TECHNICAL DOCUMENT

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Title:	**AC-P54 and AC-RL7 Exploration and Appraisal Drilling Environment Plan Summary**		
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ABBREVIATIONS

Abbreviation	Description
ABF	Australian Border Force
AFZ	Australian Fishery Zone
AHIS	Aboriginal Heritage Inquiry System
AHS	Australian Hydrographic Services
AHTS	Anchor Handling Tug Supply
AICS	Australian Inventory of Chemical Substances
AIS	Automatic Identification System
ALARP	As Low As Reasonably Practicable
AMOSC	Australian Marine Oil Spill Case
AMP	Australian Marine Parks
AMSA	Australian Maritime Safety Authority
ANZECC	Australian and New Zealand Environment and Conservation Council
APASA	Asia Pacific Applied Science Associates
API	American Petroleum Institute
APPEA	Australian Petroleum Production & Exploration Association
AS/NZS	Australian Standard/ New Zealand Standard
AUD	Australian Dollars
Bbl	Barrel of Oil (unit)
BCP	PTTEP AA Blowout Contingency Plan
BIA	Biologically Important Area
BOD	Biological Oxygen Demand
BOM	Bureau of Meteorology
Bonn Convention	Convention on the Conservation of Migratory Species of Wild Animals 1979
BOP	Blowout Preventer
BWMP	Ballast Water Management Plan
BWMS	Ballast Water Management System
CAMBA	China-Australia Migratory Bird Agreement
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CEMP	Crisis and Emergency Management Plan
CEO	Chief Executive Officer
CHARM	Chemical Hazard Risk Management
CMR	Commonwealth Marine Reserve
CMS	Capability Management System
CMT	Crisis Management Team
COLREGs	Convention on the International Regulations for Preventing Collisions at Sea 1972
CO_2	Carbon dioxide
CPT	Cone Penetrometer Testing

Abbreviation	Description
CSS	Check-Shot Survey
DAWR	Department of Agriculture and water Resources
dB	Decibel
DBCA	Department of Biodiversity, Conservation and Attractions
DEWHA	Department of Environment, Water, Heritage and the Arts (now Department of Environment)
DFAT	Department of Foreign Affairs and Trade
DMIRS	Department of Mines, Industry Regulation and Safety
DMS	Drilling and Well Services Management System
DOAA	Department of Aboriginal Affairs
DoE	Department of Environment
DoEE	Department of Environment & Energy (formerly)
DoF (WA)	Department of Fisheries (WA)
DoIR	Department of Industry and Resources
DoNP	Director of National Parks
DoT	Department of Transport
DPaW	Department of Parks and Wildlife
DPIRD	Department of Primary Industries and Regional Development
DRAs	Due Regard Areas
DSV	Drilling Supervisor
EADA	Exploration and Appraisal Drilling Area
EADP	Exploration and Appraisal Drilling Program
EEZ	Exclusive Economic Zone
EHS	Environmental, Health and Safety
EIAPP	Engine International Air Pollution Prevention
EMBA	Environment that May Be Affected
EMT	Emergency Management Team
ENVID	Environmental Hazard Identification
EP	"Environment Plan" – refers to this PTTEP AA AC/P54 and Ac/RL7 Exploration and Appraisal Drilling Environment Plan
EPA	Environmental Protection Agency
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
EPOs	Environmental Performance Outcomes
EPSs	Environmental Performance Standards
ERM	*Environmental Resources Management Pty Ltd*
ESD	Ecological Sustainable Development
E & P Forum	Exploration and Production Forum
FEWD	Formation Evaluation While Drilling
FPSO	Floating Production, Storage and Offtake facility
gt	Gross tonnes
HMCS	Harmonised Mandatory Control Scheme

Abbreviation	Description
HSE	Health, Safety and Environment
HQ	Hazard Quotient
IAP	Incident Action Plan
IAPP	International Air Pollution Prevention
IEE	International Energy Efficiency
IFC	International Finance Corporation
IMDG	International Maritime Dangerous Goods
IMO	International Maritime Organisation
IMP	Invasive Marine Pests
IOGP	International Association of Oil & Gas Producers
IOPPC	International Oil Pollution Prevention Certificate
IPIECA	International Petroleum Industry Environmental Conservation Association
ISB	In situ Burning
ISO	International Organization for Standardization
ISPP	International Sewage Pollution Prevention
ISPPC	International Sewage Pollution Prevention Certificate
ITOPF	International Tanker Owners Pollution Federation
IUCN	International Union for Conservation of Nature
JAMBA	Japan-Australia Migratory Bird Agreement
JHA	Job Hazard Analysis
KCl	Potassium chloride
KEF	Key Ecological Features
Km	Kilometres
KPIs	Key Performance Indicators
KROWRP	Kimberley Regional Oiled Wildlife Response Plan
Kw	Kilowatt
LAT	Lowest Astronomical Tide
LOWC	Loss of Well Control
MAFMF	Marine Aquarium Fish Managed Fishery
MARS	Maritime Arrivals Reporting Systems
MDO	Marine Diesel Oil
M	Metre
Mm	Millimetre
MNES	Matters of National Environmental Significance
MARPOL	Marine Pollution Convention (International Convention for the Prevention of Pollution from Ships)
MODU	Mobile Offshore Drilling Unit
MOP	Marine Oil Pollution
MoU	Memorandum of Understanding
MSA	Master Service Agreement
NADF	Non Aqueous Drilling Fluid

Abbreviation	Description
NatPlan	National Plan for Maritime Environmental Emergencies
NAXA	North Australian Exercise Area
NEC	No Effect Concentration
NEBA	Net Environmental Benefit Analysis
NEPM	National Environment Protective Measures
NERA	National Energy Resources Australia
NERP	National Environmental Research Program
NICNAS	National Industrial Chemicals Notification and Assessment Scheme
NMFS	National Marine Fisheries Service
Nm	Nautical mile
NPI	National Pollutant Inventory
NOAA	National Oceanic and Atmospheric Administration
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NT	Northern Territory
NSW	New South Wales
NWMR	North West Marine Region
OCNS	Offshore Chemical Notification Scheme
OGUK	Oil & Gas UK
OIM	Offshore Installation Manager
OIW	Oil in Water
OPGGS	*Offshore Petroleum and Greenhouse Gas Storage*
OPGGSA	*Offshore Petroleum and Greenhouse Gas Storage Act 2006*
OPGGS(E)R	*Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009*
OPEP	Oil Pollution Emergency Plan
OPRC 90	Convention on Oil Pollution Preparedness, Response and Co-operation 1990
OSCA	Oil Spill Control Agents
OSMP	Operational and Scientific Monitoring Program
OSRA	Oil Spill Responses Atlas
OWRT	Oiled Wildlife Response Team
POB	Persons on Board
PAH	Poly aromatic Hydrocarbons
PAR	Pre-arrival Report
PEC	Predicted Effect Concentration
PHG	Pre-Hydrated Gel
PHPA	Partially Hydrolised Polyacrylamide
PMS	Preventative Management Systems
PMST	Protected Matters Search Tool
PNEC	Predicted No Effect Condition
Ppm	Parts per million

Abbreviation	Description
Ppb	Parts per billion
PSD	Particle Size Distribution
PSV	Production Supply Vessels
PTS	Permanent Threshold Shift
PTTEP AA	PTTEP Australasia (Ashmore Cartier) Pty Ltd being the operator or the title holder of AC/P54 and AC/RL7 or being the Australian subsidiaries of PTT Exploration and Production Public Company Ltd as the context requires
PTW	Permit to Work
P & A	Plugged and abandoned
QLD	Queensland
RAMSAR	International Convention on Wetlands of International Importance
RAN	Royal Australian Navy
RAPs	Response Action Plans
RCC	Rescue Coordination Centre
ROC	Residual On Cuttings
ROV	Remotely Operated Vehicle
ROKAMBA	Republic of Korea Australian Migratory Bird Agreement
SA	South Australia
SBT	South Bluefin Tuna
SBTF	South Bluefin Tuna Fishery
SCE	Solids Control Equipment
SDS	Safety Data Sheet
SEP	Stakeholder Engagement Plan
SEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities (previously DEWHA and now DoI)
SFRT	Subsea First Response Toolkit
SOLAS	Safety of Life at Sea
SOPEP	Shipboard Oil Pollution Emergency Plan
SPL	Sound Pressure Level
SPRAT	Species Profile and Threats
SSDI	Subsea Dispersant Injection
SSHE	Safety, Security, Health and Environment
SSHE MS	Safety, Security, Health and Environment Management Systems
STF	Sewage Treatment Facility
SW	Sea Water
SWA	Stop Work Authority
SWASP	State Wide Array Surveillance Program
TAs	Technical Authorities
TA1s	Local Subject Matter Technical Authorities
TA2s	Corporate Subject Matter Technical Authorities
TAS	Tasmania
TBT	Tributyltin

Abbreviation	Description
TRP	Technical Response Plan
TTS	Temporary Threshold Shift
UHC	Ultimate Holding Capacity
UK	United Kingdom
VIC	Victoria
VOCs	Volatile Organic Compounds
VSP	Vertical Seismic Profile
WA	Western Australia
WAFIC	Western Australian Fishing Industries Council
WAOWRP	Western Australia Oiled Wildlife Response Plan
WBM	Water based mud
WCD	Worst case discharge
WIAMS	Well Integrity Assurance Management System
WMC	Waste Management Coordinator
WMSP	Waste Management Sub-Plan
WOMP	Well Operations Management Plan
WTBF	Western Tuna and Billfish Fishery
WWC	Wild Well Control

1 INTRODUCTION

1.1 BACKGROUND

PTTEP Australasia (Ashmore Cartier) Pty Ltd (PTTEP AA) proposes to undertake an exploration and appraisal drilling program (EADP) within the petroleum title areas AC/P54 and AC/RL7. The AC/P54 title area contains the Orchid, Frangipani and Mali prospects and is adjacent to AC/RL7 which contains the Cash Maple prospect. The proposed wells are targeting prospects that may contain specifically, or a mix of, light crude oil, gas or condensate.

This Environment Plan (EP) has been prepared by PTTEP AA as the titleholder of petroleum titles AC/P54 and AC/RL7, in accordance with Regulation 11(3) and (4) of the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS(E)R).

1.2 THE TITLEHOLDER

The titleholder undertaking this activity within the AC/P54 and AC/RL7 petroleum titles is PTTEP AA.

Contact details for PTTEP AA are as follows:

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2 LOCATION OF THE ACTIVITY

This EP applies to exploration and appraisal well drilling and abandonment activities in petroleum title areas AC/P54 and AC/RL7. These title areas are collectively referred to in this document as the exploration and appraisal drilling area (EADA).

The EADA is located in a remote area of the Timor Sea, approximately 240 km northwest of the Kimberley coastline of Western Australia, and approximately 700 km from Darwin, Northern Territory (NT) (Figure 2-1).

It is expected that up to five wells will be drilled in the EADA during that period. The Orchid-1 well will be drilled in AC/P54 with the approximate location provided in Table 2-1.

Table 2-1 Orchid-1 Exploration Well Location

Latitude	11° 55’ 42.8” S
Longitude	124° 51’ 52.7”E

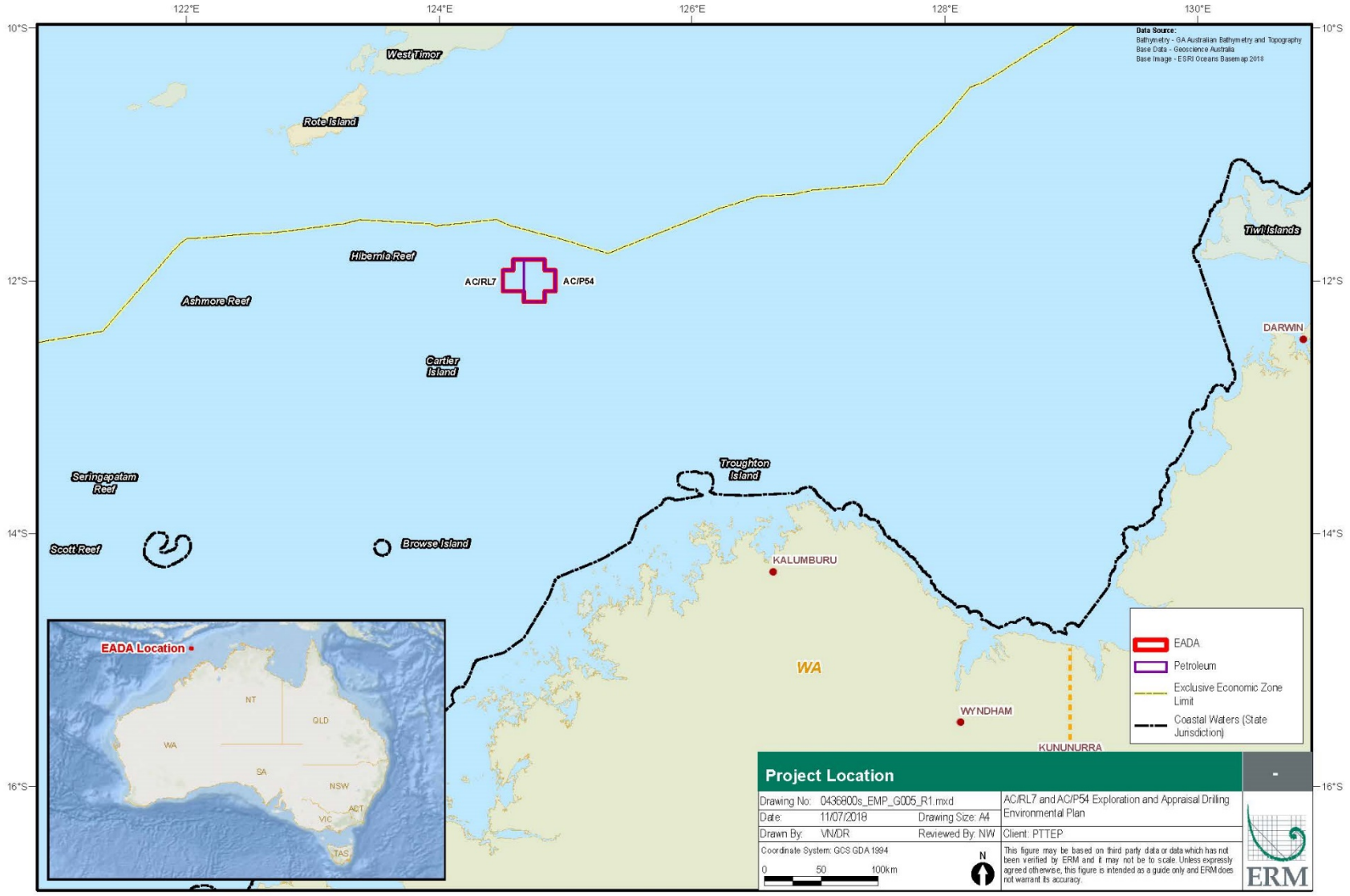

Figure 2-1 Exploration and Appraisal Drilling Area

3 DESCRIPTION OF ACTIVITIES

3.1 TIMING OF THE ACTIVITY

The EADP will involve drilling, evaluation and abandonment of up to five wells over five years.

The first exploration well (Orchid-1), is a commitment well which is scheduled to be drilled, evaluated and abandoned in 2018. These activities are proposed to start in September / October 2018. A site survey will be performed prior to the rig arriving on location. The drilling of the Orchid-1 well is expected to take between 35 and 50 days.

Scheduling of additional wells over the five year EP period is subject to PTTEP AA planning and approval. Commencement of each well drilling campaign will be communicated to stakeholders in accordance with Section 9.5.

In general, an exploration or appraisal well in AC/P54 is expected to take 35 – 50 days to drill, allowing for contingencies, plus coring and testing for an appraisal well. In AC/RL7, an exploration or appraisal well may require up to 100 days, allowing for coring testing and contingencies. Prior to individual well drilling activities commencing, a site survey may be conducted at each location.

3.2 DRILLING ACTIVITIES

3.2.1 Pre-drilling Surveys

Pre-drill geophysical/geotechnical site surveys will be conducted to determine if there are any surface or subsea drilling hazards or subsea features in the vicinity of each well location. These surveys may incorporate a range of survey techniques/technologies, including side-scan sonar, single and multi-beam echo sounders, sub-bottom profilers, and coring (grab, box corer, piston corer, gravity corer, vibro-corer or cone penetrometer testing (CPT)).

3.2.2 MODU Description

A Mobile Offshore Drilling Unit (MODU) will be contracted to undertake all or part of the proposed drilling exploration and appraisal activities. Both semi-submersible and jack-up rig options are included in the EP. For any individual campaign, the MODU may be mobilised from another permit holder's location in Australia, from an Australian port or directly from an international location.

The jack-up may have a hull height of approximately 9m, a length of 70m, and a breadth of 85m. Semi-submersible MODUs are generally larger than jack-ups, with an indicative operating draft of approximately 20m, and a length of 75m. The dimensions provided are an indicative for both a large jack-up and a large (deep-water) semi-submersible MODU.

Semi-Submersible Mooring System

A semi-submersible mooring system consists of running and setting of anchors at a distance of up to 1200m from the drilling location. The anchor spread will be dependent on the rig selected and the mooring analysis conducted during planning phase of each well/campaign. Some semi-submersible MODUs will have a dynamic positioning system to maintain station keeping while not on anchor, however dynamic positioning is not intended to be in use during the drilling activity.

Jack-Up Jacking System

The use of a Jack-up rig will be limited by water depth. This varies depending on the rig design. Typical limits of rigs within Australia waters are approximately 120m. Jack-up rigs will have 3 legs which are jacked down to the seabed, and the drilling rig jacked out of the water and elevated to provide a safe "air gap" between the sea level and the base of the hull (typically 18-25m).

3.2.3 Drilling

The drilling activities described here are representative of activities for all five wells. Representative drilling activities include:

- Move MODU to location;
- Run anchors, or conduct jack up activities (depending on rig selected);
- Drill conductor hole (typically 42”), displacing drill cuttings and WBM drilling fluids at seabed;
- Run and cement conductor (typically 36”), displacing annulus fluid and excess cement to seabed;
- Where engineering and financial benefit are attainable (where there is concern regarding hole stability), install a riserless mud recover (RMR) system for the surface hole (this is the case for Orchid-1);
- Drill surface hole (typically 26”), displacing drill cuttings and WBM drilling fluids at seabed;
- Run and cement surface casing (typically 20”), displacing annulus fluid and excess cement (if any) to seabed;
- Drill 17 ½” hole, either displacing drill cuttings and drilling fluids at seabed with an open drilling system, OR, have returns back to the MODU’s drilling fluids package utilising a closed fluid system, with drill cuttings and drilling fluids returning to the rig for surface discharge;
- Run and cement intermediate casing (typically 13.3/8”), displacing annulus fluid to the seabed (dependent on the well design – sometimes this may be returned to surface for surface discharge);
- Installation of the drilling blow out preventer (BOP);
- Drill 12 ¼” hole with closed fluid system, with drill cuttings and drilling fluids returning to the rig for surface discharge;
- Run and cement production casing (typically 9.5/8”), displacing annulus fluid back to surface;
- Drill 8.1/2” hole with closed fluid system, with drill cuttings and drilling fluids returning to the rig for surface discharge; and
- In the case of well testing (i.e. an appraisal well), a 7” liner will typically be run and cemented across the reservoir. If a well is tested the drilling mud will be displaced to a brine.

Contingency activities may include:

- Re-spudding a well at an adjacent location; or
- Side-tracking a well when the initial well bore cannot be completed for technical reasons, such as a drill tool being stuck down hole, or well bore instability.

Well suspension is not planned for any wells associated with the EADP, and as such, has not been included within the EP.

3.2.4 Drilling Fluids and Cuttings

A drilling fluid program will be developed in accordance with the PTTEP AA Drilling & Well Services Management System (DMS) prior to each drilling campaign. The primary function of the drilling fluid is to control sub-surface formation pressures, cool and lubricate the drill bit, transport the cuttings to the surface, maintain wellbore stability and minimize reservoir damage. Drilling fluid is continually circulated down the drill string to the drill bit and returns to the surface via the annulus space between the drill string and the wellbore.

Initial offset well reviews for the exploration wells within AC/P54 indicate that Water Based Mud (WBM) is suitable for all hole sections of the wells. However, Non Aqueous Drilling Fluid (NADF) is included as a contingency option in wells to be drilled in this permit area, but will only be considered in the event of hole stability problems that cannot be remedied with WBM.

For AC/RL7, appraisal wells on the Cash Maple field are likely to include 1 or 2 hole sections where Non Aqueous Drilling Fluid (NADF) is used.

Final fluid design and selection will be part of the detailed well engineering design.

3.2.4.1 Water Based Mud

WBM typically consists of between 80-90% by volume of fresh, or saline water, with the balance made up of water soluble and insoluble drilling fluid additives, which give the mud the exact properties it requires to meet the desired functions for a particular hole interval. In the marine environment these additives are either completely inert, (naturally occurring benign materials) or readily biodegradable organic polymers, with a very fast rate of biodegradation in the marine environment. Drilling fluid additives that are typically used include; sodium chloride, potassium chloride, bentonite (clay)/pre-hydrated gel (PHG), naturally occurring water soluble polymers, barium sulphate (barite) and calcium carbonate.

3.2.4.2 Non Aqueous Drilling Fluid

NADF will consist of a base non aqueous fluid to which other ingredients such as emulsifiers, wetting agents, rheology modifiers, organophilic clay, lime and barite are added. The base non aqueous fluid typically represents about 50 to 65% of the total volume of the complete mud, and approximately 20 to 30% of its mass.

Drilling fluid containing suspended drilled cuttings is processed with solids control equipment to remove the drill cuttings from the NADF. NADF is then returned to the MODU mud pits for recirculation down-hole. Following processing via primary solids control equipment (shale shakers and centrifuges) drill cuttings retain some levels of adhered NADF. In order to minimise the NADF associated with cuttings discharge, drill cuttings will be further treated using secondary solids control equipment, i.e. cutting dryers prior to being discharged overboard. When NADF is used, daily monitoring of both the primary and secondary solids control equipment will be conducted to ensure that the required levels of performance of these controls is met in relation to residual NADF adhered on cuttings (ROC) is achieved.

Whole NADF, both used and unused, will be transferred from the MODU to a support vessel and transported back to the suppliers shore-based facility to be reconditioned for future use, or disposal. The control, containment and appropriate use of NADF during drilling operations will be monitored on board by a specialist third party NADF compliance engineer.

3.2.4.3 Drilling Fluid and Drill Cuttings Discharge

The surface hole sections, typically 42”, 26” and 17-1/2” in diameter, will be drilled utilising seawater (SW) and water based high viscosity sweeps (WBM) regime or a pre-hydrated gel (PHG). The subsequent well sections, typically 12-1/4” and / or 8-1/2” will be drilled with an engineered mud system, such as a potassium chloride (KCl) Partially Hydrolized Polyacrylamide polymer WBM, if it is considered suitable to control potential reactive formations. For particular wells, with known troublesome and reactive formations, such as the Lower Vulcan and some Plover / Challis formations in (AC/RL7), NADF will be considered as the primary drilling fluid.

Cuttings will be discharged directly to the seabed in the case of riserless drilling (42” and 26” and potentially 17-1/2” hole sections), or overboard while drilling with a closed system, either via a RMR system for top-hole sections and/or riser for the lower hole sections. Drill cuttings discharged overboard will have received post processing on the MODU to separate and recycle drilling fluids, with the theoretical worst case total volume of cuttings to be discharged equating to approximately 830 m^3 for the each well. Contingency volumes are based on respudding a well due to operational issues such as a stuck pipe and possible sidetracks. The theoretical worst case volume of cuttings and drilling fluid discharges (calculated based on the greatest volumes for each well section across all wells) are summarised below (Table 3-1 and Table 3-2).

In the event of well testing (appraisal well) the drilling mud will be displaced from the cased hole with a brine, which will act as the weighting fluid. The brine is pumped down the well and the excess brine required for this process will be discharged (100 m^3 to 200 m^3). Brine consists of sodium chloride with small quantities of biocide, oxygen scavenger and corrosion inhibitors.

Table 3-1 Well Profile Information drill cuttings and fluids (Worst Case)

Well Section	Drilling Fluid Type	Discharge Release Level	Hole Diameter (in)	Section Length (m)	Cuttings Discharged (Per Well) (m3)	Fluid Discharged (Per Well Design) (m3)
Conductor Hole	SW and PHG	Sea Floor	42	50	56	130
Surface Hole	SW and PHG OR WBM	Sea Floor or Sea Level (RMR or riser)	26	400	171	877
Intermediate Hole 1	WBM	Sea Level	17.5	1960	380	639
Intermediate Hole 2 (AC/RL7 only)	NADF or WBM	Sea Level	12.25	1000	95	334
Production Hole	1. WBM for AC/P54 (NADF contingent) 2. NADF AC/RL7	Sea Level	12.25	1345	128	444
P&A	WBM	N/A	N/A	N/A	N/A	370
Worst case scenario total	N/A	N/A	N/A	N/A	830	2793

Table 3-2 Well Profile Information drill cuttings and fluids (Contingency)

Well Section	Drilling Fluid Type	Discharge Release Level	Hole Diameter (in)	Section Length (m)	Cuttings Discharged (Per Well) (m3)	Cuttings Discharged (Contingency) (m3)	Fluid Discharged (Per Well Design) (m3)	Fluid Discharged (Contingency) (m3)
Conductor Hole (Re-Spud Contingency)	SW and PHG	Sea Floor	42	50	N/A	56	N/A	130
Surface Hole (Re-Spud Contingency)	SW and PHG OR WBM	Sea Floor or Sea Level (RMR or riser)	26	400	N/A	171	N/A	877
Intermediate Hole (Mechanical Sidetrack Contingency)	WBM	Sea Floor or Sea Level (RMR or riser)	17.5	1960	N/A	380	N/A	639
Production Hole (Geological Sidetrack Contigency)	WBM or NADF	Sea Level	12.25	1345	N/A	143	N/A	61

3.2.5 Cementing

Cement is used to isolate permeable zones from each other and the environment, provide mechanical strength, secure casing in the well bore and to act as permanent abandonment plugs (if required). Cementing chemicals are added to the base slurry and are used to modify the technical properties of the cement slurry.

During cementing operations, the majority of these chemicals are left downhole but a small quantity of cement may be discharged onto the seabed around the top of the casing when cementing the surface casing strings (for riserless drilling). During conductor cementing operations (riserless drilling), cement returns will be observed at the seabed (approximately 5 m^3). Additional small volumes of cement or cement-contaminated water (up to 2 m^3) will be discharged into the sea during clean-up of the cementing unit after each job is completed.

Careful estimates of the final hole volume will be made during drilling, and the volume of cement used will be adjusted accordingly to minimise the risk of excess cement discharge at the seabed.

3.2.6 Residual Dry Bulk Material Discharge

On completion of drilling activities, residual dry bulk material, including but not limited to; bentonite, barite and cement, will be required to be discharged to the ocean if the MODU is not handed over to another operator following PTTEP AA operations. The detailed drilling program for each well will minimise the potential for unnecessarily large volumes of excess bulk materials at the end of drilling for each well.

3.2.7 Well Evaluation

3.2.7.1 Mud Logging

Mud-logging will be undertaken during drilling operations to evaluate the formation. This will involve the collection and processing of cuttings samples, analysis of mud gas, monitoring and recording of all drilling parameters, pressure detection and full evaluation of the formation.

3.2.7.2 Formation Evaluation

Formation evaluation is the interpretation of a combination of measurements taken inside a wellbore to detect and quantify oil and gas reserves in the rock adjacent to the well.

Formation Evaluation While Drilling (FEWD) is provided by the inclusion of drilling tools run at the bottom of the drillstring, directly above the drillbit, which are able to evaluate rock, formations fluids and hole properties while drilling the well. A wireline log is a continuous measurement of formation properties with electrically powered instruments to enable decisions to be made about drilling operations. A well specific wireline open and cased hole logging program will define both primary and contingent logging programs.

Cased hole wireline logging will be performed to verify annulus cement isolation for critical casing strings.

3.2.7.3 Borehole Seismic Surveying

For exploration well activities, borehole seismic surveying (Check-Shot Survey [CSS] or Vertical Seismic Profiling [VSP]), in the form of wireline logging, are routinely conducted. For exploration wells a CSS will potentially be included while VSP logs are not planned. For appraisal wells, a VSP may be undertaken to obtain further well information.

CSS and VSP are processes of taking measurements in the vertical wellbore using a source (i.e., airgun) at the surface of the well, deployed from the MODU, and geophones (acting as receivers) positioned at different depths within the wellbore. The borehole seismic measurements are used for correlation with and calibration of surface seismic data. Typically, a CSS or VSP survey takes between 8-12 hours to complete per log, with normally one log per well. Noise levels will typically range from 90 to 239 dB re 1 µPa@1 m (Pk), <180 Pk within 1.2 km of the source, predominantly at low frequencies (<200 Hz).

3.2.7.4 Well Testing

For an appraisal well, well evaluation through well testing operations may be undertaken with use of a temporary well test production package where the wells are flowed to gather information on the reservoir. The hydrocarbons flowed during the test will be flared on the MODU.

3.2.8 Well Plugging and Abandonment

PTTEP AA will plug the wells using the MODU. Wells will be plugged and abandoned (P&A) in accordance with specific P&A procedures as described in a NOPSEMA accepted Well Operations Management Plan (WOMP).

3.2.9 Drilling Support Operations

Drilling support will be provided by support vessels, either anchor handling tug supply (AHTS) vessels or production supply vessels (PSV). Indicative support vessel specifications are detailed in Table 3-3. Support vessels will be operated out of the Port of Darwin and will transfer well construction materials including casing, drilling equipment, bulk chemicals, liquid drilling fluids, potable water and diesel fuels to the MODU, and remove wastes, excess materials and equipment from the MODU back to Darwin for management and disposal. The Port of Broome may also be used by support vessels.

Helicopter support will be based at Mungalalu – Truscott air base to support the rig as follows:

- Personnel transfers between Mungalalu-Truscott and the rig for crew changes;
- Down-manning of the rig for tropical cyclone response (note: an additional helicopter and crew will be available during cyclone season); and
- Emergency response, including medivac, evacuation of the rig, and search and rescue.

Routine helicopter operations are expected to be during daylight hours with the helicopter flight time between Mungalalu-Truscott and the well location estimated at 70 minutes with approximately 5 to 7 flights per week.

Table 3-3 Indicative MODU Support Vessels

	AHTS #1	AHTS #2	PSV #1
Type / Service	Swire D Class Vessel 220-238 BP	Swire D Class Vessel 220-238 BP	Swire H Class 1,000 m^2 PSV
Length (m)	92	92	88.1
Gross Registered Tonnage (tonnes)	6,641	6,641	4,059
Maximum Speed (knots)	16	16	14
Accommodation	37	37	44
Total Fuel Tank Capacity (m^3)	1,172 m^3 (dedicated) 1,940 m^3 (including combination BO, Mud tanks)	1,172 m^3 (dedicated) 1,940 m^3 (including combination BO, Mud tanks)	Fuel tanks – 773 m^3 @ 100% Including the use of Base Oil Tanks – 912 m^3 @ 100%

4 DESCRIPTION OF THE ENVIRONMENT

4.1 OVERVIEW

This section describes the existing environment that may be affected by the EADP. It includes the relevant values and sensitivities of the physical and ecological environment, as well as the social and economic features of the environment. The description includes the environmental values and sensitivities within the EADA and the wider 'environment that may be affected' (EMBA). A description of how the EMBA and associated values and sensitivities were defined is provided in Section 4.2. The EADA values and sensitivities are summarised in Section 4.3.

4.2 EMBA DEFINITION

The environment that may be affected (EMBA) beyond the EADA is defined by the geographical area that could potentially be affected in the event of an emergency condition such as an oil pollution event or the establishment of an invasive pest. The widest extent of the oil pollution-based EMBA is conservatively estimated based upon worst case discharge (WCD) oil spill modelling presented in Section 6.14, conservatively assuming no oil spill response is implemented during the modelled spill and using thresholds above which impacts from a spill may be expected to occur (as defined in Table 4-1 below, with more detail provided in Table 6-2). It is important to note that the extent of the EMBA is based on stochastic spill modelling which compiles data from 300 hypothetical worst case spills under different environmental conditions. The trajectory of single spill would have a considerably smaller footprint. In the event of an actual hydrocarbon spill, modelling of the spill trajectory specific to the conditions at that time would be undertaken (known as deterministic modelling). Furthermore, predicted hydrocarbon concentrations would be verified in the field through monitoring to confirm the potential for impacts.

For the purposes of this EP, PTTEP AA have defined two broad EMBAs that combine the potential spatial extent of surface and in-water (entrained and dissolved) hydrocarbons. The 'low threshold EMBA' is based on thresholds for visible surface oil and potential sub-lethal impacts to early life stages of fish and invertebrates (considered to be the most sensitive organisms to dissolved and entrained oil) (Table 4-1). The 'moderate threshold EMBA' is based on an ecological impact threshold for surface oil and potential in-water lethal impact (LC50) concentrations for early life stages of fish and invertebrates (Table 4-1).

Table 4-1 Hydrocarbon Spill Thresholds used to Define EMBAs for Surface and In-water Hydrocarbons

Hydrocarbon Type	Low Threshold EMBA[1]	Moderate Threshold EMBA[1]
Surface	0.5 g/m^2 This represents a visible sheen on the surface but is below concentrations at which ecological impacts are expected to occur.	10 g/m^2 This represents the minimum oil thickness (0.01 mm) at which ecological impacts are expected to occur.
In-water – dissolved aromatics	1 ppb This represents a sub-lethal threshold for early life stages of fish and invertebrates (considered to be the most sensitive organisms to dissolved aromatics).	10 ppb This represents a lethal concentration (LC50) threshold for early life stages of fish and invertebrates (considered to be the most sensitive organisms to dissolved aromatics).
In-water - entrained	100 ppb This represents a sub-lethal threshold for early life stages of fish and invertebrates	1000 ppb This represents a lethal concentration (LC50) threshold for early life stages of fish and

	(considered to be the most sensitive organisms to entrained oil droplets).	invertebrates (considered to be the most sensitive organisms to entrained oil droplets).

[1] Further details including the source of the thresholds used to define the EMBA in this table are provided in Table 6-2.

In addition to the EMBAs defined by surface and in-water hydrocarbons, a further EMBA is defined for areas that are predicted to experience shore-line contact with hydrocarbons above an ecological impact threshold of 100 g/m^2. Shoreline exposure to hydrocarbons above this threshold is predicted for the WCD at the Tiwi Islands, Seringapatam Reef, Scott Reef and Browse Island, within Australian waters; and at locations along the Indonesian shoreline (Rote Island and West Timor) and Timor Leste.

The geographical extents of the various EMBAs are illustrated in Figure 4-1.

Two PMST database searches were conducted to identify listed threatened and migratory species, ecological communities and protected areas occurring within the EMBAs as follows:

- The area within the moderate threshold EMBA defined by surface and in-water hydrocarbon exposure;
- The area within the low threshold EMBA (which also incorporated the extent of the shoreline EMBA within Australian waters) (Figure 4-1).

The boundaries of EPBC Act Protected Matters Search Tool (PMST) database searches are also shown in Figure 4-1.

Table 4-2 illustrates which of the EMBAs (and therefore which of the PMST searches) is relevant for each component of the existing environment discussed within this section.

While the PMST searches are limited to matters protected under the EPBC Act within Australian waters, information is also included in this section on known values and sensitivities for relevant coastlines in Indonesia and Timor Leste.

In addition to the EMBAs defined by oil spill modelling results, additional areas that could be impacted in the event of the establishment of an invasive marine pest include the ports of Darwin and Broome, from where the support vessels servicing the EADP may operate.

Table 4-2 EMBAs of Relevance to the Environmental and Socio-Economic Components of the Existing Environment Described in this EP

Environmental and Socio-Economic Receptors	Low threshold EMBA (surface and in-water)	Moderate threshold EMBA (surface and in-water)	Shoreline EMBA
Listed marine fauna of conservation significance and non-listed species (e.g. adult fish assemblages)		X	
Plankton (including fish eggs and larvae) and secondary impacts to listed marine fauna that feed exclusively on plankton	X		
Benthic communities (soft sediment habitat)		X	
Benthic communities (coral reefs, banks and shoals)	X		
Shoreline habitat			X

Protected areas	X		X
Key ecological features	X		
Heritage places	X		X
Maritime heritage		X	
Commercial fisheries	X		
Traditional & subsistence fisheries	X		
Tourism & recreation	X		X
Petroleum exploration & production		X	
Maritime surveillance and defence		X	
Ports & commercial shipping		X	

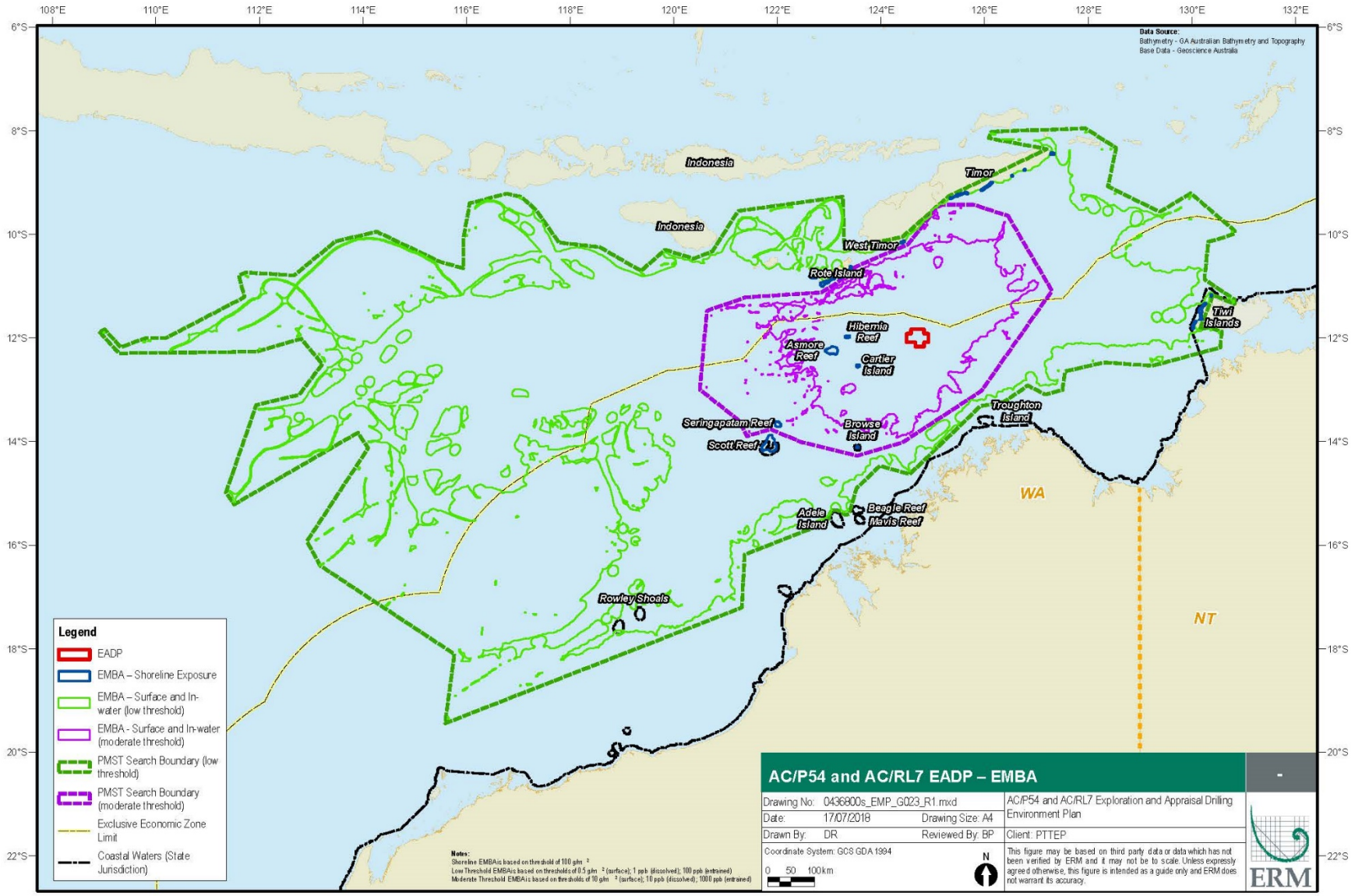

Figure 4-1 Environment that may be Affected (EMBA)

4.3 EADA SUMMARY

The EADA is located in relatively deep waters (115 – 230 m), in an area that is largely devoid of bathymetric features. Three unnamed shoals lie along the northern border of AC/P54 (approximately 10 km from the proposed Orchid-1 well). No other shoals or banks are located within the EADA. The closest named shoals are Pee Shoal and Mangola Shoal situated 8 km and 35 km from the EADA boundary respectively. As described in Section 4.5, the EADA is primarily composed of soft-sediment habitats of unconsolidated substrate, typically associated with sparse epifauna distribution. The EADA also does not overlap any key ecological features (KEF) or Australian Marine Parks (AMP), with the closest being The Carbonate Bank and Terrace System of the Sahul Shelf and the Cartier Island Marine Park, situated 13.5 km south-east and 106 km south-west from the EADA respectively (Figure 4-2 and Figure 4-3).

According to a search of the PMST database, 26 listed threatened species and 35 migratory species have geographic distributions that overlap the EADA. Upon further investigation into the preferred habitats and likelihood of occurrence within the EADA the following have been identified and discussed further in Section 4.7.4:

- three shark species;
- six marine turtle species;
- six cetacean species; and
- six avifauna species.

The only Biologically Important Area (BIA) for protected marine fauna that overlaps the EADA is the whale shark foraging BIA, which overlaps the southern portion of the EADA at its most northern extent (Figure 4-5).

In the context of socio-economic values, no World Heritage Properties or Commonwealth Heritage Places are located within the EADA. The closest Commonwealth Heritage Place is the Ashmore Reef and Surrounds, located approximately 135 km from the EADA. This area is also registered as a RAMSAR wetland due to its significant ecological characteristics, particularly its importance for migratory bird species. Three Commonwealth managed fisheries and eight WA state managed fisheries overlap the EADA, however no fishing effort has historically been focused in the waters surrounding the EADA (see Section 4.8.4 for more details).

4.4 REGIONAL SETTING

4.4.1 North-west Marine Region

The offshore waters of Australia have been divided into six marine regions in order to facilitate their management by the Australian Government under the EPBC Act. The EADA is partially located within the North-west Marine Region (NWMR), on the northern boundary. The NWMR covers an area of 1.07 million km² from the border between WA and the NT to Kalbarri, south of Shark Bay.

A number of regionally important marine communities and habitats exist in the northern part of the NWMR. These include Ashmore Reef and Cartier Island, which support a high biodiversity of marine life as well as foraging / breeding aggregations of various species. These features are defined as KEFs. Other relevant KEFs of this region include The Carbonate Bank and Terrace System of the Sahul Shelf, which is a unique seafloor feature that contributes to the biodiversity and productivity of the local area, and Continental Slope Demersal Fish Communities, which displays high species diversity and endemism (Figure 4-3). KEFs are discussed further in Section 4.5.

4.4.2 North Marine Region

The North Marine Region (NMR) comprises Commonwealth waters from west Cape York Peninsula to the Northern Territory–Western Australia border. The region covers approximately 625,689 km² of tropical waters in the Gulf of Carpentaria, Arafura and Timor seas, and adjoins the coastal waters of Queensland and the Northern Territory. The EADA is located approximately 300 km west of the

NMR, with the Low Threshold EMBA for in-water hydrocarbons partially overlapping the western portion of the NMR.

The marine environment of the NMR is known for its high diversity of tropical species but relatively low endemism, in contrast to other marine bioregions. The lack of physical barriers within the region allows for greater species dispersal. Waters in and/or adjacent to the region provide important bird, marine turtle and dugong breeding, feeding and nursery sites.

Of the eight KEFs identified in the NMR, three KEFs are located within the EMBA; these include the carbonate bank and terrace system of the Van Diemen Rise, the Pinnacles of the Bonaparte Basin and Shelf break and slope of the Arafura Shelf. These KEFs are further discussed in Section 4.5.

4.4.3 Indonesia and Timor Leste

In the event of a hydrocarbon spill from a loss of well control there is potential for impact to locations along the Indonesian shoreline (Rote Island and West Timor) and Timor Leste. The Indonesian coastline is rich in tropical marine ecosystems such as sandy beaches, mangroves, coral reefs and seagrasses ecosystems (Hutomo and Moosa, 2005). These are home to a wide variety of living communities and a high species diversity and richness.

The shoreline habitats that are present in the Indonesian East Nusa Tengarra Province (where West Timor and Rote Island are located) and Timor Leste are:

- Rote Island features mangrove communities with sparse patches of seagrass habitats and high abundance of coral reef communities;
- The majority of the West Timor coastline features a narrow fringing coral reef community with four dense areas of mangrove communities occurring primarily along the south coast; and
- The Timor Leste coastline features mangrove communities surrounding entrance to rivers primarily on the south coast, whilst the north and eastern coast feature a higher degree of coral reef communities. Further details on the shoreline habitats of Indonesia and Timor Leste are discussed in Section 4.7.3.

4.5 PROTECTED AREAS

4.5.1 Commonwealth Managed Australian Marine Parks

The Australian Marine Park (AMP) Network has been established around Australia as part of a National Representative System of Marine Protected Areas, the primary goal of which 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.

The EADA is not located within any AMPs (Figure 4-2). AMPs within the low threshold EMBA are provided in Table 4-3.

Table 4-3 AMPs within the low threshold EMBA

Australian Marine Park	Distance from the EADP	Relevant IUCN Categories
Cartier Island	106 km west south-west of the EADA	• IUCN Category Ia (Sanctuary Zone)
Oceanic Shoals	125 km east of the EADA	• IUCN Category VI (Multiple Use Zone) • IUCN Category VI (Special Purpose Zone [Trawl]) • IUCN Category IV (Habitat Protection Zone) • IUCN Category II (National Park Zone)

Australian Marine Park	Distance from the EADP	Relevant IUCN Categories
Kimberley	130 km south-west of the EADA	• IUCN Category VI (Multiple Use Zone) • IUCN Category IV (Habitat Protection Zone) • IUCN Category II (National Park Zone
Ashmore Reef	135 km west of the EADA	• IUCN Category Ia (Sanctuary Zone) • IUCN Category II (Recreational Use Zone)
Argo-Rowley	490 km south-west of the EADA	• IUCN Category VI (Multiple Use Zone) • IUCN Category II (National Park Zone) • IUCN Category VI (Special Purpose Zone [Trawl])
Mermaid Reef	747 km south-west of the EADA	• IUCN Category II (National Park Zone)

Activities undertaken in AMPs must be managed in accordance with the Australian IUCN management principles relevant to each IUCN zone category (Environment Australia 2002).

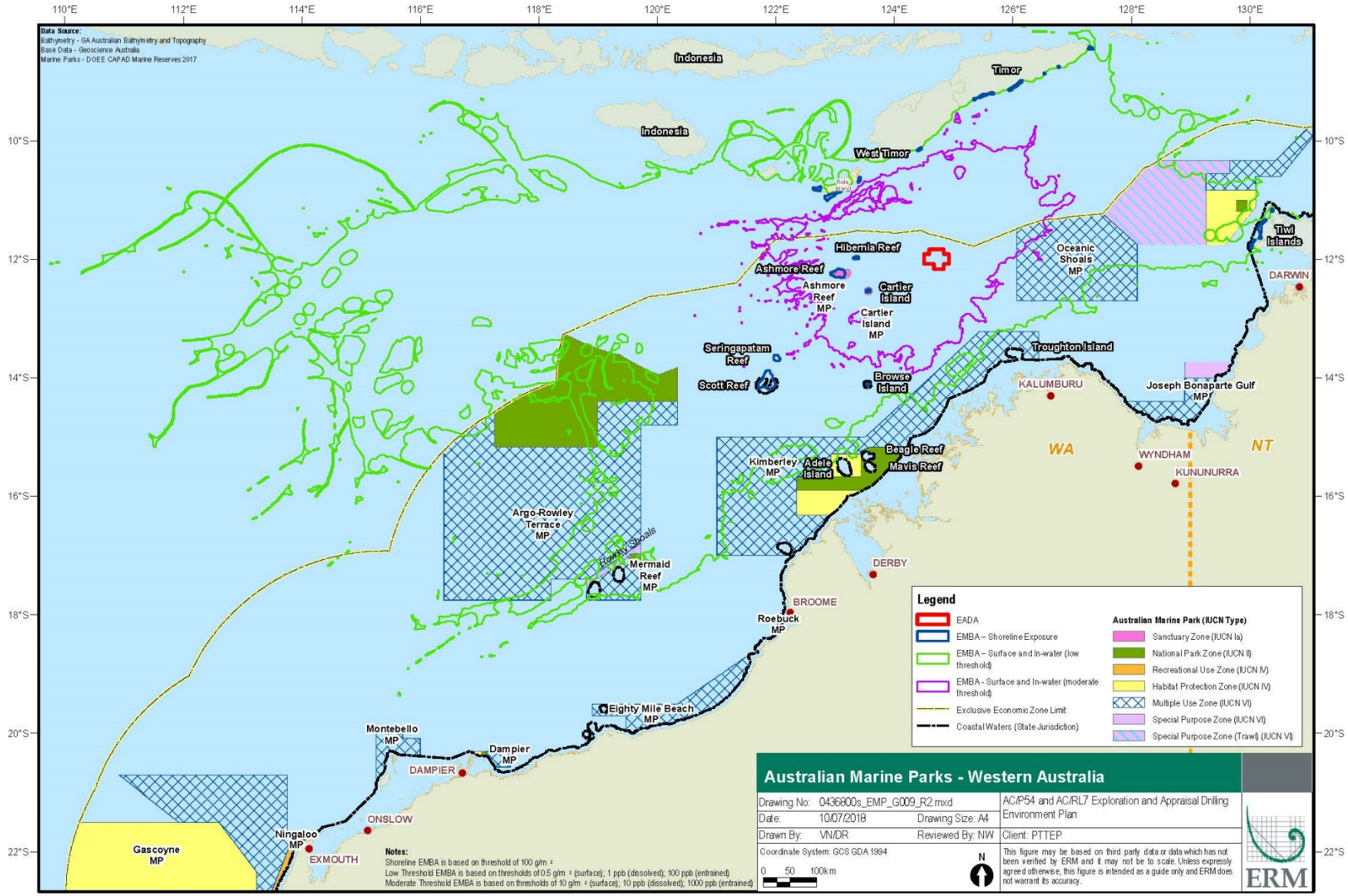

Figure 4-2 Australian Marine Park Network - Marine Parks within the EMBA

4.5.2 Western Australian State Managed Reserves

The EADA is not located within any state managed reserves. WA state managed reserves within the low threshold EMBA are provided in Table 4-4.

