Sea Snake, Bar-bellied Sea Snake [1104]		Species or species habitat may occur within area
Hydrophis hardwickii as Lapemis hardwickii Spine-bellied Sea Snake [93516]		Species or species habitat may occur within area
Hydrophis inornatus Plain Sea Snake [1107]		Species or species habitat may occur within area
Hydrophis kingii as Disteira kingii Spectacled Sea Snake [93511]		Species or species habitat may occur within area
Hydrophis macdowelli as Hydrophis mcdowelli MacDowell's Sea Snake, Small-headed Sea Snake, [75601]		Species or species habitat may occur within area
Hydrophis major as Disteira major Olive-headed Sea Snake [93512]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Sea Snake, Ornate Reef Sea Snake [1111]		Species or species habitat may occur within area
Hydrophis pacificus Pacific Sea Snake, Large-headed Sea Snake [1112]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Hydrophis peronii as Acalyptophis peronii Horned Sea Snake [93509]		Species or species habitat may occur within area
Hydrophis platura as Pelamis platurus Yellow-bellied Sea Snake [93746]		Species or species habitat may occur within area
Hydrophis stokesii as Astrotia stokesii Stokes' Sea Snake [93510]		Species or species habitat may occur within area
Hydrophis zweifeli as Enhydrina schistosa Australian Beaked Sea Snake [93514]		Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Parahydrophis mertoni Arafura Smooth Sea Snake, Northern Mangrove Sea Snake [1090]		Species or species habitat may occur within area

Whales and Other Cetaceans		[Resource Information]
Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area

Current Scientific Name	Status	Type of Presence
[Balaenoptera physalus](#) Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
[Delphinus delphis](#) Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
[Feresa attenuata](#) Pygmy Killer Whale [61]		Species or species habitat may occur within area
[Globicephala macrorhynchus](#) Short-finned Pilot Whale [62]		Species or species habitat may occur within area
[Grampus griseus](#) Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
[Kogia breviceps](#) Pygmy Sperm Whale [57]		Species or species habitat may occur within area
[Kogia sima](#) Dwarf Sperm Whale [85043]		Species or species habitat may occur within area
[Lagenodelphis hosei](#) Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area
[Megaptera novaeangliae](#) Humpback Whale [38]		Breeding known to occur within area
[Mesoplodon densirostris](#) Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
[Orcaella heinsohni](#) Australian Snubfin Dolphin [81322]	Vulnerable	Breeding known to occur within area

Current Scientific Name	Status	Type of Presence
[Orcinus orca](#) Killer Whale, Orca [46]		Species or species habitat may occur within area
[Peponocephala electra](#) Melon-headed Whale [47]		Species or species habitat may occur within area
[Physeter macrocephalus](#) Sperm Whale [59]		Species or species habitat may occur within area
[Pseudorca crassidens](#) False Killer Whale [48]		Species or species habitat likely to occur within area
[Sousa sahulensis](#) Australian Humpback Dolphin [87942]	Vulnerable	Breeding known to occur within area
[Stenella attenuata](#) Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
[Stenella coeruleoalba](#) Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
[Stenella longirostris](#) Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
[Steno bredanensis](#) Rough-toothed Dolphin [30]		Species or species habitat may occur within area
[Tursiops aduncus](#) Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
[Tursiops aduncus (Arafura/Timor Sea populations)](#) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area

Current Scientific Name	Status	Type of Presence
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks	[Resource Information]
Park Name	Zone & IUCN Categories
Kimberley	Habitat Protection Zone (IUCN IV)
Oceanic Shoals	Habitat Protection Zone (IUCN IV)
Joseph Bonaparte Gulf	Multiple Use Zone (IUCN VI)
Kimberley	Multiple Use Zone (IUCN VI)
Oceanic Shoals	Multiple Use Zone (IUCN VI)
Oceanic Shoals	Multiple Use Zone (IUCN VI)
Kimberley	National Park Zone (IUCN II)
Oceanic Shoals	National Park Zone (IUCN II)
Cartier Island	Sanctuary Zone (IUCN Ia)
Joseph Bonaparte Gulf	Special Purpose Zone (IUCN VI)
Oceanic Shoals	Special Purpose Zone (Trawl) (IUCN VI)