Table 4-4 WA state managed reserves within the low threshold EMBA

WA State Managed Reserves	Distance from the EADA (km)	Relevant IUCN Categories
Browse Island Nature Reserve	447 km south west of the EADA	IUCN Category Ia (Nature Reserve)
Unnamed Reserve WA41775 (Browse Island)	447 km south west of the EADA	IUCN Category V (Protected Landscape/Seascape)
Scott Reef Nature Reserve	351 km south west of the EADA	IUCN Category Ia (Nature Reserve)
Rowley Shoals Marine Park	790 km south west of the EADA	IUCN Category IV (Marine Park)

The first two state managed reserves listed in Table 4-4 are situated surrounding Browse Island, and are located approximately 245 km to the southwest of the EADA. They are collectively designated a Class C nature reserve. The island is an isolated sand cay surrounded by an intertidal reef platform and shallow fringing reef. Rocky shore habitat is represented only by exposed beach rock, and there are no intertidal sand flats.

The values and sensitivities of Scott Reef and Rowley Shoals are described below in Section 4.5.3, as both these areas are also designated as Key Ecological Features (KEFs).

The coral reef communities of Scott Reef, Browse Island and the Rowley Shoals are further detailed in Section 4.7.2.

4.5.3 Key Ecological Features

Key Ecological Features (KEFs) are components of the Commonwealth marine environment recognised for their regional importance with respect to the region's biodiversity, ecosystem function and/or integrity (Commonwealth of Australia, 2012). KEFs that are relevant to the EADA and the low threshold EMBA are summarised in Table 4-5 and presented in Figure 4-3.

Table 4-5 Values and Functions of Key Ecological Features in the EMBA

Key Ecological Feature	Present in EADA?	Present in EMBA?	Values
The Carbonate bank and terrace system of the Sahul Shelf	No	Yes	Unique seafloor feature with ecological properties of regional significance
Ashmore Reef and Cartier Island and surrounding Commonwealth waters	No	Yes	High productivity and aggregations of marine life.
Continental Slope Demersal Fish Communities	No	Yes	High levels of endemism

Key Ecological Feature	Present in EADA?	Present in EMBA?	Values
Seringapatam Reef and Commonwealth waters in the Scott Reef complex	No	Yes	High primary productivity and high species richness
Ancient coastline at 125 m depth contour	No	Yes	Unique seafloor feature with ecological properties of regional significance
Canyons linking the Argo Abyssal Plain with the Scott Plateau	No	Yes	Unique seafloor feature with enhanced productivity and feeding aggregations of species.
Pinnacles of the Bonaparte Basin	No	Yes	Provide a hard substrate in an otherwise soft sediment environment and so are important for sessile species.
Carbonate banks and terrace system of the Van Diemen Rise	No	Yes	Variability in water depth and substrate composition supports a high diversity of epifauna. The area has been identified as a sponge biodiversity hotspot.
Shelf break and slope of the Arafura Shelf	No	Yes	Ecological significance associated with productivity emanating from the slope.
Mermaid Reef and Commonwealth waters surrounding Rowley Shoals	No	Yes	High productivity and aggregations of marine life

4.5.4 Wetlands of Conservation Significance (declared Ramsar wetlands)

There are no “wetlands of international importance” under the Convention on Wetlands of International Importance (Ramsar Convention), referred to henceforth as Ramsar wetlands, within the EADA. Within the EMBA, Ashmore Reef Marine Park is designated a Ramsar Wetland.

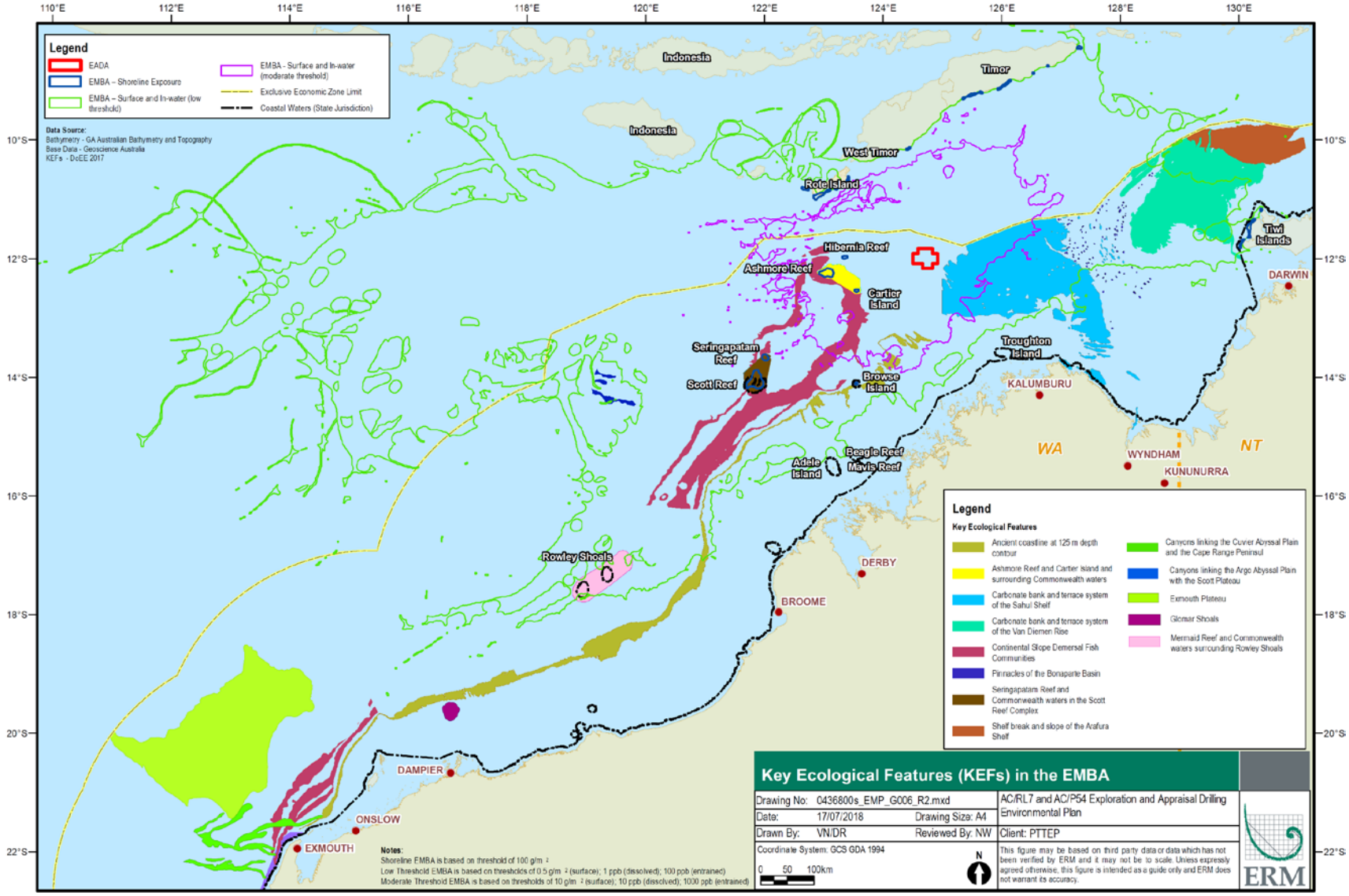

Figure 4-3 Key Ecological Features in the EMBA

4.6 PHYSICAL ENVIRONMENT

4.6.1 Climate

The EADA is characterised by two distinct seasons; a mild, dry winter during the months of April to September, and a hot, wet (monsoonal) summer during the months of October to March. Cyclonic activity occurs between November to April and the area typically experiences on average three cyclones a year.

4.6.2 Oceanography

The oceanography of the north-west Australian offshore area, combined with temperature, salinity and other water-column properties, influence sediment transport and turbidity patterns, primary production in the water column and bottom sediments, and distribution and recruitment patterns for marine organisms (DEWHA 2008b).

The currents in the EADA and EMBA are influenced by semi-diurnal tides. Tidal currents are reported to flow east-northeast, and ebb west-southwest, in the upper 100 metres of the water column, while flooding southeast, and ebbing west-northwest in the lower portion of the water column (Heyward et al. 1997). The north-west Australian coastline experiences some of the largest tides along a coastline adjoining an open ocean in the world. Three oceanic currents dominate the north-west Australian offshore area: the Indonesian Throughflow, the Leeuwin Current and the Holloway Current.

Surface waves may comprise locally generated wind waves or distant generated swell waves. In general, the maximum and mean sea swells are larger during the dry winter season than the summer wet season. Occasional monsoonal storms and cyclones can result in much larger waves and swell. Extreme winds associated with cyclones can generate maximum wave heights waves up to 21 m from any direction (RPS Metocean 2008).

Seawater temperature in the region generally ranges from 25ºC to 31ºC at the surface and 22ºC to 25ºC at the seafloor. Water temperatures throughout the north-west Australian offshore area are largely derived from the influence of the Indonesian Throughflow that delivers warm, low-salinity water to the region (Brewer et al. 2007).

4.6.3 Bathymetry, Seabed Geomorphology and Sediment Composition

The EMBA is located in an area of the continental shelf known as the Sahul Shelf, which is generally characterised by soft sediments. The soft sediments typically consist of sandy and muddy substrate, occasionally made up of patches of coarser sediments (DEWHA 2008b).

Water depths on the Sahul Shelf range from 50 and 120 m, before dropping sharply along the continental slope to 3,000 m in the Timor Trough (approximately 75 km south-east of the coastline of Timor-Leste) (Heyward et al. 1997).

A series of submerged carbonate banks lie along the edge of the Sahul Shelf, which once formed a string of islands along this coastline. Shoals and banks of the Sahul Shelf are abrupt geomorphological features that typically rise to within 5 to 30 m of the sea surface and extend along the continental shelf in a north-east/south-west direction.

The water depths within the EADA range from 115 m to 230 m in depth (LAT). There are no shoals located directly within the EADA. The shoals in the EMBA are discussed further in Section 4.7.2.

4.7 BIOLOGICAL ENVIRONMENT

4.7.1 Productivity and Planktonic Communities

The mixing of warm surface waters with deeper, more nutrient-rich waters (i.e. areas of upwelling) generates phytoplankton production and zooplankton blooms. In the offshore waters of north-western Australia, productivity typically follows a ‘boom and bust’ cycle. Productivity booms are thought to be triggered by seasonal changes to physical drivers or episodic events, which result in rapid increases in primary production over short periods, followed by extended periods of lower productivity.

The Indonesian Throughflow has an important effect on biological productivity in the northern areas of Australia. Generally, its deep, warm and low nutrient waters suppress upwelling of deeper, comparatively nutrient-rich waters, thereby forcing the highest rates of primary productivity to occur at depths associated with the thermocline (generally 70 – 100 m depth). When the Indonesian Throughflow is weaker, the thermocline lifts, and brings deeper, more nutrient-rich waters into the photic zone, which results in conditions favourable to increased productivity.

Consequently, plankton populations have a high degree of temporal and spatial variability. In tropical regions, higher plankton concentrations generally occur during the winter months (June to August).

4.7.2 Benthic Habitats and Communities

Given the large spatial extent of the EMBA, a large number of different benthic communities occur within this area. These habitats include banks, shoals, coral reefs and seagrasses, and are described below. The EMBA for soft sediment benthic habitats in deep offshore waters is defined by the moderate threshold EMBA. However, due to the greater species diversity and sensitivity of coral reefs, banks and shoals, the EMBA for these habitats is defined by the low threshold EMBA.

Spatial and temporal distribution of benthic fauna depends on factors such as sediment characteristics, depth and season. The softer, muddy substrates in this region are generally sparsely covered by sessile, filter-feeding organisms (such as gorgonians, sponges, ascidians and bryozoans) and mobile invertebrates (such as echinoderms, prawns, and detritus-feeding crabs) (Ramirez-Llodra et al. 2010). The harder substrates have a more diverse range of sessile benthos (such as hard and soft corals, gorgonians, encrusting sponges and macroalgae).

4.7.2.1 Soft-sediment Habitats

Benthic habitat mapping and macrofauna sampling were undertaken during the 2010-11 and 2017 marine baseline surveys (ERM 2012; O2 Marine 2018). The EADA is primarily composed of soft-sediment habitats of unconsolidated substrate, with no relief and no pockmarks and are typically associated with sparse epifauna distribution.

Within the AC/RL7 permit area, benthic habitats were comprised of white sandy substrate with shell grit, and sites were primarily homogenous, flat, featureless soft-sediment habitats (Section 4.6.3). Whilst bioturbation was evident in the 2010-11 surveys along with tracks in the sand and fish/shrimp burrows, these were not observed in the 2017 survey. Epibenthic macrofauna were sparse, with sea stars and small bony fish the only fauna recorded. The absence of hard substrate is considered a limiting factor for recruitment of epibenthic organisms.

4.7.2.2 Banks and Shoals

A number of shoals and banks occur within the EMBA. Three unnamed shoals lie along the northern border of AC/P54 (approximately 10 km from the proposed Orchid-1 well). It is noted that while the locations of other wells covered by this EP within the EADA are not yet confirmed, the Orchid-1 well will be the closest well to these shoals. No other shoals or banks occur within the EADA. Based on bathymetry analysis, over 20 possible shoal features (defined as abrupt, submerged features rising from deeper than 50 m) have been identified within a 100 km radius of the EADA, and greater than 100 similar bathymetric features within 200 km, the majority not yet named (Heyward et al. 2010). The closest of the named shoals is Pee Shoal, which is approximately 8 km from the EADA. Other named shoals within a 100 km radius of the EADA are listed in Table 4-6. There are also considerably more unnamed shoals located in the surrounding area.

Due to their remote location, most of the shoals in the region are either unstudied or poorly characterised. The benthic environments of the few shoals that have been surveyed in some detail, such as Vulcan and Barracouta Shoals, provide an indication of shoal habitats present in the region. In general, these bank and shoal systems support diverse biological communities including corals, sponges, seagrasses and a variety of reef fish, with dominant organisms ranging from the algal species *Halimeda* to soft and hard coral communities (Heyward et al. 1997). The coral and algal species identified between surveyed shoals are typical of shallow, tropical reef systems. Therefore, the shoal benthic communities may act as a stepping stone for enhanced biological connectivity

throughout both the submerged and emergent reef systems of Australia's north-west (Heyward et al. 2011a).

Table 4-6 Named shoals and banks within 100 km of the EADA

Shoal or bank	Approximate closest distance (km)
	EADA
Pee Shoal	8
Mangola Shoal	35
Fantome Banks	70
Barracouta Shoal	70
Vee Shoal	74
Vulcan Shoal	81
Goeree Shoal	86
Barton Shoal	87

4.7.2.3 Coral Reef Communities

There are no coral reefs within the EADA. Ashmore Reef, Cartier Island and Hibernia Reef are located within the moderate threshold EMBA; while Scott Reef, Seringapatam Reef, the reefs surrounding Browse Island and the reefs of the Rowley Shoals are located within the low threshold EMBA. These reefs, in particular Ashmore Reef, are recognised as having the highest richness and diversity of coral species in Western Australia (Mustoe and Edmunds 2008).

4.7.2.4 Seagrass and Macroalgae

Seagrasses are marine flowering plants and important benthic primary producers. The maximum depth of seagrass is largely controlled by the availability of light, restricting these species to shallow waters. No seagrass was recorded during benthic surveys and benthic habitat mapping of the AC/RL7 retention lease (ERM 2012; O2 Marine 2018). This is likely due to water depth and a lack of suitable habitat.

Macroalgae are important components of coastal ecosystems, occupying a wide range of habitats. Many species are restricted to hard surfaces due to the lack of a root system for anchoring in soft sediment. Macroalgae plays a major role in reef health, acting as primary producers and providing food for reef fish and invertebrates. No macroalgae was reported was recorded during marine baseline surveys in the EADA (ERM 2012; O2 Marine 2018).

4.7.3 Shoreline Habitats

4.7.3.1 Mangroves

Mangrove systems provide complex structural habitats that act as nurseries for many marine species as well as nesting and feeding sites for many birds and reptiles. Mangroves also maintain sediment, nutrient and water quality within habitats and minimise coastal erosion. Mangrove communities make up a common shoreline habitat along the Northern Territory and Western Australian coastlines with extensive mangrove communities along the Tiwi Islands and coasts of Indonesia and Timor-Leste.

4.7.3.2 Sandy Beaches

Sandy beaches are located throughout the region and some are considered significant habitat for turtles and seabirds, with turtle and seabird nesting occurring above the high tide line. Refer to *Section 4.7.4* for locations of biologically important areas (BIAs) for turtles and seabirds. Sandy beaches are present within the region at the sandy cays of Ashmore Reef, Cartier Island, Sandy Islet at Scott Reef, Browse Island, and along the coastlines of the Tiwi Islands, Indonesia and Timor Leste.

Sandy beaches may comprise fine or coarse sands with mixed levels of gravel and shells. Sandy beaches do not typically support abundant or diverse invertebrate fauna, relative to finer, muddy sediments and wetlands.

4.7.3.3 Summary of Shoreline Habitats in the EMBA

Browse Island

Browse island is a sand and limestone cay (up to 10 m above sea level) situated on a limestone and coral reef. Browse Island is vegetated with herbs and low shrubs (Clarke 2010). The island represents an important marine turtle nesting site in the region for the Green turtle (Chelonia mydas). No seagrass communities have been observed surrounding Browse Island (Skewes et al. 1999a) and this was confirmed by surveys conducted there a decade later as part of the INPEX EIS (INPEX 2010).

Tiwi Islands

The Tiwi Islands are located approximately 550 km to the east of the EADA. The islands coastal areas are typically lined with long beaches and rocky headlands. They support mangroves and coral communities found on the east coasts of the islands. The islands host the world's largest breeding colony of crested terns and a large population of the vulnerable olive ridley turtle (Ecosure 2009).

Timor Leste/Rote Island

As part of the Montara oil spill in 2009, PTTEP AA and APASA developed a set of detailed aerial imagery and habitat mapping for the Indonesian and Timor coastlines. Below provides a snapshot of the shoreline habitats that are present in the Indonesian East Nusa Tengarra Province (where West Timor and Rote Island are located) and Timor Leste:

- Rote Island features mangrove communities with sparse patches of seagrass habitats and high abundance of coral reef communities;
- The majority of the West Timor coastline features a narrow fringing coral reef community with four dense areas of mangrove communities occurring primarily along the south coast; and
- The Timor Leste coastline features mangrove communities surrounding entrance to rivers primarily on the south coast, whilst the north and eastern coast feature a higher degree of coral reef communities.

4.7.4 Listed Marine Fauna of Conservation Significance

4.7.4.1 Overview

The EPBC listed threatened and/or migratory species relevant to the EADA and EMBA are summarised in Table 4-7 and described in the sections below. The EMBA for listed marine fauna is defined by the moderate threshold EMBA as described in Section 4.2.

Table 4-7 EPBC Listed Threatened and/or Migratory Species Potentially Occurring within the EADA and/or EMBA

Species Name	Common Name	EPBC Threatened Status	Migratory Status	EPBC Search Area	
				EADA	EMBA
Elasmobranchs					
Carcharodon carcharias	White Shark, Great White Shark	Vulnerable	Migratory	✓	✓
Anoxypristis cuspidata	Narrow Sawfish, Knifetooth Sawfish	N/A	Migratory	✓	✓
Glyphis garricki	Northern River Shark, New Guinea River Shark	Endangered	N/A	✓	✓
Isurus oxyrinchus	Shortfin Mako, Mako Shark	N/A	Migratory	✓	✓
Isurus paucus	Longfin Mako	N/A	Migratory	✓	✓
Manta alfredi	Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray	N/A	Migratory	✓	✓
Manta birostris	Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray	N/A	Migratory	✓	✓
Pristis pristis	Largetooth Sawfish, Freshwater Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish	Vulnerable	Migratory	✓	✓
Pristis zijsron	Green Sawfish, Dindagubba, Narrowsnout Sawfish	Vulnerable	Migratory	✓	✓
Rhincodon typus	Whale Shark	Vulnerable	Migratory	✓	✓
Marine Reptiles					
Aipysurus apraefrontalis	Short-nosed Seasnake	Critically endangered	N/A	✓	✓
Aipysurus foliosquama	Leaf-scaled Seasnake	Critically endangered	N/A	✓	✓

Species Name	Common Name	EPBC Threatened Status	Migratory Status	EPBC Search Area	
				EADA	EMBA
Caretta caretta	Loggerhead Turtle	Endangered	Migratory	✓	✓
Chelonia mydas	Green Turtle	Vulnerable	Migratory	✓	✓
Crocodylus porosus	Salt-water Crocodile, Estuarine Crocodile	N/A	Migratory	x	✓
Dermochelys coriacea	Leatherback Turtle, Leathery Turtle, Luth	Endangered	Migratory	✓	✓
Eretmochelys imbricata	Hawksbill Turtle	Vulnerable	Migratory	✓	✓
Natator depressus	Flatback Turtle	Vulnerable	Migratory	✓	✓
Lepidochelys olivacea	Olive Ridley Turtle, Pacific Ridley Turtle	Endangered	Migratory	✓	✓
Mammals					
Balaenoptera borealis	Sei Whale	Vulnerable	Migratory	✓	✓
Balaenoptera edeni	Bryde's Whale	N/A	Migratory	✓	✓
Balaenoptera musculus	Blue Whale	Endangered	Migratory	✓	✓
Balaenoptera physalus	Fin Whale	Vulnerable	Migratory	✓	✓
Dugong dugon	Dugong	N/A	Migratory	x	✓
Megaptera novaeangliae	Humpback Whale	Vulnerable	Migratory	✓	✓
Orcinus orca	Killer Whale, Orca	N/A	Migratory	✓	✓
Orcaella brevirostris	Irrawaddy Dolphin	N/A	Migratory	x	✓
Physeter macrocephalus	Sperm Whale	N/A	Migratory	✓	✓
Tursiops aduncus (Arafura/Timor Sea populations)	Spotted Bottlenose Dolphin (Arafura/Timor Sea populations)	N/A	Migratory	✓	✓

Species Name	Common Name	EPBC Threatened Status	Migratory Status	EPBC Search Area	
				EADA	EMBA
Avifauna					
Acrocephalus orientalis	Oriental Reed-Warbler	N/A	Migratory	X	✓
Actitis hypoleucos	Common Sandpiper	N/A	Migratory	✓	✓
Anous stolidus	Common Noddy	N/A	Migratory	✓	✓
Anous tenuirostris melanops	Australian Lesser Noddy	Vulnerable	N/A	✓	✓
Ardenna pacifica	Wedge-tailed Shearwater	N/A	Migratory	X	✓
Calidris acuminata	Sharp-tailed Sandpiper	N/A	Migratory	✓	✓
Calidris canutus	Red Knot, Knot	Endangered	Migratory	✓	✓
Calidris ferruginea	Curlew Sandpiper	Critically endangered	Migratory	✓	✓
Calidris melanotos	Pectoral Sandpiper	N/A	Migratory	✓	✓
Calonectris leucomelas	Streaked Shearwater	N/A	Migratory	✓	✓
Fregata ariel	Lesser Frigatebird, Least Frigatebird	N/A	Migratory	✓	✓
Fregata minor	Great Frigatebird, Greater Frigatebird	N/A	Migratory	✓	✓
Hydroprogne caspia	Caspian Tern	N/A	Migratory	X	✓
Limosa lapponica	Bar-tailed Godwit	N/A	Migratory	X	✓
Limosa lapponica baueri	Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit	Vulnerable	N/A	X	✓
Limosa lapponica menzbieri	Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri)	Critically endangered	N/A	X	✓
Numenius madagascariensis	Eastern Curlew, Far Eastern Curlew	Critically endangered	Migratory	✓	✓

Species Name	Common Name	EPBC Threatened Status	Migratory Status	EPBC Search Area	
				EADA	EMBA
Onychoprion anaethetus	Bridled Tern	N/A	Migratory	X	✓
Pandion haliaetus	Osprey	N/A	Migratory	X	✓
Papasula abbotti	Abbott's Booby	Endangered	N/A	X	✓
Phaethon lepturus	White-tailed Tropicbird	N/A	Migratory	X	✓
Phaethon rubricauda	Red-tailed Tropicbird	N/A	Migratory	X	✓
Sterna dougallii	Roseate Tern	N/A	Migratory	X	✓
Sternula albifrons	Little Tern	N/A	Migratory	X	✓
Sula dactylatra	Masked Booby	N/A	Migratory	X	✓
Sula leucogaster	Brown Booby	N/A	Migratory	X	✓
Sula sula	Red-footed Booby	N/A	Migratory	X	✓
Thalasseus bergii	Crested Tern	N/A	Migratory	X	✓

4.7.4.2 Habitat Critical to the Survival of a Species

The Recovery Plan for Marine Turtles in Australia (DoEE 2017d) has established a 'Habitat Critical to the Survival of a Species' that identifies critical habitats for the survival for marine turtle stocks under the EPBC Act.

Nesting and internesting habitats have been identified, described and mapped for the green turtle, loggerhead turtle, flatback turtle, hawksbill turtle, olive ridley turtle and the leatherback turtle (DoEE 2017d).

The EADA does not include any 'habitat critical to the survival of a species'. The areas of 'habitat critical to the survival of a species' that overlap with the EMBA are shown in Figure 4-4. While the EMBA for listed marine fauna is defined by the moderate threshold EMBA as described in Section 4.2, the potential for overlap with the low threshold EMBA is also illustrated in Figure 4-4. This enables consideration of secondary impacts to marine turtles from impacts to foraging habitat that could result from the lower thresholds. No other 'habitat critical to the survival of a species' has been identified in the EMBA for other species.

It is noted that 'habitat critical to the survival of a species' 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.

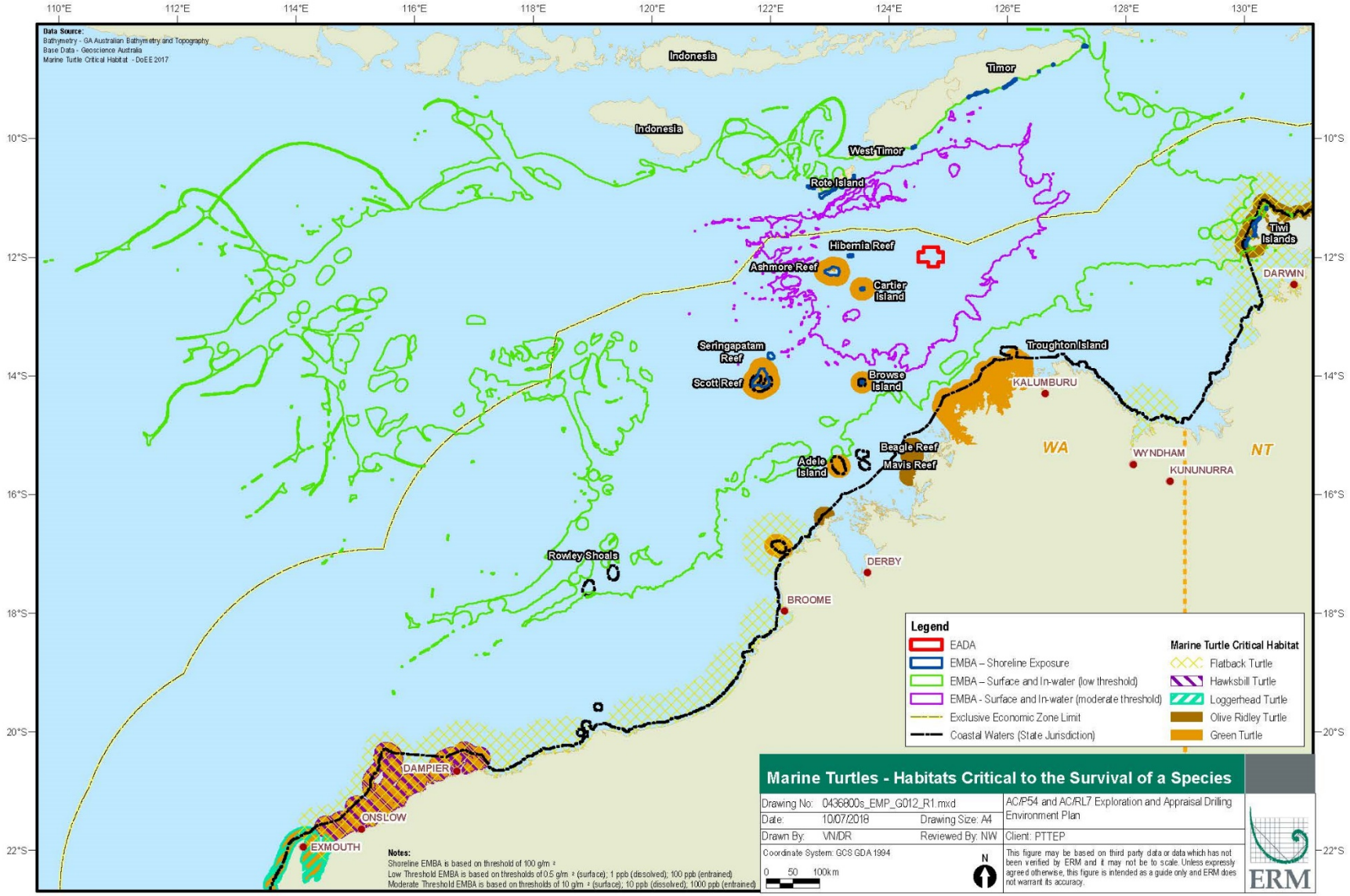

Figure 4-4 Marine Turtles – Habitat Critical to the Survival of a Species

4.7.4.3 Biologically Important Areas

BIAs have been identified, described and mapped for protected species under the EPBC Act through the marine bioregional planning program. BIAs are spatially and temporally defined areas or regions where species protected under the EPBC Act display biologically important behaviours, such as breeding, foraging, resting or migration.

The EADA overlaps with the northern edge of the whale shark foraging BIA (Figure 4-5). The EADA also borders the south-western edge of the pygmy blue whale migration BIA (Figure 4-7). There are no BIAs for turtles or birds located within the EADA, but a number are present in the EMBA, including a foraging BIA for Dugongs.

The closest BIAs for birds are located approximately 45 km south-west of the EADA and approximately 100 km south-west of the EADA for turtles (Figure 4-6 and Figure 4-8). While the EMBA for listed marine fauna is defined by the moderate threshold EMBA as described in Section 4.2, the potential for overlap with the low threshold EMBA is also illustrated in Figure 4-5 to Figure 4-8. This enables consideration of secondary impacts to listed species from impacts to foraging habitat that could result from the lower thresholds.

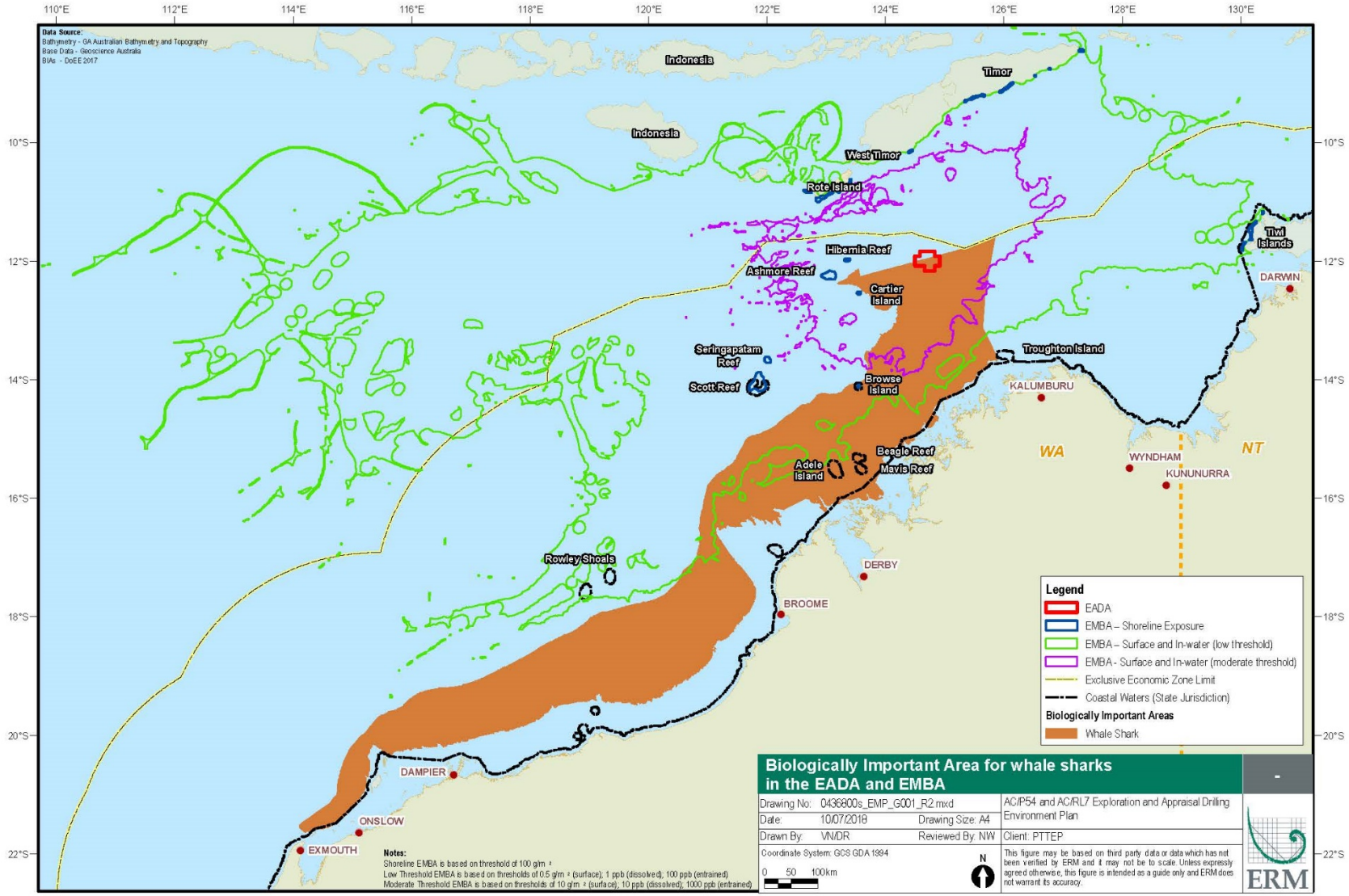

Figure 4-5 Biologically Important Area for whale sharks in the EADA and EMBA

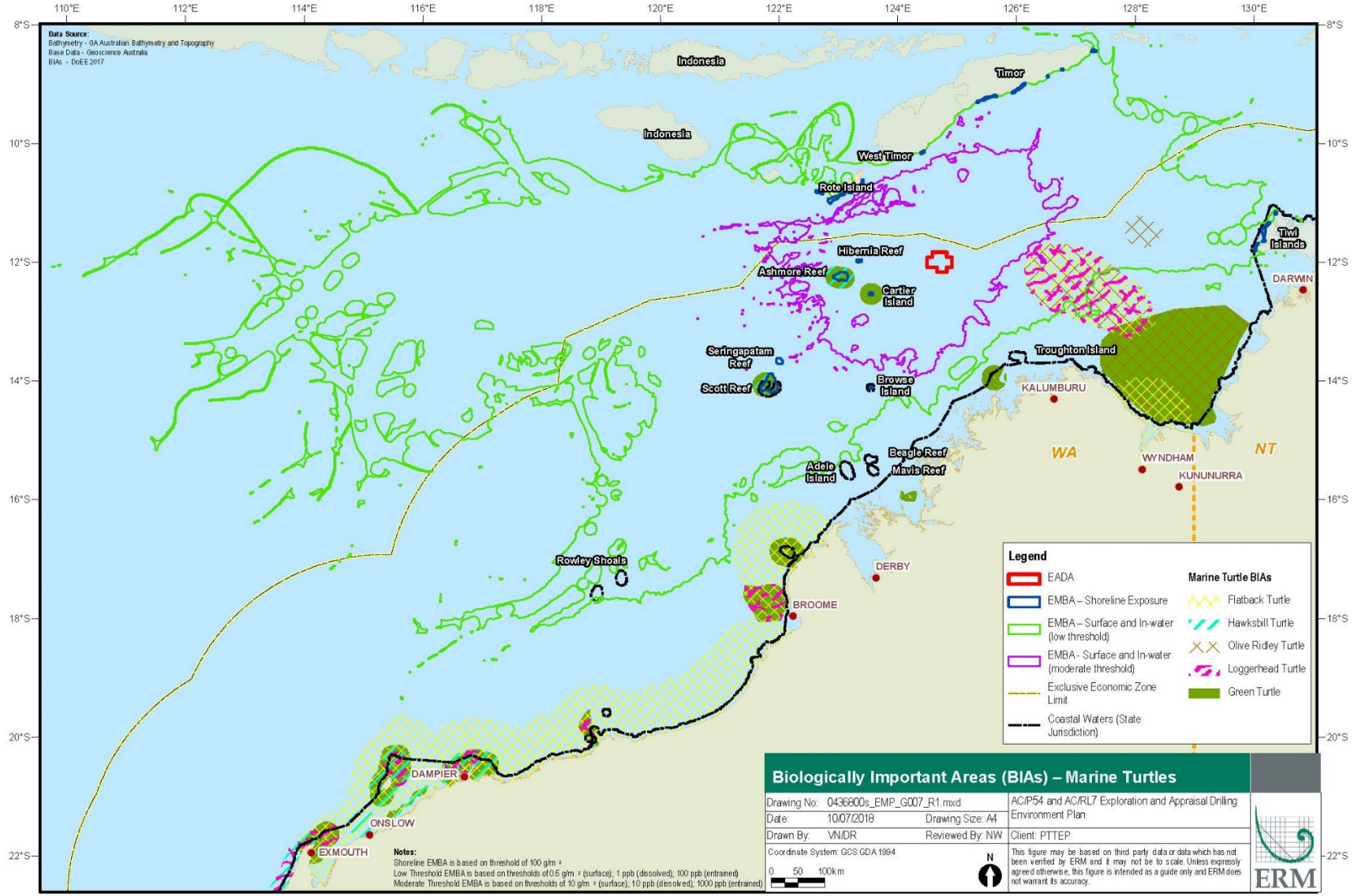

Figure 4-6 Biologically Important Areas (BIAs) for marine turtles in the EMBA

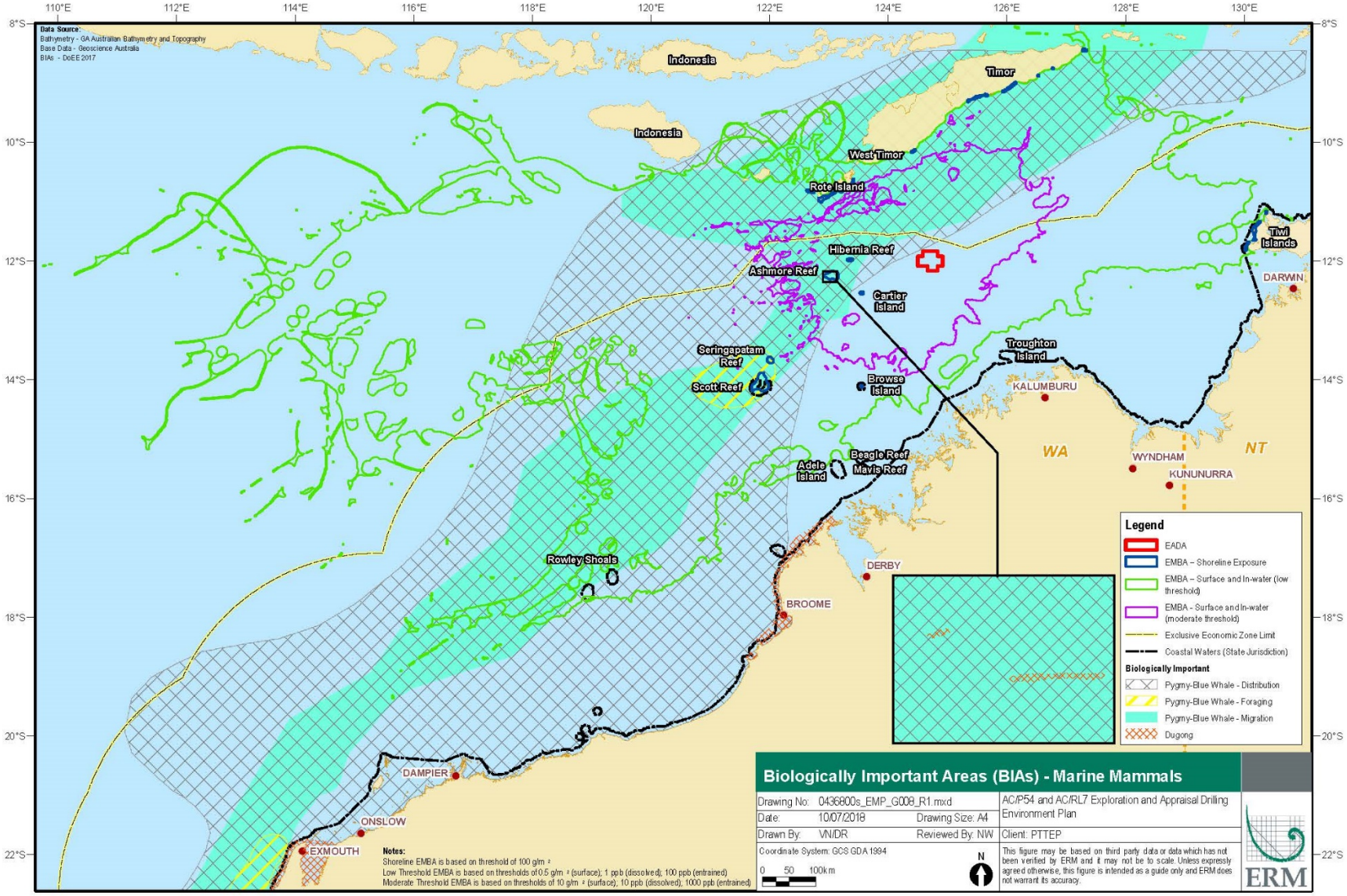

Figure 4-7 Biologically Important Areas (BIAs) for marine mammals in the EMBA

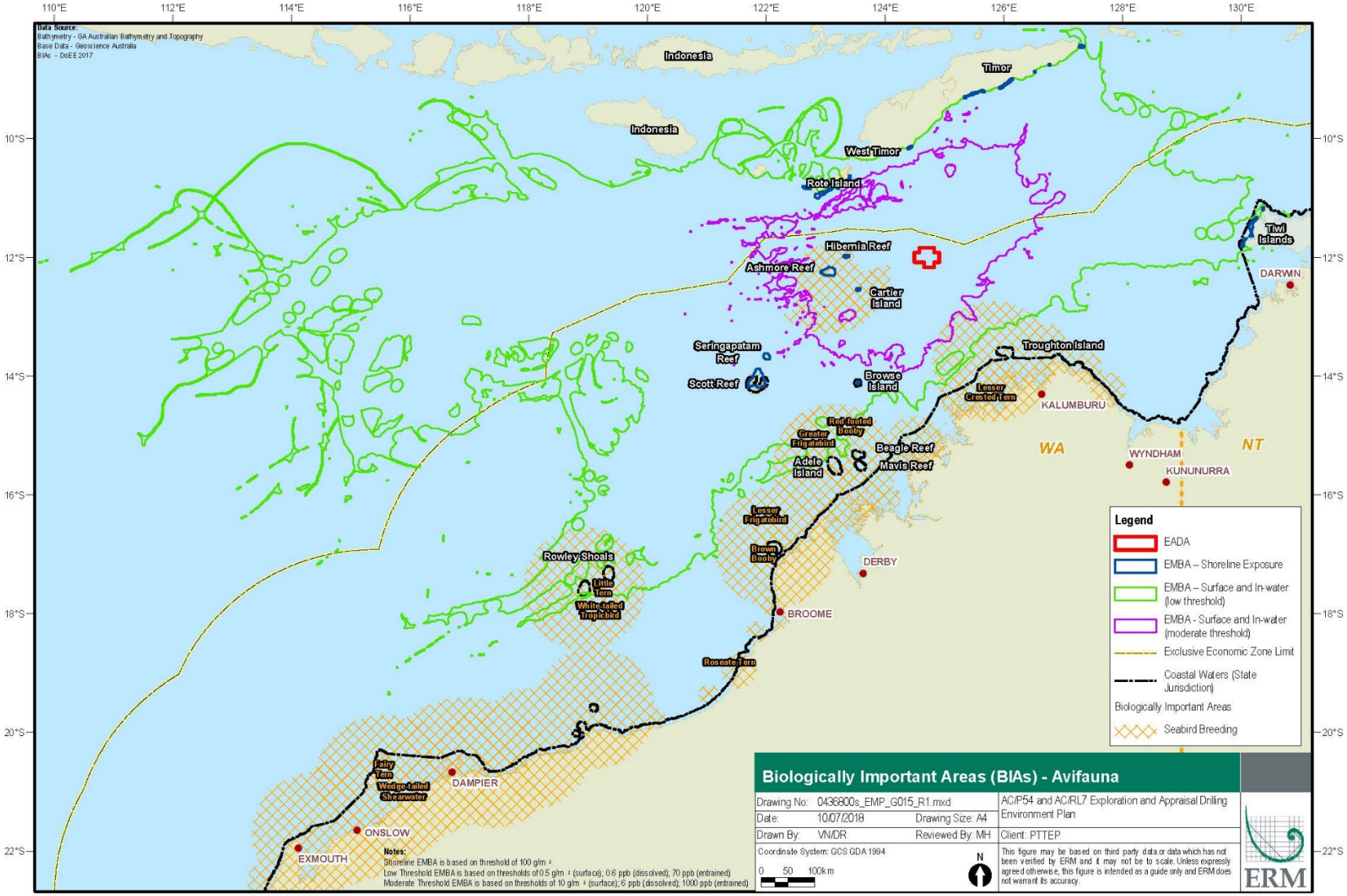

Figure 4-8 Biologically Important Areas (BIAs) for avifauna in the EMBA

4.7.4.4 Seahorses and Pipefish

Of the fish species identified in the PMST search as potentially occurring within the EADA and EMBA, 32 are species of pipefish and seahorse. However, none of these species are listed as threatened or migratory.

Overall, pipefish and seahorses are unlikely to occur within the EADA. However, within the wider EMBA, seahorses and pipefish are likely to be found in a wide variety of shallow habitats, including seagrass meadows, reefs and sandy substrates.

4.7.4.5 Fish Assemblages

No threatened and/or migratory fish species (excluding elasmobranchs) were identified in the PMST search (Table 4-7).

Demersal fish surveys conducted during the 2010-11 and 2017 marine baseline surveys indicate that low numbers of fish are present within the AC/RL7 permit area.

No protected fish species, spawning aggregations, feeding or nursery grounds or sensitive/threatened fish communities were recorded within the AC/RL7 permit area at the time of the 2010 wet season survey (ERM 2012). However, it is noted that the reef habitats of the surrounding shoals are possibly reef fish spawning grounds.

Within the EMBA, potential spawning grounds exist for southern bluefin tuna, goldband snapper, and red emperor. Southern bluefin tuna spawn from August to April (peak October to February), goldband snapper from January to April (peak March), and red emperor from October to March (peak October). None of these species are listed as threatened; however, they are commercially valuable. As such, they are described in more detail in Section 4.8.4

4.7.4.6 Elasmobranchs

The PMST search identified three threatened shark species and two sawfish species as potentially occurring within the EMBA. Of the threatened species identified, only the northern river shark is listed as Endangered in Australian waters, with the other species being listed as Vulnerable. An additional two shark species, two ray species, and one sawfish species were identified as migratory, but not threatened.

Of the threatened shark species, whale sharks are the only species likely to be encountered within the EADA and surrounds, as northern river sharks, great white sharks and sawfish species are associated with nearshore coastal waters and estuarine river systems. The whale shark is listed as Vulnerable and has a foraging BIA that overlaps with the EADA (Figure 4-5).

4.7.4.7 Sea Snakes

All sea snakes in Australia are listed as protected species under the EPBC Act. Sea snakes are essentially tropical in distribution and are typically found in shallow inshore regions and islands however, they also occur further offshore at atolls such as Scott Reef, Ashmore Reef, Cartier Island and Hibernia Reef (Guinea 2006b). Sea snakes are not expected to be common in the EADA.

According to the PMST search, a total of 17 species of sea snake were identified within the EMBA. Of these, only two species are listed as threatened: the leaf-scaled sea snake (*Aipysurus foliosquama*) and the short-nosed sea snake (*Aipysurus apraefrontalis*). Given the restricted distribution of the former and the shallow-water preference of the latter, these species are unlikely to be encountered in the EADA; however, they may be present in the EMBA.

4.7.4.8 Marine Turtles

Six species of marine turtles are found within the wider EMBA. Critical habitats and BIAs for marine turtles that directly overlap the EMBA are presented in Figure 4-4 and Figure 4-6 respectively.

No turtle BIAs directly overlap with the EADA. The closest BIAs are located approximately 100 – 145 km to the west of the EADA, around Cartier Island (green turtles) and Ashmore Reef (green and

hawksbill turtles) (Figure 4-6). However, marine turtles have extensive movement patterns and migrations, therefore low numbers of individuals may transit through the EADA.

The EMBA overlaps with the foraging BIAs for green, flatback, loggerhead, and olive ridley turtles (Figure 4-6). Of these four species, the EMBA overlaps habitat critical to the survival of the species of green turtles, flatback turtles and Olive Ridley turtles. The closest critical habitat to the EADA is 100 – 145 km west, situated in the waters of Ashmore and Cartier Islands (Figure 4-4).

4.7.4.9 Saltwater Crocodile

The saltwater crocodile (*Crocodylus porosus*) is found in Australian coastal waters, estuaries, lakes, inland swamps and marshes. Distribution ranges from Rockhampton in Queensland, throughout coastal waters of the NT to King Sound (near Broome) in WA. Movement patterns are not well known, but the movements of relocated animals demonstrate their ability to make long distance movements (up to 280 km) (Walsh and Whitehead 1993). The species was identified in the PMST search in the most southern area of the EMBA, but it is not expected to occur in the deep waters of the EADA or EMBA.

4.7.4.10 Dugongs

Dugongs (*Dugong dugon*) are listed as migratory under the EPBC Act. Dugongs feed exclusively on seagrass, and are found in shallow, protected waters in tropical and sub-tropical regions. Although there is limited information on the presence of dugongs in deeper offshore waters, such as the EADA, the absence of seagrass beds upon which the species grazes suggests that their presence is unlikely. However, dugongs are likely present within the EMBA. Dugongs are known to frequent Ashmore Reef, with an estimated population of between 10 and 60 individuals (Whiting and Guinea 2005), and are likely to extend to Cartier Island as critical seagrass habitat is available at this site (Commonwealth of Australia 2002). Ashmore Reef is a BIA for dugongs due to the foraging opportunities afforded by the seagrass beds present (approximately 150 km west of the EADA).

4.7.4.11 Cetaceans

Numerous species of cetaceans occur in the region and have wide distributions that are associated with feeding and migration patterns linked to reproductive cycles. There are 30 species of cetaceans that occur regularly in the waters of the region. The PMST search revealed that 26 species of cetaceans potentially occur in the EMBA. Nine are recorded as threatened and/or migratory. Of these species, only the pygmy blue whale has a BIA present within the EMBA and borders the north-west edge of the EADA with no direct overlap (Figure 4-7).

The region is thought to be an important migratory pathway between feeding grounds in the Southern Ocean and breeding grounds in tropical waters for several cetacean species. Pygmy blue whales (*Balaenoptera musculus*), fin whales (*Balaenoptera physalus*), dwarf minke whales (*Balaenoptera acutorostrata*) and Antarctic minke whales (*Balaenoptera bonaerensis*) may travel through the region on their way to breeding grounds, which are thought to be in deep oceanic waters around the Indonesian Archipelago.

4.7.4.12 Avifauna

The avifauna of the north-west Australia offshore area consists of tropical and sub-tropical breeding seabird species, and non-breeding migratory shorebirds.

There are no seabird BIAs located within the EADA. Within the wider EMBA there are several BIAs for breeding seabirds (Figure 4-8). The closest of these is associated with Ashmore and Cartier Islands, extending to within approximately 45 km of the EADA at its closest point. The islands at Ashmore Reef are regarding as supporting some of the most important seabird rookeries in the north-west Australian offshore area. However, breeding seabirds also make use of other offshore islands within the region, with breeding typically occurring from mid-April to mid-May (Clarke 2010).

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. The annual cycle for shorebirds in the flyway has four approximate periods: breeding (outside Australia; May to August), southward migration (August to November); non-breeding (in Australia;

December to February); and northward migration (March to May). There are no important sites for migratory shorebirds within the EADA. However, given their migratory nature, it is expected that some individuals may pass through the EADA. Within the wider EMBA, Ashmore Reef is recognised as an internationally-important site for several species of migratory shorebird, and the sand flats of Ashmore and Cartier islands are recognised as particularly important for feeding migratory shorebirds during non-breeding periods.

4.7.5 Summary of Ecological Values and Sensitivities

A summary of the values and sensitivities within the EADA and wider EMBA is provided below in Table 4-8, along with their temporal occurrence and peak times.

Table 4-8 Summary of Values And Sensitivities

Key Peak Times	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
Key Ecosystems and Biological Resources												
Coral: Spawning												
Seagrass: Flowering and Fruiting												
Plankton: Concentrations												
Fish Spawning												
Southern Bluefin Tuna: Spawning												
Goldband Snapper: Spawning												
Red Emperor: Spawning												
Elasmobranchs												
Whale Shark: Foraging												
Marine Reptiles												
Flatback Turtle: Nesting												
Green Turtle: Nesting (Ashmore and Cartier)												
Hawksbill Turtle: Nesting												
Leatherback Turtle: Nesting												
Loggerhead Turtle: Nesting												
Olive Ridley Turtle: Nesting												
Marine Mammals												
Dugong: Calving / breeding												
Pygmy Blue Whale: Northern migration												
Pygmy Blue Whale: Southern migration												
Humpback Whale: Calving / breeding												

Avifauna												
Seabirds: Breeding												
Shorebirds: Migrating												

4.8 SOCIO-ECONOMIC AND CULTURAL ENVIRONMENT

4.8.1 Commonwealth/National Heritage Sites

There are no Commonwealth or National heritage listed places within, or in the immediate vicinity of, the EADA.

There are no listed National Heritage Places within the EMBA; however Ashmore Reef National Nature Reserve, Mermaid Reef, Scott Reef and Surrounds and Seringapatam Reef and Surrounds are listed on the Commonwealth Heritage List and are recorded in the Register of the National Estates. The EMBA for heritage sites is defined by the low threshold EMBA as described in Section 4.2.

4.8.2 Indigenous Heritage

Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for thousands of years. A search of the Department of Aboriginal Affairs (DOAA) Aboriginal Heritage Inquiry System (AHIS) revealed that the EADA does not overlap with any areas of Indigenous Heritage value.

There is limited information about the Indigenous cultural significance of the Ashmore Reef, Cartier Island, and Oceanic Shoal Marine Parks (DoNP, 2017a; DoNP, 2017b). However, the Ashmore Reef Marine Park contains Indonesian artefacts and grave sites, and Ashmore lagoon is still accessed as a rest or staging area for traditional Indonesian fishers travelling to and from fishing grounds within the Memorandum of Understanding (MoU) Box (DoNP 2017a) (refer to Section 4.8.5).

4.8.3 Maritime Heritage

Australia protects its shipwrecks and associated relics older than 75 years through the Historic Shipwreck Act 1976, which applies to Australian waters that extend from the low tide mark to the continental shelf. There are no known shipwrecks located in the EADA. The EMBA for maritime heritage is defined by the moderate threshold EMBA as described in Section 4.2. Within the EMBA, the shipwreck Ann Millicent, sunk in 1888, was wrecked on the southern reef edge of Cartier Island. It is the closest historic shipwreck to the EADA, located approximately 115 km to the south-west (Australian National Shipwreck Database 2017). No other shipwrecks are known to be located in the EMBA.

4.8.4 Commercial Fisheries

The Commonwealth and State managed fisheries that overlap the EADA and the low threshold EMBA are listed in Table 4-9.

Table 4-9 Commercial Fisheries that overlap the EADA and the low threshold EMBA

Management Area	Commercial Fishery
Commonwealth Managed Fisheries	• Western Tuna and Billfish Fishery • Southern Bluefin Tuna Fishery • Skipjack Tuna Fishery • North West Slope Trawl Fishery • Northern Prawn Fishery
Western Australia Managed Fisheries	• Northern Demersal Scalefish Fishery • Northern Shark Fishery • Pearl Oyster Fishery • Mackerel Managed Fishery • Specimen Shell Fishery • WA Broome Prawn Managed Fishery • WA Kimberley Prawn • WA Mackerel Managed Fishery Area 2 • WA Pearl Oyster Managed Fishery Zones 1 and 2 • WA Pilbara Line Fishery • WA North Coast Shark Fishery • WA West Coast Deep Sea Crustacean
Northern Territory Managed Fisheries	• NT Demersal Fishery • NT Timor Reef Fishery • NT Spanish Mackerel Fishery • NT Pearl Oyster Fishery • NT Offshore Net and Line Fishery • NT Aquarium Fishery

4.8.5 Traditional and Subsistence Fisheries

Indonesian fishers have traditionally visited reefs in the NWMR to collect target species such as Trepang (sea cucumber), shark fin and other marine species that are economically significant. The Government of Australia and the Government of the Republic of Indonesia signed a Memorandum of Understanding in 1974 (MoU 74), allowing Indonesian fishers to continue to fish using “methods which have been the tradition over decades of time”. These methods include reef gleaning, free-diving, hand lining and other non-mechanised methods.

The MoU Box is located approximately 77 km west of the EADA and encompasses Scott Reef and associated reefs, including Seringapatam Reef, Browse Island, Ashmore Reef, Cartier Island and various banks. Fishing is concentrated on reefs or in reef lagoons and target species include trochus, sea cucumbers, abalone, sponges, giant clams, reef fish/finfish and sharks; predominantly between August and October with fishers departing the region at the onset of the North-west monsoon season.

In 1997, the Australian and Indonesian Governments also established an EEZ Boundary and certain seabed boundaries, labelled the 1997 Perth Treaty. Under the 1997 Perth Treaty, there are areas of overlapping jurisdiction where Australia exercises seabed jurisdiction including the exploration for petroleum, and Indonesia exercises water column jurisdiction including fishing rights (the Perth Treaty Area). Although both overlap the EMBA, neither of these areas overlap the EADA.

4.8.6 Mariculture Activities

Western Australia's pearling industry, worth about $67 million in 2014 (DPIRD, 2018), is the second most valuable fishing industry to the State after rock lobster. The geographic extent of the pearl

oyster fishery directly coincides with the location of the EADA; however hatcheries are located in Broome and Darwin (using broodstock sourced from WA) supplying significant quantities of juvenile P. maxima to pearl farms (approximately 485 km south west of the EADA).

Additional mariculture and aquaculture activities situated throughout Western Australian and Northern Territory coastal waters are confined within the 3nm Commonwealth/State maritime boundary, and none overlap the EMBA.

4.8.7 Tourism and Recreational Activities

The remote location of the EADA means, that it is not likely to be accessed for tourism activities (e.g. recreational fishing and boating and charter boats operations). Such activities tend to be focussed around nearshore waters, islands and coastal areas and will therefore rarely occur within the EMBA (the EMBA for tourism and recreational activities is defined by the low threshold EMBA as described in Section 4.2). Exceptions include a small group of recreational fishing and charter vessels that occasionally visit the Ashmore Reef and surrounds and other reefs in the EMBA.

4.8.8 Petroleum Exploration and Production

Oil and gas exploration activities off the coast of WA commenced in the late 1960s, and today the petroleum exploration and production industry is a significant user of offshore waters in the region. There are 17 oil and gas companies that hold active petroleum permits within the EMBA (Table 4-10). The EMBA for petroleum exploration and production is defined by the moderate threshold EMBA.

PTTEP AA also has production operations within title blocks AC/L7 and AC/L8 in the Timor Sea, between Australia and the island of Timor approximately 690 km east of Darwin.

Table 4-10 Petroleum Titleholders within the EMBA

Titleholder	Title blocks
Bounty Oil & Gas NL	AC/P32
Carnarvon Petroleum Limited	WA-523-P, AC/P62, AC/P63
Cornea Resources Pty Ltd	WA-54-R
ConocoPhillips Pty Ltd	WA-398-P, WA-315-P
Eni Australia Limited	AC/P21
Finder Exploration Pty Ltd	AC/P61, AC/P56, AC/P55, AC/P45
INPEX	AC/P36, WA-343-P, WA-56-R, WA-285-P
IPB Petroleum Limited	WA-471-P, WA-485-P
Murphy Australia Pty Ltd	AC/P57, AC/P59
Octanex Bonaparte Pty Ltd	WA-420-P
Santos Limited	WA-74-R, WA-274-P, WA-513-P
SGH Energy Pty Ltd	WA-377-P
Shell Australia	AC/P52, AC/P41, WA-44-L, AC/RL9, WA-371-P
Sinopec O&G Pty Ltd	AC/RL1
Timor Sea Oil & Gas Australia Pty Ltd	AC/L5
Total E&P Australia Exploration Pty Ltd	AC/P60
Vulcan Exploration Pty Ltd	AC/P50

4.8.9 Maritime Surveillance

Australian Border Force (ABF) and Royal Australian Navy (RAN) vessels undertake civil and maritime surveillance within the boundaries of the MoU, the Australian EEZ and Territorial seabed of the Continental Shelf, an area extending roughly 200 nm from the mainland (Jones 2013).

4.8.10 Defence Activities

The two closest defence training areas to the EADA are the North Australian Exercise Area (NAXA) (approximately 330 km to the east) and the Curtin Air-to-Air Air Weapons Range (approximately 350 km south west). The NAXA is the primary location of the biennial KAKADU training exercise , with the 2018 exercise scheduled from the 31 August – 15 September. The next scheduled exercise in 2018 will therefore not affect the supply vessel transport routes to and from the EADA.

4.8.11 Ports and Commercial Shipping

The majority of the major commercial shipping around the EADA is concentrated along a channel approximately 335 km west, signifying the main Western Australian to South-east Asian shipping route. The Ports of Darwin and/or Broome will be utilised as a materials/logistics supply base to service the proposed activities.

5 ENVIRONMENTAL IMPACT AND RISK ASSESSMENT METHODOLOGY

5.1 INTRODUCTION

This section outlines PTTEP AA's environmental risk assessment methodology for the identification, analysis and evaluation of potential environmental risks and impacts associated with the EADP.

This environmental risk assessment methodology specifically provides an account of the processes undertaken by PTTEP AA to:

- Identify the potential environmental impacts and risks to the particular values and sensitivities identified within Section 4 associated with the petroleum activity; and
- Perform ALARP and acceptable level assessments for the residual risks and impacts delivered by the selected control measures.

The outcomes of the risk assessment are presented in Section 6.

5.2 RISK ASSESSMENT PROCESS

The PTTEP AA risk assessment process has been developed with reference to Australian Standards, specifically AS/NZS ISO 31000:2009 Risk Management - Principles and Process (Standards Australia 2009) and HB 203:2006 Environmental risk management – Principles (Standards Australia 2006).

The environmental risk assessment is a systematic process comprised of risk identification, risk assessment and risk evaluation (detailed further in the following sections and within Figure 5-1):

Each stage of the risk assessment is undertaken with consideration of stakeholder functions, interests and activities, with any specific feedback from stakeholder consultation being taken into account.

5.2.1 Risk Identification

The risk identification stage of the assessment includes a systematic review of all activities under consideration and the subsequent identification of the potential aspects of the activities which could result in an environmental impact or risk.

At this stage, available information on the sensitivities of the environment which may be affected (EMBA) is identified for consideration, both environmental and social (as described in Section 4).

5.2.2 Risk Assessment

The risk assessment stage involves the assessment of the aspects in context of the particular values and sensitivities (environmental and social) which may be impacted, with consideration given to the proposed industry "Good Practice" control measures to be implemented. Based on this assessment and using the PTTEP AA Risk Matrix (Table 5-2), a rating is given to:

- The severity of the consequences of the potential impacts and risks, taking into account the nature and scale of the activity/aspect;
- The likelihood of the identified consequences occurring, given the control measures to be implemented and based on knowledge/historical data of similar events/incidents occurring within PTTEP AA or in the exploration and petroleum industry as-a-whole; and
- The relative level of residual risk.

5.2.3 Risk Evaluation

The risk evaluation stage involves comparing the results of the risk assessment with risk criteria to decide whether additional risk treatment is necessary, and the activity should go ahead. The two

overarching criteria assessed are whether the risks and impacts are ALARP (sub-regulation 10A(b)) and are at an acceptable level (sub-regulation 10A(c)).

5.2.3.1 Determination of ALARP

In alignment with NOPSEMA's ALARP Guidance Note (N-04300-GN0166, June 2015), PTTEP AA have adapted the approach developed by Oil and Gas UK (OGUK) (formerly UKOOA) Guidance on Risk Related Decision Making (Oil & Gas UK, 2014)[1] for use in an environmental context to determine the assessment technique required to demonstrate that potential impacts and risks are ALARP (Figure 5-1). Specifically, the framework considers impact severity based upon contextual information in relation to the following factors:

- activity type;
- potential (environmental) risk/impact and (engineering / scientific) uncertainty; and
- stakeholder influence (objects or claims).

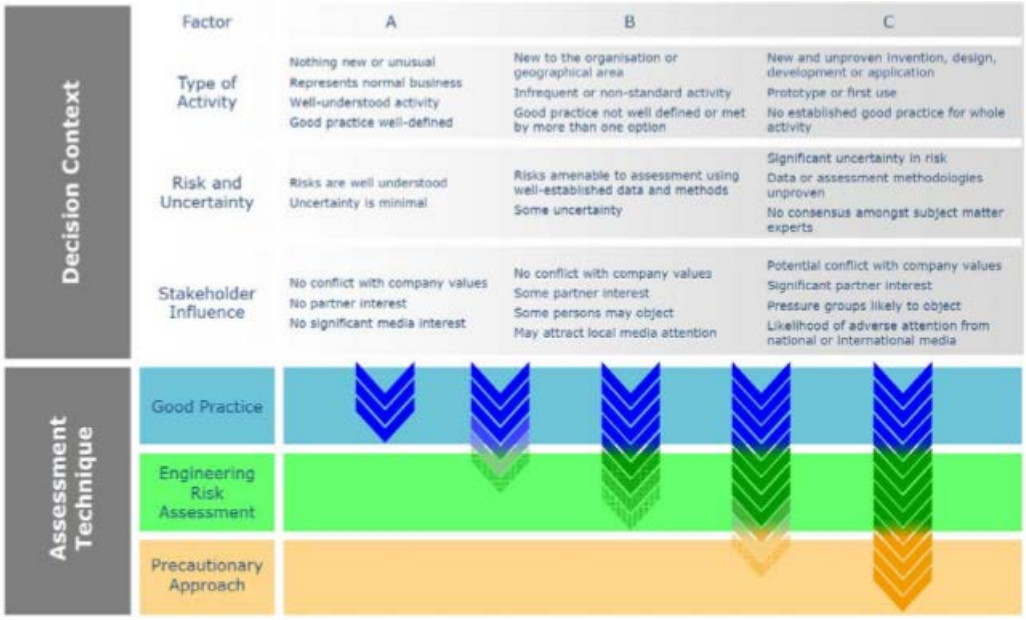

Figure 5-1 Decision support framework used to demonstrate ALARP (NOPSEMA, 2015)

Once the overall context for each risk is established it is allocated to one of the three "Types" defined below. This categorisation also aligns with the PTTEP AA approach to the low, medium and high residual risk levels as outlined in the SSHE Risk Management Standard is shown in (Figure 5-1)

In accordance with the regulatory requirement to demonstrate that environmental impacts and risks are managed to ALARP, PTTEP AA has considered the above risk context in determining the level of ALARP assessment required. The assessment techniques considered include:

- Good Practice;
- Engineering risk assessment; and
- Precautionary approach.

The application of each assessment technique in relation to the risk context is discussed further below.

[1] Oil & Gas UK (2014) (formerly UKOOA) Guidance on risk-related decision making. Issue 2. Oil & Gas UK. London. 25 p.

5.2.3.2 Type A Risk

The risk is determined to be Type A if the activity is relatively well understood, the potential risk is low and/or the potential consequence is minor (including to MNES when considering seasonal sensitivities), activities are well practised, and there is no significant stakeholder interest.

If the risk context is categorised as 'Type A', PTTEP AA considers the application of 'Good Practice' to be sufficient to demonstrate potential impacts and risk are managed to ALARP and further assessment ('Engineering Risk Assessment') is not necessarily required to identify additional controls. However, PTTEP AA may apply additional controls if good practice is not sufficiently well-defined, or when there is the potential to further reduce environmental impacts and risks for a small or negligible cost i.e., in relation to time, effort, money.

5.2.3.3 Type B Risk

The risk is determined to be Type B if there is greater uncertainty or complexity around the activity and/or risk, the potential impacts are moderate or greater (including those to MNES when considering seasonal sensitivities), or the risk is medium or greater or generates several concerns from stakeholders.

If the context is categorised as 'Type B', PTTEP AA will undertake Engineering Risk Assessment which is an analysis of alternate and/or additional control measures to those identified by 'Good Practice'.

The implementation of a risk management hierarchy encourages the implementation of hard / engineering control measures and provides for an effective spread of controls measures as outlined in the PTTEP AA SSHE Risk Management Standard as follows:

- Elimination and minimization of risk by using options with a lower impact on receptors;
- Substitution by using products and/or processes with a lower impact on receptors;
- Engineering controls – prevention and mitigation; and
- Administrative/procedural controls.

5.2.3.4 Type C Risk

A risk is determined to be Type C if it is sufficiently complex, has serious or greater potential impact (including to MNES when considering seasonal sensitivities), available engineering and scientific evidence is insufficient, inconclusive, or uncertain, or stakeholder interest to require a precautionary approach. In this case, relevant good practice still has to be met and additional engineering risk assessment is required.

PTTEP AA will apply a precautionary approach to risk management. The precautionary approach will mean that uncertainty is counterbalanced with the use of conservative assumptions when undertaking environmental risk assessment, with additional control measures more likely being adopted. That is, environmental and social considerations are expected to take precedence over economic considerations, when evaluating the suitability of additional controls. In this context, PTTEP AA would be exposed to higher levels of financial cost associated with managing potential environmental impacts and risks to ALARP.

5.2.3.5 Identification of Changes to Residual Risk

Following the ALARP evaluation, any changes to the initial assessment of residual risk as a result of adoption of alternate and/or additional control measures are identified for the purposes of determining whether potential impacts and risks have been reduced to an acceptable level.

5.2.3.6 ALARP Justification

For each risk, a statement of justification is provided regarding the overall certainty and effectiveness of the sum-total of the adopted control measures in reducing potential impacts and risks to ALARP.

5.2.3.7 Acceptable Level

In alignment with the NOPSEMA Environment Plan Decision Making Guideline (GL1721 Rev 3 May 2017), the Offshore Petroleum Greenhouse Gas Storage (Environment) Regulations 2009 (Sub-regulation 10AI and Part 1, Section 3 – Objects of the Regulations), and Part 3 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), PTTEP AA have defined that a risk or impact is of an acceptable level if the following criteria have been met:

General criteria (applied to all environmental impacts and risks):

1. The environmental risk is deemed to have a low or medium ranking and is ALARP. The environmental consequence from routine operations does not exceed a ranking of 2 and the environmental consequence from potential emergency conditions or emergency response operations does not exceed a ranking of 4. If ranked medium risk additional control measures have been applied to manage potential environmental impacts and risks to ALARP;
2. The aspect of the activity does not compromise relevant principles of Ecologically Sustainable Development (ESD) or breach relevant requirements for environmental approvals (EPBC Act Part 3, Division 1), namely:
    - does not pose a threat of serious or irreversible environmental damage to matters of national environmental significance:
        a. the world heritage values of a declared World Heritage property;
        b. the national heritage values of a National Heritage place;
        c. the ecological character of a declared Ramsar wetland;
        d. any values and sensitivities that exist in, or in relation to, part or all of a Commonwealth marine area or Commonwealth land.
    - does not pose a [significant] threat to biodiversity and ecological integrity of:
        a. a listed threatened species or listed threatened ecological community; or
        b. a listed migratory species;
    - does not pose a threat to the quality of the environment available to future generations
3. The management of the activity is consistent with any relevant plan of management for a Australian Marine Park (AMP) and/or a recovery plan for a threatened species that include specific management and conservation requirements.
4. All relevant legislative and other requirements have been met or considered in context,;
5. All relevant internal PTTEP AA requirements have been met; and
6. All relevant person(s) have been provided with sufficient information with respect to potential impacts on their functions, interests or activities and all valid objections or claims made by relevant (potentially affected) person(s) have been sufficiently addressed.

Criteria applicable to particular values and sensitivities

For particular values and sensitivities that may be impacted by routine drilling operations during the EADP, the criteria in Table 5-1 have been developed to determine whether the predicted impact is below an acceptable level of impact.

PTTEP AA does not consider it acceptable for an emergency condition to occur. Emergency conditions assessed in this EP include establishment of an invasive pest and marine oil pollution emergency resulting from a loss of well control or a vessel fuel tank rupture. However, PTTEP AA considers the level of risk to be acceptable when the environmental consequence from potential emergency conditions does not exceed a ranking of 4 and preventative and response control measures are demonstrated to reduce potential environmental impacts and risks to ALARP (as per General Criteria 1 above).

To provide additional assurance of the acceptable level of impact associated with the implementation of oil pollution emergency response strategies, PTTEP AA commit to engaging with relevant

person(s) to establish external context during the operational Net Environmental Benefit Assessment (NEBA) process as described in the OPEP. Pending the outcome of this engagement, the upper limit of acceptable impact on a stakeholder's functions, interests or activities can be evaluated holistically considering the overall cost-benefit of response strategy implementation.

Table 5-1 Criteria for Acceptable Level of Impact – Routine Drilling Operations

Identified Value or Sensitivity
Marine Fauna
In alignment with the EPBC Act, Part 3 (18A and 20A), PTTEP AA considers it unacceptable to have a significant[1] impact (including mortality of an individual) on an EPBC listed (marine fauna) species.
Given the widespread distribution of non-listed marine fauna species, and that non-listed species are not formally managed, PTTEP AA considers it acceptable to have a minor (1) or moderate (2) consequence to a population or community of non-listed marine fauna.
Avifauna
In alignment with the EPBC Act, Part 3 (18A and 20A), PTTEP AA considers it unacceptable to have a significant[1] impact (including mortality of an individual) on an EPBC listed (bird) species.
Given the widespread distribution of non-listed bird species, and that non-listed species are not formally managed, PTTEP AA considers it acceptable to have a minor (1) or moderate (2) consequence to a population or community of a non-listed bird species.
Benthic Communities
Benthic communities within the EADA are primarily associated with soft sediment habitats and are considered to be relatively low sensitivity and widely represented in the region. An acceptable level of consequence to these communities is considered to be minor (1) or moderate (2).
Given the distance to bank/shoal habitat (>10 km from closest well (Orchid-1)) and any KEFs (>13 km from EADA), no impact is expected to benthic communities in these areas during planned EADP activities, therefore no acceptable level of impact has been established for these benthic communities.
Shoreline Habitats
Given the distance of the EADA to shoreline habitats no impact is expected during routine operations, therefore no acceptable level of impact has been established.
Protected Areas
Given the distance of the EADA to any protected areas, and that no impact is expected during routine operations, no acceptable level of impact has been established.
Heritage Places
Given the distance of the EADA to any heritage places, and that no impact is expected during routine operations, no acceptable level of impact has been established.
Commercial Fisheries
PTTEP AA considers the application of OPGGSA Section 6.6 (Petroleum Safety Zone), and the establishment of a 500 m safety zone around the MODU to represent an acceptable level of disruptive impact to commercial fisheries in the EADA. PTTEP AA considers it acceptable to have a minor (1) or moderate (2) consequence to a population or community of a commercial fish species.
Traditional & Subsistence Fisheries

Given the distance of the EADA to any identified traditional or subsistence fishing grounds, and that no impact is expected during routine operations, no acceptable level of impact has been established.
Tourism & Recreation
Given the distance of the EADA to any identified tourism operations or recreational areas, and that no impact is expected during routine operations, no acceptable level of impact has been established.
Petroleum Exploration & Production
Given the distance of the EADA to any other petroleum or exploration activities, and that no impact is expected during routine operations, no acceptable level of impact has been established.
Ports & Commercial Shipping
PTTEP AA considers the application of OPGGSA Section 6.6 (Petroleum Safety Zone), and the establishment of a 500 m safety zone around the MODU to represent an acceptable level of disruptive impact to other marine users.
Defence
PTTEP AA does not consider any disruptive impact to Australian Commonwealth defence activities as acceptable.
[1] The definition of 'significant impact' is as defined in the 'Matters of National Environmental Significance: Significant Impact Guidelines 1.1 (Commonwealth of Australia 2013).

Table 5-2 PTTEP AA Environmental Risk Assessment Matrix

PTTEP AA Environmental Risk Assessment Matrix						
Consequence Rating	**Environmental Consequence Description**	**Likelihood of Occurrence**				
		Rare (A)	**Unlikely (B)**	**Possible (C)**	**Likely (D)**	**Almost Certain (E)**
		Event occurrence is remote and/or never heard of within the E&P industry	Event has occurred a few times in the E&P industry or is unlikely to occur in PTTEP	Event has occurred several times in the E&P industry or occurred once in PTTEP or may occur in PTTEP	Event has occurred several times per year in the E&P industry or more than once in PTTEP or occurred in the same location or is likely to [illegible] PTTEP	Event occurs frequently in the E&P industry or occurred more than once per year at the same location or is expected to occur in PTTEP
Major (5)	Wide-spread to regional change to the environment (sub-lethal and/or lethal), well outside the immediate vicinity of the source, potentially extending to another bioregion. Persistent or irreversible change to baseline – populations, communities or species. Impact at population and/or species level of listed and/or non-listed species. Potential threat to ecological integrity of listed species. Potential serious or irreversible damage to World Heritage, National Heritage, Ramsar wetland, values within Australian Marine Parks or on Commonwealth Land. Very high financial consequence (>$50M AUD). Potential for significant level of remediation required. Likely multiple breaches of statutory or prescribed limits, or cause for multiple complaints/objections from relevant external stakeholders and other interested parties. Potential for legal proceedings					
Serious (4)	Wide-spread to regional change to the environment (sub-lethal and/or lethal), well outside the immediate vicinity of the source but within the same bioregion. Long-term but reversible change to baseline – population, community or species. Impact to multiple or population of listed species and/or non-listed species. High financial consequence ($10M - $50M AUD). Potential remediation required. Likely multiple breaches of statutory or prescribed limits, or cause for multiple complaints/objections from relevant external stakeholders and other interested parties.				**High Risk**	
Significant (3)	Wide-spread change to the environment (sub-lethal or lethal), well outside the immediate vicinity of the source. Noticeable but reversible (short to medium-term) change to baseline – population or community. Impact to individual or multiple listed species or population of non-listed species. Moderate financial consequence ($1M - $10M AUD). Potential for multiple breaches of statutory or prescribed limits, or cause for multiple complaints/objections from relevant external stakeholders.			**Medium Risk**		
Moderate (2)	Localised to wide-spread change to the environment (nuisance or sub-lethal), potentially outside the immediate vicinity of the source Negligible and reversible change to baseline of population / community (no lasting effect). Impact to individual listed species or large number of non-listed species. Negligible to small financial consequence ($50K - $1M AUD). Single breach of statutory or prescribed limit, or cause for single complaint/objection from relevant external stakeholder.		**Low Risk**			
Minor (1)	Localised change to environment (nuisance or sub-lethal), within immediate vicinity of the source. Practically indistinguishable from existing baseline. Impact to individual or small number of non-listed species. No or negligible financial consequences (<$50K AUD). Little to no potential impacts to relevant external stakeholders.					

6 ENVIRONMENTAL IMPACT AND RISK ASSESSMENT

This section provides the results of the risk evaluation based on the environmental aspects identified for the EADP (Table 6-1).

Table 6-1 Routine and Emergency Response Activities

Routine Activities		
R1	Physical Presence (MODU, Support Vessels and Helicopters)	Section 6.1
R2	Invasive Pests: Terrestrial and Marine	Section 6.2
R3	Artificial Light	Section 6.3
R4	Anthropogenic Noise	Section 6.4
R5	Atmospheric Emissions: Power Generation and Flaring	Section 6.5
R6	Seabed Disturbance	Section 6.6
R7	Discharge of Sewage, Greywater and Food Waste	Section 6.7
R8	Discharge of Deck Drainage and Bilge Water	Section 6.8
R10	Discharge of Cooling Water and Desalination Brine	Section 6.9
R10	Dropped Objects and Solid Waste	Section 6.10
R11	Discharge of Drill Cuttings and Fluids	Section 6.11
R12	Discharge of Cement	Section 6.12
R13	Marine Chemical Spills	Section 6.13
R14	Marine Hydrocarbon Spills	Section 6.14
Emergency Response Activities		
ER1	Nearshore and Shoreline Disturbance	Section 6.15
ER2	Discharge of Chemical Dispersants	Section 6.16
ER3	Atmospheric Emissions: In Situ Burning	Section 6.17
ER4	Oiled Fauna Displacement and Handling	Section 6.18

6.1 R1 PHYSICAL PRESENCE (MODU, SUPPORT VESSELS AND HELICOPTERS)

Assessment of Nature and Scale of Impacts and Risks
The physical presence of the MODU and support vessels could result in interference with the rights of other marine users by restricting access to the marine environment within the EADA and increase potential for physical or disruptive interaction with marine fauna. The physical presence of helicopters has the potential to be disruptive to marine fauna. Seabed disturbance associated with the physical presence of the MODU is discussed in Section 6.6. Potential marine hydrocarbon spills associated with a collision between support vessels, the MODU or an errant vessel is discussed in Section 6.14. ***Interference with the rights of other marine users and safety exclusion zone*** Once the MODU is moved into location it remains in a fixed position for the duration of the proposed drilling activity (35 to 100 days). A 500m rig safety exclusion zone will be established around the MODU once on location. The rig safety exclusion zone enables the controlled access to the MODU by support vessels and excludes other marine users from directly interfacing with the MODU whilst fixed on location. One support vessel will remain in the EADA at all times to provide support to the MODU. Additional support vessels will be used to supply the MODU, typically 1-3 times per week. Support vessels may enter the 500m rig safety exclusion zone once authorised for safe entry. Entry of vessels is at low speed and communication is maintained with the MODU during these support / supply activities. The physical presence of the MODU and the implementation of a safety exclusion zone have the potential to interfere with established shipping corridors, thus requiring commercial vessels to avoid the safety exclusion zone surrounding the MODU. Commercial shipping may be encountered during the EADP. Feedback from AMSA as part of stakeholder consultation indicates that commercial vessels will be encountered in the southern section of the EADA travelling to and from Darwin; and other oil and gas operator support vessels will be encountered in the northern and southern section of the EADA. Interaction between EADP support vessels and other marine users is expected to be minimal due to the remote location and low fishing effort expended within the EADA. Any overlap with active fisheries is relatively small. The potential for interference as a result of the physical presence of the MODU and support vessels will be limited to localised displacement/avoidance by commercial fishing vessels within the immediate vicinity of the MODU i.e., within the 500 m safety exclusion zone for a relatively short time period (35-100 days per well). The EADA is located in a very remote geographical area. No known tourist, recreational or traditional/subsistence fishing occurs in the area. There may be the possibility of occasional passing private motor vessels or yachts in the area. ***Interaction with marine fauna*** The movement of support vessels operating within the EADA has the potential to disturb or collide with marine fauna, such as cetaceans, whale sharks and turtles.

Vessel speed is a strong contributor to the rate of collisions with marine fauna, with increasing vessel speed resulting in a higher collision risk (Hazel et al. 2007; Silber et al. 2010). A study conducted by Laist et.al (2001) on collisions between ships and whales observed that most lethal or severe injuries to cetaceans involved vessels 80 m or longer in length and were associated with vessels travelling at 14 knots or faster.

The only known biologically important area (BIA) that overlaps the EADA is the most northern part of the whale shark foraging BIA as described in Section 4.7.4.3. However, only occasional individuals are expected to occur as there are no whale shark aggregations (such as the Ningaloo Reef aggregation) in the region.

Turtles are also susceptible to vessel strikes when they come to the sea surface to breathe. While turtles typically avoid vessels by rapidly diving, their response varies significantly in relation to the speed of the vessel and the activity of the turtle.

The support vessels described in Section 3 typically travel at speeds under 14 knots during most supply runs as this represents the most economical speed, On rare occasions higher speeds may be used where urgent delivery of supplies is needed. Due to the general low vessel speeds, the chance of a vessel collision with marine fauna resulting in a lethal outcome is reduced as individuals are expected to display avoidance behaviour.

There are no identified specific seasonal sensitivities for matters protected under Part 3 of the EPBC Act, i.e., matters of national environmental significance (MNES) in relation to the physical presence of the MODU, support vessels and helicopters within the EADA.

The potential impacts associated with the physical presence of the MODU, support vessels and helicopters are:

- Physical interaction, including potential collision, with marine fauna by support vessels;
- Behavioural changes to marine fauna caused by helicopters in the immediate vicinity of the MODU; and
- Disruption to other marine users through the establishment of a 500m safety exclusion zone.

The potential exposure to marine fauna and/or other marine users from the physical presence of project support vessels is:

- Short term exposure to support vessels for the duration of each drilling campaign;
- Short term (35 – 100 days) continuous exclusion zone limited to a 500m radius surrounding the MODU at its fixed location;
- Short term intermittent exposure to helicopters for the duration of each drilling campaign during daylight hours in the immediate vicinity of the MODU, typically 5-7 times per week. Night time helicopter operations may occur in the event of a medivac; and
- Intermittent transiting of support vessels during supply runs for the duration of each drilling campaign, typically 1-3 times per week.

There is very little uncertainty regarding the physical presence of the MODU, support vessels and helicopters into and around the EADA. In the unlikely event of a loss of well control resulting in an uncontrolled release the presence of a second MODU to drill a relief well may be required along with additional support vessels.

As part of the stakeholder consultation program, consultation with relevant stakeholders was conducted. Feedback was received from the Western Australian Fishing Industry Council (WAFIC), and individual license holders in the Mackerel Managed Fishery and Northern Demersal Scalefish Fishery.

Detailed Environmental Impact Assessment					
Identified Value or Sensitivity Potentially Exposed to Impact	**Potential Severity / Consequence Discussion**	**Rating**	**Likelihood of Impact Occurrence**	**Rating**	**Risk**
Marine Fauna • Marine Mammals	There are no known key aggregation areas (resting, breeding or feeding) located within or immediately adjacent to the EADA; however, occasional individuals may be present. Should a support vessel strike a marine mammal, the worst-case consequence would be a potentially lethal effect on a single individual with no lasting effect to population or community baseline.	Moderate (2)	Support vessels within the EADA will generally be travelling at speeds less than 14 knots and therefore the chance of a vessel collision with a marine mammal resulting in a lethal outcome is reduced as individuals are expected to display avoidance behaviour. Given the short-duration of transit activities and the ability of marine mammals to display avoidance behaviour, and that no critical habitats and/or BIAs for marine mammals overlap the EADA, it is considered unlikely that a fauna strike incident will occur.	Unlikely (B)	Low (2B)
Marine Fauna • Marine Mammals	Helicopter presence is expected to occur 5-7 times per week during the drilling of each well. Helicopters are expected to operate at altitudes lower than 500 metres during take off and landing only. There are no known key aggregation areas (resting, breeding or feeding) located within or immediately adjacent to the EADA; however, occasional individuals may be present. Whales have been observed to resume their pre-disturbed activity within a few minutes (Richardson and Malme 1993).	Minor (1)	Given the short-duration of take off and landing and the ability of marine mammals to display avoidance behaviour and resume their pre-disturbed activity within a few minutes it is considered rare for an encounter with a marine mammal to result in a change in behaviour.	Rare (A)	Low (1A)

Marine Fauna • Whale Sharks	Although whale sharks do not breach the surface as marine mammals do, they are known to swim near to the water surface and therefore are susceptible to vessel interactions. The EADA overlaps with the northern most section of the whale shark foraging BIA (Figure 4-5). However, only occasional individuals are expected to occur as there are no whale shark aggregations (such as the Ningaloo Reef aggregation) in the region (Section 4). However, should a support vessel strike a whale shark at the surface, the worst-case consequence would be a potentially lethal effect on a single individual with no lasting effect to population or community baseline.	Moderate (2)	Due to there being no known aggregation areas for feeding or breeding in the region, it is considered unlikely that a whale shark strike incident will occur.	Unlikely (B)	Low (2B)
Marine Fauna • Marine Turtles, • Other Sharks, Sawfish and Rays	Should individuals of EPBC listed and non-listed marine fauna species transit through the EADA, the worst-case consequence of a fauna strike would be a potentially lethal effect on a single individual of a listed species with no lasting effect to population or community baseline.	Moderate (2)	Given the short-duration of transit activities, and that no critical habitats and/or BIAs overlap the EADA, it is considered unlikely to encounter protected species (marine reptiles; sharks, sawfish and rays; and listed fish species) and for a fauna strike incident to occur.	Unlikely (B)	Low (2B)
Avifauna	Should individuals of listed or migratory bird species transit through the EADA, the worst-case consequence of a bird strike with a helicopter would be localised, with a potentially lethal effect on a single individual with no lasting effect to population or community baseline. There is no potential impact to avifauna associated with the physical presence of the MODU and support vessels.	Moderate (2)	Given the short term and intermittent helicopter activities and mobile nature of listed or migratory bird species, it is considered rare for a strike incident to occur.	Rare (A)	Low (1A)

Commercial Fisheries	Any overlap of the EADA with active fisheries is relatively small and the potential for interference as result of the physical presence of the MODU and support vessels will be limited to localised displacement/avoidance by commercial fishing vessels within the immediate vicinity of the MODU i.e., within the 500 m safety exclusion zone for a relatively short time period. Any potential impact to commercial fisheries would therefore be highly localised, limited to individual marine users & have a negligible financial consequence.	Minor (1)	Given the low fishing effort exhibited by commercial fisheries within the EADA, it is deemed unlikely that there will be an impact on commercial fisheries.	Unlikely (B)	Low (1B)
Traditional & Subsistence Fisheries	Physical presence of the MODU/support vessels and the establishment of a rig safety exclusion zone poses no known impacts or risk of interference with traditional or subsistence fishing, given no known fishing occurs in the area. Should traditional fishers enter the EADA, any potential impact would be highly localised, limited to individual marine users & have a negligible financial consequence.	Minor (1)	Given there are no known traditional/subsistence fisheries within the EADA, it is unlikely for any impact to occur.	Unlikely (B)	Low (1B)
Tourism & Recreation	Physical presence of the MODU/support vessels and the establishment of a rig safety exclusion zone poses no known impacts or risk of interference with tourism or recreation activities. Should a private vessel enter the EADA, any potential impact would be highly localised, limited to individual marine users & have a negligible financial consequence.	Minor (1)	Given there are no known tourism operators within the EADA, it is unlikely for any impact to occur.	Unlikely (B)	Low (1B)
Ports & Commercial Shipping	The physical presence of the MODU or support vessels would have little or no impact on restricting access to commercial shipping.	Minor (1)	The safety zone established around the MODU excludes non-authorised vessels.	Rare (A)	Low (1A)

			Interaction between the MODU and other vessels, or support vessels and other vessels is expected to be minimal due to the remote location, in addition to the range of mitigation measures and exclusion zones implemented.		

Summary of Control Measures, ALARP and Acceptability

The decision context for impacts and risks to the marine environment associated with the physical presence of MODU, support vessels and helicopters is 'Type A' as defined in Section 5. As such, the demonstration of ALARP is based on assessment against industry good practice.
The following controls will be adopted to manage potential environmental impacts and risks to ALARP and acceptable level:

- Offshore Petroleum & Greenhouse Gas Act 2006 (OPGGSA) Section 6.6: Petroleum Safety Zone and Section 280 – Interference with Others Rights
- Navigation Act 2012, as administered via the Australian Maritime Safety Authority (AMSA) Marine Order 30 (Prevention of Collisions):
  - Notice to Mariners to be issued to accurately reflect the planned activities and safety zones in place.
- Support vessels and helicopters will comply with relevant requirements of EPBC Regulations 2000 - Part 8 Division 8.1, including:
  - Vessels will not exceed a speed of 6 knots within the 300 m of a cetacean;
  - Vessels will not approach closer than 100 m from a whale or 50 m from a dolphin
  - Helicopters will avoid operating at altitudes lower than 500 m, except during take-off and landing and during emergency search and rescue activities;
  - At altitudes less than 500 m, helicopters will avoid approaching within a horizontal radius of 500 m of a cetacean or approaching a cetacean from head on.
- Support vessels will comply with Whale Shark Wildlife Management Program No. 57, including:
  - Vessels will not exceed a speed of 8 knots within 250 m of a whale shark; and
  - Vessels will not approach closer than 30 m of a whale shark.

ALARP and Acceptability

Given the decision context is 'Type A' the adoption of 'Good Practice' measures above provides for multiple layers of engineering and administrative controls to manage potential environmental impacts and risks to ALARP. All acceptability criteria have been met and the potential environmental risks and impacts are determined to be acceptable.

6.2 R2 INVASIVE PESTS: MARINE AND TERRESTRIAL

Assessment of Nature and Scale of Impacts and Risks
There is the potential for the MODU and support vessels to transfer invasive marine pests (IMPs) from either international waters or Australian waters into the EADA and for them to establish in the surrounding areas. There is also the potential for invasive marine pests and terrestrial pests to be transferred into Australian Territory and coastal waters via the support vessels when returning to the supply base ports of Darwin or Broome. For any individual campaign the MODU and support vessels could mobilise to the EADA: • From an Australian port (where the MODU will have been cleared as a 'low risk' installation under the *Biosecurity Act 2015* [2]); or • From another permit holders location in Australian waters (the MODU having previously been cleared as a 'low risk' installation); or • Directly from an international port (following which the MODU will be cleared as a 'low risk' installation). The MODU will not be self-propelled, and therefore will be mobilised to site with the aid of support vessels. This risk assessment and proposed control measures also consider the biosecurity requirements of 'exposed conveyance', in the event that the MODU is unable to maintain its status as a 'low risk' installation. E.g. in the event that it is exposed to an international vessel, persons or goods, such as if critical equipment is required to come from overseas in an emergency situation. ***Invasive marine pests*** IMPs could potentially be transported and introduced into the EADA through marine fouling, including establishment on hulls or in niches on the MODU and/or support vessels, or as a component of ballast water and associated sediments. IMPs are marine fauna or flora that have been introduced into an area beyond their natural range; they do not occur naturally in that environment. IMPs which are able to survive outside of their natural range may pose a significant threat to the Australian marine environment, including commercial fisheries, as they can cause a range of ecological effects, including displacement of species, increased competition with native species, increased predation, disruption of ecological processes and changes in ecosystem function (i.e. the food chain in that area). It is estimated that Australia has over 250 established marine pests, and it is estimated that approximately one in six introduced marine species becomes pests (DoE 2015l).

[2] Consistent with the Biosecurity (Exposed Conveyances—Exceptions from Biosecurity Control) Determination 2016, an installation may be classed as low risk/acceptable if:
a) Only domestic persons or persons confirmed by the Department of Agriculture and Water Resources to be low risk are on board the installation; and
b) Only the following kinds of goods have ever been on board the installation: i) domestic goods; ii) low risk goods (i.e. fuel or petroleum); iii) goods that are to be deployed to the sea or the seabed; iv) goods that are in the possession of a domestic person who left the installation temporarily and later returned to it; or other equipment and goods determined by the Department of Agriculture and Water Resources to be low risk; and
c) The Director of Biosecurity is satisfied that the level of biosecurity risk associated with the installation is acceptable before the exposure to vessels occurs, as confirmed in a 'low risk letter'; and
d) During the period between receiving the 'low risk letter' from the Director of Biosecurity and the exposure to the vessels occurring, no persons boarded the installation or only domestic persons boarded the installation; and no goods were brought on board the installation or only goods of a kind referred to in paragraph (b) were brought on board the installation.

Fishery impacts and increased concerns following the introduction of IMPs into Australian waters has led to increased management requirements by State and Commonwealth regulators in recent years, with the introduction of the Australian National System for Prevention and Management of Marine Pest Incursions (Commonwealth of Australia 2008) and the *Biosecurity Act 2015*.

The likelihood of IMPs being establishing in Commonwealth or State/Territory waters is dependent on successful IMP colonisation on a vessel or presence in ballast water; the survivorship of IMPs during oceanic voyages, potentially across varying temperature and salinity gradients; the spread of viable IMP propagules and larvae from a vessel; the IMPs' arrival at a suitable habitat; and establishment of a viable IMP population (Commonwealth of Australia 2009). Establishment would require suitable environmental conditions which include water temperature, water depth and habitat range. The marine species recognised as representing an elevated pest risk in Australia are typically coastal or shallow water species.

Shallow water, coastal marine environments are most susceptible to the establishment of invasive populations, with most IMS associated with artificial substrates in disturbed shallow water environments such as ports and harbours (e.g. Glasby et al. 2007; Dafforn et al. 2009a, 2009b).

Therefore, the undisturbed, deep water, offshore location of the EADA (115 m to 230 m water depth) is unlikely to represent suitable habitat for the establishment of IMPs. The nearest shallow shoal feature (at approximately 10 m depth) is located outside the EADA, 10.8 km to the north of the nearest drilling location (Orchid-1) which is also an undisturbed location with no man-made structures such as jetties or piers.

It is expected that support vessels will be in close proximity to the MODU for periods of up to 12 hours at a time. The vessels will transit between the EADA and the port of Darwin 1-3 times a week over the period of the drilling activity (for planned activities). Broome port may be utilised in the unlikely event of an emergency situation. It has been found that highly disturbed environments (such as ports) are more susceptible to the colonisation of marine pests than open water environments where the number of dilutions and the degree of dispersal are high (Paulay et al. 2002).

There are no identified marine threatened ecological communities within the EADA, coastal waters or port limits protected under Chapter 2, Part 3 of the EPBC Act, i.e. MNES, that may be exposed to a potential incursion of IMPs. The benthic environmental conditions and status of known and existing IMPs in Darwin and Broome ports are outlined below.

Darwin Port

Darwin Harbour has a complex assemblage of marine habitats and there are large differences in the extent, diversity and significance of the associated biological communities. Rocky intertidal areas are found around headlands, while extensive mangrove communities and intertidal flats are present in the bays and other sheltered areas (INPEX 2010). Seaward of the mangroves, a range of intertidal and subtidal habitats occur supporting seagrass, coral and macroalgae communities (INPEX 2010).