Habitat Critical to the Survival of Marine Turtles		[Resource Information]
Scientific Name	Behaviour	Presence
All year (Jun - Aug)		
Natator depressus Flatback Turtle [59257]	Nesting	Known to occur
Dec - Jan		
Dermochelys coriacea Leatherback Turtle [1768]	Nesting	Known to occur
May - Jul		

Scientific Name	Behaviour	Presence
Lepidochelys olivacea		
Olive Ridley Turtle [1767]	Nesting	Known to occur

Oct - Mar		
Chelonia mydas		
Green Turtle [1765]	Nesting	Known to occur

Extra Information

State and Territory Reserves		[Resource Information]
Protected Area Name	Reserve Type	State
Browse Island	Nature Reserve	WA
Casuarina	Coastal Reserve	NT
Charles Darwin	National Park	NT
Djukbinj	National Park	NT
Garig Gunak Barlu	National Park	NT
Garig Gunak Barlu	Marine Park	NT
Holmes Jungle	Nature Park	NT
Lalang-gaddam	Marine Park	WA
Lesueur Island	Nature Reserve	WA
Low Rocks	Nature Reserve	WA
Niiwalarra Islands	National Park	WA
North Kimberley	Marine Park	WA
Ord River	Nature Reserve	WA
Pelican Island	Nature Reserve	WA
Scott Reef	Nature Reserve	WA
Unnamed WA41775	5(1)(h) Reserve	WA
Unnamed WA44677	5(1)(h) Reserve	WA

Nationally Important Wetlands	[Resource Information]
Wetland Name	State
Adelaide River Floodplain System	NT

Wetland Name	State
Cobourg Peninsula System	NT
Daly-Reynolds Floodplain-Estuary System	NT
Finniss Floodplain and Fog Bay Systems	NT
Legune Wetlands	NT
Moyle Floodplain and Hyland Bay System	NT
Ord Estuary System	WA
Parry Floodplain	WA
Port Darwin	NT
Shoal Bay - Micket Creek	NT