Targeted marine pest monitoring programs in Darwin Harbour have previously detected the green algae species, *Caulerpa racemosa* var. *lamourouxii*, barnacle *Amphibalanus amphitrite*, bryozoan *Bugula neritina*, and the ascidians *Botryllus schlosseri*, *Botrylloides leachi* and *Didemnum perlucidum* (Cardno and Golder Associates 2013). In addition, an outbreak of black stripped mussels (*Mytilopsis sallei*) was recorded in Darwin Harbour in 1999, although this species was subsequently eradicated (Ferguson 2000). In summary, numerous IMPs have previously been identified in Darwin Port and it is therefore not considered to be pristine.

Broome Port

Substrates surrounding the port are predominantly soft mud tidal flats but some rocky substrates occur around the headlands in the area. Submerged artificial substrates include the steel jetty piles as well as the boat moorings, although most of these are intertidal. Willie Creek, approximately 30 km north of Broome, also contains submerged structures associated with pearling aquaculture. Areas of mangroves exist within and nearby to the port, particularly in Dampier Creek to the north-east of the port, and in Willie Creek directly to the north (Bridgwood and McDonald 2014). Roebuck Bay Marine park is located to the south of Broome Port and is an important wetland for migratory shorebirds.

The Kimberley Ports Authority monitor for the presence of IMPs through the DPIRD's State Wide Array Surveillance Program (SWASP), although monitoring results are not publically available. Previous incursions of marine pests reported at Broome Port include black-striped mussel (*Mytilopsis sallei*) (McDonald 2008) and the colonial sea squirt (*Didemnum perlucidum*) (Muñoz and McDonald 2014). Therefore, IMPs have previously been identified in Broome Port and it is not considered to be a pristine environment.

Terrestrial pests

In the event a MODU and/or support vessels are sourced internationally, terrestrial pests could potentially be introduced to the Australian mainland through transportation on-board the MODU and/or support vessels if the MODU and/or support vessels enter an Australian port.

Terrestrial pests are fauna or flora that have been introduced into an area beyond their natural range; they do not occur naturally in the environment (i.e. non-endemic or invasive species). Terrestrial species which are able to survive outside of their natural range pose a significant threat to the Australian environment, including the agricultural industry and terrestrial MNES, as they can causes a range of ecological effects, including displacement of species, increased competition with native species, increased predation, disruption of ecological processes and changes in ecosystem function (i.e. the food chain in that area).

The likelihood of terrestrial pests being introduced to the Australian mainland is dependent on the successful establishment on-board a vessel, the survivorship of the pests during oceanic voyages and introduction to a suitable habitat in Australia in which to establish.

The potential impacts associated with the establishment of invasive pests are:

- Physical displacement or biological alteration of local or endemic species / ecological communities;
- Socio-economic implications associated with direct / indirect disturbance, such as to commercially targeted fish or species targeted by traditional and sustenance fishers.

The potential exposure of marine and terrestrial species / ecological communities to the establishment of invasive pests are:

- Not likely within the 115 m to 230 m water depths of the EADA;
- Unlikely at the nearest shoals for the duration that the MODU and vessels are present for each drilling campaign; and
- Unlikely within port limits and coastal waters during resupply and provisioning activities of support vessels.

The scope of this EP does not cover a detailed assessment of potential impacts from incursion of terrestrial pests; however, it is noted that the risk of potential introduction of terrestrial pests will be managed in accordance with the *Biosecurity Act 2015* and the International Health Regulations 2005 as detailed in the identification of good practice control measures below.

The potential risk of introduction and establishment of marine or terrestrial pests in the offshore environment or at ports which are a supply base as a result of the EADP is well understood. As such, there is little uncertainty surrounding this aspect.

As part of the stakeholder consultation program, consultation with relevant stakeholders was conducted. Feedback received indicated no objections or claims were made relating to the potential for introduction of invasive pests.

Detailed Environmental Impact Assessment

Identified Value or Sensitivity Potentially Exposed to Impact	Potential Severity / Consequence Discussion	Rating	Likelihood of Impact Occurrence	Rating	Risk
Marine Fauna • Marine Mammals • Marine Reptiles • Sharks, Sawfish & Rays • Listed Fish Species	Should IMPs establish either within Commonwealth waters or within State / Territory waters there is potential for a localised to wide-spread but negligible effect on listed marine fauna populations or communities as a result of indirect effects e.g. through competition or effects on prey species.	Moderate (2)	It has been determined unlikely for the establishment of IMPs to occur in Commonwealth waters due to the remote location and water depths of the EADA (water depths of 115 m to 230 m); the predominantly soft substrate and lack of significant benthic habitat or hard substrate on which IMPs can settle within the EADA; the nearest shallow shoal feature being located 10.8 km to the north of the nearest drilling location (Orchid-1); and the 'Good Practice' controls proposed above. Establishment of IMPs in State/Territory or port waters as a result of support vessel transits to Darwin or Broome is also unlikely given the short duration of interactions between the MODU and vessels in the EADA, existing regulatory controls in place to manage vessels under the *Biosecurity Act 2015* and other 'Good Practice' biofouling controls identified above.	Unlikely (B)	Low (2B)

Benthic Communities	Should IMPs establish within Commonwealth waters , there is potential for a wide-spread persistent change to benthic communities. IMPs have previously been identified in waters surrounding the ports of Darwin and Broome and these are not pristine environments. However, introduction and establishment of other IMP species in these ports or adjacent State / Territory waters may result in wide-spread persistent changes to the sub-tidal and intertidal benthic communities.	Serious (4)	It has been determined unlikely for the establishment of IMPs to occur in Commonwealth waters due to the remote location and water depths of the EADA (water depths of 115 m to 230 m); the predominantly soft substrate and lack of significant benthic habitat or hard substrate on which IMPs can settle within the EADA; the nearest shallow shoal feature being located 10.8 km to the north of the nearest drilling location (Orchid-1); and the 'Good Practice' controls proposed above. Establishment of IMPs in State/Territory or port waters as a result of support vessel transits to Darwin or Broome is also unlikely given the short duration of interactions between the MODU and vessels in the EADA, existing regulatory controls in place to manage vessels under the *Biosecurity Act 2015* and other 'Good Practice' biofouling controls identified above	Unlikely (B)	Medium (4B)
Protected Areas	The nearest protected area to the EADA is the Carbonate Bank and Terrace System of the Sahul Shelf KEF, approximately 13 km to the east and within the EMBA, with water depths of flat tops between 150 and 300m deep. The Roebuck Bay State Marine park is located to the south of Broome Port and is an important wetland for migratory shorebirds. Should IMPs establish within protected areas due to the mobilisation of the MODU and/or support vessels to the EADA, there is potential for a wide-spread persistent change to the values and sensitivities that are present within,	Serious (4)	It has been determined rare for the establishment of IMPs to occur in in protected areas given: the distance to and the depth of the nearest protected area; the nearest shallow shoal feature being located 10.8 km to the north of the nearest drilling location (Orchid-1) while the nearest protected area is 13 km to the east and within the EMBA, with water depths of flat tops between 150 and 300m deep; and the proposed 'Good Practice' controls.	Rare (A)	Medium (4A)

	and contribute to the formal management of protected areas, namely benthic communities as detailed above.		Establishment of IMPs in State/Territory or port waters as a result of support vessel transits to Darwin or Broome is also unlikely given the short duration of interactions between the MODU and vessels in the EADA, existing regulatory controls in place to manage vessels under the *Biosecurity Act 2015* and other 'Good Practice' biofouling controls identified above		
Commercial Fisheries • Commonwealth-Managed • State/Territory-Managed	Should IMPs establish within Commonwealth or State / Territory waters due to the mobilisation of the MODU and support vessels, there is potential for a wide-spread persistent change to commercial fish species or to aquaculture resources (e.g. pearling operations out of Broome Port) due to increased competition for food / habitat or alteration in ecosystem functioning. There is also a potential high financial cost associated with lost revenue if commercially targeted species are impacted.	Serious (4)	It has been determined unlikely for the establishment of IMPs to occur in Commonwealth waters due to the remote location and water depths of the EADA (water depths of 115 m to 230 m); the predominantly soft substrate and lack of significant benthic habitat or hard substrate on which IMPs can settle within the EADA; the nearest shallow shoal feature being located 10.8 km to the north of the nearest drilling location (Orchid-1); and the 'Good Practice' controls proposed above. Establishment of IMPs in State/Territory or port waters as a result of support vessel transits to Darwin or Broome is also unlikely given the short duration of interactions between the MODU and vessels in the EADA, existing regulatory controls in place to manage vessels under the *Biosecurity Act 2015* and other 'Good Practice' biofouling controls identified above	Unlikely (B)	Medium (4B)

Traditional & Subsistence Fisheries	Should IMPs establish within Commonwealth or State / Territory waters due to the mobilisation of the MODU and support vessels, there is potential for a wide-spread persistent change to traditional or subsistence fish species due to increased competition for food / habitat or alteration in ecosystem functioning. There is also a potential high financial cost associated with lost revenue if commercially targeted species are impacted.	Serious (4)	It has been determined unlikely for the establishment of IMPs to occur in Commonwealth waters due to the remote location and water depths of the EADA (water depths of 115 m to 230 m); the predominantly soft substrate and lack of significant benthic habitat or hard substrate on which IMPs can settle within the EADA; the nearest shallow shoal feature being located 10.8 km to the north of the nearest drilling location (Orchid-1); and the 'Good Practice' controls proposed above. Establishment of IMPs in State/Territory or port waters as a result of support vessel transits to Darwin or Broome is also unlikely given the short duration of interactions between the MODU and vessels in the EADA, existing regulatory controls in place to manage vessels under the *Biosecurity Act 2015* and other 'Good Practice' biofouling controls identified above	Unlikely (B)	Medium (4B)
Tourism & Recreation	Should IMPs establish within State / Territory waters due to the mobilisation of the MODU and support vessels, there is potential for a wide-spread persistent change to recreational fish species due to increased competition for food / habitat or alteration in ecosystem functioning. There may also be high financial implication associated with loss of tourism revenue and/or the application of remediation requirements, with potentially multiple complaints / objections from affected person(s).	Serious (4)	It has been determined unlikely for the establishment of IMPs to occur in Commonwealth waters due to the remote location and water depths of the EADA (water depths of 115 m to 230 m); the predominantly soft substrate and lack of significant benthic habitat or hard substrate on which IMPs can settle within the EADA; the nearest shallow shoal feature being located 10.8 km to the north of the nearest drilling location	Unlikely (B)	Medium (4B)

			(Orchid-1); and the 'Good Practice' controls proposed above. Establishment of IMPs in State/Territory or port waters as a result of support vessel transits to Darwin or Broome is also unlikely given the short duration of interactions between the MODU and vessels in the EADA, existing regulatory controls in place to manage vessels under the *Biosecurity Act 2015* and other 'Good Practice' biofouling controls identified above		

Summary of Control Measures, ALARP and Acceptability

The decision context for impacts and risks associated with an incursion of IMPs as a result of the mobilisation of the MODU and support vessels from international waters is 'Type B' as defined in Section 5. As such, the demonstration of ALARP is based on assessment against industry good practice and an engineering risk assessment to further evaluate a range of control measure options.

The following good practice controls will be adopted to manage potential environmental impacts and risks to ALARP and acceptable levels:

- If arriving from international waters via an Australian Port, the MODU and support vessels will complete pre-arrival reporting via the Maritime Arrival Reporting System (MARS) prior to arrival in Australian territorial waters and will have been released from biosecurity control under the Biosecurity Act 2015 by the Department of Agriculture and Water Resources (or the MODU will be confirmed 'low risk' by the Director of Biosecurity) prior to mobilizing to the EADA.
- If a MODU loses its low risk status through exposure to international or uncontrolled goods or vessels, PTTEP AA will confirm that during the drilling campaign supply vessels complete pre-arrival reporting and biosecurity clearances when re-entering Australian territory if classed as 'exposed conveyance'.
- The MODU and support vessels have a Ship Sanitation Control Certificate or Ship Sanitation Control Exemption Certificate from the Department of Agriculture and Water Resources if they have entered an Australian port.
- The MODU and support vessels have a valid Ballast Water Management Certificate and Ballast Water Management Plan (BWMP), consistent with the Australian Ballast Water Management Requirements (Version 7).
- The MODU and support vessels will maintain an accurate Ballast Water Record System.
- Consistent with the Australian Ballast Water Management Requirements (Version 7), discharge/exchange of ballast water will only be discharged via an IMO Type Approved Ballast Water Management System (BWMS) or via other approved methods of management described in the Australian Ballast Water Management Requirements, and >12 nm from land, >500 m from the MODU, and in water depths of >50 m.
- The MODU and support vessels (of appropriate class) hold a current International Anti-fouling Systems certificate or a Declaration on Anti-fouling Systems consistent with the requirements of Annex 1 of the International Convention on the Control of Harmful Anti-Fouling Systems on Ships and the requirements of the Protection of the Sea (Harmful Antifouling Systems) Act 2006.
- The MODU and support vessels have a Biofouling Management Plan and Record Book consistent with IMO Resolution MEPC.207(62).

- A biofouling risk assessment will be undertaken for the MODU/support vessels using the WA biofouling vessel check tool to confirm a low/acceptable level of risk. In the event a low risk is not achieved, additional risk assessment, inspection and mitigation measures commiserate with the risk will be determined in consultation with an independent biosecurity expert and with the DAWR and DPIRD.
- Consistent with the WA State government biofouling management guidelines, in the event that:
  - the MODU/vessel is in WA/NT coastal waters 75 days following first arrival in WA coastal waters;
  - it has spent more than seven consecutive days in a single overseas or inter-state location since its last IMP inspection or since anti-fouling coating was applied before arriving in WA coastal waters;
  - and the MODU/vessel remains on hire to PTTEP AA

  PTTEP AA will confirm that an IMP inspection is undertaken by an independent biofouling inspector.
- In the event that a live pest or infestation of goods is identified on board the MODU or support vessels, the incident will be reported to a biosecurity officer at the Department of Agriculture and Water Resources and corrective actions are implemented.
- If an IMS is identified on the MODU or support vessels, PTTEP AA will confirm that the occurrence has been reported to a biosecurity officer at the Department of Agriculture and Water Resources, WA Department of Fisheries, or NT Fisheries' Aquatic Biosecurity Unit, as relevant, and corrective actions are implemented.

The following additional control measures evaluated as part of the engineering risk assessment were determined to be reasonably practicable and will also be adopted:

- In addition to the good practice WA State government biofouling management guideline control for in-water inspections of the MODU and/or support vessels in WA coastal waters PTTEP AA will also implement the same follow up inspection requirement in NT coastal waters.
- PTTEP AA will direct vessels to not anchor during the EADP
- PTTEP AA will direct vessels to minimise time spent nearby shoals and islands.

ALARP and Acceptability

As described above, the demonstration of ALARP for a 'Type B' decision context is based on assessment against industry good practice and analysis of alternate and/or additional control measures through an engineering risk assessment. The adoption of 'Good Practice' measures and the additional control measures identified through the engineering risk assessment above provide for multiple layers of engineering and administrative controls to manage potential environmental impacts and risks to ALARP. All acceptability criteria have been met and the potential environmental risks and impacts are determined to be acceptable.

6.3 R3 ARTIFICIAL LIGHT

Assessment of Nature and Scale of Impacts and Risks
The key light sources associated with the EADA include the MODU and the project support vessels entering the EADA. For safety and navigational reasons, lighting on the MODU and support vessels will be required 24 hours a day, in accordance with the Navigation Act 2012. The MODU and associated support vessels will be lit using lights that meet required navigational and occupational safety standards as required by the vessel safety case. In addition to the light sources from navigational and safety lighting, intermittent hydrocarbon flaring may be conducted during appraisal well activities. In the event of an appraisal, well testing operations may be undertaken where the wells are flowed to gather information on the reservoir. The hydrocarbons flowed during the test will be subsequently flared on the MODU for an average of 3 days per appraisal well, producing a more intense light source than that of standard navigational and safety lighting. Lighting can affect turtles, particularly hatchling turtles, and other marine species that are attracted to artificial light. Studies have shown that diffuse light glow associated with light sources can result in disorientation of hatchlings up to 4.8 km from the light source (Limpus 2006). The nearest coastline is over 100 km away from the EADA, therefore lighting will not be visible at sea level from any mainland or island beaches. The offshore waters surrounding the EADA are not a known important feeding, breeding or aggregation area for marine fauna and are distant from islands used as rookeries for seabirds or hatchling sea turtles (Cartier Island is the closest at approximately 113 km south west of the EADA). While the EADA is outside a flyway, it is recognised that migratory seabirds and shorebirds traverse the general area. Studies on the impact of light on migratory birds in the North Sea suggest that migratory birds are attracted to lights on offshore platforms when travelling within a radius of 3-5 km from the light source (Marquenie et al. 2008). The nearest migratory bird breeding/ roosting site is situated at Cartier Island, located approximately 113 km south-west of the EADA. Artificial light also has the potential to attract planktonic communities to the light source, thus creating an aggregation of food sources for many other species and faunal groups further up the trophic level (Springer and Skrzypczak 2015, Becker et al. 2013). Such aggregations may increase the risk of predation and/or collisions with support vessels in the vicinity of the MODU and the surrounding EADA. The potential impact associated with light emission is: • Behavioural changes to marine fauna and avifauna species / communities through attraction to lighted areas and amassed food sources (plankton and fish assemblages); The potential exposure of marine and avifauna species / communities to light sources is: • Limited to the EADA in Commonwealth waters; • Although lighting remains in place 24 hrs/day, exposure is limited to night time, i.e., approximately 12 hours per day; • Intermittent flaring as a result of well appraisal activities (average of 3 days flaring per appraisal well); • Limited to the duration of the proposed drilling activities (35 – 100 days per well).

There are no identified specific seasonal sensitivities for matters protected under Part 3 of the EPBC Act, i.e., matters of national environmental significance (MNES) in relation to artificial light from the MODU or support vessel activities.

There is very little uncertainty surrounding artificial light emissions from the MODU and support vessels.

As part of the stakeholder consultation program, consultation with relevant stakeholders was conducted. Feedback received indicated no objections or claims were made relating to artificial light.

Detailed Environmental Impact Assessment

Identified Value or Sensitivity Potentially Exposed to Impact	Potential Severity / Consequence Discussion	Rating	Likelihood of Impact Occurrence	Rating	Risk
Marine Fauna	Marine fauna within the EADA are predominantly pelagic fish and zooplankton, with occasional transient species such as marine turtles, whale sharks and cetaceans expected to occur. There are no known critical habitats within the area for EPBC listed species. The project lease area overlaps with the northern most section of the whale shark foraging BIA (Figure 4-5). However, only low numbers are likely to be present in the area as there are no whale shark aggregations (such as the Ningaloo Reef aggregation) in the region; and attraction to amassed food sources (i.e. plankton) around lighted facilities is expected to be minimal. Any impact from lighting to marine fauna is expected to be localised and negligible.	Minor (1)	Given transient nature of marine fauna, and the closest turtle nesting habitat to the EADA is significantly beyond the distance at which light glow would be expected to impact turtle hatchlings, and the temporary nature of light emissions, it is considered unlikely for light emissions to have an adverse consequence on marine fauna.	Unlikely (B)	Low (1B)
Avifauna	There is potential for light to attract birds in the vicinity of the EADA. Birds may either be attracted by the light source itself or indirectly as lighted structures may provide enhanced foraging opportunities for seabirds at night. Studies on the impact of light on migratory birds in the North Sea suggest that migratory birds are attracted to lights	Minor (1)	Given the transient nature of avifauna, and the distance from any shoreline, it is considered unlikely that avifauna would be adversely impacted.	Unlikely (B)	Low (1B)

	on offshore platforms when travelling within a radius of 3-5 km from the light source (Marquenie et al. 2008). However, light from the MODU and support vessels is unlikely to attract a significant number of seabirds or migratory shorebirds as the EADA is located distant from key aggregation areas, such as Ashmore Reef and Cartier Island (>100 km away). Any impact from lighting to avifauna is therefore expected to be localised and negligible.				

Summary of Control Measures, ALARP and Acceptability

The decision context for impacts and risks associated with light emissions is 'Type A' as defined in Section 5. As such, the demonstration of ALARP is based on assessment against industry good practice. However, no external good practice controls have been identified as relevant to this aspect. There is no control identified that would not compromise either navigation and occupational safety requirements under the Navigation Act 2012 as administered under Marine Order 30 (Prevention of Collisions).

- PTTEP AA will ensure that Environmental Awareness Induction materials for support vessels include information to raise awareness on minimising lighting where practicable, while meeting occupational safety and navigational requirements, as part of the inductions for support vessel crew.

ALARP and Acceptability

Given the decision context is 'Type A' the adoption of 'Good Practice' measures above provides for multiple layers of engineering and administrative controls to manage potential environmental impacts and risks to ALARP. All acceptability criteria have been met and the potential environmental risks and impacts are determined to be acceptable.

6.4 R4 ANTHROPOGENIC NOISE

Assessment of Nature and Scale of Impacts and Risks

During the EADP, continuous noise will be generated by the drill bit, associated equipment and machinery operated on the decks and working areas of the MODU, and also from support vessel engines, propeller rotations and directional positioning thrusters. If the MODU is equipped with a dynamic positioning system, these thrusters will produce a similar noise to the support vessels directional positioning thrusters while positioning at the well locations. Drilling is expected to take between approximately 35 days and 100 days per well to complete. Drilling of a relief well in the unlikely event of loss of well control will produce the same noise profile as exploration and appraisal drilling.

Other marine operations conducted on the decks and working areas of the MODU and vessels may introduce some additional sounds of varying characteristics into the water column through the MODU legs (Jack-up) or pontoons (semi-submersible) and vessel hulls, largely at low frequencies. Helicopter operations, required for personnel transfer, will also be a temporary source of underwater noise. However, a large proportion of the sound produced from activities above the sea surface will be reflected at the air-water interface and will not penetrate the water column. These sounds are expected to be limited relative to drilling and vessel noise.

Impulsive sounds will be produced by geophysical and geotechnical survey instruments during pre-drill site surveys and well evaluations. Pre-drill site survey duration will be 1-2 days per well. Side-scan sonar, single and multi-beam echosounders, and sub-bottom profilers may be used. Geotechnical coring devices will also be used occasionally, but such instruments are only expected to produce brief, incidental sounds that are not of a level that poses a risk to marine fauna.

During well evaluations, CSS or VSP will be used, which will generate high-intensity, impulsive sound that propagates into the water column. However, CSS / VSP surveys are expected to be of short duration (8 – 12 hours per well, with typically one log per well).

Anthropogenic noise sources associated with the EADP, and natural underwater noise sources, are provided in below.

Noise Characteristics

Source	Sound Intensity (dB re 1 µPa)	Dominant Frequency (Hz)
Natural Noises		
Ambient sea sound [1, 2]	80 – 120	Varied
Undersea earthquake [2]	272	50
Seafloor volcanic eruption [2]	255+	Varied
Lightning strike on sea surface [2]	250	Varied
Breaching whale [2]	200	10-100
Bottlenose dolphin click [2]	Up to 229	Up to 120,000

Humpback whales (tail fluke and fin slaps) [3]	192	30 – 1,200
Humpback whale song [4]	179	50 – 10,000
Sperm Whale clicks [2]	Up to 235	100 – 30,000
Blue whale vocalisations [2]	190	12 – 400
Anthropogenic Noise Sources Expected from the EADP		
Drilling operations (semi-submersible / jack-up MODU) [5, 6, 7, 8, 9, 10]	148-188 (route-mean-square sound pressure level; SPL)	Broadband sound between 10 Hz and 10 kHz, dominant energy at low frequency (<2 kHz)
Sub-bottom profiler (pre-drill geophysical site survey) [5, 11] (e.g. chirp / pinger / parametric / boomer / sparker sources)	160-245 (SPL)	Directional beam of tonal pulses (300 Hz – 30 kHz depending on the device)
Multi/single beam echo sounder (pre-drill geophysical site survey) [5]	210-245 (SPL)	Directional beam of tonal, high-frequency bursts (12-700 kHz, depending on the device)
Side-scan sonar (pre-drill geophysical site survey) [5]	200-235 (SPL)	Directional beam of tonal, high-frequency bursts (10 kHz – 1 MHz depending on the device)
CSS / VSP (well evaluation) [5, 10, 11, 12]	190 – 239 (peak pressure; Pk) < 180 (Pk) within 1.2 km	Predominantly low frequency (<200 Hz)
Support vessels and tug support [5]	150 – 188 (SPL)	Broadband noise up to 100 kHz modulated by propeller cavitation. Dominant energy at low frequency (50-150 Hz)
Helicopter flyover [5, 11]	Varies on type and size of helicopter and height above sea level. E.g. From 101 to 109 dB re 1 uPa measured at 3 m water depth for a helicopter at altitudes of 610 m and 152 m respectively.	Most acoustic energy is low frequency (<500 Hz)

Compiled from: [1] Ambient noise recorded for PTTEP AA at the Cash Maple, Oliver and Montara fields (McPherson *et al.* 2012), [2] APPEA (2004), [3] Thompson and Cummings (1986), [4] McCauley and Jenner (2001); [5] Jiménez-Arranz *et al.* (2017); [6] Nedwell and Edwards (2004); [7] McCauley (1998); [8] Greene (1986); [9] Hannay *et al.* (2004); [10] INPEX 2010; [11] Salgado Kent *et al.* (2016); [12] Matthews 2012.

Drilling and vessel noise

Drilling source levels are expected to be in the approximate range of 148-188 dB re 1 µPa. Sound levels decrease rapidly with distance from the source. For example, McCauley (1998) measured drilling sounds in the Timor Sea of 117 dB re 1µPa at a distance of 125 m and 115 dB re 1µPa at a distance of 405 m (Jiménez-Arranz et al., 2017). Nedwell & Edwards (2004) report measured sound levels of 136 dB re 1µPa at 100 m range. Greene (1986) measured sound levels at 117 dB re 1µPa at 185 m and 110 dB re 1µPa at 926 m.

Vessel noise varies with the size, speed, and engine type and the activity being undertaken. The loudest noise level from support vessels are during rig loading and unloading activities where thrusters are used to maintain position. Noise levels for a range of vessels have been measured at 150-188 dB re µPa at 1 m (Jiménez-Arranz *et al.* 2017). Similar to drilling noise, vessel noise is expected to decrease rapidly with distance from the source.

In combination, drilling and vessel thruster noise may be audible over a number of kilometres. Modelling undertaken elsewhere in the region for the INPEX Ichthys project predicted that drilling noise would reduce to 120 dB re 1µPa (approaching ambient levels) within approximately 6 km, and the area receiving 130 dB re 1µPa was approximately 1 km in radius (INPEX, 2010). Modelling of combined vessel and drilling noise (INPEX 2010) found that low-frequency noise above 130 dB re 1 µPa was predicted to be limited to within approximately 2 km. Therefore, drilling noise combined with associated vessel and MODU engines and thrusters may result in sound that is detectable above ambient noise levels over several kilometres from the MODU, but will be most evident within closer proximity to the MODU, potentially causing a range of behavioural response from different species.

Cetaceans have been observed to exhibit behavioural responses to underwater sounds ranging from, for example, momentary pauses in vocalisations and changes in body orientation, to changes in travel direction and behavioural avoidance between approximately 120 dB re 1 µPa and >180 dB re 1 µPa (Southall *et al.* 2007; Gomez *et al.* 2016). Behavioural responses to noise are highly variable and context-specific; higher received levels are not always associated with stronger behavioural responses (Southall *et al.* 2007; Gomez *et al*. 2016). However, it is reasonable to expect that significant behavioural responses such as avoidance are more likely to occur in response to higher sound levels. Based on these findings, cetaceans may display some level of avoidance within approximately 1 or 2 km of the drilling activities and vessels, beyond which, sound levels approach ambient levels. Popper *et al.* (2014), a working group of leading experts, suggested that behavioural responses in turtles and fish, which are less sensitive to noise, are more likely to occur within tens or hundreds of metres from vessels and other continuous noise sources. While fish may show an initial behavioural response, fish are known to quickly habituate to continuous noise sources such as vessel noise (Smith *et al*., 2004; Wysocki *et al.* 2006; Spiga *et al*., 2012; Nichols *et al*., 2015; Johansson *et al*., 2016; Holmes *et al*., 2017).

Helicopter noise

Helicopters are expected to follow a direct course to and from the MODU, typically flying at high altitude. Underwater noise exposures are expected to be limited to a few tens of seconds as a helicopter ascends or descends at the MODU, and only to marine fauna that is near the surface. Underwater noise exposure is not expected from helicopters at other times.

Underwater noise has been measured at 3 m water depth from 101 to 109 dB re 1 µPa from a helicopter flying at altitudes of 610 m and 152 m respectively (Richardson *et al.* 1995, cited in Salgado Kent *et al*. 2016; Jiménez-Arranz *et al.* 2017). A study of whales indicates individuals were observed to resume their pre-disturbed activity within a few minutes of such exposures (Richardson and Malme 1993).

Helicopter noise may also disturb other marine fauna and has been known to disturb avifauna, however there are no known marine mammal, turtle or avifauna aggregations in the immediate vicinity of the EADA and the planned flight path will generally be at high altitude. Any impacts are likely to be brief, localised and incidental behavioural impacts during take-off and landing only.

Pre-drill geophysical site surveys

Sub-bottom profilers produce directional beams of sound downwards towards the seabed. Different devices may produce different sound characteristics, but sound is typically produced in a narrow frequency band ranging from low frequency sources at 300 Hz to mid or high-frequency sources up to 30 kHz. Source levels may range from 160-245 dB re 1 µPa @1 m (SPL), although most commercial sub-bottom profilers are small, low-powered, high-resolution and shallow-penetrating systems (Jiménez-Arranz *et al.* 2017) and so the higher source levels are uncommon. As the sound produced is directional, horizontal sound propagation is limited. Modelling by Zykov *et al*. (2013) of a number of different sub-bottom profiler technologies over a sandy seabed (similar to the seabed in the EADA), indicated that sound levels may be audible over several kilometres, although the potential extent of behavioural responses from cetaceans (i.e. greater than 160 db re 1 µPa) may extend up to approximately 1-1.5 km, depending on which technologies are used and the hearing range of the receptors. The potential for hearing impairment when accounting for both single pulse and cumulative exposures was limited to just a few tens of metres radius of the source (Zykov *et al*. 2013).

Side-scan sonar and echo sounders produce high-frequency, tonal sound in a narrow frequency band. The instruments produce a highly focussed beam of sound towards the seabed, which is very narrow in the along-track direction, but can be a wide swath in the across-track direction. The high-frequency sound produced by these instruments is rapidly attenuated (MacGillivray *et al.* 2013), therefore, there is very limited to no horizontal propagation of sound outside of the primary beam beneath the instrument. The peak operational frequencies of these instruments tend to be at the upper limit or well above the audible ranges of cetaceans and other marine fauna, although some instruments may be audible to mid-frequency and high-frequency cetaceans such as some dolphin species (MacGillivray *et al.* 2013; Zykov *et al*. 2013). Zykov *et al*. (2013) predicted that the potential for both hearing impairment and behavioural responses in cetaceans was limited to within just a few tens of metres of the beams produced by these instruments. Hearing impairment impacts to marine fauna from side-scan sonar and echo sounders have not been reported previously from these high-frequency acoustic sources.

Based on the above, the extent of potential behavioural impacts from the geophysical survey instruments is unlikely to exceed that generated by the vessel towing or deploying the survey instruments, with the possible exception of the sub-bottom profiler, which may result in behavioural responses from some cetaceans and other marine fauna within approximately one kilometre.

CSS / VSP surveys

In addition to drilling and vessel noise, CSS and VSP surveys will produce temporary, high-intensity, impulsive sounds in the order or 190 to 239 dB re 1 µPa@1 m (Pk), depending on the airgun source characteristics. Matthews (2012) predicted that a VSP with a source level of 238 dB re 1 µPa@1 m (Pk) would reduce to less than 180 dB re 1µPa (Pk) within approximately 1 km. Such sound levels are likely to be audible above ambient levels over a several kilometres. A review of 49 seismic surveys in north-western Australia by Curtin University (Salgado Kent et al. 2016) indicates that seismic pulses of this magnitude may reduce to levels of 120 dB re 1 µPa over approximately 5-10 km.

Within very close proximity to the CSS / VSP source, there is the potential for hearing impairment impacts to occur. For example, based on NMFS (2016a) impact criteria for permanent hearing impairment (termed permanent threshold shift; PTS), PTS may occur if a cetacean is within a few metres of the CSS/VSP source when it is discharged at full power. NMFS (2016a) thresholds for temporary changes in hearing (temporary threshold shift; TTS) resulting from a single impulse are 213 dB re 1 µPa (Pk) for low-frequency hearing mysticetes, such as pygmy blue whales, and 224 dB re 1 µPa (Pk) for mid-frequency hearing odontocetes (toothed whales and dolphins). The hearing range of dugongs is similar to mid-frequency cetaceans although they are less sensitive (NMFS 2016a). Matthews (2012) predicted that sound levels with the potential for to cause TTS in cetaceans during VSP would be limited to within just a few tens of metres from a single pulse, and within a few hundred metres of the source from cumulative sound exposures resulting from multiple pulses. The range expected for marine turtles, dugongs and whale sharks is expected to be less, given their less sensitive hearing capabilities. Popper *et al.* (2014) indicate that the potential for TTS in turtles is high within tens of metres of seismic sources only.

Behavioural responses to CSS / VSP surveys may occur over longer distances. For example, while Southall *et al.* (2007) observed a range of behavioural reactions from cetaceans in response to approximately 120 dB re 1 µPa and >180 dB re 1 µPa and NMFS (2016b) recommend a threshold of 160 dB re 1 µPa (SPL) for cetacean avoidance. Such levels are likely to extend a few kilometres from the CSS / VSP source, based on the review of seismic surveys in the region by Salgado Kent *et al.* (2016). McCauley *et al.* (2003) and Moein *et al.* (1995; 2006) have found that turtles show behavioural responses to approaching seismic survey noise at approximately ranging from approximately 166 dB re 1 µPa to 179 dB re 1 µPa, although the turtles habituated to the sound over time. Consistent with these findings, a 166 dB re 1 µPa (SPL) is proposed as the behavioural disturbance response threshold by NMFS in the U.S. (NSF 2011). Based on these research findings, marine mammals may exhibit behavioural avoidance responses may occur within a few kilometres of the short-duration CSS / VSP surveys and turtles are more likely to exhibit a response within 1-2 km. Popper *et al.* (2014) indicate that the potential for significant behavioural impacts in fish in response to seismic pulses is likely to be limited to within tens to hundreds of metres, or within thousands of metres for the most sensitive fish species.

Some benthic invertebrates have been found to show potential sub-lethal stress effects and chronic health impacts following exposure to seismic airguns at close range (Day *et al*. 2016a, 2016b). Therefore, it is possible that some benthic invertebrates may experience similar effects. However, the sound pressures produced by a VSP source that may potentially result in these impacts are likely to be limited to sessile invertebrates in sediments directly beneath the CSS / VSP source.

Based on the above review of underwater noise characteristics associated with the EADA, the potential impacts associated with the noise emissions is:

- Localised behavioural avoidance from marine fauna over 1-2 km in response to continuous drilling and engine noise from the MODU and vessels;
- Localised behavioural avoidance from marine fauna within approximately 1 km in response to geophysical instruments and vessels used to complete pre-drill site surveys
- Potential TTS effects within tens to hundreds of metres of VSP surveys, and behavioural avoidance from marine fauna within a few kilometres of VSP surveys.
- Potential sub-lethal and chronic effects to benthic invertebrates directly beneath the VSP source.

Matters protected under Part 3 of the EPBC Act, i.e., matters of national environmental significance (MNES) in relation to anthropogenic noise within the EADA include a BIA for foraging whale sharks. The nearest BIA for cetaceans is the pygmy blue whale migration BIA, which is located 35 km from the EADA and is therefore not expected to be impacted by noise from within the EADA

The assessment has been based on measurements and predictions from comparable activities in similar environments, including other projects in the Timor Sea. Therefore, there is reasonable certainty in the order of magnitude of the extent of potential impacts from anthropogenic noise emissions from the EADP.

Cumulative impacts are not expected due to the transient nature of marine and avifauna and the open ocean environment surrounding the EADA and the temporary nature of the drilling programme.

As part of the stakeholder consultation program, consultation was conducted with relevant stakeholders. Feedback received indicated no objections or claims were made relating to noise from the EADP.

Detailed Environmental Impact Assessment

Identified Value or Sensitivity Potentially Exposed to Impact	Potential Severity / Consequence Discussion	Rating	Likelihood of Impact Occurrence	Rating	Risk
Marine Fauna • Cetaceans • Dugongs	Cetacean species known to occur in the vicinity of the EADA are expected to be transient and there are no BIAs near the EADA. Dugongs are unlikely to be encountered as the deep water location does not provide favourable habitat for this species. The pygmy blue whale migration BIA (northbound during winter and southbound during summer) is located 35 km from the EADA. While migratory pygmy blue whale may potentially occur outside of this BIA and pass close to the EADP, any deviation as a result of avoiding noise from these activities is negligible in the context of the long distance migration and therefore drilling will not be required to be limited by migration seasons.	Moderate (2)	With the implementation of good practice control measures under EPBC Act Policy Statement 2.1, cetaceans are not expected to be present within the proposed shutdown zone when CSS / VSP is activated at full power and so no permanent hearing impairment impacts are expected. Temporary hearing impairment impacts are also unlikely. Further, given the transient nature of marine fauna, the likely impacts associated with noise emissions from the EADP are limited to localised behavioural impacts. It is considered possible that such nuisance impacts will occur.	Unlikely (B)	Low (2B)

	The potential for PTS impacts to occur is limited to the immediate proximity (a few metres) of a CSS/VSP source if it is discharged suddenly at full power. There is potential for TTS impacts to occur in marine mammals within a few tens of metres, or up to a few hundred metres of a CSS/VSP source if they remain within this range for multiple discharges. TTS impacts from geophysical survey instruments such as sub-bottom profilers may only occur within a few tens of metres. Impacts to marine mammals are more likely to be limited to temporary and localised behavioural avoidance (by a few kilometres) of survey and drilling activities by occasional, transient individuals. Based on the potential for localised nuisance impacts to listed species outside the immediate vicinity of the source, or sub-lethal hearing impairment impacts to individuals in the immediate vicinity of the source, the worst-case consequence is considered to be Moderate.				
Marine Fauna • Whale Sharks	The EADA overlaps with the northern most section of the whale shark foraging BIA. However, only occasional individuals are expected to occur as there are no whale shark aggregations (such as the Ningaloo Reef aggregation) in the region.	Minor (1)	Given the overlap with whale shark foraging BIA, it is considered possible for minor behavioural impacts to whale sharks to occur.	Unlikely (B)	Low (1B)

	Cartilaginous fish (such as whale sharks and rays) lack a swim bladder and are considered less sensitive to sound than bony fish (Myberg 2001; Popper *et al.* 2014) and, therefore behavioural avoidance impacts are likely to be limited to tens or hundreds of metres from the MODU and vessels. Therefore, the potential consequence to transient individuals is considered to be localised. Based on the potential for localised nuisance impacts to listed species, the consequence is considered to be Minor.				
Marine Fauna • Marine turtles •	Marine turtles are understood to be less sensitive to noise than marine mammals. There is potential for TTS impacts to occur in marine turtles within a few tens of metres of a CSS/VSP source or sub-bottom profiler. Impacts to turtles are more likely to be limited to localised and temporary behavioural avoidance by transient individuals. Avoidance may range between tens or hundreds of metres from geophysical surveys, drilling, vessels and helicopters, or up to 1-2 km of CSS / VSP surveys. Given the deep, open water location of the EADA, there are no key habitats for turtle aggregations such as reefs, shoals or islands. There are no BIAs for turtles within the project area and, therefore, no areas of significance for feeding, breeding or nesting will be affected.	Moderate (2)	It is considered possible that minor behavioural impacts to transient marine turtles may occur during the EADP.	Unlikely (B)	Low (2B)

	Based on the potential for localised nuisance impacts to listed species outside the immediate vicinity of the source, or sub-lethal hearing impairment impacts to individuals in the immediate vicinity of the source, the worst-case consequence is considered to be Moderate.				
Marine Fauna • Fish	Disturbance to fish is likely to be minimal as impacts are also expected to be limited to localised changes in schooling behaviour and possible avoidance of the MODU, vessels and CSS / VSP. The extent of such impacts depends upon the type of fish that may be present and their hearing sensitivity, but may range from tens of metres for less sensitive species to a few kilometres for the most sensitive species. Given the open water location of the EADA and absence of significant benthic habitat, no site-attached fish communities are present and fish are likely to be free-roaming species. The nearest shoal (Pee Shoal) is located approximately 8 km north of the EADA, and noise levels are not expected to be audible to fish at this distance. Based on the potential for localised and temporary nuisance impacts to fish, the consequence is considered to be Minor.	Minor (1)	It is considered possible that minor behavioural impacts to free-roaming benthic and pelagic fish species may occur during the EADP.	Possible C	Low (1C)

Benthic Communities	Sound pressures generated by the CSS / VSP source may potentially result in sub-lethal stress effects and chronic health impacts to some sessile benthic invertebrates in sediments directly beneath the CSS / VSP source. Based on the potential for localised and recoverable impacts to soft-sediment benthic invertebrates in the immediate vicinity of a CSS / VSP source, the consequence is considered to be Minor.	Minor (1)	Benthic epifauna communities within the sandy sediments of the EADA are sparse. Any potential effects of CSS / VSP to benthic invertebrates are not expected to result in any alteration of benthic community structure or productivity, and are expected to be recoverable. Minor impacts to benthic communities are therefore considered to be unlikely.	Unlikely (B)	Low (1B)
Commercial Fisheries	There is no potential for commercial fisheries to be impacted directly by underwater noise. Target fish species may temporarily avoid waters within a few hundred metres or a few kilometres of the MODU and vessels during drilling and survey activities.	Minor (1)	The effects of sound on commercially targeted fish species are unlikely to result in a discernible impact to fisheries catches.	Unlikely (B)	Low (1B)

Summary of Control Measures, ALARP and Acceptability

The decision context for impacts and risks associated with associated with anthropogenic noise is 'Type B' as defined in Section 5. As such, the demonstration of ALARP is based on assessment against industry good practice and an engineering risk assessment to further evaluate a range of control measure options.

The following good practice controls will be adopted to manage potential environmental impacts and risks to ALARP and acceptable levels:

- Implement the following precaution zones and procedures consistent with Part A of EPBC Policy Statement 2.1 during CSS/VSP surveys, including:
  - Observation zone: 3+ km horizontal radius from the acoustic source;
  - Shut-down zone: 500 m horizontal radius from the acoustic source;
  - Pre-Start-Up Visual Observations and Start-Up Delay Procedures, whereby observations will be undertaken for 30 minutes prior to soft-start procedures and soft-start delayed if a whale is sighted within 500 m of the acoustic source;
  - Soft-Start Procedures undertaken over 30 minutes;
  - Operational Shut-down Procedures, whereby the acoustic source is shut down completely if a whale is sighted within the 500 m shut-down zone; and
  - Night-time and Low Visibility Procedures, whereby start-up may commence in low visibility conditions according to soft-start procedures provided that there have not been 3 or more whale instigated shut-down situations during the preceding 24 hour period; or if CSS/VSP operations were not previously underway during the preceding 24 hours, the MODU/vessel has been within 10 km of the proposed CSS/VSP start-up location for at least 2 hours (under good visibility conditions) within the preceding 24 hour period, and no whales have been sighted.
- Support vessels and helicopters will comply with relevant requirements of EPBC Regulations 2000 - Part 8 Division 8.1, including:
  - Vessels will not exceed a speed of 6 knots within the 300 m of a cetacean;

  - Vessels will not approach closer than 100 m from a whale or 50 m from a dolphin
  - Helicopters will avoid operating at altitudes lower than 500 m, except during take-off and landing and during emergency search and rescue activities;
  - At altitudes less than 500 m, helicopters will avoid approaching within a horizontal radius of 500 m of a cetacean or approaching a cetacean from head on.
- Support vessels will comply with Whale Shark Wildlife Management Program No. 57, including:
  - Vessels will not exceed a speed of 8 knots within 250 m of a whale shark; and
  - Vessels will not approach closer than 30 m of a whale shark.
- Relevant personnel will be briefed in the requirements of EPBC Policy Statement 2.1 for whales and other proposed measures for managing underwater noise effects to marine fauna.

The following additional control measures evaluated as part of the engineering risk assessment were determined to be reasonably practicable and will also be adopted:

- A 250 m shut-down zone will be applied to dolphins, marine turtles, dugongs and whale sharks during CSS/VSP surveys. Start-up delay and shut-down procedures will be implemented for these marine fauna groups consistent with the manner in which they are applied for the 500 m zone required for whales under the EPBC Policy Statement 2.1.
- A 250 m shut-down zone will be applied to whales, dolphins, dugongs, turtles and whale sharks during sub-bottom profiler surveys. Start-up delay and shut-down procedures will be implemented for these marine fauna groups consistent with the manner in which they are applied for seismic surveys under the EPBC Policy Statement 2.1.

ALARP and Acceptability

As described above, the demonstration of ALARP for a 'Type B' decision context is based on assessment against industry good practice and analysis of alternate and/or additional control measures through an engineering risk assessment. The adoption of 'Good Practice' measures and the additional control measures identified through the engineering risk assessment above provide for multiple layers of engineering and administrative controls to manage potential environmental impacts and risks to ALARP. All acceptability criteria have been met and the potential environmental risks and impacts are determined to be acceptable.

6.5 R5 ATMOSPHERIC EMISSIONS: POWER GENERATION, INCINERATION AND FLARING

Assessment of Nature and Scale of Impacts and Risks

Atmospheric emissions will be produced throughout the duration of the operational activities described in Section 3 via two pathways, power generation and appraisal well flaring.

Fuel is required to power the MODU, mobile plant and equipment, support vessels and helicopters. Routine combustion emissions, namely exhaust gases, are produced from power generation equipment and various pieces of machinery on-board the MODU, support vessels and helicopters that are released into the atmosphere. Waste incineration on-board the MODU and support vessels may be undertaken also resulting in the generation of atmospheric emissions.

There is no planned well testing as part of the exploration well activities. However, flaring may be undertaken during the testing of an appraisal well if required. In the event of an appraisal well, well testing operations may be undertaken with use of a temporary well test production package where the wells are flowed to gather information on the reservoir (well evaluation). The hydrocarbons flowed during the test will be flared on the MODU. Flaring will be undertaken an average of three days per appraisal well.

The EADA is remote from any land mass or receptor particularly sensitive to reduced air quality, however these emissions could present potentially localised and temporary impacts to air quality within the EADA. The only receptor that may be affected is therefore avifauna, although it is noted that greenhouse gas emissions will contribute in a very minor increase to Australian and global greenhouse emissions.

As described in Section 5, no avifauna BIAs overlap the EADA, however, eleven threatened and/or migratory seabirds were identified as potentially occurring within, or having habitat potentially occurring within the EMBA. These species may be impacted by a deterioration in air quality if they are transiting the immediate area of the MODU and vessel exhaust release points. Symptoms of exposure could include irritation of eyes and respiratory tissues or breathing difficulties. There are no known air quality standards or guidelines specifically for avifauna. However, if avifauna are exposed it is expected they would only be exposed to changes in air quality for an extremely short period. Chronic exposures are not considered credible given that avifauna would be transiting through the area.

The potential impact associated with the generation of atmospheric emissions is:

- Potential for sub-lethal effects to avifauna through a change to ambient air quality within the direct vicinity of the MODU and support vessels located within the EADA.

The potential exposure of avifauna to atmospheric pollutants is:

- Within the immediate vicinity of the emission sources;
- Over an approximate three day period per appraisal well for flaring activities; and
- Over the 35 to 100 day duration for the drilling of each well for power generation emissions.

There are no identified specific seasonal sensitivities for matters protected under Part 3 of the EPBC Act, i.e., matters of national environmental significance (MNES) in relation to atmospheric emissions from the MODU and support vessels.

Given the remote location and ready dispersion of atmospheric emissions, no cumulative impacts are anticipated.

The overall volume of atmospheric emissions generated during drilling activities is well understood, and there is little uncertainty relating to this aspect.

As part of the stakeholder consultation program, consultation with relevant stakeholders was conducted. Feedback received indicated no objections or claims were made relating to atmospheric emissions from power generation or flaring activities.

Detailed Environmental Impact Assessment

Identified Value or Sensitivity Potentially Exposed to Impact	Potential Severity / Consequence Discussion	Rating	Likelihood of Impact Occurrence	Rating	Risk
Avifauna	Highly localised and temporary changes in air quality may create a nuisance effect to a small number of transient avifauna individuals. Given the short duration and exposed, open ocean location of the MODU, and support vessels within the EADA (resulting in the rapid dispersion of atmospheric emissions), any potential impacts are expected to be minor.	Minor (1)	Given the emission source is located at and around exhaust and flare locations, and this represents a negligible volume of air space, it has been deemed unlikely that avifauna will be exposed to exhaust or flaring emissions.	Unlikely (B)	Low (1B)

Summary of Control Measures, ALARP and Acceptability

The decision context for impacts and risks associated with atmospheric emissions from power generation and flaring is ‘Type A’ as defined in Section 5. As such, the demonstration of ALARP is based on assessment against industry good practice.

The following controls will be adopted to manage potential environmental impacts and risks to ALARP and acceptable levels:

- MARPOL 73/78 (Annex VI, regulation 14), administered under AMSA Marine Orders – Part 97: Marine Pollution Prevention – Air Pollution – Division 7: Support vessels and MODU will use marine diesel with a low Sulphur content (of ≤ 3.5 % by mass). After 1st January 2020, the vessels will use marine diesel with an ultra-low Sulphur content of ≤0.5% by mass.
- As relevant, support vessels and MODU will have a valid IAPP Certificate confirming that any incinerators on board are certified to meet requirements in MARPOL 73/78 (Annex VI).
- Waste prohibited for incineration by MARPOL 73/78, Annex VI, Regulation 16 (as implemented by Marine Orders Part 97, Division 4) will not be incinerated on support vessels or MODU.
- As per MARPOL 73/78, Annex VI, Regulation 16 personnel responsible for operation of any incinerator will be trained and capable of implementing the guidance provided in the manufacturer's operating manual
- As required by Marine Order 97 Marine Pollution Prevention – Air Pollution (Division 2), support vessels and MODU will have:

- a valid International Air Pollution Prevention (IAPP) Certificate,
- an Engine International Air Pollution Prevention (EIAPP) certificate for each installed marine diesel engine of >130 kW output power, and
- an International Energy Efficiency (IEE) Certificate as required under AMSA Marine Orders – Part 97: Marine Pollution Prevention – Air Pollution (Division 2).

- PTTEP AA Internal Requirements:
  - MODU power generation units (engines) to be maintained as per manufacturer's specification.
  - Support vessel engines to be maintained as per manufacturer's specification.
  - In the event of well testing, flaring will be managed as part of the well testing program, which will include the following:
    - Conditions when flaring should not occur for technical or operational reasons;
    - Systems and procedures to be implemented to reduce the volume and duration of flaring and ensure efficient burning of hydrocarbons as far as practicable.

ALARP and Acceptability

Given the decision context is 'Type A' the adoption of 'Good Practice' measures above provides for multiple layers of engineering and administrative controls to manage potential environmental impacts and risks to ALARP. All acceptability criteria have been met and the potential environmental risks and impacts are determined to be acceptable.

6.6 R6 SEABED DISTURBANCE

Assessment of Nature and Scale of Impacts and Risks
Either a 'jack up' or semi-submersible rig may be used for a given drilling campaign and both options have been assessed throughout this section. Seabed disturbance associated with cementing operations will not be addressed as they are described within Section 6.12**.** Either a semi-submersible rig or a 'jack up' rig will be towed into position by support vessels and positioned over each drilling location. A typical semi-submersible rig would be moored in position by eight anchors, but could be moored by up to 12 anchors. The anchors are run out to a distance of approximately 800 – 1,200 m The anchors typically weigh between 12 and 15 T and are approximately 6m wide and 6m long. Mooring chains and wire would touch down at a radius of approximately 640 m from the rig centreline and anchors are positioned by support vessels to minimise seabed scouring. A typical 'jack up' rig, has three or four legs that are lowered to the sea floor so the working platform remains elevated above the water surface. The bases of the legs are each fitted with a 'spud can' (approximately 18 m diameter) that sit on the seabed, and due to the heavy weights applied, penetrate the sediments to provide stability for the drilling rig. On completion of drilling, the legs will retract and the rig will move off location. The spud cans penetrate into the seabed impacting benthic infauna directly below the cans. The footprint of the seabed disturbance will be defined by the combined footprint of the three or four spud cans. Given the combined footprint of the MODU spud cans, any impacts to mobile demersal marine fauna species would be a highly localised and negligible, with no lasting effect to population or community baselines. The most sensitive receptors of impacts associated with the seabed disturbance from the MODU are epibenthic marine faunal species and benthic habitats directly impacted by a 'jack up' rig spud cans or the anchor points and chain moorings for a semi-submersible rig. These receptors will therefore be used to establish overall level of 'acceptable' impact and inform the worst-case impact of seabed disturbance. Previous marine baseline surveys conducted within AC/RL7 (outlined in Section 5.3), revealed a homogenous, flat, featureless sandy habitat with low and patchy abundance of microbenthic faunal assemblages. The benthic habitats and communities in AC/P54, immediately adjacent to AC/RL7 have not been surveyed. The bathymetry and water depths of AC/P54 and AC/RL7 are similar and so the substrate and communities are expected to be similar. Pre-drill site surveys will identify seabed features to be avoided in the immediate vicinity of each well location. The potential impacts associated with seabed disturbance from a 'jack up' MODU are: • Direct disturbance to benthic habitats and communities within the footprint of the spud can configuration; and • Temporary and localised increase in water column turbidity as a direct result of sediment disturbance during positioning and retrieval of spud cans The potential impacts associated with seabed disturbance from a semi-submersible MODU are • Direct disturbance to benthic habitats and communities from the 8 -12 mooring anchors and associated chain/wire used to secure the rig; and • Temporary and localised increase in water column turbidity as a direct result of sediment disturbance during positioning and retrieval of mooring anchors The potential exposure to marine fauna and benthic habitats from a 'jack up' MODU is: • Highly localised to the direct seabed disturbance at each drill site within the EADA during positioning and retrieval of spud cans;

- Highly localised to the sediment plumes in the immediate vicinity of the seabed disturbance at each drill site within the EADA during positioning and retrieval of spud cans (1-2 days); and
- A total of approximately 750 m² for the three spud cans, 3750 m² cumulatively

The potential exposure to marine fauna and benthic habitats from a semi-submersible MODU is:

- Highly localised to the direct seabed disturbance at each drill site spanning approximately 1,200 m from the surface MODU position within the EADA during positioning and retrieval of mooring anchors;
- Highly localised to the sediment plumes in the immediate vicinity of the seabed disturbance at each drill site within the EADA during positioning and retrieval of mooring anchors (1-2 days);
- Limited to the duration of the proposed drilling activities; and
- Localised to the 8 anchor points spanning approximately 1,200 m from the surface MODU position

Cumulative impacts of seabed disturbance can be caused by multiple drilling locations within the EADA. There are expected to be up to five wells drilled within the EADA over a five year period. These wells are not expected to be drilled in close proximity. Additionally, a second MODU may be required to drill additional well/s in emergency situations. The seabed disturbance from an MODU required to drill a relief well may be in close proximity to the seabed disturbance of a previously drilled well.

There are no identified specific seasonal sensitivities for matters protected under Part 3 of the EPBC Act, i.e., matters of national environmental significance (MNES) in relation to seabed disturbance within the EADA.

Due to the pre-drill site surveys and baseline survey there is very little uncertainty surrounding seabed disturbance from the MODU or 'jack-up' rig.

As part of the stakeholder consultation program, consultation with relevant stakeholders was conducted. Feedback received indicated no objections or claims were made relating to seabed disturbance within the EADA.

Detailed Environmental Impact Assessment

Identified Value or Sensitivity Potentially Exposed to Aspect	Potential Severity / Consequence Discussion	Rating	Likelihood of Impact Occurrence	Rating	Risk

Marine Fauna • Sharks, Sawfish & Rays • Listed Fish Species	Given the combined footprint of the MODU spud cans or mooring anchors, any impacts to mobile demersal marine fauna species (including EPBC listed pipefish and seahorses, should they occur in proximity to the MODU) would be a highly localised and negligible, with no lasting effect to population or community baseline.	Minor (1)	Given the mobile nature of demersal marine fauna species (including EPBC listed pipefish and seahorses) and the combined footprint of the MODU spud cans or the combined footprint of the anchors and mooring chains (semi-submersible rig design) it is considered unlikely that placement of spud cans or moorings on the seabed would have an adverse consequence on marine fauna.	Unlikely (B)	Low (1B)
Benthic Communities • Banks & Shoals • Coral Reef Communities • Seagrass • Invertebrates	The EADA is distant from key habitats of ecological importance such as coral reefs or shoals (detailed in Section 4), the nearest being Pee and Mangola Shoals located approximately 8 km and 35 km to the north-east respectively. Such habitats will therefore not be disturbed by MODU placement or retrieval. Given there are no sensitive or unique marine habitats in the area and the diversity and coverage of epibenthos is low (ERM 2011), benthic communities are expected to rapidly recolonise any damaged areas once the rig has left the site (Currie and Isaac, 2004). The scars from the jack up spud cans or anchor points (semi-submersible rig design) would typically be recolonised by benthic organisms over a period of 2-3 years. Given the combined footprint of the spud cans or the combined footprint of the anchors and mooring chains (semi-submersible rig design), the absence of sensitive benthic communities within the EADA and the timescale of the drilling activities, the consequence to benthic communities would be a highly localised, temporary and negligible.	Minor (1)	Given the placement of spud cans or anchoring and mooring on the seabed is required to stabilise the MODU in place above the drilling location, it is considered possible that there may be a highly localised impact to benthic communities surrounding the contact areas, should they be located in the near vicinity. Any such changes to benthic assemblages or habitats are also believed to be temporary and replenished within 2-3 years of cessation of drilling activities. The cumulative impacts of seabed disturbance to drill multiple wells would therefore reduce over time as individual drilling location recolonised.	Possible I	Low (1C)

Summary of Control Measures, ALARP and Acceptability
The decision context for impacts and risks associated with securing the MODU to the seabed is 'Type A' as defined in Section 5. As such, the demonstration of ALARP is based on assessment against industry good practice. The following controls will be adopted to manage potential environmental impacts and risks to ALARP and acceptable levels: • To prevent loss of station keeping, a mooring analysis will be completed for the MODU, which considers the mooring and station keeping systems on the MODU, and the seabed and metocean conditions at the EADA, consistent with Mooring Code API RP 2SK (API 2005) and the APPEA MODU Mooring in Australian Tropical Waters Guidelines (APPEA 2017). • Mooring performed compliant with Mooring Code API RP 2SK (API 2005) and the APPEA MODU Mooring in Australian Tropical Waters Guidelines (APPEA 2017). • PTTEP AA Internal Requirements: A pre-drill site survey will be performed at each well location and requirements to avoid seabed features and minimise seabed disturbance will be implemented through the Rig Move Plan prior commencement of drilling. **ALARP and Acceptability** Given the decision context is 'Type A' the adoption of 'Good Practice' measures above provides for multiple layers of engineering and administrative controls to manage potential environmental impacts and risks to ALARP. All acceptability criteria have been met and the potential environmental risks and impacts are determined to be acceptable.

6.7 R7 DISCHARGE OF SEWAGE, GREYWATER AND FOOD WASTE

Assessment of Nature and Scale of Impacts and Risks

Treated sewage, greywater and putrescible food waste generated on-board the MODU and supports vessels during the EADP will be routinely discharged to the marine environment. This section does not include the assessment of deck drainage or bilge water discharge, which are addressed in Section 6.8**.**

The MODU will be manned on a continual basis with discharges of treated sewage, greywater and putrescible waste expected daily, for 35 to 100 days at each drilling location. With the maximum persons on board (POB) of the MODU being 170 personnel (with a lower average number typically on board), based upon the following assumptions derived from existing PTTEP AA operations, the volume of treated black water and greywater is conservatively estimated to be <102 m^3/day (@ 0.6 m^3 / person / day) and putrescible food waste <170 kg/day (@ 1 kg / person / day).

In addition, support vessels operating within the EADA will routinely discharge treated sewage, greywater and putrescible food wastes. Given the lower POB of support vessels and the intermittent nature of support operations, overall discharge volumes and frequencies from support vessels are lower than that from of the MODU.

The effects of releasing sewage, grey water and putrescible food waste to the marine environment are largely focussed on impacts to water quality and changes to fauna behaviour. Fish and other marine biota may also be attracted to discharges as an alternative food source. The primary concerns relating to sewage discharge are increases in nutrient availability and biological oxygen demand (BOD). Increased nutrient availability and the subsequent bio-stimulation of planktonic communities can potentially create a knock on effect throughout different trophic levels.

There are no identified specific seasonal sensitivities for matters protected under Part 3 of the EPBC Act, i.e., matters of national environmental significance (MNES) in relation to the discharge of treated effluent and macerated food wastes from the MODU and support vessels.

The potential impact associated with the routine discharge of sewage, grey water and putrescible food waste is:

- Changes to ambient water quality and BOD levels from nutrient loading within the direct vicinity of the MODU and support vessels
- Behavioural responses of marine fauna to discharges as an alternative food source
- Biostimulation of planktonic communities
- Biological exposure to pathogens; and
- Deposition and accumulation of solids/ particulates leading to a decrease in sediment quality

The potential exposure of planktonic communities and marine fauna from the discharge of treated sewage, greywater and macerated food wastes from the MODU are:

- An estimated discharge rate of 100m^3 of grey water and sewage, and 170 kg food waste per day, estimated for approximately 170 POB on the MODU and lower discharge rates from the support vessels
- Highly localised effects to water quality surrounding the MODU, within the EADA;
- Limited in duration of 35 to 100 days at each well location.

Given the hydro-dynamically active open water environment surrounding the EADA, it is expected that the surface discharges of treated effluent and putrescible food waste would rapidly disperse and dilute in the surrounding waters, therefore nutrient loading leading to eutrophication or deposition to sea floor would be negligible. Only receptors in close proximity to the discharge point have the potential to be impacted. The effect of the effluent BOD on seawater oxygen concentrations is also expected to be minor. As cited within NERA (2017), any potential change in phytoplankton or zooplankton abundance and composition is expected to be localised, typically returning to background conditions within tens to a few hundred metres of the discharge location (e.g. Abdellatif, 1993; Axelrad et al., 1981; Parnell, 2003). Effects on environmental receptors along the food chain, namely, fish, reptiles, birds and cetaceans are therefore not expected beyond the immediate vicinity of the discharge in deep open waters.

As the MODU will drill a well in a fixed location within an open ocean environment and support vessel operations are well established, PTTEP AA have a high degree of confidence in the level of interaction with the surrounding environment in relation to the discharge of sewage, greywater and putrescible food wastes during the EADP.

As part of the stakeholder consultation program, consultation with relevant stakeholders was conducted. No objections or claims have been received by PTTEP AA in relation to the planned discharge of sewage, greywater and putrescible food waste within the EADA.

Detailed Environmental Impact Assessment

Identified Value or Sensitivity Potentially Exposed to Aspect	Potential Severity / Consequence Discussion	Rating	Likelihood of Impact Occurrence	Rating	Risk
Marine Fauna	Given the potential impact to marine fauna is a function on the population density of plankton, the effects on planktonic communities from increased nutrient levels would be highly localised and rapidly diluted within the immediate vicinity of the facility with an indistinguishable change to community baseline. The consequence to marine fauna is therefore considered minor.	Minor (1)	Whilst nutrient levels within the immediate vicinity of the facility will increase, potentially effecting planktonic communities, given use of the STF, the high dilution factor within open ocean and the transient nature of marine fauna, it is considered unlikely that marine fauna would not be adversely impacted.	Unlikely (B)	Low (1B)

Summary of Control Measures, ALARP and Acceptability

The decision context for impacts and risks associated with the planned discharge of sewage, greywater and putrescible food waste is ‘Type A’ as defined in Section 5. As such, the demonstration of ALARP is based on assessment against industry good practice. No external good practice controls have been identified as relevant to this aspect.

The following controls will be adopted to manage potential environmental impacts and risks to ALARP and acceptable levels:

- MARPOL Annex V (Garbage) (as implemented by Marine Order 95):

- Grey water and putrescible wastes (those wastes that are liable to decay, i.e. kitchen wastes) will only be released to the sea after the material has passed through a comminutor or grinder so that the material to be released is capable of passing through a screen with openings no greater than 25mm; and
- Records of food waste disposal to be maintained in a Garbage Record Book
- Vessels (facility) of 12 metres in length or over are required to display placards notifying passengers and crew of the disposal requirements, including for food wastes.
- Personnel must be appropriately trained in tasks and aware of requirements.

- MARPOL 73/78 Annex IV (Sewage) (as implemented by Marine Order 96):
  - Sewage waste generated will be treated by a certified on-board sewage treatment facility (STF). The MODU and support vessels must have a valid International Sewage Pollution Prevention Certificate (ISPPC) applicable to vessel class.
  - Personnel must be appropriately trained in tasks and aware of requirements.
  - Sewage that has been stored in holding tanks on support vessels shall not be discharged instantaneously, but at a moderate rate (in accordance with specifications in Marine Order 96) while a vessel is en-route and proceeding at a speed not less than 4 knots.
- PTTEP AA Internal Requirements:
  - Preventative maintenance will be undertaken on the sewage treatment plant and food macerator as per manufacturer's specifications or preventative maintenance system.

ALARP and Acceptability

Given the decision context is ‘Type A’ the adoption of ‘Good Practice’ measures above provides for multiple layers of engineering and administrative controls to manage potential environmental impacts and risks to ALARP. All acceptability criteria have been met and the potential environmental risks and impacts are determined to be acceptable.

6.8 R8 DISCHARGE OF DECK DRAINAGE AND BILGE WATER

Assessment of Nature and Scale of Impacts and Risks
Deck drainage from the MODU and support vessels consists primarily of stormwater and deck wash-down water. It may include very small amounts of detergents, oil and grease, spilled chemicals and dirt from the decks. The volume of drainage likely to be generated is difficult to determine with accuracy as it depends on the rainfall and frequency of deck washing. This section does not include the management of chemical spills, which is addressed in Section 6.13. Oily water from the bilge machinery spaces and contaminated deck drainage water from bunded areas on the MODU and support vessels will contain a mixture of water, oily fluids, lubricants, cleaning fluids, etc. Oily water from these sources will be collected and treated prior to discharge via an oil-water separator in accordance with MARPOL requirements (<15 ppm (v) oil-in-water). Once separated, the oil and grease will be stored in suitable containers ahead of transfer ashore for recycling, and the treated water discharged to sea. The discharge of deck drainage and bilge water could result in a reduction in water quality, and impacts to marine fauna. No important foraging or nesting BIA for marine turtles or marine mammals overlaps the EADA. The northern boundary of the whale shark foraging BIA does overlap the EADA providing potential for whale sharks to be present. The presence of marine fauna is expected to be limited to individuals transiting through the area, including whale sharks due to the size of the whale shark foraging BIA. The potential for exposure of marine fauna to bilge and slops is limited to individuals close to the discharge point at the time of discharge. The closest worst-case impact may include direct toxic effects, such as damage to lungs and airways, and eye and skin lesions from exposure to oil at the sea surface (AMSA 2015). Considering the low concentrations of oil and the location of the discharges in the dispersive open-ocean environment, a surface slick is not anticipated and therefore there is a low likelihood of exposure for marine fauna. The potential impact associated with the discharge of treated deck drainage and bilge water is: • Potential change to ambient water quality through chemical loading within the direct vicinity of the MODU and support vessels. • Potential chemical toxicity to marine species within the direct vicinity of the MODU and support vessels. The potential exposure of marine fauna to deck drainage and bilge water is: • Within the EADA in Commonwealth waters; and • In relation to general deck drainage – intermittent • In relation to discharges from OIW separator – limited to ≤15 ppm (v) oil-in-water concentration at point of discharge with further dilution in open water. Cumulative impacts are not expected due to the transient nature of marine fauna, the open ocean environment surrounding the EADA and the temporary nature of the drilling activities. There are no identified specific seasonal sensitivities for matters protected under Part 3 of the EPBC Act, i.e., matters of national environmental significance (MNES) in relation to deck drainage from the MODU or support vessel activities.

There is very little uncertainty surrounding deck drainage and bilge water discharges from the MODU and support vessels.

As part of the stakeholder consultation program, consultation with relevant stakeholders was conducted. Feedback received indicated no objections or claims were made relating to deck drainage and bilge water.

Detailed Environmental Impact Assessment

Identified Value or Sensitivity Potentially Exposed to Aspect	Potential Severity / Consequence Discussion	Rating	Likelihood of Impact Occurrence	Rating	Risk
Marine Fauna	The consequence of potential impacts from discharge of treated deck drainage and bilge water is highly localised and sub-lethal with no lasting effect to individuals or a small number of species.	Minor (1)	With the standard industry controls measures in place, and the high dilution factor in the open ocean it is unlikely that there would be a sufficient concentration of chemical discharged to cause an adverse impact to marine species.	Unlikely (B)	Low (1B)

Summary of Control Measures, ALARP and Acceptability

The decision context for impacts and risks associated with the planned discharge of deck drainage and bilge water is 'Type A' as defined in Section 5. As such, the demonstration of ALARP is based on assessment against industry good practice. No external good practice controls have been identified as relevant to this aspect.

The following controls will be adopted to manage potential environmental impacts and risks to ALARP and acceptable levels:

- MODU and support vessels will comply with the following requirements of MARPOL Annex I – Oil (as implemented by Marine Order 91);
  - will have a valid International Oil Pollution Prevention Certificate (IOPPC) applicable to vessel class.
  - will be equipped with MARPOL/International Maritime Organisation (IMO) compliant oil-water treatment system (as appropriate to vessel class).
  - will maintain an Oil Record Book (applicable to vessels of 400 gross tonnage and above).
  - discharge into the sea of oil or oily mixtures will have oil in water content which does not exceed 15ppm and for support vessels will only occur when a vessel is en route.
- All vessels will comply with MARPOL Annex V (as implemented by Marine Order 95), which includes requirements for the discharge of deck and external surfaces washdown water in Commonwealth waters, including:
  - only cleaning agents and additives that are not harmful to the marine environment (in accordance with criteria in MARPOL 73/78, Annex III) will be used, and will not contain components which are known to be carcinogenic, mutagenic or reprotoxic.
  - vessel records will contain evidence provided by the producer of the cleaning agent or additive that the product meets the criteria for not being harmful to the marine environment.
- PTTEP AA Internal Requirements:
  - Oil in water meters for the MODU and support vessels must be calibrated as per manufacturers specifications

- The oil-water treatment systems to be maintained as per manufacturers' recommendations or preventative maintenance system.

ALARP and Acceptability

Given the decision context is 'Type A' the adoption of 'Good Practice' measures above provides for multiple layers of engineering and administrative controls to manage potential environmental impacts and risks to ALARP. All acceptability criteria have been met and the potential environmental risks and impacts are determined to be acceptable.

6.9 R9 DISCHARGE OF COOLING WATER & DESALINATION BRINE

Assessment of Nature and Scale of Impacts and Risks
Cooling water is used as a heat exchange medium to cool machinery on the MODU. The water is then discharged at a temperature higher than that of the ambient seawater (Black et al., 1994). The cooling water discharge system is a segregated system, with no direct contact with hydrocarbons. Cooling water may be treated with biocide to prevent biofouling of pipes. Cooling water discharges to the marine environment will result in a localised and temporary increase in the ambient water temperature of approximately 10ºC. Once discharged into the ocean, the cooling water will initially be subject to mixing due to ocean turbulence and some heat will be transferred to the surrounding waters. The plume will then disperse and rise to the ocean surface, where further loss of heat and dilution will occur (Black et al., 1994). The volume of water discharged will be small compared to the receiving waters, the environmental effects of the elevated temperature of discharged waters is therefore predicted to be insignificant due to the large buffering capacity of the ocean. The plume will quickly lose heat and water in only a small area around the outfall will have a substantially elevated temperature (Black *et al*., 1994). Effects of elevation in seawater surface temperatures can cause a range of behavioural responses in marine fauna including attraction and avoidance behaviour. There are no key habitats for feeding or breeding for any of the listed marine mammals or turtle species in the EADA. Therefore, only occasional individuals are expected to pass through the area. The whale shark BIA that overlaps the EADA may result in the presence of individuals, however given the open-ocean location in a water depth of approximately 115 to 230 m and the short-duration of drilling activities (35 to 100 days) any impacts to marine fauna from thermally elevated water temperatures are expected to be highly localised and temporary. Discharge of cooling water has the potential to cause changes in marine ecology through elevated temperatures, as well as the presence of anti-fouling biocides being discharged. These small amounts of biocides will disperse rapidly on discharge to concentrations below levels of environmental concern. Fresh water is produced on board the MODU via desalination. The fresh water makers on board result in discharge of desalination brine. Brine water will contain low concentrations of anti-scale chemicals. Any increase in salinity within the receiving environment as a result of desalination brine discharges is expected to be limited to the immediate point of discharge. As brine is of greater density than seawater (typically, desalination brine has a salinity of 50 ppt in comparison to seawater with a salinity of 35 ppt) it is expected to sink and rapidly disperse in the currents. Given the hydro-dynamically active open water environment surrounding the EADA, it is expected that the surface discharges of cooling water and desalination brine would rapidly disperse, cool and dilute in the surrounding waters, therefore temperature, biocides and increased salinity loading leading to changes to water quality or behavioural changes in marine species would be negligible. Therefore, only receptors in close proximity to the discharge point have the potential to be impacted. There are no identified specific seasonal sensitivities for matters protected under Part 3 of the EPBC Act, i.e., matters of national environmental significance (MNES) in relation to the discharge of cooling water and desalination brine within the EADA. The potential impacts associated with the discharge of cooling water and desalination brine are: • Potential increase to ambient water temperature within the direct vicinity of the MODU and support vessels resulting in behavioural change in marine species;

- Chemical effects to marine fauna from cooling water biocides within the direct vicinity of the MODU;
- Chemical effects to marine fauna from elevated salinity and anti-scale chemicals in the desalination brine discharge within the direct vicinity of the MODU.

The potential exposure of marine species to cooling water is:

- Limited to the near vicinity of the MODU, within the EADA
- Approximately 2088 m^3 per day for the duration of the proposed drilling activities (35-100 days per well)

The potential exposure of marine species to desalination brine is:

- Limited to the near vicinity of the MODU, within the EADA
- Approximately 40 m^3 per day of 50 ppt desalination brine from each vessel
- Approximately 150 m^3 per day of 50 ppt desalination brine from the MODU

Numerical modelling to examine the potential behaviour of cooling water discharge from the Montara Venture FPSO indicated that the zone of impact associated with temperature impact from the discharge of cooling water is predicted to be extremely limited in extent with the plume mixing to within 2ºC of the ambient temperature within 40 m from the point of discharge (GEMS 2003). As the volumes from the FPSO are considerably greater than those from the MODU (65,000 m^3/day compared with 2088 m^3/day); cooling water temperature discharge from the FPSO is higher; and both locations are similar open ocean environment, the modelling results for the FPSO are expected to represent a conservative mixing zone for cooling water discharged from the MODU. Furthermore, the plume modelling results are compliant with the IFC (2007) guideline recommendation that temperature at the edge of the cooling water mixing zone, 100 m from the point of discharge, will be no greater than 3°C above ambient water temperature. Exposure of transient marine organisms to the cooling water is expected to be temporary due to the remote nature of the EADA.

PTTEP AA has a high degree of certainty in the level of interaction with the surrounding environment in relation to the discharge of cooling water and desalination brine.

As part of the stakeholder consultation program, consultation with relevant stakeholders was conducted. Feedback received indicated no objections or claims were made relating to cooling water or desalination brine discharge.

Detailed Environmental Impact Assessment					
Identified Value or Sensitivity Potentially Exposed to Impact	**Potential Severity / Consequence Discussion**	**Rating**	**Likelihood of Impact Occurrence**	**Rating**	**Risk**
Marine Fauna	The consequence of highly localised increase in water temperature and salinity from discharge of cooling water and desalination brine is considered to be practically indistinguishable from the existing baseline and limited to a small number of individuals within the immediate vicinity of the discharge location. Furthermore, any effects will also be temporary over the short-duration of drilling activities.	Minor (1)	Given the low level increase to ambient water temperature and salinity within a remote open ocean environment, it is unlikely that there will be any adverse impact on marine fauna.	Unlikely (B)	Low (1B)

Summary of Control Measures, ALARP and Acceptability

The decision context for impacts and risks associated with the planned discharge of cooling water and desalination brine is 'Type A' as defined in Section 5. As such, the demonstration of ALARP is based on assessment against industry good practice. PTTEP AA has not identified any regulatory or legal or industry 'Good Practice' control measures that are relevant to the control of cooling water and desalination brine during the EADP. PTTEP AA has identified measures to support the reduction of cooling water temperatures and minimisation of the chemical concentrations in the discharges.

The following controls will be adopted to manage potential environmental impacts and risks to ALARP and acceptable levels:

- PTTEP AA Internal Requirements:
  - MODU and vessel engines to be maintained in accordance with manufacturer specification to reduce the temperature of cooling water discharges.
  - Chemical dosage rates for cooling water and the desalination process are at minimum levels to meet technical requirements.

ALARP and Acceptability

Given the decision context is 'Type A' the adoption of 'Good Practice' measures above provides for multiple layers of engineering and administrative controls to manage potential environmental impacts and risks to ALARP. All acceptability criteria have been met and the potential environmental risks and impacts are determined to be acceptable.

6.10 R10 DROPPED OBJECTS & SOLID WASTE

Assessment of Nature and Scale of Impacts and Risks
Waste generation from the MODU and support vessels will consist of a variety of solid wastes. Non-hazardous solid materials may include paper, rope, cardboard, sacking, timbers, scrap metal, domestic packaging (food and drink containers, etc.) and plastic. Environmental impact can occur when objects including waste items or equipment are dropped into the ocean, or lighter materials such as paper or plastics become wind-blown potentially landing in the ocean. This assessment does not include the planned discharges of sewage, greywater and putrescible food waste, which is addressed in Section 6.7. Marine fauna can become entangled in waste plastics, which can also be ingested when mistaken as prey (Ryan et al. 1988), potentially leading to injury or death. Indiscriminate foraging behaviour in turtles has resulted in turtles mistaking plastic for jellyfish (Mrosovsky et al. 2009). There may also be impacts to the benthic environment due to the physical presence of dropped objects or solid waste, however no credible impacts to the benthic environment are expected. The accidental release of waste may result in injury or even death to individual marine fauna but is not expected to result in a threat to population viability. The key sources of unplanned releases of waste or equipment to the marine environment associated with EADA activities include: • Accidental release of solid waste (e.g. plastics, glass, metal, etc.) due to inadequate storage or disposal procedures; or • Accidental drop to ocean of waste or equipment during transfer operations. Solid waste items have the potential to pollute marine habitats and injure or kill fauna through ingestion or exposure if released to the marine environment. The effects of discharges of solid wastes are dependent on the nature of the material involved. Marine fauna can become entangled in waste plastics, which can also be ingested when mistaken as prey (Ryan et al. 1988), potentially leading to injury or death. Indiscriminate foraging behaviour in turtles has resulted in turtles mistaking plastic for jellyfish (Mrosovsky et al. 2009). There are no identified specific seasonal sensitivities for matters protected under Part 3 of the EPBC Act, i.e., matters of national environmental significance (MNES) in relation to dropped objects and solid waste within the EADA. The potential impacts associated with dropped object and solid waste are: • Ingestion of objects including waste by marine fauna or avifauna potentially leading to injury or death • Entanglement of marine fauna in plastic or other solid wastes potentially leading to injury or death • Physical contact and potential smothering of benthic habitats and communities; and • Potential deterioration in water quality within the direct vicinity of the MODU and support vessels resulting in behavioural change in marine species The potential exposure to marine fauna, avifauna or benthic communities from the accidental release of objects and solid waste: • Exists for the duration of the drilling campaign at each well (35-100 days)In relation to the risk of ingestions and entanglement, extends beyond the EADA depending on the buoyancy and mobility of waste due to ocean currents and wind condition; • Limited to individual items, or numerous items if released during a bulk transfer i.e. a single skip load of waste; and • Limited to the overall dimension (footprint) of a non-buoyant dropped object

- 3m³ solid waste based upon the size of a standard offshore skid – assuming full release of contents

The potential accidental release of equipment or solid waste to the marine environment would be considered an isolated incident, and although there is potential for these releases to occur over the duration of EADP, PTTEP AA does not consider there are potential cumulative impacts associated with this aspect.

As part of the stakeholder consultation program, consultation with relevant stakeholders was conducted. Feedback received indicated no objections or claims were made relating to dropped object and solid waste.

Detailed Environmental Impact Assessment

Identified Value or Sensitivity Potentially Exposed to Aspect	Potential Severity / Consequence Discussion	Rating	Likelihood of Impact Occurrence	Rating	Risk
A. Marine Fauna	Marine fauna within the EADA are predominantly pelagic fish and zooplankton, with occasional transient species such as marine turtles, whale sharks and cetaceans expected to occur. There are no known critical habitats within the EADA for EPBC listed species. The EADA overlaps with the northern most section of the whale shark foraging BIA, however, only low numbers are likely to be present. Dropped objects or waste (depending on size and type) may result in entanglement or ingestion, resulting in a lethal impact to an individual of either a listed or non-listed species via the ingestion of waste.	Moderate (2)	Given transient nature of marine fauna, the lack of foraging habitat within the EADA and the controls in place for dropped objects and solid waste, it is considered unlikely for a dropped or waste to have an adverse consequence on marine fauna or species communities.	Unlikely (B)	Low (2B)
B. Avifauna	Dropped objects or waste (depending on size and type) may impact avifauna via entanglement or should waste be ingested, resulting in a potential lethal impact to an individual of either a listed or non-listed species.	Moderate (2)	Given transient nature of avifauna and the controls in place for dropped objects and solid waste, it is considered unlikely for a dropped object and solid or waste to have an adverse consequence to avifauna with no lasting effects to avifauna communities.	Unlikely (B)	Low (2B)

C. Benthic Communities	The EADA is distant from key habitats of ecological importance such as coral reefs or shoals, the nearest being Pee and Mangola Shoals located approximately 8 km and 35 km to the north-east respectively. Given there are no sensitive or unique marine habitats in the area and the diversity and coverage of epibenthos is low (ERM 2011), benthic communities are expected to rapidly recolonise any damaged area (Currie and Isaac, 2004). Given the relatively small footprint of any dropped object, the widespread distribution and abundance of benthic communities within the EADA, the consequence to benthic communities would be a highly localised, negligible, and reversible change to a very small proportion of the of the overall benthos.	Minor (1)	Given there are no sensitive or unique benthic habitats in the area and the diversity and coverage of epibenthos is low and the controls in place for dropped objects and solid waste, it is considered unlikely for dropped object and solid waste to have an adverse consequence on benthic communities.	Unlikely (B)	Low (1B)

Summary of Control Measures, ALARP and Acceptability

The decision context for impacts and risks associated with dropped objects and solid waste is 'Type A' as defined in Section 5. As such, the demonstration of ALARP is based on assessment against industry good practice.

The following controls will be adopted to manage potential environmental impacts and risks to ALARP and acceptable levels:

- MARPOL 73/78 Annex V – Garbage, as administered under Marine Order 95 (Marine pollution prevention — Garbage), specifically:
  - MODU and support vessels will maintain a Garbage Management Plan, which details written procedures for minimising, collecting, storing, processing and disposal of waste, including the use/transfer of equipment on-board.
  - Personnel must be appropriately trained in tasks and aware of requirements.
- PTTEP AA Internal Requirements:
  - Lifting and transfer procedures are required to be in place.
  - All outside bins will have lids which can be closed or nets fitted.

ALARP and Acceptability

Given the decision context is 'Type A' the adoption of 'Good Practice' measures above provides for multiple layers of engineering and administrative controls to manage potential environmental impacts and risks to ALARP. All acceptability criteria have been met and the potential environmental risks and impacts are determined to be acceptable.

6.11 R11 DISCHARGE OF DRILL CUTTINGS AND DRILLING FLUIDS

Assessment of Nature and Scale of Impacts and Risks
PTTEP AA propose to drill the AC/P54 wells with Water Based Mud (WBM), as it is expected to be suitable for all hole sections of the wells. Non Aqueous Drilling Fluid (NADF) is included as a contingency option in wells to be drilled in this permit area, but will only be considered in the event of hole stability problems that cannot be remedied with WBM. For AC/RL7, wells are likely to include one or two hole sections where NADF is used. Final fluid design and selection will be part of the detailed well engineering design. Five wells are planned to be drilled over a period of five years. Each well is expected to take between 35 and 100 days to complete. More than one well may be drilled in a campaign. ***Water Based Mud*** Depending the specific gravity of the drilling fluid required to drill each hole section, WBM typically consists of between 80-90% by volume of fresh, or saline water, with the remaining 10-20% balance made up of water soluble and insoluble drilling fluid additives, which give the mud the exact properties it requires to meet the desired functions for a particular hole interval. In the marine environment these additives are either completely inert (naturally occurring benign materials), or readily biodegradable organic polymers, with a very fast rate of biodegradation in the marine environment. Small quantities of drilling fluid additives are also used to control borehole stability and drilling performance and reliability. These typically include; sodium chloride, potassium chloride, bentonite (clay)/pre-hydrated gel (PHG), naturally occurring water-soluble polymers, barium sulphate (barite) and calcium carbonate. ***Non Aqueous Drilling Fluid*** NADF will consist of a base non aqueous fluid to which other ingredients such as emulsifiers, wetting agents, rheology modifiers, organophilic clay, lime and barite are added. The base non aqueous fluid typically represents about 50 to 65% of the total volume of the complete mud, and approximately 20 to 30% of its mass. ***Drill Cuttings and Fluids Discharge*** The surface hole sections will be drilled utilising a seawater (SW) and water-based high viscosity sweeps (WBM) regime. The subsequent well sections will be drilled with an engineered mud system, such as a potassium chloride (KCl) Partially Hydrolized Polyacrylamide (PHPA) polymer WBM. In the case of riserless drilling, where there is no conduit for the drilling fluid to return to the MODU (as is the case with the installation of the conductor casing in the surface hole section), cuttings will be discharged directly to the seabed. When a riserless mud recovery(RMR) system (also known as a mud recovery without riser (MRR) system) is installed, cuttings from the top hole sections shall be returned to the MODU for discharge at sea level. For lower hole sections drilled with a closed-system, drilling fluid carrying cuttings will be circulated out of the well and back to the MODU via the drilling riser. The returns are passed over the shale shakers, separating the majority of the drill cuttings from the drilling fluid. The drill cuttings are discharged overboard, while the drilling fluid remains in the active system and recirculated down hole. The total volume of cuttings to be discharged for a theoretical worst case well (calculated based on greatest volumes for each section across all wells) equating to approximately 830 m^3 for each well and the total volume of fluids to be discharged equating to approximately 2,776 m^3.

Where NADF is used, drilling fluid containing suspended drill cuttings is processed with solids control equipment to remove the drill cuttings from the NADF. NADF is then returned to the MODU mud pits for recirculation down-hole. Following processing via primary solids control equipment (shale shakers and centrifuges) drill cuttings retain some levels of adhered NADF. In order to minimise the NADF associated with cuttings discharge, drill cuttings will be further treated using secondary solids control equipment, i.e. cutting dryers, to reduce the residual base fluid contents prior to discharge prior to being discharged overboard.

In the case of well testing (i.e. for an appraisal well) a 7" liner (form of casing) will typically be run and cemented across the reservoir. If the well is tested a test string will be run and the drilling fluid will be displaced with completion brine. Well completion brine acts as a weighting fluid during well completions. At the end of well testing operations, the brine is displaced from the well with a suitably weighted drilling fluid, with the brine being discharged to the marine environment (approximately 100 m^3 to 200m^3 of brine per well). Completion brine consists of sodium chloride with small quantities of biocide, oxygen scavenger and corrosion inhibitors.

On completion of drilling activities, residual dry bulk material, including but not limited to; bentonite and barite, will be discharged overboard if the MODU is not handed over to another operator who is willing to use the material in their campaign. The volumes of residual quantities will be subject to operational requirements and will as a minimum, be the volumes as stated in the PTTEP AA Drilling & Well Services Management System (DMS). Contingency volumes will include volumes to troubleshoot drilling complications, wellbore instability, re-spudding and mechanical/geological sidetracks if deemed required at the time of drilling. The worst-case volume of cuttings and fluids discharges, including volumes for different contingency situations are summarised in Table 3-1 and Table 3-2.

Where NADF is used (for AC/RL7 appraisal well or for contingency purposes in AC/P54), barite would not be used in a materially larger quantity than for WBM. Whether a constituent of WBM or NADF, the heavy metal components within barite constitute a total maximum volume of no greater than mercury (Hg): max 1 mg/kg dry weight in stock barite; cadmium (Cd): max 3 mg/kg dry weight in stock barite; and lead (Pb) max 1,000 mg/kg dry weight in stock barite for WBM and NADF.

Drill cuttings discharge may potentially result in a minor localised increase in concentrations of organic compounds and metals near the well, such as aluminium from aluminium phyllosilicate clay (bentonite). Upon cessation of drilling, concentrations of most contaminants would be expected to gradually return to within the range of background conditions, through mechanisms including dissolution, biodegradation and resuspension and transport by bottom currents. A potential exception to this is barium from barium sulphate (barite) present in drilling fluids, which is insoluble and relatively persistent in the marine environment. Concentrations of barite (a non-toxic PLONOR substance) will, however, be sufficiently low and not in a readily bioavailable form.

There are no identified specific seasonal sensitivities for matters protected under Part 3 of the EPBC Act, i.e., matters of national environmental significance (MNES) in relation to discharge of drilling cuttings and fluids in the EADA.

The potential impacts associated with the drilling cuttings and fluids discharges:

- Potential smothering of benthic habitats and communities within the direct vicinity of the wellhead from drilling fluids and cuttings discharge
- Potential chemical effects to benthic and pelagic marine organisms in the localised area of drilling fluids and cuttings discharge
- Chemical effects to marine fauna from elevated salinity and chemicals in the completion brine discharge within the direct vicinity of the MODU.

The potential exposure to benthic habitats and communities and marine organisms from drilling cuttings and fluids discharges is:

- Highly localised to within close proximity of each drill site within the EADA

- Limited to between 35 and 100 days of drilling cuttings and fluids discharge per well, plus a period of recovery as assessed in this section.

The most sensitive receptors of the impacts associated with drilling cuttings and fluids discharge are marine faunal species, specifically benthic communities in the near vicinity of the drill site. These receptors are therefore used to establish overall level of 'acceptable' impact and inform the worst-case potential impact of the discharge of drilling cuttings and fluids. There is also potential for localised increases in turbidity, which may temporarily affect marine organisms in the water column at each drill site, but the impacts to the receiving environment within the EADA are predicted to be limited.

Extent of Drill Cuttings Settlement on the Seabed

PTTEP AA conducted drill cuttings modelling for a single well location in the Cash Maple field in 2017 (RPS 2017b). The modelling was for a proposed production well with a total volume of drill cuttings and WBM for each well estimated to be 784 m^3 along with 1,456 m^3 respectively. The volume of drill cuttings is similar to predicted volumes for this EP (720 m^3 per well), although the volume of drilling fluids is lower. The volume of drilling fluids would affect the density of the discharge. However, grain size has a greater influence on the rate of settling than density (Neff, 2005); therefore the difference in drilling fluid volume is not expected to significantly affect the modelling results.

The results of combined near seabed and near sea surface discharges for a single well were reported for the area affected by an increase of 1 mm (the low exposure threshold) and 10 mm (the high exposure threshold) due to settlement of cuttings on the seabed. The thresholds were based on a study by Kjeilen-Eilertsen et al. (2004), which showed deposition of greater than 9.6 mm is considered likely to cause smothering impacts on benthic ecosystems.

The dispersion modelling results showed that the majority of cuttings from all the well sections will be deposited in the immediate vicinity of the well sites. An area of between 0.15 to 0.43 km^2, extending up to 770 m from the discharge location, was predicted to be potentially subject to deposits exceeding 1 mm thickness. An area of between 0.02 and 0.04 km^2, extending between 110 and 160 m from the discharge location, would be potentially subject to deposits exceeding 10 mm. Given the similarity in location and drill cuttings volumes, a similar area of impact is expected for drill cuttings from wells in AC/RL7 and AC/P54. However, to account for uncertainty related to the direct applicability of the modelling to well locations for this EP, a more conservative impact area of 1 km from the discharge location has been adopted for the low exposure threshold of 1 mm and 300 m for the high exposure threshold of 10 mm.

Numerous additional studies support a conservative maximum extent of impact of 1 km by indicating that biological effects to seabed communities associated with the deposition of drill cuttings are typically limited to approximately 500 m from a well site (Daniels 1998; Limia 1996; Oliver and Fisher 1999; Terrens et al.1998).

Physical alteration to benthic communities through smothering by cuttings

Based on the drill cuttings modelling conducted for a similar well in the Cash Maple field, it is considered that a cuttings pile spreading out to an extent of 300 m from the drill site at a depth of up to 10 mm, and 1 km from the drill site for a depth of up to 1 mm is a representative, if not conservative, extent for this drilling activity. The summarised review is:

- The main environmental disturbance from discharging drilling cuttings and fluids is associated with the smothering and burial of sessile benthic and epibenthic fauna. These impacts are generally localised (100 to 250 m from the drill site, which is consistent with the modelled results) and short-lived, less than 24 months (Hinwood et al. 1994)

- The smothering effects of sedimentation depends on the mobility of benthic fauna and the rate of cuttings deposition. Generally, most species present in high-energy environments are well adapted to changes in substrate, especially species with burying behaviour, and experience hardly any effect from sediment deposition (Bijkerek 1988, cited in Kjeilen-Eilertsen et al. 2004)
- Benthic fauna tolerance to sedimentation depends on the species and sediment type. For instance, sessile epibenthic fauna are generally unable to escape more than a 10 mm burial depth, whereas infauna, which are adapted to be covered with sediment, may adapt and escape from burial to 100 mm depth or more (Bellchambers and Richardson 1995)
- Recolonisation of synthetic-based, mud-cuttings piles in cold-water marine environments have been observed to begin within one to two years of cessation of discharges, once the hydrocarbon component of the cutting piles biodegraded (Neff (2010). Additional studies indicate that benthic infauna and epifauna recover relatively quickly, with substantial recovery in deep water benthic communities within 3–10 years (Jones et al. 2012). Ten years (long term) is considered a maximum and highly conservative recovery duration for the EADA and is likely to be considerably shorter for the warmer and productive waters of the EADA.

This indicates there is the potential for smothering impacts to result in benthic mortality to a distance of 300 m based on a cuttings deposition of 10 mm, or 1 km based on a highly conservative cuttings deposition of 1 mm. The benthic communities of AC/RL7 are characterised as being sandy with sparse epifauna. Therefore, any smothering effects at the drill sites in AC/RL7 are expected to be limited to infauna communities. The benthic habitats and communities in the AC/P54, immediately adjacent to AC/RL7 have not been surveyed. The bathymetry and water depths of AC/P54 and AC/RL7 are similar and so the substrate and communities are expected to be similar. However, the presence of epifauna and more sensitive habitats within AC/P54 cannot be discounted. For the purposes of this assessment it is conservatively assumed that some more sensitive benthic receptors may be present within the area settled by drill cuttings.

Based on this conservative extent of potential smothering and the conservative benthic infauna recovery timeframe of up to 10 years (Jones et al. 2012), the potential impacts associated with these drill sites is considered to be limited to localised, but long-term degradation of benthic habitat and communities.

Potential sediment chemical toxicity

The toxicity effects of WBM are expected to be limited as the additives are typically inert or biodegradable. NADF is only planned for up to two sections for appraisal wells in AC/RL7 and may be used as a contingency for other wells in limited quantities. The concentrations of heavy metals in barite are also regulated. With the application of the PTTEP AA chemical assessment process aligned to industry 'Good Practice' and the preferential use of OCNS PLONOR and CHARM-rated drilling chemicals, the fluids are likely to be non-toxic to almost non-toxic, slightly toxic or low toxicity.

Some components of NADF are potentially bioaccumulative (i.e. aromatic hydrocarbons). However, Melton et al. (2000) reason that the ability of organisms to oxidise and expel aromatics means that while hydrocarbons may be bioavailable, they are not expected to bioaccumulate.

When studying the impacts of drilling in the Bass Strait, Terrens et al. (1998) observed biological effects within 100 m of the drilling site shortly after drilling; recovery of seabed communities across the area were reported within four months. Also, after a period of 11 months, NADF was not detectable in sediments, indicating that recovery of the seabed is through a combination of dispersion and biodegradation. One to two years is therefore considered a conservative recovery evaluation for this impact for this activity.

There is therefore the potential for localised toxicity impacts to benthic infauna and epifauna around the well site. The drill cuttings modelling discussed above is based on use of WBM. However, the extent of potential impact from drill cuttings predicted from the modelling is conservative for NADF given that cuttings with residual adhered NADF base fluids will be more dense and expected to settle out of the water column more rapidly. The soft sediment benthic communities within the EADA are expected to be well represented in the wider region. These communities are known to recover from chemical toxicity effects over relatively short periods of time (within the conservative two year period assumed in this assessment) and consequently, the potential toxicity impacts associated with this program are considered to be limited to localised short-term degradation of habitat.

Increased Turbidity in the Water Column

Neff (2005) states that although the total volumes of muds and cuttings discharged to the ocean during the drilling of a well are relatively large, the impacts in the water column environment are minimal, because discharges of small amounts of materials are intermittent. When cuttings are discharged to the ocean, the larger particles, which represent ~90% of the mass of the mud solids, form a plume that settles quickly to the bottom (or until the plume entrains enough sea water to reach neutral buoyancy). Hinwood et al. (1994) indicates that larger particles of cuttings and adhered muds (90–95%) fall to the seabed close to the release point. The American Chemistry Council (2006) found that as NADF adhered to cuttings, the cuttings tended to clump together in particles that rapidly settle to the sea bed, suggesting that NADF coated cuttings tend to be less likely to increase water column turbidity. Approximately 10% of the mass of mud solids forms another plume in the upper water column that drifts with prevailing currents away from the platform and is diluted rapidly in the receiving waters (Neff 2005; Neff 2010). Hinwood et al. (1994) and Neff (2005) note that within 100 m of the discharge point, a drilling cuttings and fluid plume released at the surface will have diluted by a factor of at least 10,000. Neff (2005) also states that in well-mixed ocean waters (as is likely to be the case within the drilling area), drilling mud is diluted by more than 100-fold within 10 m of the discharge point.

Jenkins and McKinnon (2006) reported that levels of suspended sediments greater than 500 mg/L are likely to produce a measurable impact upon larvae of most fish species, and that levels of 100 mg/L will affect the larvae of some species if exposed for periods greater than 96 hours. Jenkins and McKinnon (2006) also indicate that levels of 100 mg/L are likely to affect the larvae of several marine invertebrate species and that fish eggs and larvae are more vulnerable to suspended sediments than older life stages.

Assuming that solids control equipment reduces residual solids to below typical levels of 20% leaving the material discharged comprising 80% solid cuttings, turbidity in the water column is expected to be reduced to below 20 mg/L (18 ppm) within 100-200m of release (Hinwood et al. 1994; Neff 2005).

Consequently, any impact to fish, larvae or other organisms in the water column would be negligible, due to the small exposure footprint, high natural mortality of larvae (McGurk 1986), and dispersive characteristics of the open water in the EADA. Considering the relatively short-lived nature of the intermittent plumes, and that concentrations of suspended solids rapidly dissipate with the prevailing currents, the potential impacts on fish and their larvae are expected to be minimal. Thus, there is the potential for localised, short-term impact on species.