EPBC Act Referrals			[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status
2 geotechnical surveys - preliminary and final	2006/2886		Completed
Bayview, The Boulevarde, Darwin, NT	2015/7466		Completed
Boskalis Cambridge Gulf Marine Sand Sourcing Project	2025/10106		Referral Decision
Browse Carbon Capture and Storage Project	2024/10028		Referral Decision
Browse to North West Shelf Development, Indian Ocean, WA	2018/8319		Approval
Clarence Strait Offshore Tidal Energy Project	2008/4660		Assessment
Darwin Pipeline Duplication (DPD) Project	2022/09372		Post-Approval
Darwin Pipeline Duplication DPD Project	2022/9166		Completed
Deep Water Northwest Shelf 2D Seismic Survey	2007/3260		Completed
Marine Route Survey for Subsea Fibre Optic Data Cable System - Australia West	2024/09826		Completed
Project Crux Cable Lay and Operation	2022/09441		Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Project Fitzroy Expansion Offshore Cable Lay	2023/09674		Referral Decision
Puffin Oil wells 7, 8 & 9 development	2005/2336		Completed
Replacement of the East Point Outfall	2011/6099		Completed
Tiwi H2 Project	2022/09347		Assessment
Controlled action			
275 km gas pipeline from Wadeye to existing Darwin gas pipeline	2006/2930	Controlled Action	Post-Approval
2-D seismic survey Scott Reef	2000/125	Controlled Action	Post-Approval
Augmentation of the East Point Effluent Rising Main and Extension of East Point Outfall	2009/5113	Controlled Action	Post-Approval
Barramundi Nursery Farm	2005/2378	Controlled Action	Completed
Blacktip Project - Wharf Construction	2007/3293	Controlled Action	Completed
Bonaparte Liquified Natural Gas Project	2011/6141	Controlled Action	Post-Approval
Browse FLNG Development, Commonwealth Waters	2013/7079	Controlled Action	Post-Approval
Conduct an exploration drilling campaign	2010/5718	Controlled Action	Completed
Darwin to Moomba Gas Pipeline	2001/213	Controlled Action	Completed
Develop Ichthys gas-condensate field permit area W	2006/2767	Controlled Action	Completed
Development of Blacktip Gas Field	2003/1180	Controlled Action	Post-Approval
Development of Browse Basin Gas Fields (Upstream)	2008/4111	Controlled Action	Completed
Glyde Point and Middle Arm Peninsula Infrastructure Support	2001/334	Controlled Action	Completed
Glyde Point Industrial Estate	2001/336	Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Glyde Point Industrial Estate and Associated Infrastructure	2004/1506	Controlled Action	Completed
Hardwood Plantation	2001/229	Controlled Action	Post-Approval
Ichthys Gas Field, Offshore and onshore processing facilities and subsea pipeline	2008/4208	Controlled Action	Post-Approval
Kilimiraka Mineral Sands and Associated Infrastructure (Bathurst Island), NT	2012/6587	Controlled Action	Assessment Approach
Lee Point Master-planned urban development, Darwin, NT	2015/7591	Controlled Action	Post-Approval
Montara 4, 5, and 6 Oil Production Wells, and Montara 3 Gas Re-Injection Well	2002/755	Controlled Action	Post-Approval
Muirhead Subdivision	2010/5525	Controlled Action	Post-Approval
Operation of 17 Tiger Helicopters at Robertson Barracks	2004/1459	Controlled Action	Post-Approval
Port Patterson Barramundi Sea Cage Farm	2005/2149	Controlled Action	Completed
Prelude Floating Liquefied Natural Gas Facility and Gas Field Development	2008/4146	Controlled Action	Post-Approval
Project Sea Dragon stage 1 prawn aquaculture project, NT	2015/7527	Controlled Action	Post-Approval
PTTEP AA Floating LNG Facility	2011/6025	Controlled Action	Completed
Residential subdivision of Lot 9793 (formerly Lots 9774 and 9779) Lee Point Road	2005/2108	Controlled Action	Post-Approval
Shipping Channel Enhancement	2010/5431	Controlled Action	Completed
Talisman Saber 2005 Military Exercise	2004/1819	Controlled Action	Post-Approval
Tassie Shoal Gas Reforming and Methanol Production Plants - NT/P48	2000/108	Controlled Action	Post-Approval
Tassie Shoal LNG Project	2003/1067	Controlled Action	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Torosa South Initial Appraisal Drilling	2007/3500	Controlled Action	Completed
Trans-territory Gas Pipeline	2003/1186	Controlled Action	Completed
Tropical Tidal Testing Centre, Clarence Strait, 50km NE Darwin	2014/7299	Controlled Action	Guidelines Issued
Wuudagu Bauxite Project	2019/8606	Controlled Action	Assessment Approach
Not controlled action			
2D seismic survey, exploration permit NT/P67	2004/1587	Not Controlled Action	Completed
2D Seismic Survey in Permit Areas WA-318-P & WA-319-P, near Cape Londonderry	2004/1687	Not Controlled Action	Completed
3D marine seismic survey in WA 314P and WA 315P	2004/1927	Not Controlled Action	Completed
Adele Trend TQ3D Seismic Survey	2001/252	Not Controlled Action	Completed
AEC International Hydrocarbon Well Puffin 6	2000/36	Not Controlled Action	Completed
Aquaculture farm	2002/737	Not Controlled Action	Completed
Backpacker-1 Offshore Hydrocarbon Exploration Well	2001/300	Not Controlled Action	Completed
Barossa-1 (NT/P69), Caldita-2 (NT/P61) exploration wells	2006/2793	Not Controlled Action	Completed
Caldita-1 Hydrocarbon Exploration Well, NT/P61	2004/1854	Not Controlled Action	Completed
Construction and operation of Radar Infrastructure	2004/1406	Not Controlled Action	Completed
Coot-1 hydrocarbon exploration well, Permit Area AC/L2 or AC/L3	2001/296	Not Controlled Action	Completed
Core Breeding and Broodstock Maturation Centre development, Point Ceylon, NT	2016/7713	Not Controlled Action	Completed
Cox Peninsular Remediation Project, NT	2015/7587	Not Controlled Action	Completed
Crux-A and Crux-B appraisal wells, Petroleum Permit Area AC/P23	2006/2748	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Crux gas-liquids development in permit AC/P23	2006/3154	Not Controlled Action	Completed
Darwin Port Maintenance Dredging, Darwin Harbour, NT	2017/8122	Not Controlled Action	Completed
Drilling of 12 Hydrocarbon Exploration Wells, Permit Area WA-371-P	2006/3005	Not Controlled Action	Completed
Drilling of exploration wells, Permit areas WA-301-P to WA-305-P	2002/769	Not Controlled Action	Completed
Drilling of Marina-1 Exploration Well	2007/3586	Not Controlled Action	Completed
Echuca Shoals-2 Exploration of Appraisal Well	2006/3020	Not Controlled Action	Completed
Exploration Well AC/P23	2001/234	Not Controlled Action	Completed
Kaleidoscope exploration well	2001/182	Not Controlled Action	Completed
Marine Seismic Survey in WA-239-P	2000/24	Not Controlled Action	Completed
Marine Survey for the Australia-ASEAN Power Link AAPL	2020/8714	Not Controlled Action	Completed
Montara-3 Offshore Hydrocarbon Exploration Well Permit Area AC/RL3	2001/489	Not Controlled Action	Completed
Nexus Drilling Program NT-P66	2007/3745	Not Controlled Action	Completed
P30 Hydrocarbon Exploration Well	2001/293	Not Controlled Action	Completed
Project Highclere Geophysical Survey	2021/9023	Not Controlled Action	Completed
Project Sea Dragon Stage 1 Hatchery - Gunn Point, NT	2017/8092	Not Controlled Action	Completed
Residential Complex - Lots 6575 and 6576	2001/163	Not Controlled Action	Completed
Saucepan 1 Exploration Well ACP23	2000/2	Not Controlled Action	Completed
Skua and Swift Oilfields	2006/3195	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Strumbo-1 Gas Exploration Well Permit Area WA-288-P	2002/884	Not Controlled Action	Completed
Thresher-1 Well	2000/84	Not Controlled Action	Completed
Waterfront Redevelopment	2003/1256	Not Controlled Action	Completed
Not controlled action (particular manner)			
2 (3D) Marine Seismic Surveys	2009/4994	Not Controlled Action (Particular Manner)	Completed
2D and 3D Seismic Survey	2011/6197	Not Controlled Action (Particular Manner)	Post-Approval
2D and 3D Seismic Survey WA-405-P	2008/4133	Not Controlled Action (Particular Manner)	Post-Approval
2D and 3D Seismic Survey WA-405-P	2009/5104	Not Controlled Action (Particular Manner)	Post-Approval
2D Marine Seismic Survey	2009/4728	Not Controlled Action (Particular Manner)	Post-Approval
2D marine seismic survey of Braveheart,Kurrajong,Sunshine and Crocodile	2006/2917	Not Controlled Action (Particular Manner)	Post-Approval
2D marine seismic survey within permit area WA-318-P	2007/3879	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic Marine Survey	2001/363	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic survey	2009/5076	Not Controlled Action (Particular Manner)	Post-Approval
2D seismic survey in permit areas WA-274P and WA-281P	2004/1521	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
2D Seismic Survey in WA Permit Area TP/22 and Commonwealth Permit Area WA-280-P	2005/2100	Not Controlled Action (Particular Manner)	Post-Approval
3D Marine Seismic Survey	2008/4437	Not Controlled Action (Particular Manner)	Post-Approval