Potential chemical toxicity to fauna in the water column

Only transient marine fauna would have the potential to be exposed to drill cuttings discharges. Although some drilling fluids and completion brine chemicals can be toxic, their dilution rate means that only organisms at the immediate point of discharge will be exposed to chemical concentrations above toxicity thresholds (Melton et al 2000; Boehm et al 2002; Kinhill 1998; IRCE 2003; SKM 1996).

Within 100 m of the discharge point, a drilling cuttings and fluid plume will have diluted by a factor of at least 10,000, and in well-mixed ocean waters (as is likely to be the case within the EADA), drilling mud is diluted by more than 100-fold within 10 m of the discharge point (Neff 2005; Hinwood et al. 1994). This analysis is consistent with studies that indicate fluid concentrations and toxicity effects are limited to the discharge location (Melton et al 2000; Boehm et al 2002; Kinhill 1998; IRCE 2003; SKM 1996). Consequently, any potential impact is expected to be limited to transient individuals, with recoverable concentrations resulting in localised, short-term impacts on species.

Cumulative impacts from drilling cuttings and fluids are not expected due to the transient nature of marine, the open ocean environment surrounding the EADA, and the temporary nature of the EADP. The footprints of drill cutting plumes and settlement from each drill site are not expected to overlap spatially or temporally, except in emergency situations when a relief well may be required adjacent to the initial well.

Given the nature of this activity, and the well understood risks associated with drill cuttings and fluids discharge to the environment of the EADP area, PTTEP AA has a reasonable degree of certainty regarding the potential impacts to particular values and sensitivities. To account for any possible uncertainty in the likely extent, smothering threshold and recovery durations conservative assumptions have been applied. It has also been conservatively assumed that some more sensitive benthic receptors may be present within the AC/P54 than have been reported in the AC/RL7 for risk assessment purposes.

As part of the stakeholder consultation program, consultation with relevant stakeholders was conducted. There have been no objections or claims made relating to the discharge of drill cuttings and fluids in the EADA.

Detailed Environmental Impact Assessment

Identified Value or Sensitivity Potentially Exposed to Impacts	Potential Severity / Consequence Discussion	Rating	Likelihood of Impact Occurrence	Rating	Risk
Marine Fauna • Marine Mammals • Marine Reptiles • Whale Sharks • Sharks, Sawfish & Rays • Listed Fish Species	The potential for toxicity effects to fish and pelagic organisms, including larvae, due to impacts to water quality will be limited by the use of WBM and NADF with a rating of non-toxic, slightly toxic or low toxicity. The consequence to marine fauna is considered a sub-lethal, localised nuisance to individual or small populations of marine fauna. Also, given that fish and pelagic organisms are mobile and would have only temporary (acute) exposures to the plume, the potential for toxicity effects to occur is limited. Turbidity impacts are also likely to be minimal. Thus, there is the potential for localised, short-term sub-	Minor (1)	Localised and sub-lethal effects could occur from acute exposures in close proximity to the discharge point, but more significant effects are unlikely. This likelihood of occurrence considers: • The rapid settlement of drill cuttings and fluid discharged to the seabed • The use of solids control equipment to reduce to overall proportion of residual NADF adhered to drill cuttings: and	Possible C	Low (1C)

	lethal impact on species for both toxicity and turbidity in water column.		• The discharge of drill cuttings with residual NADF in the upper water column rapidly diluting and dispersing to below levels that could elicit a toxic response.		
Benthic Communities • Benthic invertebrate communities (infauna and epifauna)	Drill cutting discharge may results in minor localised increase in concentrations of organic compounds and metals at the seabed in the vicinity of each well. Upon cessation of drilling, concentrations of most contaminants would be expected to gradually return to background levels through mechanisms including dissolution, biodegradation, resuspension, and transport by bottom currents. A potential exception to this is barium from barium sulphate (barite) present in drilling fluids, which is insoluble and relatively persistent in the marine environment. Concentrations of barite (a non-toxic PLONOR substance) will, however, be sufficiently low and not in a readily bioavailable form. Potential smothering effects to benthic communities are conservatively assumed to be limited to within approximately 300 m to 1 km of the drill site. Recovery of benthic communities is also conservatively assessed to occur within a maximum of 1-2 years (toxicity effects) and within 10 years (smothering effects) (Jones et al. 2012). The soft sediment benthic communities within AC/RL7 are well represented in the wider region, but as the presence of more sensitive habitat	Minor (1)	Benthic infauna within the soft sediment communities of the AC/RL7 permit area are well represented in the wider region. While it is assumed that there is the potential for some more sensitive benthic communities in AC/P54, impacts are expected to be localised and are unlikely to be significant at a regional scale. Conservative assumptions have been applied to the extent, magnitude and recovery period for benthic receptors and such long-term impacts are unlikely.	Likely D	Medium (1D)

	in AC/P54 cannot be discounted, it is conservatively assumed that some more sensitive benthic receptors may be present. Impacts are therefore assessed to be localised, but potentially long-term impacts (including lethal effects) to benthic communities, which is assessed as significant. The discharge of drill fluids and cuttings within the EADA poses no hazard to the banks and shoals or significant coral reef communities, or to the values and ecological functioning of KEFs in the region. The nearest shoal habitat is located over 8 km from the EADA.				
Commercial Fisheries • Commonwealth-Managed • State/Territory-Managed	The potential for toxicity effects to commercially valuable fish, including larvae, due to impacts to water quality will be limited due to the use of WBM and NADF with a rating of non-toxic, slightly toxic or low toxicity. Therefore the consequence to commercial fisheries is considered in the context of a sub-lethal, localised nuisance to individuals or small populations of fish and not the fishery in entirety. Also, given that fish are mobile and would have a temporary, transient exposure to the plume, the potential for toxicity effects to occur is considered negligible. Turbidity impacts are also likely to be minimal. Thus, there is the potential for localised, short-term impact on fisheries for both toxicity or turbidity in water column.	Minor (1)	The potential for impacts to adult and larval fish is limited to the immediate proximity of the point of discharge and will not occur at a population level, therefore is considered unlikely commercial fisheries would be affected.	Unlikely (B)	Low (1B)

Summary of Control Measures, ALARP and Acceptability

The decision context for impacts and risks associated with the use and discharge of drill fluids and cuttings is 'Type B' as defined in Section 5. As such, the demonstration of ALARP is based on assessment against industry good practice and an engineering risk assessment to further evaluate a range of control measure options.

The following good practice controls will be adopted to manage potential environmental impacts and risks to ALARP and acceptable levels:

- Chemicals used in drilling fluids and completion brines will be selected in accordance with PTTEP AA's Chemical Management Procedure that aligns with the OSPAR Harmonised Mandatory Control Scheme (HMCS) developed through the OSPAR Decision 2000/2 on a Harmonised Mandatory Control System for the Use and Discharge of Offshore Chemicals as implemented under the UK OCNS, notably:
  - Use of a PLONOR, CHARM Gold or Silver or OCNS Category E of D rated chemicals which do not have a product warning or substitution warning require no further assessment.
  - If other rated or non- rated chemicals are required, the chemical(s) are assessed using a process consistent with the OCNS hazard assessment process for Non-CHARMable products, taking into account toxicity, bioaccumulation and biodegradation data obtained from the chemical supplier.
  - If an equivalent D or E rating is not achieved, or if a product warning or substitution warning is in place for the preferred chemical a risk assessment and ALARP assessment will be performed for the individual chemical, in the context of the complete discharge stream consistent with the methodology in Section 6 of this EP, noting that the following will form part of the ALARP assessment, regardless of "risk decision type":
    - an alternative chemical assessment; and
    - identification of additional controls, with consideration of the risk of the individual chemical
  - Chemicals which are deemed "toxic" (i.e. with initial OCNS group of A or B) and also deemed bioaccumulative and not biodegradeable (as defined by OCNS) will be determined unacceptable for use, irrespective of concentration or proposed application volume.
- PTTEP AA will ensure the barite used during the drilling activity has concentrations of the following compounds at concentration not greater than:
  - Mercury – maximum 1 mg/kg dry weight in stock barite;
  - Cadmium – maximum 3 mg/kg dry weight in stock barite;
  - Lead – maximum 1000 mg/kg dry weight in stock barite.
- When drilling with WBM:
  - A number of shale shakers will be in use at all times when drilling with an enclosed mud system and the mesh will be sized to optimize the separation of cuttings from mud, maximising the reuse of the drilling mud and minimising the solids retained in the mud.
  - Cuttings discharges will be recorded in a monthly environmental report.
- PTTEP AA Internal Requirements:
  - Volume of bulk WBM chemicals to be used for each well will be planned as per the Detailed Drilling Program to minimise volumes discharged into the ocean at the end of a campaign.
  - Where possible excess drilling mud bulk chemicals will be passed to the next operator.
  - In the event of discharge of bulk WBM drilling chemicals at the end of a drilling campaign, the following shall be performed:
    - Excess WBM discharged at the end of the campaign will be mixed as lean as possible to ensure good dispersion.
    - Where practicable and at the discretion of the Drilling Supervisor release of excess WBM will be at times of high current.

The following additional control measures evaluated as part of the engineering risk assessment were determined to be reasonably practicable and will also be adopted:

- NADF will only be selected where WBM cannot meet the technical objectives of the well. NADF is provided for within this EP as a 'contingent' item in the event of engineering and technical requirements such as to maintain well-bore stability.
- Should NADF be used, a Drill Cuttings and Fluids Management Plan will be developed and implemented and will include the following requirements:
  - Clearly identified discharge parameters and limits.
  - Protocols / procedures for monitoring residual NADF on cutting (ROC%), no less than twice per shift when drilling with NADF.
  - Definition of specific roles and responsibilities for monitoring, recording and reporting discharges.
  - When using industry standard solids control equipment (SCE) to treat cuttings with residual NADF, the percentage of drill fluids on cutting (dry weight) shall be limited to 7.5% for each well section drilled.
  - SCE shall be monitored and maintained to ensure optimum efficiency.
  - No whole NADF will be discharged overboard.
  - All unused or recovered NADF will be shipped onshore.
  - NADF tank wash will be ≤2% base fluid content prior to overboard discharge.

ALARP and Acceptability

As described above, the demonstration of ALARP for a 'Type B' decision context is based on assessment against industry good practice and analysis of alternate and/or additional control measures through an engineering risk assessment. The adoption of 'Good Practice' measures and the additional control measures identified through the engineering risk assessment above provide for multiple layers of engineering and administrative controls to manage potential environmental impacts and risks to ALARP. All acceptability criteria have been met and the potential environmental risks and impacts are determined to be acceptable.

6.12 R12 DISCHARGE OF CEMENT

Assessment of Nature and Scale of Impacts and Risks
During drilling operations, cement is used to isolate permeable zones from each other and the environment, provide mechanical strength and secure casing in the well bore and to act as permanent abandonment plugs. Cement is mixed on board the MODU. Normally the first section of a well (the conductor) is drilled riserless with cement returns made at the sea bed. Subsequent casing strings will be cemented with the top of the cement below the mud-line with no discharge to the sea bed. Excess cement as per the drill plan will be used in all well bore sections and abandonment plugs to account for potential wash outs, over gouge hole and small seepage losses into the formation in accordance with the PTTEP AA DMS. During cementing operations, the majority of the cement is left downhole. A small quantity of cement may be discharged onto the seabed around the top of the wellhead when cementing the surface casing strings and the volume of cement used will be adjusted accordingly to minimise cement discharge at the seabed. In the event of a significant mechanical failure of cement mixing equipment during the cementing operation, the cement can potentially be 'circulated out' of the hole with the cement pumped out of the annulus with release at the seabed (riserless drilling), or circulated back to the MODU when a closed mud system is being used (estimated maximum volume of 24 m^3). During conductor cementing operations, cement returns will be observed at the seabed (approximately 5m^3). Subsequent casing strings will be cemented with the top of cement well below seabed, however additional small volumes of cement or cement contaminated water (approximately 2m^3) will be discharged into the sea during clean-up of the cementing unit after each casing is cemented. Up to 3m^3 of dry cement may be blown overboard from the hopper at the end of each cement job. If a drilling liner is run and fully cemented, a quantity of cement that will be present above the liner top at the end of the liner cementation will be circulated out of the well and overboard to the environment. Contaminated water/spacer will be circulated out of the well and overboard to the environment. It is expected that the drilling of a relief well in the unlikely event of a loss of well control will result in comparable cement discharges. At the end of each drilling campaign excess cement may need to be discharged overboard, in the event that it is not possible to pass the cement on to the next user of the MODU or use up completely during plugging and abandoning of the well. Residual quantities will be subject to operational requirements and cover the minimum required volumes as stated in the PTTEP AA DMS. The worst case volume would be 50-100 metric tonnes. Cementing chemicals are used to modify the technical properties of the cement slurry. A number of additives with different chemical functions are required during cementing operations these include defoaming agents, dispersants and fluid loss control additives. Impacts associated with cement discharges include smothering of benthic habitats and communities in the vicinity of the discharge at the wellhead and toxicity associated with cement additives. As outlined in Section 4.3, benthic habitats in the area generally dominated by sand (84 – 94%), with a smaller proportion of fine sediments (6 – 15%) with low and patchy abundance of 120 microbenthic faunal assemblages. There are no identified specific seasonal sensitivities for matters protected under Part 3 of the EPBC Act, i.e., matters of national environmental significance (MNES) in relation to seabed disturbance within the EADA. The most sensitive receptors of the impacts associated with cementing operations are marine faunal species, specifically benthic habitats (as above) in the near vicinity to the drill site and fish assemblages and pelagic organisms within the immediate area of operations. The potential impacts associated with the discharge of cement are:

- Potential smothering of benthic habitats and communities within the direct vicinity of the wellhead from discharge of excess cement;
- Potential chemical effects to benthic and pelagic marine species in the localised area of cement discharges due to toxicity associated with cement additives.

The potential exposure to marine fauna and benthic habitats from the discharge of cement is:

- Highly localised to the immediate vicinity of the drill site within the AC/RL7 and AC/P54 EADP area;
- Approximately 2m^3 of contaminated cement water discharged into the sea during the clean-up of the cementing unit;
- Approximately 5m^3 associated with excess cement discharge at the sea bed;
- Up to 3m^3 of dry cement blown overboard from the hopper at the end of cement job; and
- Maximum 24 m^3 discharge in the event of significant mechanical failure of cement mixing
- End of each drilling campaign residual excess cement worst case volume of 50-100 metric tonnes discharged overboard during times of high current, where practicable.

Due to the use of cement being common industry practice, there is very little uncertainty surrounding the potential impacts from the discharge of cement.

As part of the stakeholder consultation program, consultation with relevant stakeholders was conducted. There have been no objections or claims made relating to the discharge of cement.

Detailed Environmental Impact Assessment

Identified Value or Sensitivity Potentially Exposed to Aspect	Potential Severity / Consequence Discussion	Rating	Likelihood of Impact Occurrence	Rating	Risk
Marine Fauna • Marine Mammals • Marine Reptiles • Sharks, Sawfish & Rays • Listed Fish Species	The potential for toxicity effects to fish and pelagic organisms due to impacts to water quality will be limited due to the use of cement additives as per the PTTEP AA Chemical Management Procedure. Furthermore, any effects would be limited to a small number of individuals within the immediate vicinity of the discharge location given the minor quantities involved, the expected localised mixing zone and high level of dilution into the open water marine environment of the EADA.	Minor (1)	Given the localised mixing zone and the mobile nature of fish and pelagic organisms, exposure is expected to be temporary and transient. The potential for toxicity effects to occur is considered unlikely.	Unlikely (B)	Low (1B)

Benthic Communities • Banks & Shoals • Coral Reef Communities • Seagrass • Invertebrates	The absence of sensitive benthic communities in the vicinity of the wells should result in limited impacts to benthic communities as a result of smothering or toxicity effects from cement discharges. Any smothering or toxic effects to benthic communities or habitats from cement additives will be highly localised to around the well head and recovery by recruitment of new colonising organisms and migration from adjacent undisturbed seabed area is expected to commence shortly after drilling finishes (Neff, 2005; IOGP, 2016). The closest shoals are located 8 km north and 35 km north east of the EADA (Pee and Mangola Shoals respectively) and therefore due to the localised nature of the cement discharges, no impacts are anticipated.	Minor (1)	Given the limited discharge volumes at the seabed of cement and localised extent of potential smothering or toxicity effects, the likelihood of a minor consequence of impact occurring is considered unlikely. Excess cement may be discharged at the end of the campaign and if this is done will be mixed as light as possible to ensure good dispersion. Smothering of benthic communities is considered unlikely.	Unlikely (B)	Low (1B)

Summary of Control Measures, ALARP and Acceptability

The decision context for impacts and risks associated with the discharge of cement is 'Type A' as defined in Section 5. As such, the demonstration of ALARP is based on assessment against industry good practice.

The following controls will be adopted to manage potential environmental impacts and risks to ALARP and acceptable levels:

- Chemicals used in cements will be selected in accordance with PTTEP AA's Chemical Management Procedure that aligns with the OSPAR Harmonised Mandatory Control Scheme (HMCS) developed through the OSPAR Decision 2000/2 on a Harmonised Mandatory Control System for the Use and Discharge of Offshore Chemicals as implemented under the UK OCNS, notably:
  - Use of a PLONOR, CHARM Gold or Silver or OCNS Category E of D rated chemicals which do not have a product warning or substitution warning require no further assessment.
  - If other rated or non- rated chemicals are required, the chemical(s) are assessed using a process consistent with the OCNS hazard assessment process for Non-CHARMable products, taking into account toxicity, bioaccumulation and biodegradation data obtained from the chemical supplier.
  - If an equivalent D or E rating is not achieved, or if a product warning or substitution warning is in place for the preferred chemical a risk assessment and ALARP assessment will be performed for the individual chemical, in the context of the complete discharge stream consistent with the methodology in Section 6 of this EP, noting that the following will form part of the ALARP assessment, regardless of "risk decision type":
    - an alternative chemical assessment; and
    - identification of additional controls, with consideration of the risk of the individual chemical

- Chemicals which are deemed “toxic” (i.e. with initial OCNS group of A or B) and also deemed bioaccumulative and not biodegradeable (as defined by OCNS) will be determined unacceptable for use, irrespective of concentration or proposed application volume

- PTTEP AA Internal Requirements:
  - Only cement and cement additives approved under PTTEP AA Chemical Management Procedure shall be used during the EADP.
  - Volume of cement and cement additives required to be used for each well will be planned as per the Detailed Drilling Program to minimise excess bulk at the end of campaign and volumes discharged into the ocean.
  - Where possible excess bulk cement and additives on board the MODU at the end of the campaign will be passed to the next operator.
  - In the event of discharge of bulk WBM drilling chemicals at the end of a drilling campaign:
    - discharge of excess cement will be as lean as possible with consideration to maximize dispersion.
    - where practicable and at the discretion of the DSV the slurries will be released at times of high current.

ALARP and Acceptability

Given the decision context is ‘Type A’ the adoption of ‘Good Practice’ measures above provides for multiple layers of engineering and administrative controls to manage potential environmental impacts and risks to ALARP. All acceptability criteria have been met and the potential environmental risks and impacts are determined to be acceptable.

6.13 R13 MARINE CHEMICAL SPILLS

Assessment of Nature and Scale of Impacts and Risks

This section addresses potential impacts and risks from accidental chemical spills to the marine environment. Planned discharges of chemicals are addressed separately as follows: deck drainage and bilge water (Section 6.8); cooling water and desalination brine (Section 6.9); drilling fluids (Section 6.11) and cement (Section 6.12). The loss of hydrocarbons to the marine environment (refuelling spills and emergency conditions such as loss of well control and vessel fuel tank rupture) is assessed in Section 6.14.

Both non-hazardous and hazardous chemicals will be transferred to, stored and used aboard MODU. There is potential for these chemicals to be accidentally spilled to the marine environment from both the MODU and support vessels.

Accidental releases of chemicals to the marine environment may include chemicals such as water based muds (WBM), non-aqueous drilling fluids (NADF), hydraulic fluids, paint, thinners, waste oil and proprietary cleaning agents. Releases can occur as a result of small leaks during drilling operations, mostly likely resulting from the failure of mechanical fittings or hoses or during chemical transfer from support vessels.

Should hazardous chemicals be spilled to the marine environment, the potential impact pathways to marine fauna and benthic communities are:

- Ingestion or physical contact with chemical compounds within the water column or sediment;
- Accumulation and biomagnification of chemicals within the food chain.

The potential exposure to chemicals would be dependent on chemical type, volume of discharge, concentration at discharge, toxicity, persistence and bioaccumulation potential. Also, exposure may vary depending on the dilution and dispersion potential of the chemical, or whether the chemical sinks to the sea floor. As such, the following information has been used to inform the detailed environmental risk assessment below:

- Accidental chemical releases may occur during any season at any time during drilling activities;
- The volume of spill is conservatively estimated for the transfer of chemicals such as drilling base fluids. Based upon the standard flow rates and volumes for transfer operations, and a conservative shut-in time of 5 min (given operations are constantly monitored), the total worst-case volume of spill would be 8.5 m3 Volumes would be smaller for other chemicals.

Whilst cumulative effects are not anticipated from a single accidental chemical release, some chemicals may persist in the marine environment.

Given a chemical spill scenario may occur at any time during the year, all seasonal conditions have been evaluated.

As part of the stakeholder consultation program, consultation with relevant stakeholders was conducted. No objections or claims have been received by PTTEP AA in relation to the management controls proposed by PTTEP AA for potential chemical spills.

Detailed Environmental Impact Assessment

Identified Value or Sensitivity Potentially Exposed to Impacts	Potential Severity / Consequence Discussion	Rating	Likelihood of Impact Occurrence	Rating	Risk

A. Marine Fauna	Given the limited potential volume of release and the low toxicity or high volatility of chemicals onboard the MODU and support vessels, an accidental release of chemicals to the marine environment within the EADA may cause a sub-lethal to lethal impact to individual listed species or to non-listed species within the EADA through ingestion.	Moderate (2)	Given the controls in place for chemical transfer, secure storage and on board cleanup of spills, the transient nature of marine fauna and the remote open ocean environment, it is unlikely that there would be any adverse impacts on marine fauna.	Unlikely (B)	Low (2B)
B. Benthic Communities	The accidental release of chemicals within the EADA may pose a highly localised nuisance impact to individual benthic assemblages, with no lasting effects on the quality of the surrounding environment.	Minor (1)	Given the low-toxicity of weighted fluids, the propensity of fluids to disperse in the marine environment, the water depths at the EADA and the sparsity in populations of benthic fauna assemblages in the EADA, it is considered unlikely that benthic communities would be adversely affected by an accidental release of chemicals from the MODU or support vessels.	Unlikely (B)	Low (1B)

Summary of Control Measures, ALARP and Acceptability

The decision context for impacts and risks associated with the accidental release of chemicals is 'Type A' as defined in Section 5. As such, the demonstration of ALARP is based on assessment against industry good practice. No external good practice controls have been identified as relevant to this aspect.

The following controls will be adopted to manage potential environmental impacts and risks to ALARP and acceptable levels:

- Vessels will comply with Marine Order 93 (Marine pollution prevention – noxious substances), including:
  - Vessels will have a valid International Pollution Prevention Certificate.
  - Vessels will have a Shipboard Marine Pollution Emergency Plan.
  - Vessel tanks will be washed in accordance with the Pollution Prevention Act.
- All support vessels will comply with Marine Order 94 (Marine pollution prevention—packaged harmful substances), including:
  - Vessels carrying harmful substances in packaged form will comply with part 5 of MARPOL Annex III, specifically they shall be properly stowed and secured so as to minimize the hazards to the marine environment without impairing the safety of the ship and persons on board.
  - A vessel Master may only wash a substance overboard if;
    - The physical, chemical & biological properties of the substance have been considered; and
    - Washing overboard is considered the most appropriate manner of disposal; and

- the vessel Master has authorised the washing overboard.

- PTTEP AA Internal Requirements:
  - Chemical transfers are only undertaken in suitable weather conditions, as determined by the Offshore Installation Manager (OIM)
  - Dry-break couplings will be used for NADF transfers
  - All chemical transfer activities will comply with the MODU lifting and transfer procedures; and
  - Where there is a risk that a stored chemical is located such that a leak has the potential to reach the marine environment, the chemical will be stored in a bund.

ALARP and Acceptability

Given the decision context is 'Type A' the adoption of 'Good Practice' measures above provides for multiple layers of engineering and administrative controls to manage potential environmental impacts and risks to ALARP. All acceptability criteria have been met and the potential environmental risks and impacts are determined to be acceptable.

6.14 R14 MARINE HYDROCARBON SPILLS

There is potential for marine hydrocarbon spills to occur during the EADP. Credible scenarios have been identified through the environmental risk assessment process and evaluations have been based upon the hydrocarbon types, potential volumes, durations, discharge rates, discharge locations (surface or subsurface) and timeframes (including seasonality).

6.14.1 Credible Hydrocarbon Spill Scenarios

The following credible spill scenarios were identified through the environmental risk assessment process:

- Loss of well control (LOWC) at the Orchid-1 well site (AC/P54) – Light Crude;
- LOWC at the Cash Maple well site (AC/RL7) – Cash Condensate; and
- Surface release of Marine Diesel Oil (MDO) from a breach of support vessel fuel tank within the EADA.

PTTEP AA commissioned RPS to undertake stochastic and deterministic spill modelling of the LOWC scenarios and the MDO fuel tank release to understand the potential fates, extents and exposures of spilled hydrocarbons under a range of ocean currents and wind conditions. Modelling results were assessed against the hydrocarbon exposure thresholds presented below (Section 6.14.2) and a potential EMBA developed, as presented in Section 4.2.

6.14.2 Hydrocarbon Exposure Thresholds

Exposure thresholds have been defined for hydrocarbons on the sea surface (i.e. a surface slick), entrained or dissolved in the water column, and stranded on shorelines based on available scientific literature on the tolerance of different types of environmental receptors.

The thresholds for surface and shoreline exposure are widely accepted and consistent with those used for other offshore oil and gas projects. The thresholds used for dissolved and entrained hydrocarbons vary between operators. The dissolved and entrained thresholds are based on conservative threshold values defined in an expert review of hydrocarbon toxicity undertaken for PTTEP AA by French McCay (2018) (Appendix B). Further detail is provided in Table 6-2 below. It is noted that the dissolved and entrained hydrocarbon thresholds are relevant to time-based exposures (i.e. applied across a 96-hour interval). To apply these thresholds for shorter durations of exposure, or to apply instantaneously, to estimate potential impacts to the environment, would be inappropriate and extremely conservative. For example, during actual spills, exposures of water column biota are typically on time scales of minutes to hours, with the exception of planktonic organisms that may be entrained in the water column within the hydrocarbon plume. Therefore, the proposed thresholds are likely to be conservative for many receptors and sensitivities.

Table 6-2 Hydrocarbon Exposure Thresholds

Surface Hydrocarbon Exposures *Surface oil has the potential to impact fauna that swim or forage at the sea surface. Surface hydrocarbon exposures have the potential to impact fauna through ingestion, inhalation of surface vapours, or coating of fur or feathers, which can inhibit thermoregulation and mobility.*	
Threshold	**Description**
High: >25 g/m^2	The surface oil threshold of 25 g/m^2 is based on research by Scholten *et al*. (1996) and Koops *et al*. (2004) which indicates that a concentration of surface oil equal to 25 g/m^2 or greater would be harmful for all birds that contact the slick. Seabirds are particularly vulnerable to oil spills because their feathers easily become coated as they forage at the surface and in the upper water column. Exposure to oil concentrations at or above the 25 g/m^2 threshold is therefore used to define the zone of potential high exposure.
Moderate: 10 g/m^2	The surface oil threshold of 10 g/m^2 is based on research by French-McCay (2009) who has reported the minimum oil thickness (0.01 mm) required to impact on thermoregulation of marine species, predominantly seabirds and furred mammals. Other tropical marine megafauna species are unlikely to suffer from comparable physical oil coating because they have smooth skin. The 10 g/m^2 threshold has been applied to various industry oil spill impact assessments by French-McCay (2002; 2003) and is recommended in the AMSA guidelines (AMSA 2013).
Low: 0.5 g/m^2	Ecological impacts are not expected below the 10 g/m^2 threshold, but it is recognised that a light sheen may be visible at the surface at lower surface hydrocarbon concentrations. Surface exposures below the 10 g/m^2 threshold are not expected to cause environmental harm but are indicative of areas that may be perceived to be affected due to the visibility of a sheen on the sea surface and potential to trigger temporary closures of areas (i.e. fishing grounds) as a precautionary measure. A surface exposure threshold of 0.5 g/m^2 is considered to represent the extent of potentially visible sheen on the sea surface. This broader area therefore provides a conservative extent of potential impacts to socio-economic receptors associated with visual amenity (i.e. fisheries, tourism and recreation and indigenous heritage).
Dissolved Hydrocarbon Exposures *The main toxic components of oil to marine organisms are the volatile and soluble / semi-soluble compounds, polynuclear aromatic hydrocarbons (PAHs), and monoaromatic hydrocarbons (MAHs), including BTEX (benzene, toluene, ethylbenzene, and xylenes), and the soluble alkanes. These soluble and semi-soluble hydrocarbons are bioavailable to marine organisms through external surfaces and gills, or through ingestion. PAH-based lethal and sub-lethal thresholds are always used to evaluate the risks of oil toxicity; PAHs exert the most toxic effects because they are semi-soluble and not highly volatile, so they persist in the environment long enough for significant exposure to occur.*	
Threshold	**Description**

High: 300 ppb [equivalent to 28,800 ppb.hrs, based on a 96-hour exposure] *	Lethal effects to less sensitive organisms and/or older life stages French McCay (2018) reports that for acute lethality (96-hour exposures), total PAH LC50s (Lethal Concentrations to 50% of exposed biota) are generally in the order of several hundred ppb or more for less sensitive organisms and older life stages.
Moderate: 10 ppb [equivalent to 960 ppb.hrs, based on a 96-hour exposure] *	Lethal effects to sensitive organisms and early life stages French McCay (2018) reports that early life stages of fish are more sensitive than older fish stages and invertebrates. For acute lethality, total PAH LC50s begin at approximately 10 ppb for sensitive organisms and early life stages of fish (e.g. embryos, larvae).
Low: 1 ppb [equivalent to 96 ppb.hrs, based on a 96-hour exposure] *	Sub-lethal effects to sensitive organisms and early life stages French McCay (2018) notes that sub-lethal effects to marine organisms may occur at lower concentrations of PAH than lethal effects concentrations. A threshold of 1 ppb is considered conservatively protective for sub-lethal effects to a broad range of biota, including sensitive organisms and early life stages of fish (e.g. embryos, larvae).

Entrained Hydrocarbon Exposures

Entrained hydrocarbon are whole oil droplets dispersed in the water column. These may come into contact with and adhere to filter feeding organisms and the gills of fish. The toxic PAH component of oil is accounted for by the dissolved aromatic exposure thresholds above, and the PAH component of entrained droplets will change over time as PAHs are removed through dissolution and degradation in the water column. Therefore, the environmental effects of undissolved droplets require different exposure thresholds that consider the total hydrocarbon content. The following thresholds are appropriate for freshly spilt oil and conservative (highly protective of aquatic resources) for weathered oil.

Threshold	**Description**
High: 30,000 ppb [equivalent to 2,880,000 ppb.hrs, based on a 96-hour exposure] *	Lethal effects to less sensitive organisms and/or older life stages French McCay (2018) reports that a lethal threshold of 30,000 ppb is appropriate for lethal effects from a range of oils to less sensitive organisms and older life stages.
Moderate: 1,000 ppb [equivalent to 96,000 ppb.hrs, based on a 96-hour exposure] *	Lethal effects to sensitive organisms and early life stages French McCay (2018) reports that exposure to 1,000 ppb of total hydrocarbons is deemed a low level of concern for sensitive life stages in marine organisms and at the low end of the range where sub-lethal impacts from acute exposure have been observed.
Low: 100 ppb [equivalent to 9,600 ppb.hrs, based on a 96-hour exposure] *	Sub-lethal effects to sensitive organisms and early life stages French McCay (2018) reports that 100 ppb is a highly conservative threshold for the total hydrocarbon content that could result in sub-lethal effects to marine biota, including sensitive organisms and early life stages of fish (e.g. embryos, larvae).

Shoreline Accumulation

The shoreline hydrocarbon exposure thresholds consider the stranding and accumulation of oil on shorelines and potential effects to a range of shoreline biota and sensitivities.

Threshold	Description
High: >1,000 g/m^2	Observations by Lin and Mendelssohn (1996) found that loadings of more than 1,000 g/m^2 were required to impact marsh plants significantly during the growing season. Similar thresholds have been found in studies assessing oil impacts on mangroves (Grant *et al*., 1993; Suprayogi and Murray, 1999). Levels of 1,000 to 5,000 g/m^2 are proposed by French McCay (2016) as representative of potential lethal and sub-lethal impacts to intertidal vegetation. Therefore, the 1,000 g/m^2 threshold represents the zone of potential high shoreline accumulation.
Moderate: 100 g/m^2	French et al. (1999) and French-McCay (2009) have defined an oil exposure threshold for shorebirds and wildlife (fur-bearing aquatic mammals and marine reptiles) on or along the shore at 100 g/m^2, which is based on studies for sub-lethal and lethal impacts. The 100 g/m^2 level is also proposed by French McCay (2016) for potential lethal impacts to invertebrates in intertidal habitats. Therefore, the 100 g/m^2 threshold has been selected to represent potential impacts to ecological receptors on shorelines. The 100 g/m^2 threshold is also recommended in the Australian Maritime Safety Authority's (AMSA) foreshore assessment guide as the acceptable minimum thickness that does not inhibit the potential for recovery and is best remediated by natural coastal processes alone (AMSA, 2007).
Low: 10 g/m^2	A more conservative threshold of 10 g/m^2 is used to define the extent of potential impacts to socio-economic receptors associated with visual amenity and perceived impacts. However, it is considered too low for the purposes of ecological impact assessment.

Notes:

** Each of the dissolved and entrained hydrocarbon thresholds provided in French McCay (2018) are relevant to time-based exposures (i.e. applied across a 96-hour interval). To apply these thresholds for shorter durations of exposure, or to apply instantaneously, to estimate potential impacts to the environment, would be inappropriate and extremely conservative. For example, during actual spills, exposures of water column biota are typically on time scales of minutes to hours, with the exception of planktonic organisms that may be entrained in the water column within the hydrocarbon plume. Therefore, the proposed thresholds are likely to be conservative for many receptors and sensitivities.*

6.14.3 R14.1 – Loss of Well Control – Light Crude / Condensate

Assessment of Nature and Scale of Impacts and Risks

The potential impacts associated with LOWC are:

- Physical oiling and toxicity effects to marine fauna and flora;
- Potential accumulation of hydrocarbons in the food chain and sediments;
- Potential habitat loss or degradation;
- Potential deterioration in water quality;
- Localised avoidance of waters by fishing vessels, shipping and other users due to the presence of visible hydrocarbons on the sea surface, and associated loss of revenue.

The potential extent of exposure to values and sensitivities is provided within the detailed risk assessment below.

As part of the stakeholder consultation program, consultation with relevant stakeholders was conducted. No objections or claims have been made by relevant person(s) in relation to the preventative and response management controls proposed by PTTEP AA.

Detailed Environmental Impact Assessment

Identified Value or Sensitivity Potentially Exposed to Impact	Potential Severity / Consequence Discussion	Rating	Likelihood of Impact Occurrence	Rating	Risk
Marine Fauna • Cetaceans	*Surface, entrained and dissolved exposures* The maximum predicted extents of surface hydrocarbons greater than 10 g/m^2 throughout the full duration of a spill are approximately 210 km from the release site. Modelling of light crude from the Orchid-1 LOWC scenario indicates that sea surface exposures above the threshold of 10 g/m^2 may reach the pygmy blue whale distribution and migration BIAs within a minimum of 1-3 days (51-52% probability) and 2-4 days (27-79% probability) respectively. Modelling of condensate from the Cash Maple CD-2 LOWC indicates that no sea surface exposures exceeding 10 g/m^2 reach the pygmy blue whale migration BIA in any season. There is a 14 to 37% probability of sea surface exposures exceeding 10 g/m^2 within the pygmy blue whale distribution BIA, depending on the season. The minimum time predicted before exposure	Significant (3)	Given the low likelihood of a LOWC occurring with preventative control measures in place, and the potential for impacts to be reduced by spill response measures, an LOWC and subsequent	Unlikely (B)	Medium (3B)

	above 10 g/m^2 within the pygmy blue whale distribution BIA is 28 to 119 hours (1 to 5 days), depending on the season. Air-breathing marine fauna such as marine mammals are primarily affected by fouling from surface oil exposures (French McCay 2016). However, whales and dolphins are smooth-skinned, hairless mammals. Given the nature of their skin, hydrocarbons do not tend to stick to their skin and they are not expected to be sensitive to the physical effects of oiling, except for possible irritation to eyes and other soft tissues. Cetaceans are also susceptible to breathing of volatile hydrocarbons evaporating from fresh oil on the surface and therefore are more vulnerable to fresh oil rather than weathered oil (French McCay 2016). In addition to the inhalation of vapours, ingestion of hydrocarbons, particularly dissolved aromatics can be toxic to marine mammals as they can remain within the gastro-intestinal tract and be absorbed into the bloodstream and thus irritate and/or destroy epithelial cells in the stomach and intestine. Physiological effects of ingesting weathered hydrocarbon residues are unknown however are expected to be less severe than those attributed to dissolved aromatics given the lower levels of toxicity. The way in which whales and dolphins consume food may influence the likelihood of hydrocarbon ingestion. Baleen whales, which may skim or gulp at or near the surface, are more likely to ingest surface hydrocarbons than toothed whales, which target specific prey items throughout the water column. Spilled hydrocarbon may also foul the baleen fibres of baleen whales, thereby impairing food-gathering efficiency or resulting in the ingestion of hydrocarbon or hydrocarbon-contaminated prey (IPIECA-IOGP 2017). Weathered oil residues from an oil spill event may persist for long periods, causing a potential risk to baleen whales' feeding systems. Studies of bottlenose dolphins found that they can detect and actively avoid a surface slick after a few brief contacts and that there were no observed adverse effects with the surface slick (Smith *et al*., 1983). It is not known if other marine mammals likely to be in the area are able to similarly detect and avoid hydrocarbon slicks. It has been proposed that even though whales and dolphins are able to detect a hydrocarbon slick, the strong attraction to specific areas for breeding, feeding or resting may override any tendency to avoid the noxious presence of hydrocarbon (IPIECA-IOGP 2017).		significant impacts to cetaceans are unlikely to occur.		

	The pygmy blue whale foraging and migration BIAs are located 315 km and 35 km from the EADA respectively and various other species of whales and dolphins may be transient in the area, as outlined in Section 4.7.4.11. Based on these modelled exposures, it is possible that a number of transient cetaceans may surface to breath or feed within the surface slick. Cetaceans may also ingest entrained or dissolved hydrocarbons within the water column, although dissolved and entrained hydrocarbon exposures that have the potential to result in lethal impacts to large marine fauna such as cetaceans (i.e. dissolved hydrocarbon exposures >300 ppb and entrained exposures >30,000 ppb) do not extend into any cetacean BIAs. The 30,000 ppb entrained hydrocarbon threshold is not exceeded at any time or location and exceedance of the 300 ppb dissolved hydrocarbon threshold is limited to within a few kilometres of the release site under specific environmental conditions (2% probability during the winter period only). The thresholds are also relevant to time-based exposures (i.e. applied across a 96-hour exposure interval) and are therefore extremely conservative for transient receptors such as cetaceans that will likely be exposed to the hydrocarbon plume for a brief period. Therefore, ingestion of dissolved or entrained hydrocarbons at the concentrations that are predicted to occur is not expected to result in direct mortality to cetaceans. However, it is acknowledged that ingestion of dissolved or entrained hydrocarbons has the potential to result in sub-lethal impacts to cetaceans over a few hundred kilometres from the release site, including absorption and accumulation in tissues. Marine mammals may also be susceptible to indirect toxic effects through ingestion of contaminated prey. The potential for significant impacts to cetaceans as a result of ingestion of hydrocarbons or inhalation of vapour is expected to be limited to low numbers of transient cetaceans that may pass through the EADA, including occasional migratory pygmy blue whales. Hydrocarbons that reach the pygmy blue whale BIAs will have undergone a significant amount of weathering and so inhalation effects will be significantly reduced in these locations, although ingestion effects and sub-lethal inhalation effects such as irritation of respiratory tissues are still possible. Therefore, lethal impacts may occur to a number of cetaceans in close proximity to the release site, with a range of sub-lethal impacts possible where animals are exposed to the surface slick and plume within a couple of hundred kilometres from the release site. The potential for such impacts to occur is wide spread,				

	although lethal impacts are expected to be limited to a few individuals, and therefore impacts to populations are expected to be recoverable. Indirect impacts to cetaceans may also occur as a result of a loss of prey. However, consistent with the assessment of impacts to fish and plankton communities below, impacts to regional fish and plankton populations are expected to be relatively small, with losses limited to waters surrounding the release site and plume. The productive waters surrounding Scott Reef and Seringapatam Reef, and the canyons linking the Argo Abyssal Plain with the Scott Plateau are identified as potentially providing consistent foraging habitat for cetaceans or increased productivity in the region. However, these areas are not exposed to dissolved or entrained hydrocarbon exposures that would result in lethal affects to plankton. Therefore, impacts to fish and plankton populations are not expected to result in a discernible impact to the ability of cetaceans to source food in locations away from the immediate vicinity of the hydrocarbon plume. The consequence of the direct and indirect impacts identified above is assessed as significant. Effective implementation of spill response controls such as dispersant application, may reduce the extent of surface hydrocarbon exposures and therefore reduce the potential extent of the predicted impacts, but the consequence is conservatively assessed as significant.				
Marine Fauna • Dugongs	<u>*Surface, entrained and dissolved exposures*</u> Dugongs may be present in the EMBA given their distribution off the northern coast of WA and the NT, and at offshore reefs and shoals. Areas of seagrass present at shoals, Ashmore Reef, Cartier Island and shallow waters along the mainland coastline and islands of Australia and Indonesia may provide dugong foraging habitat. Ashmore Reef is identified as a BIA for dugongs, with estimates of between ten and 60 individuals (Whiting and Guinea 2005). There is limited information regarding the effects of hydrocarbons on dugongs. As an air breathing mammal, it is expected that dugongs are most susceptible to hydrocarbon impacts from inhalation of evaporated volatiles and ingestion of hydrocarbons including weathered waxy residues, experiencing similar effects as cetaceans.	Significant (3)	Given the low likelihood of a LOWC occurring with preventative control measures in place, and the potential for impacts to be reduced by spill response measures, an LOWC and subsequent	Unlikely (B)	Medium (3B)

	Dugongs located at Ashmore Reef, Cartier Island and potentially at shallow shoals and islands in the EMBA may be exposed to surface slicks or may indirectly ingest hydrocarbons by feeding on seagrasses affected by dissolved or entrained hydrocarbons. A significant impact to dugong populations is not expected, as for cetaceans, this is due to the size and temporary nature of the slick as described above taking into account the potential time for exposure given the rapid weathering of the light crude and condensate that is expected. Dugong populations may be indirectly affected by the loss of seagrasses meadows impacted by entrained or dissolved oil phases at a number of offshore shoals and island locations, including Ashmore Reef and Cartier Island, and the Indonesian coastline. However, consistent with the assessments of impacts to coral reefs, seagrass, and bank and shoal communities below, worst-case impacts to seagrass and other epibiota in these locations are expected to be patchy. Loss of seagrass beds and available food resource is not expected to be extensive.. The consequence to dugong populations is assessed as potentially wide-spread but reversible and is therefore significant.		significant impacts to dugongs are unlikely to occur.		
Marine Fauna • Whale Sharks • Other Sharks, Sawfish & Rays	<u>*Surface, entrained and dissolved exposures*</u> A range of sharks and rays may occur in the EMBA. Whale sharks are considered vulnerable to the effects of surface, entrained and dissolved hydrocarbons due to the presence of the whale shark foraging BIA in the EADA and the way in which whale sharks gulp and filter feed on plankton in the upper water column and at the surface. Potential effects include damage to the liver and lining of the stomach and intestines, as well as toxic effects on embryos (Lee 2011). As whale sharks are filter feeders they are expected to be highly vulnerable to entrained hydrocarbons (Campagna *et al*. 2011). This makes whale sharks susceptible to hydrocarbons in a similar manner as baleen whales. Sea surface exposures greater than 10 g/m^2 are predicted to occur within the whale shark foraging BIA within the 1-5 hours of a release from either of the AC/P54 or AC/RI7 permit areas. The maximum predicted extent of surface hydrocarbons greater than 10 g/m^2 throughout the full duration of a spill from either permit area is approximately 210 km, although the total area exposed at any one time is expected to be less. Based on these modelled	Significant (3)	Given the low likelihood of a LOWC occurring with preventative control measures in place, and the potential for impacts to be reduced by spill response measures, an LOWC and subsequent significant impacts to whale sharks	Unlikely (B)	Medium (3B)

	exposures, it is possible that a number of transient whale shark individuals may feed within the surface slick during a spill, potentially resulting in a range of lethal or sub-lethal impacts if hydrocarbons are ingested. Whale sharks may also ingest entrained or dissolved hydrocarbons within the water column, although dissolved and entrained hydrocarbon exposures that have the potential to result in lethal impacts to large marine fauna such as whale sharks (i.e. dissolved hydrocarbon exposures >300 ppb and entrained exposures >30,000 ppb) do not extend into the whale shark foraging BIA. The 30,000 ppb entrained hydrocarbon threshold is not exceeded at any time or location and exceedance of the 300 ppb dissolved hydrocarbon threshold is limited to within just a few kilometres of the release site under specific environmental conditions (2% probability during the winter period only). Therefore, only whale sharks that feed within the immediate vicinity of the release may be exposed. The thresholds are also relevant to time-based exposures (i.e. applied across a 96-hour exposure interval) and are therefore extremely conservative for transient receptors such as whale sharks that will likely be exposed to the hydrocarbon plume for a brief period. Therefore, ingestion of dissolved or entrained hydrocarbons at the concentrations that are predicted to occur is not expected to result in direct mortality to whale sharks. However, it is acknowledged that ingestion of dissolved or entrained hydrocarbons has the potential to result in sub-lethal impacts to whale sharks over a few hundred kilometres from the release site, including absorption and accumulation in tissues. Whale sharks may also be susceptible to indirect toxic effects through ingestion of contaminated plankton in the vicinity of the spill. Individual whale sharks may occur in the impacted area due to their widespread distribution and highly migratory nature, albeit in very low numbers as there are no whale shark aggregations (such as the Ningaloo Reef aggregation) in the region. Other predatory shark species within open waters are more likely to be affected indirectly by ingestion of contaminated prey when feeding in the water column or at the seabed. The overall consequence of an LOWC to sharks and rays, particularly to whale sharks, is assessed as significant.		and other sharks and rays are unlikely to occur.		