3D Marine Seismic Survey	2009/4681	Not Controlled Action (Particular Manner)	Post-Approval
3D Marine Seismic Survey, Permit AC/P 23	2005/2364	Not Controlled Action (Particular Manner)	Post-Approval
3D marine seismic Survey - Maxima 3D MSS	2006/2945	Not Controlled Action (Particular Manner)	Post-Approval
3D Seismic Survey	2006/2729	Not Controlled Action (Particular Manner)	Post-Approval
3D Seismic Survey, Browse Basin, WA	2009/5048	Not Controlled Action (Particular Manner)	Post-Approval
3D Seismic Survey, near Scott Reef, Browse Basin	2005/2126	Not Controlled Action (Particular Manner)	Post-Approval
3D Seismic Survey (NT/P68)	2006/2980	Not Controlled Action (Particular Manner)	Post-Approval
3D Seismic Survey WA-406-P Bonaparte Basin	2007/3904	Not Controlled Action (Particular Manner)	Post-Approval
AC/P37 3D Seismic Survey Ashmore Cartier	2007/3774	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Aurora MC3D Marine Seismic Survey	2010/5510	Not Controlled Action (Particular Manner)	Post-Approval
Bassett 3D Marine Seismic Survey	2010/5538	Not Controlled Action (Particular Manner)	Post-Approval
Blacktip Gas Project Yelcherr Beach Wharf Construction	2007/3537	Not Controlled Action (Particular Manner)	Post-Approval
Bonaparte 2D & 3D marine seismic survey	2011/5962	Not Controlled Action (Particular Manner)	Post-Approval
Bonaparte 3D & 2D Seismic Survey, in NT/P82, Timor Sea	2012/6398	Not Controlled Action (Particular Manner)	Post-Approval
Bonaparte Basin Barossa Appraisal Drilling Campaign, NT	2012/6481	Not Controlled Action (Particular Manner)	Post-Approval
Bonaparte Basin Seabed Mapping Survey	2009/4951	Not Controlled Action (Particular Manner)	Post-Approval
Bonaparte Seismic and Bathymetric Survey	2012/6295	Not Controlled Action (Particular Manner)	Post-Approval
Braveheart 2D Infill Marine Seismic Survey 100km offshore	2008/4442	Not Controlled Action (Particular Manner)	Post-Approval
Braveheart 2D Marine Seismic Survey	2005/2322	Not Controlled Action (Particular Manner)	Post-Approval
Caldita 3D Marine Seismic Survey - NT/P61, NT/P69, and acreage release area NT06-5	2006/3142	Not Controlled Action (Particular Manner)	Post-Approval
Canis 3D Marine Seismic Survey	2008/4492	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Cartier East and Cartier West 3D Marine Seismic Surveys	2009/5230	Not Controlled Action (Particular Manner)	Post-Approval
Caswell MC3D Marine Seismic Survey	2012/6594	Not Controlled Action (Particular Manner)	Post-Approval
Conduct an exploration drilling campaign	2011/5964	Not Controlled Action (Particular Manner)	Post-Approval
Dredging the outer shipping channels of Darwin Harbour	2013/6988	Not Controlled Action (Particular Manner)	Post-Approval
Drilling of Exploration & Appraisal Wells Braveheart-1 & Cornea-3	2009/5160	Not Controlled Action (Particular Manner)	Post-Approval
Endurance 3D Marine Seismic Data Acquisition Survey	2007/3667	Not Controlled Action (Particular Manner)	Post-Approval
Exploration Drilling Campaign	2011/6047	Not Controlled Action (Particular Manner)	Post-Approval
Exploration Drilling Campaign, Browse Basin, WA-341-P, AC-P36 and WA-343-P	2013/6898	Not Controlled Action (Particular Manner)	Post-Approval
Exploration Drilling in Permit Areas WA-402-P & WA-403-P	2010/5297	Not Controlled Action (Particular Manner)	Post-Approval
Exploration Drilling Program - Permit areas - WA-314-P, WA-315-P, WA-398-P.	2008/4064	Not Controlled Action (Particular Manner)	Post-Approval
Fishburn2D Marine Seismic Survey	2012/6659	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Floyd 3D and Chisel 3D Seismic Surveys	2011/6220	Not Controlled Action (Particular Manner)	Post-Approval
Geoscience Australia - Marine survey in Browse Basin to acquire data to assist assessment of CO2 sto	2013/6747	Not Controlled Action (Particular Manner)	Post-Approval
Gicea 3D Marine Seismic Survey	2008/4389	Not Controlled Action (Particular Manner)	Post-Approval
Gigas 2D Pilot Ocean Bottom Cable Marine Seismic Survey	2007/3839	Not Controlled Action (Particular Manner)	Post-Approval
Gold 2D Marine Seismic Survey Permit Areas WA375P and WA376P	2009/4698	Not Controlled Action (Particular Manner)	Post-Approval
Ichthys 3D Marine Seismic Survey	2010/5550	Not Controlled Action (Particular Manner)	Post-Approval
Joseph Bonaparte Gulf Seabed mapping survey	2010/5517	Not Controlled Action (Particular Manner)	Post-Approval
Kingtree & Ironstone-1 Exploration Wells	2011/5935	Not Controlled Action (Particular Manner)	Post-Approval
Kraken, Lusca & Asperus 3D Marine Seismic Survey	2013/6730	Not Controlled Action (Particular Manner)	Post-Approval
Malita West 3D Seismic Survey WA-402-P and WA-403-P	2007/3936	Not Controlled Action (Particular Manner)	Post-Approval
Marine Environmental Survey 2012	2012/6310	Not Controlled Action (Particular Manner)	Post-Approval
Nova 3D Seismic Survey	2013/6825	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
NT/P77 3D Marine Seismic Survey	2009/4683	Not Controlled Action (Particular Manner)	Post-Approval
NT/P80 2010 2D Marine Seismic Survey	2010/5487	Not Controlled Action (Particular Manner)	Post-Approval
Octantis 3D Marine Seismic Survey, Permit Area AC/P41 off northern Western Australia	2007/3369	Not Controlled Action (Particular Manner)	Post-Approval
Offshore Exploration Drilling Campaign	2011/6222	Not Controlled Action (Particular Manner)	Post-Approval
Offshore Fibre Optic Cable Network Construction & Operation, Port Hedland WA to Darwin NT	2014/7223	Not Controlled Action (Particular Manner)	Post-Approval
Offshore Gas Exploration Drilling Campaign	2012/6384	Not Controlled Action (Particular Manner)	Post-Approval
Panda NT/P76 3D Seismic Acquisition Survey Program	2009/4992	Not Controlled Action (Particular Manner)	Post-Approval
Petrel MC2D Marine Seismic Survey	2010/5368	Not Controlled Action (Particular Manner)	Post-Approval
Pilot Appraisal Well - Torosa South 1	2008/3991	Not Controlled Action (Particular Manner)	Post-Approval
Removal of Potential Unexploded Ordnance within NAXA	2012/6503	Not Controlled Action (Particular Manner)	Post-Approval
Rosebud 3D Marine Seismic Survey in WA-30-R and TR/5	2012/6493	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Santos Petrel-7 Offshore Appraisal Drilling Programme (Bonaparte Basin)	2011/5934	Not Controlled Action (Particular Manner)	Post-Approval
Schild MC3D Marine Seismic Survey	2012/6373	Not Controlled Action (Particular Manner)	Post-Approval
Schild Phase 11 MC3D Marine Seismic Survey, Browse Basin	2013/6894	Not Controlled Action (Particular Manner)	Post-Approval
Scott Reef Seismic Research	2006/2647	Not Controlled Action (Particular Manner)	Post-Approval
Searcher bathymetry & geochemical seismic survey, Brawse Basin,Timor Sea,WA	2013/6980	Not Controlled Action (Particular Manner)	Post-Approval
Sonar and Acoustic Trials	2001/345	Not Controlled Action (Particular Manner)	Post-Approval
Sunshine Infill 2D and Mimosa 2D Marine Seismic Surveys	2009/4699	Not Controlled Action (Particular Manner)	Post-Approval
Tiffany 3D Seismic Survey	2010/5339	Not Controlled Action (Particular Manner)	Post-Approval
Torosa-5 Apraisal Well, WA-30-R	2008/4430	Not Controlled Action (Particular Manner)	Post-Approval
Tow West Atlas wreck from present location to boundary of EEZ	2010/5652	Not Controlled Action (Particular Manner)	Post-Approval
Tridacna 3D Ocean Bottom Cable Marine Seismic Survey	2011/5959	Not Controlled Action (Particular Manner)	Post-Approval
Vampire 2D Non Exclusive Seismic Survey, WA	2010/5543	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Westralia SPAN Marine Seismic Survey, WA & NT	2012/6463	Not Controlled Action (Particular Manner)	Post-Approval
Woodside Southern Browse 3D Seismic Survey, WA	2007/3534	Not Controlled Action (Particular Manner)	Post-Approval
Zeemeermin MC3D seismic survey, Browse Basin, Offshore WA	2009/5023	Not Controlled Action (Particular Manner)	Post-Approval
Zeppelin 3D Seismic Survey	2011/6148	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
2D Marine Seismic Survey	2008/4623	Referral Decision	Completed
Aurora extension MC3D Marine Seismic Survey	2011/5887	Referral Decision	Completed
BRSN08 3D Marine Seismic Survey	2008/4582	Referral Decision	Completed
Experimental Study of Behavioural and Physiological Impact on Fish of Seismic Ex	2006/2625	Referral Decision	Completed
Nova 3D Seismic Survey, WA 442-NT/P81, Joseph Bonaparte Gulf	2013/6820	Referral Decision	Completed
Pilot Appraisal Well - Torosa South-1	2008/3985	Referral Decision	Completed
Puffin South-West Development of Oil Reserves	2007/3834	Referral Decision	Completed
Seismic Data Acquisition, Browse Basin	2010/5475	Referral Decision	Completed