Marine Fauna • Other Fish Species	*Entrained and dissolved exposures* Pelagic and demersal fish populations within open waters, including diverse fish assemblages associated with shallow waters around banks, shoals and coral reefs may be exposed to entrained and dissolved hydrocarbons. Toxicity to fish is primarily related to concentrations of dissolved aromatics, as outlined in Section 6.14.2 above, although both dissolved and entrained hydrocarbons may be ingested or may adhere to and be absorbed through the skin and gills. The sensitivity of fish to dissolved and entrained hydrocarbon exposures depends on the sensitivity of different species and the life stage. The different life stages of a species often show widely different tolerances and reactions to oil pollution. Usually, larval and juvenile stages will be more susceptible than adults (Harrison 1999; French McCay 2002; French McCay 2016). Impacts to fish embryos and larval stages are evaluated separately in the assessment of impacts to planktonic communities below. The review of oil toxicity thresholds undertaken by French McCay (2018) reports that for acute lethality (≤96-hour exposures), total PAH LC50s (Lethal Concentrations to 50% of exposed biota) are generally in the order of 10 ppb for sensitive organisms and early life stages, and several hundred ppb or more for less sensitive organisms and older life stages. For the purposes of the assessment of potential impacts to fish, the following dissolved and entrained hydrocarbon thresholds are applied: • Dissolved hydrocarbon exposures that may result in the onset of sub-lethal effects to juvenile fish and adults of sensitive fish species are conservatively selected to be 1 ppb (96 ppb.hrs). • Dissolved hydrocarbon exposures that may result in the onset of lethal effects are 10 ppb (960 ppb.hrs) for juvenile fish and some adults of sensitive species, and 300 ppb (28,800 ppb.hrs) for most other adults. • Entrained hydrocarbon exposures that may result in the onset of sub-lethal effects to juvenile and adults of sensitive fish species are conservatively selected to be 100 ppb (9,600 ppb.hrs). • Entrained hydrocarbon exposures that may result in the onset of lethal effects are 1,000 ppb (96,000 ppb.hrs) for both juvenile and adult fish.	Moderate (2)	Given the low likelihood of a LOWC occurring with preventative control measures in place, an LOWC and subsequent significant impacts to demersal and pelagic fish assemblages are unlikely to occur.	Unlikely (B)	Low (2B)

	The thresholds are also relevant to time-based exposures (i.e. applied across a 96-hour exposure interval) and are therefore conservative for transient receptors such as pelagic fish species that will likely be exposed to the hydrocarbon plume for shorter periods of time. Demersal fish species that have relatively high site fidelity and therefore classed as "site-attached" may be exposed to hydrocarbons for longer durations in locations where there is a sustained exposure to hydrocarbons at or near the seabed. Modelling results predict that dissolved and entrained hydrocarbon exposures may exceed sub-lethal thresholds up to a maximum distance of approximately 830 km and 450 km respectively. Modelling results predict that dissolved and entrained hydrocarbon exposures may exceed lethal thresholds up to a maximum distance of approximately 275 km and 115 km respectively, although noting that this relates mainly to juveniles and sensitive species, whereas the 300 ppb threshold for lethal effects to adult fish has only a low probability of occurrence (2%) within 3 km of the release site during winter conditions only. Therefore, impacts are expected to be mainly sub-lethal, with the potential for some lethal effects to juvenile fish and some adults of the most sensitive species. It should be noted that these distances represent the total swept area over the full 107 day duration of the modelled spill event, and the area exposed at any point in time will be significantly smaller. It is expected that the area where potential lethal and sub-lethal impacts to fish could occur may extend over tens of kilometres or over a hundred kilometres respectively at a time. Accounting for exposure durations, the impacts to mobile pelagic fish species are expected to be sub-lethal. A number of wide roaming pelagic fish may pass through these exposures, but the exposure time is likely to be relatively short compared to the 96-hour laboratory exposures to unweathered oils that may cause lethal impacts. Fish have a natural avoidance instinct for many of the aromatic hydrocarbons (Hoar *et al*. 1997) and are therefore unlikely to be exposed to high levels of entrained or dissolved hydrocarbons for extended periods. Dissolved and entrained hydrocarbon exposures above thresholds of concern are typically limited to the upper 30 m water column, with a 2% probability of sub-lethal exposures occurring down to a maximum depth of				

	90 m and lethal exposures down to a maximum depth of 70 m. Therefore, demersal fish assemblages are unlikely to be exposed to hydrocarbons above thresholds of concern except in shallow water locations surrounding reefs, banks and shoals where site-attached reef fish assemblages occur. The banks and shoals in the region with the highest probability of exposure to dissolved hydrocarbons above both the sub-lethal (96 ppb.hrs) and lethal (960 ppb.hrs) thresholds for sensitive organisms and life stages are Jabiru shoals, Pee Shoal and Mangola Shoal, located nearest to the EADA. A number of other named banks and shoals may also be exposed to dissolved hydrocarbons, although typically these banks and shoals are only exposed to sub-lethal doses with a low probability (less than 10%) of exposure to lethal doses. Such exposures typically occur in the top 10 m of the water column, decreasing to depths of 30 m, with lower probability of extending to depths of 30 m or greater. Similarly, the Jabiru shoals, Pee Shoal and Mangola Shoal are the most likely banks and shoals in the region to be exposed to doses of entrained hydrocarbons above the sub-lethal (9,600 ppb.hrs) threshold. There is a relatively low probability (36% or less) of the lethal (96,000 ppb.hrs) entrained hydrocarbon threshold being exceeded and this only applies to Jabiru Shoals and Pee Shoal during certain winter or transitional conditions. Sub-lethal and lethal exposures of entrained hydrocarbons are typically limited to the top 10 m of the water column, although there is a less than 10% probability of sub-lethal exposures of entrained hydrocarbons extending to depths greater than 10 m. Therefore, banks and shoals at depths greater than 10 m will not typically be exposed to entrained hydrocarbons above thresholds of concern, with only the shallowest areas of the shallowest shoals being exposed. The nearest coral reef systems at Ashmore Reef, Cartier Island and Hibernia Reef have between 44% and 75% probability of exposure to dissolved hydrocarbons above both the sub-lethal (96 ppb.hrs) threshold and between 3% and 15% probability of exposure to dissolved hydrocarbons above both the lethal (960 ppb.hrs) threshold. The Montara Environmental Monitoring Program included a study to determine effects of the spill incident on commercial fish species in Australian waters (Gagnon and Rawson 2012). The results of this study identified evidence of exposure of targeted fish species to petroleum				

	hydrocarbons within the vicinity of the release site but limited signs of adverse health or reproductive effects related to hydrocarbon exposure, as captured fish were in good physical condition (Gagnon and Rawson 2012). Based on this evidence from within the same geographical region, in the unlikely event of a LOWC, lethal impacts on fish populations are unlikely, although a range of sub-lethal effects are possible. The consequence to shallow water site-attached fish species at reefs, banks and shoals is considered to be moderate due to the potential wide spread extent of mainly sub-lethal effects and some lethal effects to a proportion of juveniles and or adults of sensitive species. Commercially targeted pelagic fish species or deeper water, mobile demersal species are not expected to be exposed or impacted to the same degree. Potential impacts to fish eggs and larvae, which are relevant to fish stock recruitment, are considered below with other planktonic communities.				
Marine Fauna • Marine Reptiles	<u>*Surface, entrained and dissolved exposures*</u> There is limited information regarding the effects of hydrocarbons on reptiles. Should reptiles come into contact with hydrocarbons, potential impacts include oiling of the body as well as irritations caused by contact with eyes, nasal and other body cavities and possibly ingestion or inhalation of toxic vapours (IPIECA-IOGP 2017). Turtles can be exposed to hydrocarbons if they surface within the spill, resulting in direct contact with the skin, eyes, and other membranes, as well as the inhalation of vapours or ingestion (Milton et al. 2003). Other aspects of turtle behaviour, including a lack of avoidance behaviour, indiscriminate feeding in convergence zones, and large, pre dive inhalations, make them vulnerable (Milton *et al.* 2003; IPIECA-IOGP 2017). The areas where oiled and injured turtles have previously been recovered during spills have been in surface exposures greater than 10 g/m^2 (French McCay 2016). The EADA does not overlap with any turtle BIAs, however, transient marine turtles are still expected to occur. Turtles may also be present at shallow banks and shoals in the EMBA, where the water depths may provide suitable foraging habitat, and within the Carbonate bank and terrace system of the Sahul Shelf KEF.	Serious (4)	Given the low likelihood of a LOWC occurring with preventative control measures in place, and the potential for impacts to be reduced by spill response measures, an LOWC and subsequent significant impacts to marine reptiles are unlikely to occur.	Unlikely (B)	Medium (4B)

	The maximum predicted extents of surface hydrocarbons greater than 10 g/m^2 throughout the full duration of the spill are approximately 210 km from the release site, although the total area exposed at any one time is expected to be less. It should be noted that no marine turtle BIAs, or habitat critical to the survival of marine turtles at Ashmore Reef and Cartier Island are predicted to be exposed to sea surface exposures greater than 10 g/m^2 from any of the LOWC scenarios. Dissolved and entrained hydrocarbon exposures that have the potential to result in lethal impacts to large marine fauna such as marine turtles and sea snakes (i.e. dissolved hydrocarbon exposures >400 ppb and entrained exposures >30,000 ppb) also do not extend into any BIAs or habitat critical to the survival of marine turtles. The 30,000 ppb entrained hydrocarbon threshold is not exceeded at any time or location and exceedance of the 400 ppb dissolved hydrocarbon threshold is limited to within a few kilometres of the release site under specific environmental conditions (2% probability during the winter period only). The thresholds are also relevant to time-based exposures (i.e. applied across a 96-hour exposure interval) and are therefore conservative for transient receptors such as turtles that will likely be exposed to the hydrocarbon plume for shorter periods. Therefore, the area of potential lethal effects from surface hydrocarbons is expected to affect transient individuals in immediate proximity to the release location. However, it is acknowledged that dissolved or entrained hydrocarbons have the potential to result in sub-lethal impacts to marine reptiles over a few hundred kilometres from the release site. Marine reptiles may also be susceptible to indirect toxic effects through ingestion of contaminated prey (e.g. seagrass, algae, jellyfish). Marine turtle populations have the potential to be indirectly affected by the loss of seagrasses, algae and other food sources impacted by entrained or dissolved hydrocarbons at a number of offshore banks, shoals and island locations, including Ashmore Reef and Cartier Island, and the Indonesian coastline. However, consistent with the assessments of impacts to coral reefs, seagrass, and bank and shoal communities below, worst-case impacts to seagrass and other epibiota in these locations are expected to be patchy. Loss of available food resource is not expected to be extensive. Sea snakes are also known to occur at Cartier Island and Hibernia Reef with established populations of several species present (Guinea, 2013b).				

	Sea snakes have also been reported in high abundance at Ashmore Reef in the past, but recent evidence has shown a significant decline in numbers. However, none of these locations are expected to be impacted by surface exposures greater than 10 g/m^2 or by dissolved or entrained hydrocarbon exposures above lethal effect thresholds. Therefore, impacts are likely to be limited to sub-lethal effects on transient individuals that may pass in close proximity to the release location. Based on colour patterns of the sea snake species observed during a recent survey there is thought to be very little gene flow between reefs implying that if a species is lost from a reef, recolonisation may take several years (Guinea, 2013b). Limited information is available regarding the susceptibility or sensitivity of sea snakes to hydrocarbon spills, however given they spend time at the sea surface to bask in the sun and the fact that they are air breathers, sea snakes may be vulnerable to surface slicks. The Montara Commission of Inquiry reported one dead sea snake as a result of the Montara oil spill in 2009 (PTTEP AA 2010), during which surface hydrocarbons were present for more than 74 days, with an accumulative area exposed to Montara crude wax and sheen of 95,554 km^2 (PTTEP AA 2012). However, a range of sub-lethal impacts and further mortalities may have occurred. On this basis, it is anticipated that in the unlikely event of a LOWC, turtles and sea snakes may be impacted by exposure to surface, entrained and/or dissolved hydrocarbons, but significant population level effects are not expected from such exposures.				
	Shoreline exposures There are several known turtle nesting areas of high conservation value in the region, including nesting BIAs at Ashmore Reef, Cartier Island, Browse Island and Sandy Islet at Scott Reef. Other sandy beaches at the Tiwi Islands, NT coastline, and shorelines in the Indonesian archipelago may also support nesting turtles and may be exposed to hydrocarbons. Nesting sites are typically on sandy beaches, which, if oiled, can lead to the following potential effects on turtles (IPIECA-IOGP 2017): • Digestion or absorption of oil through food contamination or direct physical contact, leading to damage to the digestive tract and other organs;				

	• Irritation of mucous membranes (such as those in the nose, throat and eyes) leading to inflammation and infection; • Contamination of eggs, either because there is oil in the sand high up on the beach at the nesting site, or because the female turtle becomes oiled whilst moving across the oiled beach to the nesting site - oiling of eggs may inhibit development; and • Newly hatched turtles, after emerging from the nests, may become oiled as they make their way over the beach to the water or the stranded oil may act as a barrier, preventing hatchlings reaching the sea. There is therefore the potential for impacts on nesting populations, which has the potential to affect population recruitment at a local population level. Although these nesting locations are not expected to be exposed to surface, entrained or dissolved hydrocarbons above the threshold, the accumulation of these hydrocarbons on shorelines is predicted to result in shoreline exposures that may exceed the 100 g/m^2 threshold. Modelling of the LOWC scenarios predicted up to 71% probability of light crude exceeding the 100 g/m^2 shoreline threshold at Ashmore Reef up to 78% probability for Cartier Island (depending on season). The minimum time before shoreline contact for a spill was 6 to 15 days at Ashmore Reef and 9 to 11 days at Cartier Island depending on season. Up to 50 km of the shoreline at Ashmore Reef and up to 10 km of the shoreline at Cartier Island could be affected. The probability of shoreline exposure at other locations was less and the minimum time before exposure was predicted to be between 9 and 80 days at sensitive receptors. Modelling of the Cash Maple LOWC scenario indicates that there is only a low probability (less than 12%) of condensate exceeding the 100 g/m^2 shoreline threshold at Ashmore Reef. The minimum time to contact was 7 days and up to 5 km of the shoreline at this location could be affected, albeit some of this shoreline may be intertidal reef habitat rather than sandy turtle nesting beach habitat. At the time the oil or condensate is predicted to reach shorelines, the hydrocarbons will have undergone a significant amount of weathering through evaporation and degradation and the most toxic and volatile fractions will have been lost.				

	Turtles on the shoreline, in particular hatchlings, may be impacted by exposure to weathered hydrocarbons where impacts are more likely to be physical smothering rather than acute toxicity. However, it is noted that while less toxic to eggs and embryos than freshly spilled oil, weathered oil residues can still have significant impacts on hatchlings and adult turtles. Hatchlings that contact oil residues while crossing a beach can exhibit a range of effects, from acute toxicity to impaired movement and normal bodily functions (Shigenaka, 2003). Lutz (1989) reported that hatchlings have been found apparently starved to death, their beaks and esophagi blocked with tarballs. Hatchlings sticky with oil residue may have greater difficulty crawling and swimming, rendering them more vulnerable to predation. Based on the above information, it is anticipated that in the unlikely event of a LOWC, turtles, in particular hatchlings, may be impacted by shoreline exposures to hydrocarbons. Stranded oil with its proximity to sandy beaches with known turtle nesting habitats, in excess of the threshold, may have significant effects on adult turtles, turtle nesting and juveniles, and local populations. Spill response measures may be implemented that reduce the extent of shoreline oiling and volumes at sensitive nesting beaches or prevent oiling of marine turtles on nesting beaches altogether, but impacts are conservatively assessed as serious.				
Marine Fauna • Plankton	<u>*Entrained and dissolved exposures*</u> As a consequence of their presence in the upper water column, phytoplankton and zooplankton may be entrained within the hydrocarbon plume and, therefore, subject to prolonged exposures to entrained/dissolved hydrocarbons. Extensive mortality of plankton may have consequences in terms of loss of food resource for species that feed on the plankton and on species spawning and recruitment success if extensive impacts to eggs and larvae occur. A number of commercially targeted fish species spawn in the waters off north western Australia, including a single known spawning ground for southern bluefin tuna in the Indian Ocean, extending between northern WA and Java from 7° S to 20° S, approximately 300 km to the west of the EADA (AFMA 2018).	Moderate (2)	Given the low likelihood of a LOWC occurring with preventative control measures in place, the described impacts to plankton communities	Unlikely (B)	Low (2B)

	The effects of oil on plankton have been well studied in both controlled laboratory and field situations. For the purposes of this assessment, dissolved hydrocarbon exposures greater than 1 ppb (96 ppb.hrs) are considered to have the potential for sub-lethal effects to plankton, while dissolved exposures greater than 10 ppb (960 ppb.hrs) have the potential for lethal effects to plankton. Similarly, entrained hydrocarbon exposures greater than 100 ppb (9,600 ppb.hrs) are considered to have the potential for sub-lethal effects to plankton, while entrained exposures greater than 1,000 ppb (96,000 ppb.hrs) have the potential for lethal effects to plankton. Modelling results predict that dissolved hydrocarbon exposures may exceed the sub-lethal and lethal thresholds up to a maximum of approximately 830 km and 275 km from the release site respectively. Entrained hydrocarbon exposures may exceed the sub-lethal and lethal thresholds up to a maximum of approximately 450 km and 115 km from the release site respectively. It should be noted that these distances represent the total swept area over the full 107 day duration of the modelled spill event, and the area exposed at any point in time will be significantly smaller. It is expected that the area where potential lethal and sub-lethal impacts to plankton could occur may extend over tens of kilometres or over a hundred kilometres respectively at a time. Therefore, in the unlikely event of a spill occurring there is potential for a reduction in plankton and larval survival over a broad area. However, natural distributions and densities of plankton can be highly ephemeral. Plankton and zooplankton biomass can vary naturally at spatial scales from hundreds of metres to hundreds or thousands of kilometres, and temporal scales of hours, days, seasons and inter-annually due to a range of environmental factors (Gibbons and Hutchings 1996; Holliday *et al*. 2011; McKinnon *et al*. 2008; Pearce *et al*. 2000; Sutton and Beckley 2017). Zooplankton mortality rates from natural causes can vary considerably spatially and temporally and can be as high as ~60% (or even 100% in some cases), approximately 25% to 33% of which may be caused by non-predatory factors (Hirst and Kiørboe 2002; Tang et al. 2014; Dubovskaya et al. 2015). Post spill studies on plankton populations are few, but those that have been conducted typically show either no effects, or temporary minor effects (Kunhold 1978). The lack of observed effects may be accounted for by the		are unlikely to occur.		

	fact that plankton biomass can naturally fluctuate significantly at a regional scale. Most studies of natural plankton communities have found a rapid return to normal densities and community composition once the oil in water concentrations have returned to background levels. Their ability to recover so quickly is due to short generation times, the production of large numbers of eggs and juveniles, distribution over large areas and rapid water exchange (IPIECA-IOGP 2015). Many marine species produce very large numbers of eggs over extended periods (i.e. weeks or months) to overcome natural losses (such as through predation by other animals; adverse hydrographical and climatic conditions; or failure to find a suitable habitat and adequate food). A possible exception to this would be if a shallow entrained/dissolved hydrocarbon plume were to intercept a single mass, synchronous spawning event. Recently spawned gametes and larvae would be particularly vulnerable to oil spill effects, since they are generally positively buoyant and would be exposed to surface spills. Under most circumstances, impacts on plankton are expected to be localised and short term; however, if an entrained/dissolved surface exposures reached a coral or fish spawning location during a spawning event, localised short to medium term impacts could occur. Overall, plankton abundance and biomass over much larger areas plays a greater role in primary productivity, food availability and species recruitment than the plankton communities affected by a spill. Few studies have described effects on densities of planktonic species lasting more than a few days or weeks (IPIECA-IOGP 2015). Impacts to plankton are expected to be temporary and recoverable. Impacts to fish larvae are unlikely to be of serious consequence to fish stocks, particularly compared with significantly larger losses through natural predation and other processes. Impacts to plankton communities may be extensive, but the implications of these losses may not be significant in the context of natural variability, unless, for example, an entire spawning period or a single discrete spawning event is impacted. Overall, the consequence to plankton communities is assessed as moderate.				

Avifauna	*Surface exposures* Numerous species of birds frequent the Timor Sea area or fly through the area on annual migrations. Seabird feeding grounds, roosting and nesting areas are found at the offshore atolls in the wider region. In particular, Ashmore Reef, Cartier and Browse Islands support internationally significant numbers of breeding seabirds and migratory shorebirds with all species variously listed under the EPBC Act. Ashmore Reef is also a Ramsar wetland of international importance. It is expected that a number of migratory bird species may pass through the EADA and EMBA during their annual migrations. A number of BIAs in addition to Ashmore Reef, Cartier and Browse Islands for seabirds have also been identified within the EMBA. Birds foraging at sea have the potential to directly interact with oil on the sea surface some considerable distance from terrestrial habitats in the course of normal foraging activities. Diving species and species that readily rest on the sea surface are most at risk. Surface concentrations above the impact threshold of 10 g/m^2 are not predicted to reach the water surrounding Ashmore Reef and Cartier Island. During summer and winter, sea surface exposures greater than 10 g/m^2 from a LOWC may reach other open water foraging and breeding BIAs for a number of bird species, including greater frigatebird, lesser frigatebird, red-footed booby, wedge-tailed shearwater and white-tailed tropicbird, within a minimum of 3 to 5 days. However, the probability of such exposures at these locations is typically less than 5%. During the transitional period, such exposures do not reach these BIAs until after 1-2 weeks, by which time significant weathering of the hydrocarbons will have occurred. Direct contact with surface hydrocarbons is likely to foul feathers and may result in hypothermia, drowning, dehydration and starvation (IPIECA-IOGP 2017). Impacts may include damage to external tissues, including skin and eyes, and internal tissue irritation in lungs and stomachs (Clark 1984). Toxic effects may also result where hydrocarbons are ingested, as birds attempt to preen their feathers (Jenssen 1994). Weathering of hydrocarbons on the sea surface will reduce the levels of toxicity that seabirds may be exposed to and, over time, the hydrocarbons on the surface will become patchy rather than continuous. Foraging avifauna	Serious (4)	Given the low likelihood of a LOWC occurring with preventative control measures in place, and the potential for impacts to be reduced by spill response measures, an LOWC and subsequent significant impacts to avifauna are unlikely to occur.	Unlikely (B)	Medium (4B)

	may also be susceptible to indirect toxic effects through ingestion of contaminated prey, such as fish exposed to in-water hydrocarbons. Based on the exposures predicted by the modelling, a number of migratory bird species may be impacted in open waters, but the EADA and immediate area of the predicted spill are not located in known important areas for seabirds. Exposures within BIAs may occur when the most toxic fractions of the hydrocarbons have weathered, but physical oiling can still affect a significant number of birds. The consequence is therefore assessed as serious.				
	Shoreline exposures Potential impacts to resting/foraging seabirds from exposure to surface oil have been discussed above. In relation to impacts from shoreline accumulation, there is potential for oiling of birds from shoreline hydrocarbon contact and eggs and young may also be impacted at these locations. Shorebirds foraging and feeding in intertidal zones are at potential risk of exposure to shoreline hydrocarbons, potentially causing acute effects. A number of offshore and coastal islands in the region provide nesting habitat for seabirds and foraging habitat for shorebirds. Ashmore Reef, Cartier Island and Browse Island support a large population of seabirds, including some of the most important seabird rookeries on the North West Shelf (Commonwealth of Australia 2002, Clarke 2010). Numbers of breeding seabirds have been reported to potentially exceed 100,000 individuals during a single year at Ashmore Reef (Clarke and Herrod 2016). Up to 33 migratory shorebirds species and 18,000 individuals have also been documented using the reserves (Clarke 2010). Ashmore Reef, Cartier Island and Browse Island are also important foraging areas for migratory shorebirds, with numbers highest between October and April (Clarke 2010). Modelling of the LOWC scenarios predicted up to 26% probability of light crude exceeding the 100 g/m^2 shoreline threshold at Ashmore Reef and Cartier Island. The minimum time before shoreline contact during the summer season is predicted to be 11 days at Cartier Island with up to 10 km of the shoreline affected at this location. The probability of shoreline exposure at other shoreline locations within the EMBA was				

	significantly less and the minimum time before exposure was predicted to be 11 to 30 days at shoreline receptors. Avifauna foraging in the intertidal zone may also be susceptible to indirect toxic effects through ingestion of contaminated prey, such as invertebrate species. At the time the oil or condensate is predicted to reach shorelines, the hydrocarbons will have undergone a significant amount of weathering through evaporation and degradation and the most toxic and volatile fractions will have been lost. In a post-impact study following a LOWC of the effects of the spill on bird populations, the total number of seabirds breeding at Ashmore Reef was found to increase after the spill event when compared to pre-impact data (Clark and Herrod 2016). This trend also applied to breeding populations of individual seabird species. Declines in non-breeding seabirds during were detected and some of these declines met the *a priori* definition of significant impact. As breeding populations increased over the same time period, Clark and Herrod (2016) conclude that these declines likely reflect variability in seasonal response rather than evidence for significant impact arising from the LOWC. Declines in migratory shorebird numbers were detected at Ashmore Reef following the LOWC, however, this response was anticipated given ongoing declines of migratory shorebirds throughout the flyway. When compared with control sites at Eighty-mile Beach, WA, the decline in numbers was not found to be significantly different and therefore no significant impact as a result of the LOWC was detected. However, based on the potential for a significant number of birds to be impacted by shoreline accumulation of oil, the potential consequence is assessed as serious.				

Benthic Communities • Banks & Shoals	*Entrained and dissolved exposures* Banks and shoals in the region may be exposed to dissolved and/or entrained hydrocarbons following a LOWC. In the event of exposure, filter feeders and corals present at submerged banks and shoals are liable to ingest entrained hydrocarbons and absorb dissolved aromatics with lethal and various sub-lethal effects. The latter include alteration in respiration rates, decreases in filter feeding activity, reduced growth rates, biochemical effects, increased predation, reproductive failure and mechanical destruction by waves due to inability to maintain a hold on substrate (Ballou *et al*. 1989; Connell and Miller 1981). The banks and shoals in the region with the highest probability of exposure to dissolved hydrocarbons above both the sub-lethal (96 ppb.hrs) and lethal (960 ppb.hrs) thresholds for sensitive organisms and life stages are Jabiru shoals, Pee Shoal and Mangola Shoal, located nearest to the EADA. A number of other named banks and shoals may also be exposed to dissolved hydrocarbons, although typically these banks and shoals are only exposed to sub-lethal doses with a low probability (less than 10%) of exposure to lethal doses. Such exposures typically occur in the top 10 m of the water column, decreasing to depths of 30 m, with lower probability of extending to depths of 30 m or greater. Similarly, the Jabiru shoals, Pee Shoal and Mangola Shoal are the most likely banks and shoals in the region to be exposed to doses of entrained hydrocarbons above the sub-lethal (9,600 ppb.hrs) threshold for sensitive organisms and life stages. There is a relatively low probability (36% or less) of the lethal (96,000 ppb.hrs) entrained hydrocarbon threshold being exceeded and this only applies to Jabiru Shoals and Pee Shoal during certain winter or transitional conditions. Sub-lethal and lethal exposures of entrained hydrocarbons are typically limited to the top 10 m of the water column, although there is a less than 10% probability of sub-lethal exposures of entrained hydrocarbons extending to depths greater than 10 m. Therefore, banks and shoals at depths greater than 10 m will not typically be exposed to entrained hydrocarbons above thresholds of concern, with only the shallowest areas of the shallowest shoals being exposed. In addition, entrained droplets will only have an effect if they adhere to tissues or become trapped by filter feeders, while momentary	Significant (3)	Given the low likelihood of a LOWC occurring with preventative control measures in place, and the relatively low likelihood of exposure at banks and shoals, an LOWC and subsequent significant impacts to the filter feeders, corals and other epibiota are unlikely to occur.	Unlikely (B)	Medium (3B)

	contact by oil droplets carried in currents is unlikely to result in any effects. Banks and shoals are more likely to be exposed to the dissolved aromatic components of the oil, which may occur to greater depths and can be absorbed by tissues. In reality, based on monitoring of historical spill events, it is unusual for high concentrations of hydrocarbons to remain over a particular patch of seabed for long and many organisms will be relatively insensitive to even high concentrations because the duration of exposure is typically short (IPIECA-IOGP 2015). The Montara Environmental Monitoring Program included a study to determine the level of impact of the LOWC on the marine life of various submerged banks, shoals and coral reefs that are within the EMBA (Heyward et al. 2010, 2011a). Key findings of this study identified that shoal and reef communities showed no obvious signs of recent disturbance (Heyward et al 2010, 2011a). However, for the purposes of this assessment, it is conservatively assumed that filter feeder organisms, algae, sponges, hard and soft corals on banks and shoals may begin to exhibit sub-lethal and lethal responses ranging from recoverable stress effects to mortality. This would affect the most sensitive of species present on the banks and shoals, but may become gradually apparent and affect more species after many days or weeks of repeated exposure. Consequently, the benthic community composition may change in shallow, patchy areas of banks and shoals. Such changes are likely to be recoverable, although recovery can take a number of years (IPIECA-IOGP 2015). The consequence of potential sub-lethal and lethal impacts to some sensitive benthic organisms and subsequent changes to the benthic communities at individual banks and shoals is assessed as significant.				
Benthic Communities • Subtidal Coral Reef Communities • Seagrass communities	*Entrained and dissolved exposures* As with the banks and shoals assessed above, a number of other sub-tidal coral reef and seagrass communities may be exposed to entrained and dissolved hydrocarbons following a LOWC. Physical oiling of coral tissue can cause a decline in metabolic rate and may cause varying degrees of tissue decomposition, which can lead to death (Negri and Heyward 2000). Direct contact from hydrocarbons can	Moderate (2)	Given the low likelihood of a LOWC occurring with preventative control measures in place, and the	Unlikely (B)	Low (2B)

	result in the death of seagrasses if it coats their leaves and stems (Taylor and Rasheed 2011). Stress response has also been demonstrated for seagrass at hydrocarbon concentrations representative of oil spill situations (Thorhaug *et al*. 1991). Ashmore, Cartier and Hibernia reefs have between 44% and 75% probability of exposure to dissolved hydrocarbons above both the sub-lethal (96 ppb.hrs) threshold for sensitive organisms and life stages. These locations also have between 3% and 15% probability of exposure to dissolved hydrocarbons above both the lethal (960 ppb.hrs) threshold for sensitive organisms and life stages. The reefs also have between 36% and 58% probability of exposure to entrained hydrocarbons above the sub-lethal (9,600 ppb.hrs) threshold for sensitive organisms and life stages, but are not predicted to be exposed to entrained hydrocarbons above the lethal threshold. Therefore, dissolved hydrocarbons have the greater potential of the two fractions to result in toxicity impacts to coral reefs and seagrass at these locations. In reality, based on monitoring of historical spill events, it is unusual for high concentrations of hydrocarbons to remain over a particular patch of seabed for long and many organisms will be relatively insensitive to even high concentrations because the duration of exposure is typically short (IPIECA-IOGP 2015). In the unlikely event that coral reef and sea grass communities are exposed to entrained and dissolved hydrocarbons, they may be subject to a range of sub-lethal to lethal effects. The corresponding impacts may affect individual sensitive coral species or patches of reef, seagrass or other epibiota associated with these habitats. Sub-lethal toxicity impacts may affect localised patches of coral reef or seagrasses. The potential impacts are not expected to significantly modify, destroy, fragment, isolate or disturb an important or substantial area of coral reef or seagrass at these locations. The overall status and ecological functioning of these coral reef communities are not expected to be significantly impacted. Other named coral reef systems in the region may also be exposed to dissolved and entrained hydrocarbons above the sub-lethal thresholds for sensitive organisms and life stages, but not to lethal doses. These locations include Scott Reef (up to 7% probability), Seringapatam Reef (up to 13% probability), Browse Island (up to 2% probability), Imperieuse Reef		relatively low likelihood of exposure at sub-tidal coral reef and seagrass communities, an LOWC and subsequent significant impacts to these benthic communities are unlikely to occur.		

	(Rowley Shoals) (1% probability), and coral reefs surrounding islands of Timor-Leste and Indonesia (up to 10% probability). However, given the potential localised and short-term exposures, and the advanced degree of weathering and microbial degradation that will have occurred to the spilled hydrocarbons prior to contact at these distant locations, discernible impacts to these reef systems are unlikely. The Montara Environmental Monitoring Program included a study to determine the level of impact of the LOWC on the marine life of various submerged banks, shoals and coral reefs that are within the EMBA (Heyward *et al*. 2010, 2011a). Key findings of this study identified that shoal and reef communities showed no obvious signs of recent disturbance (Heyward *et al*. 2010, 2011a). The Montara Environmental Monitoring Program also recorded a small representation of seagrass at Barracouta Shoal and more extensive areas of seagrass at Vulcan Shoal (up to 36% seagrass cover) (Heyward *et al*. 2010). A significant loss of seagrass was recorded at Vulcan Shoal in 2011 when compared with data from surveys conducted in 2010, six months after the LOWC. The cause of seagrass loss at Vulcan Shoal cannot be determined, however is noted that a delayed effect from LOWC resulting in a change sometime between 6 and 18 months after the incident is considered unlikely to be due to the LOWC (Heyward *et al*. 2011a). The potential consequence of patchy lethal and sub-lethal impacts to subtidal coral reef and seagrass communities is assessed as moderate.				
Shoreline Habitats • Intertidal / Emergent Coral Reef Communities	<u>*Shoreline exposures*</u> Intertidal coral reef communities are present within the region at emergent coral reefs such as Ashmore Reef, Hibernia Reef, Scott Reef and Seringapatam Reef. Fringing coral reef communities are also present at Cartier Island, Browse Island, and along parts of the Tiwi Islands and Indonesian islands. Hydrocarbons have the potential to become stranded on corals exposed during periods of low tide and moved again when the tide rises. Direct contact of hydrocarbons onto corals may impair respiration and also photosynthesis by symbiotic zooxanthellae (Peters *et al.* 1981, Knap *et al.* 1985). Physical oiling of coral tissue can also cause a decline in metabolic rate and may cause varying degrees of tissue decomposition and death (Negri and Heyward 2000). Consequently, hydrocarbon contamination	Significant (3)	Given the low likelihood of a LOWC occurring with preventative control measures in place, and the relatively low likelihood of exposure at intertidal coral reef	Unlikely (B)	Medium (3B)

	can result in reduced colonisation of corals and contribute to bleaching (Heyward et al., 2010). The timing of an oil spill event in relation to other environmental stresses, such as ambient temperature or reproductive stage, may also be of importance in that corals are likely to be more sensitive to oil spill events at times of physiological stress. For instance, the larvae of corals are more sensitive to dissolved hydrocarbons than adult colonies (Heyward et al. 1997; Harrison 1999; Epstein et al. 2000). Based on French-McCay (2009; 2016), the shoreline accumulation impact threshold was determined to be 100 g/m^2 for invertebrates on hard substrates (such as corals). Modelling of the Orchid-1 LOWC scenario predicted up to 26% probability of light crude exceeding the 100 g/m^2 shoreline threshold at Ashmore Reef and Cartier Island. The minimum time before shoreline contact was 11 days at Cartier Island where up to 10 km of the shoreline at this location could be affected. The probability of shoreline exposure at other shoreline locations within the EMBA was significantly less. The minimum time before exposure was predicted to be between 28 days at Browse Island, 18 days at Scott Reef, 22 days at Seringapatam Reef, 11 days at shorelines in Indonesia, and over 80 days at shorelines in the Tiwi Islands and NT coastline. Modelling of the Cash Maple LOWC scenario indicates that there is only a low probability (less than 12%) of condensate exceeding the 100 g/m^2 shoreline threshold and that shoreline exposure is limited to Ashmore Reef. The minimum time to contact was 7 days and up to 5 km of the shoreline at this location could be affected. By the time the oil or condensate is predicted to reach shorelines, the hydrocarbons will have undergone a significant amount of weathering through evaporation and degradation and the most toxic and volatile fractions will have been lost. Any potential stranded oil effects would likely be limited to the physical effects of accumulation and smothering, rather than toxicity.. Therefore, shoreline exposure of corals and coralline algae could result in the death or impairment of some localised patches of coral along the shorelines of Cartier Island, Ashmore Reef and Hibernia Reef if stranding and direct contact at low tide occurs. Lesser impacts to corals are		communities, an LOWC and subsequent significant impacts to these benthic communities are unlikely to occur.		

	predicted to occur from stranded oil at more distant emergent coral reefs, such as Scott Reef, Seringapatam Reef or Indonesia. As spills disperse, intertidal communities are expected to recover (Dean *et al*. 1998). The rate of recovery of coral reefs depends on the level or intensity of the disturbance, with recovery rates ranging from 1 or 2 years, to decades (Fucik et al. 1984, French McCay 2009). For example, the 1986 spill at the Baha Las Minas oil terminal in Panama resulted in impacts to fringing coral reefs, with coral cover recovering within approximately one year (IPIECA-IOGP 2015). The overall status and ecological functioning of individual intertidal coral reef communities are unlikely to be significantly impacted. However, any contact by oil at coral reef locations during spawning events (October/November) has the potential to cause more significant community level impacts by affecting recruitment. Given the regional significance of the coral reefs that may be contacted, particularly at Cartier Island, the potential consequence of patchy impacts to intertidal corals at these locations is conservatively assessed as significant.				
Shoreline Habitats • Mangroves and wetland	<u>*Shoreline exposures*</u> Mangrove and wetland habitat is present within the region along the NT coastline, Tiwi Islands and coasts of Indonesia and Timor-Leste. Mangroves are considered to be an important component of tropical ecosystems as they provide habitat for benthic invertebrates, nursery areas for a wide range of marine species, and a source of organic matter and nutrients. The potential impacts from spilled hydrocarbons on mangroves include damage as a result of smothering of lenticels (breathing pores) on pneumatophores or prop roots or by the loss of leaves (defoliation) due to toxicity effects (Duke *et al*. 1999). Thorhaug (1987) concluded that while defoliation of mangroves was a common occurrence when exposed to hydrocarbon slicks, massive mortality was not always the ultimate outcome. Mangrove death is predicted whenever more than 50% of the leaves are lost (Evans 1985). It is also known that mangroves take up hydrocarbons from contact with leaves, roots or sediments, and it is suspected that this uptake causes defoliation through leaf damage and tree death (Wardrop *et al*. 1987). The	Minor (1)	Given the low likelihood of a LOWC occurring with preventative control measures in place, and the low likelihood of contact with mangrove communities, impacts are unlikely to occur.	Unlikely (B)	Low (1B)

	recovery of mangroves from shoreline oil accumulation can be a slow process, due to the long-term persistence of contaminated anoxic sediments and subsequent release into the water column. (Burns et al. 1993). Loading of Dubai light crude at 1,000 g/m^2) reportedly caused no impacts to mangroves (McGuiness 1990), while Lin and Mendelssohn (1996) found that the equivalent of 4,000 g/m^2 could reduce vegetation biomass and 8,000 g/m^2 prevented regrowth the following year. Experiments with light Arabian crude indicated that 100 kg/m^2 (equivalent to 100,000 g/m^2 or 10 cm thick) are lethal to mangrove seedlings (Hoi-Chaw and Meow-Chan 1985). Based on these observations, French McCay (2016) concludes that more than 1,000 g/m^2 during the growing season would be required to result in sub-lethal impacts to mangrove and saltmarsh vegetation, while 5,000 g/m^2 may result in lethal impacts. Therefore, shoreline exposures greater than 1,000 g/m^2 are considered to have potential impacts on mangroves and wetlands. Similar thresholds have been found in studies assessing oil impacts on mangroves (Grant et al., 1993; Suprayogi and Murray, 1999). Intertidal invertebrates that may live within mangrove and saltmarsh habitats are typically more sensitive to hydrocarbon exposures than the vegetation and 100 g/m^2 is considered to be an appropriate threshold for lethal impacts (French McCay 2016). Modelling undertaken for the Cash CD-2 LOWC indicates that no condensate exposures with the potential to impact mangroves or other wetlands will contact any shorelines. Modelling undertaken for the Orchid-1 LOWC indicates that locations that potentially support mangroves or wetland that receive shoreline accumulation of light crude above the 1,000 g/m^2 threshold are limited to: • Timor Leste (5% probability, 3 km maximum shoreline length, 49 days minimum timeframe to contact); and • Pulau Ndana, Indonesia (1% probability, 1 km maximum shoreline length, 15 days minimum timeframe to contact). Shorelines that may support mangroves and are predicted to receive shoreline accumulation of light crude above the 100 g/m^2 threshold for associated benthic invertebrates include:				

	• the Tiwi Islands in the NT (5% probability, 12 km maximum shoreline length, 83 days minimum timeframe to contact); • Timor Leste (<15% probability, <14 km maximum shoreline length, 26-104 days minimum timeframe to contact); and • Pulau Rote and other Indonesian Islands (<12% probability, <10 km maximum shoreline length, 11-66 days minimum timeframe to contact). The CD-2 LOWC modelling does not predict contact from the condensate above these thresholds at any location that may support mangroves or wetlands. Given that the minimum timeframe to shoreline contact is predicted to be 11 days (and over 100 days in some instances), by the time the light crude is predicted to reach shorelines, the hydrocarbons will have undergone a significant amount of weathering through evaporation and degradation. Any potential stranded oil effects would likely be limited to the physical effects of accumulation and smothering, rather than toxicity. Therefore, worst-case impacts are likely to be limited to some sub-lethal impacts to mangrove seedlings and some sessile benthic invertebrates that cannot avoid smothering by the weathered oil. Some persistent fraction of the oil may adhere to muddy sediments resulting in some low-level but long-term contamination; however, impacts to biota will be limited. The consequence of these impacts is assessed as minor.				
Shoreline Habitats • Sandy Beaches	*Shoreline exposures* Sandy beaches are present within the region at the sandy cays of Ashmore Reef, Cartier Island, Sandy Islet at Scott Reef, Browse Island, and along the coastlines of the NT, the Tiwi Islands, Indonesia and Timor Leste. Sandy beaches may comprise fine or coarse sands with mixed levels of gravel and shells. Sandy beaches do not typically support abundant or diverse invertebrate fauna, relative to finer, muddy sediments and wetlands. They are also less susceptible to long term contamination than muddy sediments although a low viscosity oil such as light crude or condensate can penetrate into the sediment (IPIECA-IOGP 2015). Sandy beaches are classified as low sensitivity, based on the oil spill environmental sensitivity index outlined in IPIECA-IOGP (2012). Such	Moderate (2)	Given the low likelihood of a LOWC occurring with preventative control measures in place, impacts to sandy beach communities are unlikely to occur.	Unlikely (B)	Low (2B)

	habitats have the potential to be cleaned relatively rapidly through natural reworking by wave action and the rising and falling tide; this is particularly so for non-persistent hydrocarbons such as the condensate and light crude assessed here. It is recognised that these sandy beaches provide habitat for the EPBC Act listed species that they support, such as nesting turtles and avifauna, however, potential impacts to these species from shoreline exposure are assessed separately above. The following assessment specifically addresses potential impacts to sandy beach habitat and the sediment invertebrate fauna they support, for example polychaetes, molluscs, crustaceans, and insects. In 2002, De La Huz et al. (2005) investigated the impacts of the Prestige oil tanker spill off the Galician coast on 17 exposed sandy beaches. The study investigated species richness of polychaetes, molluscs, crustaceans, semi-terrestrial crustaceans and insects on the affected beaches, by comparing the total number of species in each group before and after the oil spill. The investigation identified that the most heavily affected beaches lost up to 66.7% of the total species richness after the oil spill and dry sand areas received the highest volumes of hydrocarbons ashore. Thomas (1978 cited in French-McCay 2009) observed recovery of invertebrates after three years on sandy beaches oiled by the 1970 Arrow spill of Bunker Oil. Additionally, Judd et al. (1991 cited in French McCay 2009) observed dune vegetation recovery after three years following removal experiments. French McCay (2016) recommends 100 g/m^2 as the shoreline exposure threshold for lethal impacts to invertebrates in sediments. By the time light crude or condensate is predicted to reach shorelines, the hydrocarbons will have undergone a significant amount of weathering through evaporation and degradation and the most toxic and volatile fractions will have been lost. Any potential stranded oil effects would likely be limited to the physical effects of accumulation and smothering, rather than toxicity. Invertebrate species abundance and density is expected to be relatively low along the sandy shorelines, but of the invertebrate communities that may be affected by the smothering or toxic effects of the light crude, full recovery may take in excess of a year. The consequence of these impacts is assessed as moderate.				

Protected Areas • AMPs	Protected areas within the EMBA include the Ashmore Reef and Cartier Island Sanctuary Zones, the Oceanic Shoals Multiple Use Zone, the Kimberley Multiple Use Zone, the Argo Rowley Terrace National Park and Multiple Use Zones, and the Mermaid Reef National Park Zone. *Ashmore Reef and Cartier Island AMPs* The ecological values of the Ashmore Reef Marine Park values include emergent coral reef habitats and communities, nesting turtles, sea snakes, dugongs, seabird rookeries and staging / feeding habitat. The ecological values of the Cartier Island Marine Park include emergent coral reef habitats and communities, marine turtles, sea snakes, and seabird rookeries. Potential impacts to the values of the Ashmore Reef and Cartier Island AMPs are incorporated in the impact assessment sections above for dugongs, marine reptiles, avifauna, benthic communities and shoreline communities. Worst-case impacts to the relevant ecological values at Ashmore Reef and Cartier Island Marine Parks are predicted to include potential lethal and sub-lethal impacts to avifauna and marine turtles, sub-lethal impacts to dugongs, and patchy sub-lethal and lethal impacts to corals, seagrasses, and intertidal communities. *Oceanic Shoals AMP* The ecological values of the Oceanic Shoals Multiple Use Zone includes foraging and internesting BIAs for marine turtles and four KEFs: carbonate bank and terrace system of the Van Diemen Rise; carbonate banks of the Joseph Bonaparte Gulf; pinnacles of the Bonaparte Basin; and shelf break and slope of the Arafura Shelf. It is noted that dissolved and entrained hydrocarbon exposures predicted by modelling to occur within the Oceanic Shoals Multiple Use Zone are limited to sub-lethal doses in the upper water column, and there is limited or no interaction with any bank, shoal or pinnacle habitats designated as KEFs within the AMP. In addition, surface, entrained and dissolved hydrocarbons predicted to reach the Oceanic Shoals AMP and the turtle BIAs it encompasses are below thresholds that may illicit lethal impacts. There is the potential for hydrocarbon exposures to exceed sub-lethal effects levels, but due to the relatively short exposure durations that foraging and interesting turtles are likely to experience, impacts are expected to be limited. *Kimberley AMP*	Serious (4)	Given the low likelihood of a LOWC occurring with preventative control measures in place, and the potential for impacts to be reduced by spill response measures, an LOWC and subsequent significant impacts to the values of the Ashmore Reef and Cartier Island AMPs are unlikely to occur.	Unlikely (B)	Medium (4B)

	The ecological values of the Kimberley AMP include the migration pathway and nursery areas for humpback whales, foraging areas for coastal dolphin species, dugongs, marine turtles, breeding seabirds and migratory shorebirds, as well as diverse sea bed features such as banks, shoals and pinnacles. Limited exposure of the Kimberley Multiple Use Zone to surface and dissolved hydrocarbons is predicted to occur under a limited number of wind and current conditions. The Multiple Use Zone is only predicted to be contacted by surface hydrocarbons below the 10 g/m^2 ecological threshold of concern, and by dissolved hydrocarbons above the 96 ppb.hrs sub-lethal effects threshold for the most sensitive species and early life stages. Exposures do not exceed any thresholds that may result in lethal or sub-lethal impacts to large marine fauna such as the cetaceans, dugongs, avifauna and turtles for which the AMP is designated. Therefore, discernible impacts to the values of the AMP are not expected. *Argo Rowley Terrace and Mermaid Reef AMPs* The Argo Rowley Terrace AMP and Mermaid Reef AMP are located within the furthest extent of the EMBA. However, spill modelling predicts that there is a 3-31% probability of these AMPs being exposed to surface hydrocarbons >0.5 g/m^2, depending on the season, and no exposure above the 10 g/m^2 threshold. Such surface exposures are not expected to result in ecological impacts and the minimum timeframe before exposure in these locations ranges from 27.5 to 57 days, by which time significant weathering of the oil will have occurred and any residual hydrocarbons will be patchy and of low toxicity. The exposure to dissolved hydrocarbons in these locations is also unlikely, with a 1-2% probability of exceeding the 96 ppb.hrs threshold for sub-lethal effects to the most sensitive organisms and early lifestages at the AMPs. These dissolved hydrocarbon exposures represent time-based exposures, which are unlikely to occur at these locations given the regularly alternating nature of currents and transient nature of marine fauna. Therefore, no impacts to the values of the Argo Rowley Terrace AMP or Mermaid Reef AMP are expected. The overall consequence of impacts from a hydrocarbon spill to protected areas reflects the consequence of impacts to the ecological values and sensitivities of the Ashmore Reef and Cartier Island AMPs. Based on the worst-case consequences from the impact assessments outlined above for marine fauna, benthic communities and shoreline communities, particularly				

	impacts to marine turtles and avifauna, the consequence is considered to be serious.				
Protected Areas • KEFs	The KEFs occurring within the defined low threshold EMBA include: • Carbonate bank and terrace system of the Sahul Shelf; • Carbonate banks and terrace system of the Van Diemen Rise; • Pinnacles of the Bonaparte Basin; • Ashmore Reef and Cartier Island and surrounding Commonwealth waters; • Ancient coastline at 125 m depth contour; • Continental Slope Demersal Fish Communities; • Seringapatam Reef and Commonwealth waters in the Scott Reef complex; • Canyons linking the Argo Abyssal Plain with the Scott Plateau; • Shelf break and slope of the Arafura Shelf; • Mermaid Reef and Commonwealth waters surrounding Rowley Shoals. The Ancient coastline at 125 m depth KEF, the Continental slope demersal fish communities KEF, the Carbonate banks and terrace system of the Van Diemen rise KEF, the Shelf break and slope of the Arafura Shelf KEF, and the Canyons linking the Argo Abyssal Plain with the Scott Plateau KEF all comprise seabed features and values that will not be exposed to hydrocarbons. These KEFs occur within the EMBA in areas where low surface hydrocarbons or dissolved hydrocarbons may occur in the upper water column, but there will be no exposure at the seabed. Therefore, the ecological values and functions of these KEFs will not be impacted and the KEFs are not assessed further. The consequence of potential impacts from a hydrocarbon spill to the ecological values and functions of the other KEFs reflects the consequence of impacts to their ecological values, which are informed by the impact assessment sections above for marine fauna, benthic communities and shoreline communities. Further discussion specific to receptors of relevance at each KEF is provided below. *Carbonate banks and shoals of the Sahul Shelf KEF*	Serious (4)	Given the low likelihood of a LOWC occurring with preventative control measures in place, and the potential for impacts to be reduced by spill response measures, an LOWC and subsequent significant impacts to the values of KEFs are unlikely to occur.	Unlikely (B)	Medium (4B)