Key Ecological Features [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Ancient coastline at 125 m depth contour	North-west

Name	Region
Ashmore Reef and Cartier Island and surrounding Commonwealth waters	North-west
Carbonate bank and terrace system of the Sahul Shelf	North-west
Carbonate bank and terrace system of the Van Diemen Rise	North
Continental Slope Demersal Fish Communities	North-west
Pinnacles of the Bonaparte Basin	North-west
Pinnacles of the Bonaparte Basin	North
Seringapatam Reef and Commonwealth waters in the Scott Reef Complex	North-west
Shelf break and slope of the Arafura Shelf	North

Biologically Important Areas		[Resource Information]
Scientific Name	Behaviour	Presence
Dolphins		
Orcaella heinsohni Australian Snubfin Dolphin [81322]	Breeding	Known to occur
Orcaella heinsohni Australian Snubfin Dolphin [81322]	Calving	Known to occur
Orcaella heinsohni Australian Snubfin Dolphin [81322]	Foraging	Known to occur
Orcaella heinsohni Australian Snubfin Dolphin [81322]	Foraging (high density prey)	Known to occur
Orcaella heinsohni Australian Snubfin Dolphin [81322]	Resting	Known to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Breeding	Likely to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Breeding	Known to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Calving	Likely to occur

Scientific Name	Behaviour	Presence
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Calving	Known to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Foraging	Known to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Foraging	Likely to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Foraging (high density prey)	Likely to occur
Sousa chinensis Indo-Pacific Humpback Dolphin [50]	Foraging (high density prey)	Known to occur
Tursiops aduncus Indo-Pacific/Spotted Bottlenose Dolphin [68418]	Breeding	Known to occur
Marine Turtles		
Caretta caretta Loggerhead Turtle [1763]	Foraging	Known to occur
Chelonia mydas Green Turtle [1765]	Foraging	Likely to occur
Chelonia mydas Green Turtle [1765]	Foraging	Known to occur
Chelonia mydas Green Turtle [1765]	Internesting	Likely to occur
Chelonia mydas Green Turtle [1765]	Internesting buffer	Known to occur
Chelonia mydas Green Turtle [1765]	Internesting buffer	Likely to occur
Chelonia mydas Green Turtle [1765]	Nesting	Known to occur
Chelonia mydas Green Turtle [1765]	Nesting	Likely to occur

Scientific Name	Behaviour	Presence
Eretmochelys imbricata Hawksbill Turtle [1766]	Foraging	Likely to occur
Eretmochelys imbricata Hawksbill Turtle [1766]	Internesting	Likely to occur
Eretmochelys imbricata Hawksbill Turtle [1766]	Internesting buffer	Known to occur
Eretmochelys imbricata Hawksbill Turtle [1766]	Internesting buffer	Likely to occur
Lepidochelys olivacea Olive Ridley Turtle [1767]	Foraging	Likely to occur
Lepidochelys olivacea Olive Ridley Turtle [1767]	Foraging	Known to occur
Lepidochelys olivacea Olive Ridley Turtle [1767]	Internesting	Likely to occur
Natator depressus Flatback Turtle [59257]	Foraging	Known to occur
Natator depressus Flatback Turtle [59257]	Internesting	Likely to occur
Natator depressus Flatback Turtle [59257]	Internesting buffer	Known to occur
Natator depressus Flatback Turtle [59257]	Nesting	Known to occur
Seabirds		
Ardenna tenuirostris Short-tailed Shearwater [84292]	Breeding	Known to occur
Fregata ariel Lesser Frigatebird [1012]	Breeding	Known to occur
Fregata minor Greater Frigatebird [1013]	Breeding	Known to occur
Phaethon lepturus White-tailed Tropicbird [1014]	Breeding	Known to occur

Scientific Name	Behaviour	Presence
Sterna dougallii Roseate Tern [817]	Breeding	Known to occur
Sternula albifrons sinensis Little Tern [82850]	Breeding	Known to occur
Sternula albifrons sinensis Little Tern [82850]	Resting	Known to occur
Sula leucogaster Brown Booby [1022]	Breeding	Known to occur
Sula sula Red-footed Booby [1023]	Breeding	Known to occur
Thalasseus bengalensis Lesser Crested Tern [66546]	Breeding	Known to occur
Thalasseus bergii Crested Tern [83000]	Breeding (high numbers)	Known to occur
Sharks		
Rhincodon typus Whale Shark [66680]	Foraging	Known to occur
Whales		
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging	Known to occur
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Migration	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Calving	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Migration	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Nursing	Known to occur

Scientific Name	Behaviour	Presence
Megaptera novaeangliae		
Humpback Whale [38]	Resting	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data is available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on the contents of this report.

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions when time permits.

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded breeding sites; and
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

© Commonwealth of Australia
Department of Climate Change, Energy, the Environment and Water
GPO Box 3090
Canberra ACT 2601 Australia
+61 2 6274 1111