	The values and sensitivities of the Carbonate banks and shoals of the Sahul Shelf KEF that may be exposed to hydrocarbons include: • Shallow, representative bank and shoal habitats; and • Diverse reef fish associated with bank and shoal habitats. Spill modelling results predict that the Carbonate banks and shoals of the Sahul Shelf KEF may be exposed to dissolved hydrocarbons above the 96 ppb.hrs threshold for sub-lethal effects and the 960 ppb.hrs threshold for lethal effects to sensitive organisms and early lifestages. Exposure is typically predicted to occur in the upper 30 m of the water column, with a low likelihood of exposure at greater depths. The Carbonate banks and shoals of the Sahul Shelf KEF may also be exposed to entrained hydrocarbons, although this is limited to the top 10 m of the water column and exposures are typically in the sub-lethal range for sensitive organisms and life stages (9,600 ppb.hrs). Therefore, benthic communities at banks and shoals in the KEF may be exposed to a range of sub-lethal to lethal effects. Based on the assessments of impacts to bank and shoal communities, and to fish provided above, the worst-case consequence of localised and patchy impacts to benthic biota at individual banks and shoals is conservatively assessed to be significant, and the impacts to associated fish assemblages are assessed to be moderate. Putting such impacts at individual banks and shoals into context of the broader KEF, the consequence to the ecological functioning of the KEF are conservatively assessed to be moderate. *Pinnacles of the Bonaparte Basin KEF* The values and sensitivities of the Pinnacles of the Bonaparte Basin KEF that may be exposed to hydrocarbons include: • Shallow, hard substrate that provides for diverse benthic communities; and • Aggregations of demersal fish species. Spill modelling results predict that the Pinnacles of the Bonaparte Basin KEF has a low probability (<10%) of being exposed to sub-lethal doses of dissolved hydrocarbons in the upper 30 m of the water column and sub-lethal doses of entrained hydrocarbons in the upper 10 m of the water column. Therefore, benthic communities and demersal fish assemblages				

	may be exposed to sub-lethal effects. The exposures may result in sub-lethal effects to only the most sensitive organisms and early lifestages, including juvenile fish. Impacts to benthic communities and fish at individual pinnacles may not be discernible in the context of the broader KEF. The consequence to the ecological functioning of the KEF is assessed as minor. *Ashmore Reef and Cartier Island and Surrounding Commonwealth Waters KEF* The values and sensitivities of the Ashmore Reef and Cartier Islands and Surrounding Commonwealth Waters KEF that may be exposed to hydrocarbons include: • Fringing coral reef communities (intertidal emergent and sub-tidal); • Diverse fish fauna; • Marine turtles and sea snakes; and • Seabirds and migratory shorebirds. The consequence of impacts from a hydrocarbon spill to these values of the KEF are based on the worst-case consequences from the impact assessments outlined above for marine fauna, avifauna, benthic communities and shoreline communities above. These assessments specifically consider receptors at Ashmore Reef and Cartier island and therefore the worst-case consequence to the KEF is considered to be serious. *Seringapatam Reef and Commonwealth waters in the Scott Reef Complex KEF* The values and sensitivities of the Seringapatam Reef and Commonwealth waters in the Scott Reef Complex KEF that may be exposed to hydrocarbons include: • Sub-tidal and intertidal coral reef communities; and • Waters of enhanced productivity that attract cetacean, whale shark, marine turtle and sea snake aggregations, including turtle nesting on Sandy Islet. Surface hydrocarbon exposures at Seringapatam Reef and the Commonwealth waters surrounding Scott Reef are predicted to be limited to a 22-33% probability of exposures exceeding 0.5 g/m^2, depending on the season, and no exposure above the 10 g/m^2 threshold. Such surface				

	exposures are not expected to result in ecological impacts and the minimum timeframe before exposure in these waters ranges from 17 to 27 days, by which time significant weathering of the oil will have occurred and any residual hydrocarbons will be patchy and of relatively low toxicity. The exposure to dissolved hydrocarbons in these waters is also unlikely, with a 4-13% probability of exposures exceeding the 96 ppb.hrs threshold for sub-lethal impacts to the most sensitive organisms and early lie stages. Therefore, impacts to the ecological values or functioning of the KEF from dissolved hydrocarbons are expected to be minor, patchy and recoverable sub-lethal changes to the most sensitive biota. Shoreline exposures at Scott Reef and Seringapatam Reef are expected to comprise weathered hydrocarbons. Shoreline exposure is not predicted to commence until after minimum timeframes of 18-36 days, depending on the season, and accumulation to loads greater than the 100 g/m^2 threshold for ecological impacts does not occur until 18-44 days after the spill commences. Exposures greater than 100 g/m^2 could occur along several kilometres of intertidal reef or at the Sandy Islet turtle nesting beach. Toxicity impacts are therefore expected to be limited although some smothering impacts to corals and ingestion impacts to turtles on Sandy Islet could still occur in patchy areas. However, it is noted that while less toxic to eggs and embryos than freshly spilled oil, weathered oil residues can still have significant impacts on some hatchlings and adult turtles, although impacts to a significant proportion of the population are not expected. The consequence of such impacts is conservatively assessed as significant. *Mermaid Reef and Commonwealth waters surrounding Rowley Shoals KEF* The values and sensitivities of the Mermaid Reef and Commonwealth waters surrounding Rowley Shoals KEF that may be exposed to hydrocarbons include: • Sub-tidal coral reef communities; and • Waters of enhanced productivity that attract migratory pelagic species such as dolphins, tuna, billfish and sharks. Spill modelling predicts that there is a 3-11% probability of the KEF being exposed to surface hydrocarbons >0.5 g/m^2, depending on the season, and no exposure above the 10 g/m^2 threshold. Such surface exposures				

	are not expected to result in ecological impacts to large marine fauna and the minimum timeframe before exposure within the KEF ranges from 48 to 53 days, by which time significant weathering of the oil will have occurred and any residual hydrocarbons will be patchy and of low toxicity. The exposure to dissolved hydrocarbons in these locations is also unlikely, with a 0-2% probability of the 96 ppb.hrs threshold for sub-lethal effects to sensitive organisms and early life stages being exceeded in the waters of this KEF. Therefore, no discernible impacts to these particular ecological values or functioning of the KEF are expected. Based on the worst-case consequence assessment for impacts to the ecological values and functions of the Ashmore Reef and Cartier Islands and Surrounding Commonwealth Waters KEF, the overall potential consequence to KEFs is assessed as serious.				
Heritage Places	Ashmore Reef and Surrounds are listed on the Commonwealth Heritage List, and is significant for its history of human occupation and use, although such values cannot be altered by the temporary effects of stranded oil in the intertidal zone. The shipwreck Ann Millicent, sunk in 1888, was wrecked on the southern reef edge of Cartier Island. The shipwreck may be exposed to hydrocarbons when exposed at low tide, but there is no potential for the oil to affect the iron remains of this vessel. The oil will weather and be removed over subsequent tidal cycle. No impacts are expected but the consequence is conservatively assessed as minor to account for public perception, should oil exposure occur.	Minor (1)	Given the low likelihood of a LOWC occurring with preventative control measures in place, and the limited potential for exposure and impacts to heritage values, the likelihood of impacts occurring is unlikely.	Unlikely (B)	Low (1B)
Commercial Fisheries • Commonwealth-Managed • State/Territory-Managed	The values and sensitivities associated with commercial fisheries (seafood quality and employment) could be impacted due to the presence of entrained, dissolved and surface hydrocarbons and associated exclusion or avoidance by fishing vessels during the response, which may impede access to fishing areas for a short to medium term, and nets and lines	Serious (4)	Given the low likelihood of a LOWC occurring with preventative	Unlikely (B)	Medium (4B)

	could become oiled (ITOPF 2011). Fisheries are likely to experience loss of financial revenue in the unlikely event of a LOWC. Commercial fisheries that transect the EMBA primarily include fishing grounds of significance for the Northern Demersal Scalefish Fishery, although the Mackerel Managed Fishery and other coastal fisheries may also be effected given perceptions of surface oil down to 0.5 g/m^2, which may be extensive. Commercially targeted fish stocks are not expected to experience a significant decline from the spill. Assessment of the potential impacts to fish provided above indicates that impacts to fish are mainly expected to be sub-lethal. Assessment of the potential impacts to plankton communities (including fish eggs and larvae) provided above indicates that impacts are expected to be temporary and recoverable, without serious consequence to fish stocks, particularly compared with significantly larger losses through predation and other natural processes. It is acknowledged, however, that similar to the studies undertaken during the Montara Environmental Monitoring Program (Gagnon and Rawson 2012), commercially targeted fish species may show evidence of exposure to hydrocarbons. Fisheries are therefore likely to be impacted by loss of financial revenue during a spill and potentially for a period after the spill has ceased due to industry or public concerns about tainting of fish by hydrocarbons. The consequence of potential exclusion from an extensive area and loss of some revenue to fisheries over a period of weeks or months is therefore considered to be serious.		control measures in place, the likelihood of impacts occurring is unlikely.		
Traditional & Subsistence Fisheries	The MOU, within the Australian Fishing Zone encompasses Scott Reef and associated reefs, including Seringapatam Reef, Browse Island, Ashmore Reef, Cartier Island and various banks within the EMBA. These areas are predicted through stochastic modelling to be reached by a surface, entrained and dissolved hydrocarbons Under the MOU, Indonesian and Timorese fishermen are legally permitted to harvest marine products using traditional methods. The peak fishing season is between August and October with fishers departing the region at the onset of the northwest monsoon season. Therefore, traditional fishing could be affected by impacts to fish and benthic habitats (discussed in the above subsections).	Serious (4)	Given the low likelihood of a LOWC occurring with preventative control measures in place, the likelihood of impacts	Unlikely (B)	Medium (4B)

	The consequence of traditional fishers being excluded from the area or having their vessels and gear fouled is considered to be serious.		occurring is unlikely.		
Tourism & Recreation	Most recreational and tourism activities in the region occur predominantly in WA State and NT waters. Occasional charter tours do however visit locations in the region such as Ashmore Reef and Browse Island for the purposes of bird watching tours and other wildlife encounters. Although infrequent, disruption to such tours, which can be scheduled many months in advance, would result in loss of income for the tour operators. Tourism may also be affected along the coastlines of the NT and in Indonesia due to visible oil along shorelines, which can affect the area aesthetically and limit access to tourism and recreational amenity. The perception of impacts from oiled shoreline or shoreline response activities at amenity beaches could also affect local tourism and businesses. The consequence is considered to be significant.	Significant (3)	Given the low likelihood of a LOWC occurring with preventative control measures in place, the likelihood of impacts occurring is unlikely.	Unlikely (B)	Medium (3B)
Petroleum Exploration & Production.	There are a number of existing and planned petroleum exploration and production activities within and surrounding the EADA. During a hydrocarbon spill a surface slick has the potential to oil and coat petroleum exploration and drilling equipment, although impacts will primarily be limited to exclusion or temporary cessation of operations at some facilities in areas of high exposure, although noting that these exposures primarily include PTTEP AA operating assets (i.e. Montara). The consequence of such impacts is considered to be moderate.	Moderate (2)	Given the low likelihood of a LOWC occurring with preventative control measures in place, the likelihood of impacts occurring is unlikely.	Unlikely (B)	Low (1B)
Ports & Commercial Shipping	International shipping has the potential to be disrupted by any response efforts to combat surface slicks resulting from a well blow out. Shipping in and around the EADA is sparse with the nearest major shipping route being approximately 335 km west. Thus, a low level of commercial shipping activity is expected. In the event of a hydrocarbon spill, surface slicks have the potential to oil and coat vessel hulls. Implementing an exclusion zone during the response operation may alter routes for some vessel, however the consequence of this is considered to be minor.	Minor (1)	Given the low likelihood of a LOWC occurring with preventative control measures in place, the likelihood of	Unlikely (B)	Low (1B)

			impacts occurring is unlikely.		
Defence	Customs Coastwatch, Navy and Customs vessels may occasionally operate within the EMBA and have the potential to be disrupted by response efforts to combat surface slicks resulting from a well blow out. Implementing an exclusion zone during the response operation may impede access to a defined area. This is considered to be minor.	Minor (1)	Given the low likelihood of a LOWC occurring with preventative control measures in place, the likelihood of impacts occurring is unlikely.	Unlikely (B)	Low (1B)

Summary of Control Measures, ALARP and Acceptability

The decision context for impacts and risks associated with a worst case hydrocarbon spill (loss of well control) is 'Type B' as defined in Section 5. As such, the demonstration of ALARP is based on assessment against industry good practice and an engineering risk assessment to further evaluate a range of control measure options.

The following good practice controls will be adopted to manage potential environmental impacts and risks to ALARP and acceptable levels:

- A 500 m Petroleum Safety Zone will be established around the MODU during the drilling activity in accordance with Section 6.6 of the OPGGSA.
- PTTEP AA will have an in force (NOPSEMA accepted) Well Operations Management Plan (WOMP) in place during the EADP.
- A Blowout Contingency Plan (BCP) will be in place for the duration of the EADP. PTTEP AA will maintain capacity to implement the BCP as required in the event of a LOWC.
- In the event of an hydrocarbon spill to the marine environment during the EADP, the NOPSEMA accepted OPEP will be implemented. The following response measures were assessed as part of the engineering risk assessment are were determined to be reasonably practicable and are addressed in the OPEP:
  - Source Control – Subsea First Response Toolkit (SFRT)
  - Subsea Dispersant Injection (SSDI)
  - Source Control - Drilling a Relief Well
  - Source Control - Subsea Capping
  - Monitor & Evaluate
  - Chemical Dispersant Application

- In-Situ Burning
- Containment & Recovery
- Protection & Deflection
- Shoreline Clean-Up
- Oiled Wildlife Response
- Oily Waste Management

- In the event of a level 2/3 hydrocarbon spill to the marine environment, PTTEP AA will implement the NOPSEMA accepted Timor Sea Operational and Scientific Monitoring Program (OSMP).
- PTTEP AA Internal Requirements:
  - PTTEP AA Drilling Management System - Well Integrity Manual
  - PTTEP AA Crisis and Emergency Management Plan (CEMP)

ALARP and Acceptability

As described above, the demonstration of ALARP for a 'Type B' decision context is based on assessment against industry good practice and analysis of alternate and/or additional control measures through an engineering risk assessment. The adoption of 'Good Practice' measures and the additional control measures identified through the engineering risk assessment above provide for multiple layers of engineering and administrative controls to manage potential environmental impacts and risks to ALARP. All acceptability criteria have been met and the potential environmental risks and impacts are determined to be acceptable.

6.14.4 R14.2 – Vessel Fuel Tank Rupture – Marine Diesel Spill (maximum 250 m^3)

Assessment of Nature and Scale of Impacts and Risks

As outlined above, modelling of a 250 m^3 diesel spill scenario predicts that oil would not persist on the surface for extended periods. Surface hydrocarbons above the ecological threshold for impact are predicted to remain within the immediate vicinity of the release location (15 km). No sensitive receptor locations were exposed above the ecological exposure thresholds for surface or shoreline hydrocarbons. Given the modelled location at the Montara field is located in closer proximity to the sensitive receptor locations of Ashmore Reef and Cartier Island, it is expected that a similar release in the open waters of the EADA will also not contact such locations. No MDO is predicted to be entrained or dissolved in the water column. No shoreline contact from this spill scenario is predicted.

The potential impacts associated with the accidental release of diesel fuel to surface waters are:

- Potential deterioration in water quality within the vicinity of the support vessels resulting in behavioural change in marine species;
- Potential toxic effects to marine fauna
- Localised avoidance of waters by fishing vessels due to the presence of visible hydrocarbons on the sea surface.

The potential exposure of marine species to diesel fuel is:

- within the EADA in Commonwealth waters;
- Based upon AMSA guidance (2013) up to 250m3 of diesel; and
- For approximately 24-48 hours.

Given a chemical spill scenario may occur at any time during the year, all seasonal conditions have been evaluated.

As part of the stakeholder consultation program, consultation with relevant stakeholders was conducted. No objections or claims have been received by PTTEP AA in relation to the management controls proposed by PTTEP AA for potential chemical spills.

Detailed Environmental Impact Assessment

Identified Value or Sensitivity Potentially Exposed to Impact	Potential Severity / Consequence Discussion	Rating	Likelihood of Impact Occurrence	Rating	Risk
Marine Fauna • Marine mammals • Dugongs • Marine reptiles • Whale sharks • Sharks, sawfish and rays	Impacts to transient marine fauna within the vicinity of the spill include the potential to impact air breathing animals such as cetaceans and turtles due to of inhalation of vapours if they surface within in the fresh diesel slick or accidental ingestion at the surface. The interaction of marine fauna with surface hydrocarbons above the ecological threshold for impact is expected to be	Moderate (2)	Given the low shipping traffic in and around the EADA and the size and speed of the support vessels that will be involved in the EADP, it is highly unlikely that a fuel tank rupture will occur during the activity and therefore the	Unlikely (B)	Low (2B)

• Other fish species	limited due to the localised area of the spill and because weathering will limit the duration of exposure resulting in only short-term and/or temporary effects (primarily within the first 24-48 hours of the release). Spilled MDO is predicted to extend up to 15 km on the surface above the 100 g/m2 threshold that may illicit lethal and sub-lethal effects in marine fauna that may breathe air or forage at the surface. No BIAs are expected to be contacted, but it is possible that individual transient fauna may be affected. The consequence is assessed to be moderate.		described consequence is unlikely.		
Avifauna	Seabirds have also been identified as at risk if they contact the diesel slick by oiling their feathers leading to loss of buoyancy and the potential for hypothermia. Should seabirds, contact the diesel slick there may be a localised and lethal effect on a relatively small number of individuals. No seabird foraging or breeding BIAs or rookeries are expected to be exposed. The consequence is assessed to be moderate.	Moderate (2)	Given the low shipping traffic in and around the EADA and the size and speed of the support vessels that will be involved in the EADP, it is highly unlikely that a fuel tank rupture will occur during the activity and therefore the described consequence is unlikely.	Unlikely (B)	Low (2B)

Commercial Fisheries	A number of commercial fisheries are known to overlap the EADA and wider EMBA. Where active effort is reported to occur, these fisheries have the potential to be affected by surface hydrocarbons in the event of a diesel spill. Any perceived impacts to fisheries from visible oil will be limited to approximately 100 km of the release location and will be short term. Impacts will be limited to short term exclusion from the area of the slick. The consequence is conservatively assessed as moderate.	Moderate (2)	Given the low shipping traffic in and around the EADA and the size and speed of the support vessels that will be involved in the EADP, it is highly unlikely that a fuel tank rupture will occur during the activity and therefore the described consequence is unlikely.	Unlikely (B)	Low (2B)

Summary of Control Measures, ALARP and Acceptability

The decision context for impacts and risks associated with the accidental release of diesel from a project support vessel is 'Type A' as defined in Section 5. As such, the demonstration of ALARP is based on assessment against industry good practice.

The following controls will be adopted to manage potential environmental impacts and risks to ALARP and acceptable levels:

- A 500 m Petroleum Safety Zone will be established around the MODU during the drilling activity in accordance with Section 6.6 of the OPGGSA.
- The MODU and the associated support vessels shall have navigational aids and communications systems as required by Marine Order 30 (Prevention of Collisions), Marine Order 27 (Radio Equipment) and Marine Order 21 (Safety of Navigation and Emergency procedures),
  - Required navigation lights and signals shall be displayed at all times on the MODU and support vessels.
  - Standard marine communications systems will be provided on the MODU and support vessels.
  - Maintenance of navigation and communications equipment
- All MODUs & vessels engaged by PTTEP AA will have a Shipboard Oil Pollution Emergency Plan (SOPEP) in alignment with MARPOL 73/78 Annex 1 (as administered by Marine Order 91).
- In the event of an hydrocarbon spill to the marine environment during the EADP, the NOPSEMA accepted OPEP will be implemented.
- In the event of a level 2/3 hydrocarbon spill to the marine environment, PTTEP AA will implement the NOPSEMA accepted Timor Sea Operational and Scientific Monitoring Program (OSMP).
- PTTEP AA Internal Requirements:
  - An AIS system is required to be functioning and in operation at all times on the support vessels and MODU.

ALARP and Acceptability

Given the decision context is 'Type A' the adoption of 'Good Practice' measures above provides for multiple layers of engineering and administrative controls to manage potential environmental impacts and risks to ALARP. All acceptability criteria have been met and the potential environmental risks and impacts are determined to be acceptable.

6.14.5 R14.3 – Refuelling Incident Resulting in Loss of Marine Diesel – (maximum 5 m^3)

Assessment of Nature and Scale of Impacts and Risks
There is a potential for small spills (<5 m^3) of diesel during refuelling operations. The main causes for such spills are hose breaks, coupling failures or overfilling which can be managed by regular inspection of hose integrity, limiting volumes of fuel held in the transfer hose and by the use of fail-safe valves to ensure rapid shutdown of fuel pumps The potential impact associated with this non-routine event is the localised and temporary reduction in water quality. As described above, diesel is a light, refined petroleum product and is expected to undergo rapid spreading and evaporation resulting in relatively rapid slick break-up. When spilled on water, most of the diesel will evaporate or naturally disperse within a few days or less. Given the small volume (5 m^3) involved with a spill during refuelling operations, the associated impacts and risks are likely to be confined to a small area and will be of short-duration. They will be considerably less than those described above for a vessel fuel tank rupture. Also, given the rapid rates of evaporation, the resultant surface slick for a 5 m^3 diesel spill is not expected to be limited to the offshore waters of the EADA and not reach shoreline or other sensitive receptor locations at concentrations that will elicit toxic effects to marine biota. Impacts to transient marine fauna within the vicinity of the spill include the potential to impact air breathing animals such as cetaceans and turtles as risk of inhalation impacts if they surface in the diesel slick. Seabirds are also at risk if they contact the diesel slick by oiling their feathers leading to loss of buoyancy and the potential for hypothermia. A detailed impact assessment provided for a large diesel spill of 250m^3 (as detailed above in *Section 6.14.4*) has been used as a worst-case proxy for the risk assessment of a 5m^3 loss of hydrocarbons due to a refuelling incident. The actual extent of sea surface exposures is likely to be an order of magnitude less than the 250 m^3 vessel fuel tank rupture scenario, although the potential to impact a small number of individual marine fauna and avifauna, and the localised and short term exclusion of fishing vessels is conservatively assumed to be the same. The potential impacts associated with the accidental release of diesel fuel to surface waters are: • Potential deterioration in water quality within the vicinity of the support vessels resulting in behavioural change in marine species; • Potential toxic effects to marine fauna • Localised avoidance of waters by fishing vessels due to the presence of visible hydrocarbons on the sea surface. The potential spill volume and exposure to an accidental release of diesel during refuelling has been calculated as follows: • 2.5 minutes to shutdown fuel transfer (30 seconds to realise the spill, 30 seconds to report the spill, 90 seconds to shut in the fuel transfer); • Transfer rate (100 m^3 per hour) multiplied by 2.5 minutes results in 4.17 m^3 of spilt diesel plus the transfer hose volume of 0.45 m^3; and • Total worst case spill volume of 4.62 m^3. As part of the stakeholder consultation program, consultation with relevant stakeholders was conducted. Feedback received indicated no objections or claims were made relating to hydrocarbon spills. The activities will comply with industry standards, best practice and relevant refuelling guidelines. Several conservation management plans identify oil spills as a key threatening process, through both direct/acute impacts of oil, as well as indirect impacts through habitat degradation (which is a potential consequence of an oil spill). The prevention of spills and implementation of refuelling guidelines demonstrates alignment with the various conservation management plans.

Summary of Control Measures, ALARP and Acceptability
The decision context for impacts and risks associated with the accidental release of diesel during refueling is 'Type A' as defined in Section 5. As such, the demonstration of ALARP is based on assessment against industry good practice. The following controls will be adopted to manage potential environmental impacts and risks to ALARP and acceptable levels: • All MODUs & vessels engaged by PTTEP AA will have a Shipboard Oil Pollution Emergency Plan (SOPEP) in alignment with MARPOL 73/78 Annex 1 (as administered by Marine Order 91). • PTTEP AA Internal Requirements: - All refuelling of the MODU with MDO from a support vessel will be carried out in accordance with refuelling and bunkering procedures under the MODU Operator Permit to Work (PTW) System which will require: ▪ Constant surveillance, communication protocols and daylight refuelling. ▪ Dry-break couplings and non-return valves on fuel transfer hoses that are to be maintained regularly. **ALARP and Acceptability** Given the decision context is 'Type A' the adoption of 'Good Practice' measures above provides for multiple layers of engineering and administrative controls to manage potential environmental impacts and risks to ALARP. All acceptability criteria have been met and the potential environmental risks and impacts are determined to be acceptable.

6.15 ER1 NEARSHORE AND SHORELINE DISTURBANCE DURING SPILL RESPONSE

Assessment of Nature and Scale of Impacts and Risks

Hydrocarbon spill trajectory modelling indicates the potential for shoreline contact during an oil pollution emergency incident during the EADP.

Accessing shorelines will have associated ecological constraints, especially if accessing uninhabited, sensitive coastal habitats. Environmentally intrusive or potentially damaging activity should only be considered if there is a positive net environmental benefit. If significant shoreline oiling occurs, removal of vegetation may be required. Habitat removal may have significant impacts on the function of coastal ecosystems.

Physical clean-up methods can alter the profile of beaches and lead to their erosion following the completion of clean-up activities, particularly if heavy machinery is used. The use of equipment, machinery and personnel in some coastal environments, e.g. mangroves and mudflats, can cause more damage than the hydrocarbon itself, thereby reducing the recovery and net environmental benefit of that clean-up approach.

The potential impact pathways associated with protection and deflection, containment and recovery, shoreline clean-up and oiled wildlife response operations are:

- Physical disturbance of habitat from the deployment and collection of spill booms;
- Physical trampling of habitat from response personnel movements;
- Physical disturbance of heritage places from personnel and equipment movements;
- Physical disturbance of habitat from landing vessels;
- Physical disturbance of marine fauna in near-shore environments from vessel movements;
- Physical clearing of vegetation;
- Mechanical tillering of shorelines;
- Alteration of beach profiles can lead to erosion;
- Physical disturbance and contamination from waste management; and
- Social and economic disruption to public and other industries.

The potential exposure to nearshore and shoreline habitats is a function of the total volume and oil stranded on shorelines or in nearshore environments and the effort required to respond and remediate affected areas, however, this disturbance may occur at any time of year. The table below provides an overview of potential shoreline contact, for each of the seasons modelled, above 10 g/m^2 for a full LOWC scenario from the Orchid 1 well. The data was calculated from stochastic modelling of 100 single spill trajectories per modelling period. The modelling periods are summer (November to March), winter, (April to August) and transitional (September and October). Stochastic modelling presents the cumulative effects of all 100 single spill trajectories per season, and is therefore useful in providing a holistic determination of the outer boundaries of the EMBA under all seasonal conditions.

Shoreline statistics	Summer	Winter	Transitional
Probability of contact to any shoreline (%)	93	95	95

Absolute minimum time for visible oil to shore (hours)	262	149	210
Maximum volume of hydrocarbons ashore (m^3)	492	147	261
Average volume of hydrocarbons ashore (m^3)	101	41	67
Maximum length of the shoreline at 10 g/m^2 (km)	74	62	59
Average shoreline length (km) at 10 g/m^2 (km)	33	23	24
Maximum length of the shoreline at 100 g/m^2 (km)	58	42	47
Average shoreline length (km) at 100 g/m^2	22	14	17
Maximum length of the shoreline at 1,000 g/m^2	12	5	7
Average shoreline length (km) at 1,000 g/m^2 (km)	5	1	3

Quantitative Oil Spill Modelling for Orchid 1 Well, RPS APASA, February 2018.

Deterministic spill modelling provides the results from worst-case spill trajectories. To provide an indication of the possible extent of shoreline and nearshore environment that may be impacted by response operations, the results for both the 'largest volume ashore' and the 'longest length of shoreline contacted at or above 100 g/m2' (the actionable degree of shoreline oil) are summarised below:

Largest volume ashore:

- A total of 500 m3 of oil was stranded on the shoreline, 491 m^3 at Ashmore Reef, 9 m3 at Hibernia Reef;
- Shoreline contact above 100 g/m^2 occurred at Ashmore Reef 492 hours (20.5 days) following the initial release, and at Hibernia Reef 684 hours (28.5 days) following the initial release.

The longest length of shoreline contacted at or above 100 g/m^2 (actionable shoreline oil):

- A total of 60 km of shoreline was predicted to be contacted above the actionable threshold of 100 g/m^2, 50 km at Ashmore Reef and 10 km at Hibernia Reef;
- Shoreline contact above 100 g/m^2 occurred at Ashmore Reef 433 hours (18 days) following the initial release, and at Hibernia Reef 459 hours (19 days) following the initial release.

Whilst the maximum length of shoreline that could theoretically be subject to shoreline and nearshore response operations is 60 km, the actual length of coastline that could be subject to response operations would likely be significantly less due to operational limitations in remote coastal areas such as access, shoreline sensitivity, and the safety of response personnel. Shoreline and nearshore environments would only be subject to the impact of response operations following a NEBA and site-specific risk assessment.

As potential response strategies would be deployed only in the event of an emergency oil pollution event impacting nearshore and shoreline habitats, and the response would be undertaken to remediate affected areas, there would be no cumulative impacts from these activities.

As part of the stakeholder consultation program, consultation with relevant stakeholders was conducted. There have been no objections or claims from potentially affected relevant stakeholders in relation to the disturbance of the natural environment when responding to a spill.

Detailed Environmental Impact Assessment

Identified Value or Sensitivity Potentially Exposed to Aspect	Potential Severity / Consequence Discussion	Rating	Likelihood of Impact Occurrence	Rating	Risk
Marine Fauna	There is potential for interaction with marine fauna with response vessels, especially in near-shore environments. However, vessel strikes of marine fauna would be limited to individuals rather than communities, and the overall response would be short-term.	Moderate (2)	With the continued application of EPBC guidelines relating to vessel and marine fauna interactions, it is considered unlikely that marine fauna would be adversely impacted by the implementation of response strategies.	Unlikely (B)	Low (2B)
Avifauna	Disturbance of nesting (protected) avifauna is related to the disturbance to shoreline habitats detailed below. Avifauna are particularly susceptible to oiling, therefore, the application of an oiled wildlife response will impact avifauna and nesting / breeding habitat. Whilst OWR is aimed at reducing the consequence of oiling, it is acknowledged that some unintended adverse impact may occur to avifauna during the response.	Significant (3)	With the application of detailed oiled wildlife response management in alignment with industry 'Good Practice' the likelihood of adverse impacts to avifauna is greatly reduced.	Unlikely (B)	Medium (3B)

Shoreline Habitats	There are no shoreline habitats within the EADA. The extent of physical disturbance to shoreline habitats from people and equipment mobilisation and clean-up operations is largely dependent on the extent of shoreline oiling. It is acknowledged that rookeries for listed avifauna species, and nesting marine reptiles are present within the EMBA. Given the managed and targeted nature of potential clean-up operations by trained responders, it is reasonable to expect that impacts to shoreline habitats may be short-term, but could impact multiple listed species.	Significant (3)	With the application of the NEBA process (as described in the OPEP), and targeted response operations undertaken in a managed approach, it is unlikely that shoreline habitats are adversely affected.	Unlikely (B)	Medium (3B)
Protected Areas	As per the assessment for shoreline habitats above.	Significant (3)	As per the assessment of shoreline habitats above	Unlikely (B)	Medium (3B)
Heritage Places	It is acknowledged that both indigenous and non-indigenous heritage places are within the EMBA, including the wreck of the Ann Millicent on the intertidal reefs of Cartier Island, and Indonesian artefacts and grave sites on islands at Ashmore Reef. Disturbance or damage to a heritage place is considered serious.	Serious (4)	With the application of the NEBA process as detailed within the project OPEP, potentially affected stakeholder will be engaged prior to the implementation of response strategies, these would include both indigenous and regulatory groups to consider heritage places in the incident planning cycle. As such, it is considered unlikely that heritage places would be adversely impacted during response operations.	Unlikely (B)	Medium (4B)

Summary of Control Measures, ALARP and Acceptability

The decision context for impacts and risks associated with nearshore and shoreline response strategies is ‘Type B’ as defined in Section 5. As such, the demonstration of ALARP is based on assessment against industry good practice and an engineering risk assessment to further evaluate a range of control measure options.

The following good practice controls will be adopted to manage potential environmental impacts and risks to ALARP and acceptable levels:

- Implementation of the NOPSEMA accepted project OPEP meets the ‘Approved Action’ as determined by the Australian Commonwealth Director of National Parks.
- PTTEP AA will align with all relevant controls as detailed within EPBC Act 1999 Management Plans whilst implementing a response.

The following additional control measures evaluated as part of the engineering risk assessment were determined to be reasonably practicable and have been incorporated into the OPEP:

- Correct equipment and personnel deployed to key shorelines areas for clean-up in accordance with PTTEP AA Kimberley Shoreline Concept of Operations'.
- Sensitive receptors protected from shoreline contact through deployment of booms, skimmers and other equipment identified through NEBA.
- Induction and training of clean-up team will ensure disturbance to sensitive areas is minimised by instructing the spill response teams to avoid disruption of environmental sensitivities as far as possible by restricting vehicle and foot traffic to and from spill response sites.
- Operational monitoring undertaken to identify sensitivities at risk and inform NEBA.

ALARP and Acceptability

As described above, the demonstration of ALARP for a 'Type B' decision context is based on assessment against industry good practice and analysis of alternate and/or additional control measures through an engineering risk assessment. The adoption of 'Good Practice' measures and the additional control measures identified through the engineering risk assessment above provide for multiple layers of engineering and administrative controls to manage potential environmental impacts and risks to ALARP. All acceptability criteria have been met and the potential environmental risks and impacts are determined to be acceptable.

6.16 ER2 DISCHARGE OF CHEMICAL DISPERSANTS DURING SPILL RESPONSE

Assessment of Nature and Scale of Impacts and Risks
Dispersant is a potential response strategy in the event of a Level 3 spill with the aim to minimise the volume of the spill in as short duration as possible that could impact sensitive locations. Aerial and vessel-based application of dispersants is seen as a viable response strategy under the National Plan, particularly for offshore waters. Dispersants minimise the volume of hydrocarbons that could impact sensitive shorelines in the region. Dispersants will only be applied in situations where there is predicted to be a net environmental benefit as determined by Net Environmental Benefit Analysis (NEBA). The conceptual NEBA as presented within the OPEP has been developed for both the implementation of in-field dispersant efficacy testing, and the potential extended application of dispersant during and emergency condition. In-field efficacy testing is used to inform the suitability of dispersant types and optimal application rates, with this information detailed incident action plans (IAPs) can be developed and revised as needed during the response. Dispersants may be effective for use on a spill of fresh Group II light crude or other relatively heavy hydrocarbon fluids. They are not proposed for use on weathered and naturally dispersed oil or on Group I light crude, condensate or MDO. Dispersants applied to oil spills have the potential to cause toxicological and physical threat to populations of protected species within sensitive and protected marine environments. However, dispersants selected for a response will be those which have been tested and approved by AMSA for efficacy and toxicity, and are listed on the Oil Spill Control Agent (OSCA) Register. The toxicity testing requirements for AMSA approval detailed in the AMSA Protocol for the Register of Oil Spill Control Agents (AMSA, December 2012). These requirements have been reviewed by PTTEP AA and are considered appropriate for the selection of dispersants for this activity to ensure the impacts to the environment are acceptable and ALARP. This is due to the OSCA register ensuring high acute toxicity (4-day LC50 less than 10 ppm) (NRC, 1989) dispersants are not utilised and based on the available literature, dilution and dispersion will occur once applied that will significantly reduce the concentration to levels considered unlikely to have significant effects on marine organisms or habitats. Sufficient stocks of dispersants meeting these criteria are currently available for use in Australia in the event of a well blowout associated with this activity and are on the OSCA Register. Dispersed oil fate modelling by APASA (2010 for the Montara well blowout indicates that the amount of oil impacting the shorelines at sensitive locations containing bird and turtle rookeries, mangroves and intertidal coral and seagrass habitats can be reduced significantly and that no additional impacts on sensitivities including shoals in the region from entrained oil or dissolved aromatics would likely result. This supports the findings of available literature. Equally, selection of dispersant and proper application is expected to minimise the volume of oil contacting sensitive locations from a loss of well control during the EADP. Dispersant application will also reduce the volume of hydrocarbon to be contained and recovered and consequently reduce the magnitude of waste that will be produced. Through effective application of dispersant, the aim is to prevent any hydrocarbons from reaching the shoreline. This approach is considered ALARP if undertaken with the controls for both surface and subsurface application listed above as it will provide a greater net environmental benefit compared to if no dispersant is applied to the spill. The aim of the response strategies for a spill from the EADP is to prevent oil reaching shorelines so that no habitat is required to be disturbed. As part of the stakeholder consultation program, consultation with relevant stakeholders was conducted. There were no objections or claims made by relevant person(s) in relation to the application of chemical dispersants during an oil pollution emergency incident.

Detailed Environmental Impact Assessment					
Identified Value or Sensitivity Potentially Exposed to Aspect	**Potential Severity / Consequence Discussion**	**Rating**	**Likelihood of Impact Occurrence**	**Rating**	**Risk**
Marine Fauna	Impacts to marine fauna may extend outside the area of dispersant application and may create noticeable but reversible changes to populations or communities.	Moderate (2)	Given the exclusion zones established for dispersant application, and the monitoring of application volumes to ensure efficiency and the open ocean environment surrounding the EADA, it is considered unlikely that there would be adverse impacts to marine fauna.	Unlikely (B)	Low (2B)
Benthic Communities	Impacts to benthic communities may be extend outside the area of dispersant application and may create noticeable but reversible changes to populations or communities.	Moderate (2)	Given the exclusion zones established for dispersant application, it is considered unlikely that there would be adverse impacts to benthic communities.	Unlikely (B)	Low (2B)
Commercial Fisheries	Impacts to commercial fisheries may occur due to the increased volume of hydrocarbon mobilised into the water column and the application of the chemical dispersant. Impacts to small numbers of non-listed commercial species may occur outside the immediate vicinity of the dispersant application. These impacts may be short to medium term sub-lethal or lethal impacts to fish populations, but there would be no lasting impact to the viability of the fishery as a whole.	Moderate (2)	Given the exclusion zones established for dispersant application, the monitoring of application volumes to ensure efficiency and the open ocean environment surrounding the Montara facility, it is considered unlikely that there would be adverse impacts to commercial fisheries.	Unlikely (B)	Low (2B)

Summary of Control Measures, ALARP and Acceptability

The decision context for impacts and risks associated with introduction of chemical dispersants to the marine environment is ‘Type B’ as defined in Section 5. As such, the demonstration of ALARP is based on assessment against industry good practice and an engineering risk assessment to further evaluate a range of control measure options.

The following good practice controls will be adopted to manage potential environmental impacts and risks to ALARP and acceptable levels:

- NOPSEMA accepted project OPEP, PTTEP AA will meet the regulatory requirements of the OPGGS(E) Regulations.

- NOPSEMA Oil Pollution Risk Management Information Paper (IP1488 Rev 1, February 2017).
- Undertake a Net Environmental Benefit Analysis Assessment including Oil Spill Trajectory Modelling.
- Use of dispersants on AMSA OSRA Register.
- Ongoing stakeholder engagement.

The following additional control measures evaluated as part of the engineering risk assessment were determined to be reasonably practicable and have been incorporated into the OPEP:

- Dispersant will not be applied within the area defined as the 'Red Zone' (refer to project OPEP):
  - within waters less than 20 m deep;
  - within 3 nm of shorelines, State and Australian Marine Parks;
  - within waters with benthic habitats (corals, seagrass) or coral and fishing spawning areas; and
  - within 1 km of shoals.
- Application of dispersant via SSDI.
- Volumes of dispersant will be monitored.
- Dispersant will only be applied in the area defined as the 'Amber Zone' (refer to project OPEP) where NEBA is undertaken to determine whether there will be a net environmental benefit of dispersing the slick.
- Monitor and evaluate the effectiveness of a dispersant response technique.

ALARP and Acceptability

As described above, the demonstration of ALARP for a 'Type B' decision context is based on assessment against industry good practice and analysis of alternate and/or additional control measures through an engineering risk assessment. The adoption of 'Good Practice' measures and the additional control measures identified through the engineering risk assessment above provide for multiple layers of engineering and administrative controls to manage potential environmental impacts and risks to ALARP. All acceptability criteria have been met and the potential environmental risks and impacts are determined to be acceptable

6.17 ER3 ATMOSPHERIC EMISSIONS: IN SITU BURNING DURING SPILL RESPONSE

Assessment of Nature and Scale of Impacts and Risks

The use of in-situ burning (ISB) as a response strategy is expected to be limited to within the first 24 hours for 'instantaneous' spills, after which time the EADA crude is likely to become unsuitable for burning. Given the mobilisation times for ISB equipment ISB is not expected to be used as a response strategy for these types of spills. However, ISB may be a suitable response option for a loss of well control scenario with an ongoing release of fresh crude. An assessment of potential impacts from smoke, fire and residue from in-situ burning is considered in order to maintain this response as a possible option.

There is the potential for environmental impacts from the flames and heat from the burn, the emissions generated by the fire and the residual material left on the surface after the fire is extinguished. Based on many detailed ecological risk evaluations previously conducted for numerous scenarios, the preferred decision would be to burn an oil spill, rather than not to burn it (Buist et al., 1994). ISB has the potential to greatly reduce the ecological effect of oil impact on the shoreline, which is a more sensitive marine ecosystem. In addition, shoreline clean-up costs are on the order of 10 times more expensive than at-sea recovery operations for the same volume of oil.

The black smoke plume generated by ISB is likely to be highly visible from several kilometres away. Despite public concern, the likely environmental impacts of the smoke are low. Although the plume contains combustion gases (mainly CO_2), carbon particles, and some unburned hydrocarbons (including small concentrations of polyaromatic hydrocarbons (PAHs)), the concentrations of these gases and particles have been shown to quickly dilute to levels below environmental concern. The key component of the smoke plume is the particulate matter. An in-situ fire will yield about 5 to 15 percent of the mass of the oil burned as smoke particles. Case studies of accidental fires in major tanker spills have resulted in little or no lasting environmental impact from the smoke plume. Even the massive, long-lasting Kuwait oil fires of 1991 did not appear to have caused any lasting environmental impact (US Coast Guard In-Situ Burn Operations Manual, 2003).

The radiative effect of the Kuwait oil fires were measured 100 km downwind of the fires and found the smoke plume absorbed about 78% of the solar radiation and that about 8% was transmitted to the land surface.

Based on limited experience, birds and mammals are more capable of surviving the temporary smoke plume than they are an oil slick. Birds flying in a smoke plume could become disoriented and suffer some toxic effects; however, this risk is believed to be minimal when compared to oil coating and ingestion. The effects of ISB on marine mammals have yet to be observed; however, the effects of smoke on mammals are likely to be minimal, compared to the effects of contact with unburned oil residues (US Coast Guard In-Situ Burn Operations Manual, 2003).

While heat from the flames is radiated downward as well as outward, much of the heat that is radiated downward is absorbed by the oil slick. Most of this energy vaporizes the hydrocarbons for further burning, but a portion of the heat is transmitted to the underlying water. In a towed boom or in a stationary boom situation in current, the water under the slick does not remain in contact with the slick long enough to be heated appreciably; however, under static conditions (the slick does not move relative to the underlying water), the upper few centimetres of the underlying water is heated in the latter stages of the burn. In a prolonged static burn, the upper few millimetres of the water column can be heated to near boiling temperatures, but the water several centimetres below the slick is normally heated only a few degrees for burns lasting 1 to 2 hours. The Alaska RRT recognizes that this heating can eliminate the small life forms that exist in the surface layer of water, but they concluded that the areas involved are small and that the lost biota will quickly be replaced, with negligible overall impact (US Coast Guard In-Situ Burn Operations Manual, 2003).

If greater amounts of oil are vaporized than can be burned, more residue (or soot) is produced as a result of incomplete combustion and residue formation is an issue that has been studied by several scientists over many years (Fingas, 2011)

The residue from an efficient burn of crude oil on water is generally environmentally inert although the potential environmental impacts of burn residues are related to their physical properties, chemical constituents and tendency to float or submerge. Burn residues may submerge only after cooling. Based on modelling the heat transfer, it is likely that the temperature of a 1cm thick burn residue will reach that of ambient water within approximately 20 to 30 minutes. Even for thicker slicks, it is likely that this cooling would occur within approximately 2 hours (API, 2002).

Physical properties of burn residues depend on burn efficiency and oil type. Efficient burns of heavier crudes generate brittle, solid residues (like peanut brittle). Residues from efficient burns of other crudes are described as semi-solid (like cold roofing tar). Inefficient burns generate mixtures of unburned oil, burned residues and soot that are sticky, taffy-like or liquid. Burns of light, distilled fuels result in a residue that is similar to the original fuel but contains precipitated soot (US Coast Guard In-Situ Burn Operations Manual, 2003). Based on the above, Montara crude oil is Group 3 oil with relatively high wax content and can be considered likely generate a more solid residue with less likelihood of rapid submersion.

Chemical analyses of crude oil burn residues show relative enrichment in metals and the higher molecular weight PAHs, which have high chronic toxicity but are thought to have low bioavailability in the residue matrix. Bioassays with water from laboratory and field-generated burn residues of crude oil showed little or no acute toxicity to marine life (US Coast Guard In-Situ Burn Operations Manual, 2003).

The residue is largely unburned oil, with some lighter or more volatile products removed, oil subject to high heat and weathered, and heavier particles re-precipitated into the fire that may sink (Fingas, 2011).

The amount of soot produced is believed to be about 0.3% to 3% for crude oil fires and consist of agglomerations of spherical particles. Although consisting largely of carbon particles, soot particles contain a variety of absorbed and adsorbed chemicals and measurements of these components have been made and are evaluated based on Fingas (2011) as follows:

- PAHs – Crude oil burns result in polyaromatic hydrocarbons downwind of the fire but the concentration is often an order of magnitude less than the concentration of PAH's in the starting oil. There may be a slight increase in the concentration of multi-ringed PAH's in the residue however most (over 95%) are destroyed by the fire in an efficient combustion.
- VOCs – Volatile organic compounds are organic compounds that have high enough vapour pressure to be gaseous at normal temperatures. These are evaporated and released when oil is burned. The emission of these was measured at several test burns and found to be relatively low when compared to the evaporating slick and appear to be below human health levels of concern even very close to the fire and not considered to constitute a major environmental threat.
- Dioxins and Dibenzofurans – These are highly toxic compounds often produced by burning chlorine containing organic material but found at background levels at test fires indicating no production by crude fires.
- Carbonyls – Oil burns produce low amounts of partially oxidised material but found in oil fires in very low concentrations and not considered an environmental threat.

Any residues that float or become submerged could be ingested by fish, birds, mammals, and other organisms and may be a source for fouling of gills, feathers, fur, or baleen; however, these impacts would be expected to be much less severe than those manifested by exposure to a large, unconstrained oil spill (US Coast Guard In-Situ Burn Operations Manual, 2003). It considered that the potential effects of smothering at the Montara location from ISB residues are highly unlikely to be significant given the depth of water and absence of sensitive benthic habitats that may be contacted by localised residue.

There have been no concerns raised by relevant stakeholders in relation to the potential application of in-situ burning as an oil spill response strategy.

Detailed Environmental Impact Assessment					
Identified Value or Sensitivity Potentially Exposed to Impact	**Potential Severity / Consequence Discussion**	**Rating**	**Likelihood of Impact Occurrence**	**Rating**	**Risk**
Marine Fauna • Marine Mammals • Marine Reptiles • Whale Sharks	Marine fauna that intermittently surface such as cetaceans, turtles, sea snakes and whale sharks may be exposed directly to fire, higher water temperatures and residues within surface waters. The impact may be lethal to a small number of individuals within the vicinity of the burn location.	Significant (3)	Given the remote location of the EADA, burn areas limited to areas of suitable surface thickness of hydrocarbon and the transient habits of marine fauna enabling avoidance, it is considered unlikely that surfacing marine fauna would be adversely impacted.	Unlikely (B)	Medium (3B)
Marine Fauna • Sharks, Sawfish & Rays • Listed Fish Species	With residue and heat transfer limited to shallow water depths, the impact to pelagic fish species is expected to be negligible	Minor (1)	Adverse impacts to pelagic marine fauna is considered unlikely	Unlikely (B)	Low (1B)
Avifauna	Smoke from in-situ burning may impact avifauna within the vicinity or outside the vicinity of the burn dependent on atmospheric conditions. The impact nuisance to sub-lethal with a negligible change to a population with no lasting effect expected.	Moderate (2)	Given the remote location of the EADA, burn areas limited to areas of suitable surface thickness of hydrocarbon and the transient habits of avifauna enabling avoidance, it is considered unlikely that avifauna would be adversely impacted.	Unlikely (B)	Low (2B)

Summary of Control Measures, ALARP and Acceptability

The decision context for impacts and risks associated with in-situ burning of surface hydrocarbons is 'Type B' as defined in Section 5. As such, the demonstration of ALARP is based on assessment against industry good practice and an engineering risk assessment to further evaluate a range of control measure options.

The following good practice controls will be adopted to manage potential environmental impacts and risks to ALARP and acceptable levels:

- IEPECA - Controlled in-situ burning of spilled oil Good Practice Guidelines
  - Water Quality: Studies show that effects are negligible
  - Heating of water layers and surface soils: Water is a strong heat sink. Studies show that burns have negligible effects on surface waters or soil temperatures.
  - Effects on birds/animals: Habitat and season dependent, but can be accommodated by burn design, timing and hazing
- Measures below are derived from the US Coast Guard In-Situ Burn Operations Manual, 2003:

- Undertake a Net Environmental Benefit Analysis (NEBA) Assessment;
- Use of experienced Burn Team and equipment to ensure most efficient burning occurring to minimise residues;
- Burning as close to source as possible to optimise performance and avoid sensitive areas; and
- Burn exclusion zones to avoid impacts on sensitive areas including shoals.

The following additional control measures evaluated as part of the engineering risk assessment were determined to be reasonably practicable and have been incorporated into the OPEP:

- ISB excluded from the area defined as the Red zone (as defined in the project OPEP):
  - within waters less than 20 m deep;
  - within 3 nm of shorelines, State and Australian Marine Parks;
  - within waters with benthic habitats (corals, seagrass) or coral and fishing spawning areas; and
  - within 1 km of shoals.
- Trained personnel will be used for ISB operations.
- Operational procedures for commencing ISB such as undertaking observations for cetacean presence within 500 m exclusion zone around proposed burning operation.

ALARP and Acceptability

As described above, the demonstration of ALARP for a 'Type B' decision context is based on assessment against industry good practice and analysis of alternate and/or additional control measures through an engineering risk assessment. The adoption of 'Good Practice' measures and the additional control measures identified through the engineering risk assessment above provide for multiple layers of engineering and administrative controls to manage potential environmental impacts and risks to ALARP. All acceptability criteria have been met and the potential environmental risks and impacts are determined to be acceptable

6.18 ER4 OILED FAUNA DISPLACEMENT AND HANDLING DURING SPILL RESPONSE

Assessment of Nature and Scale of Impacts and Risks

In the event of an oil pollution emergency incident, wildlife response may be implemented.

Potential impacts to the environment (specifically fauna) may result from hazards associated with fauna displacement, interaction and handling, these include:

- Displacing fauna to prevent wildlife from becoming oiled using hazing deterrents such as:
  - visual techniques such as balloons, reflectors and flags;
  - auditory techniques such as loud noise, alarms;
  - sensory techniques such as the use of wildlife distress calls; and
  - pre-emptive capture aims at capturing animals before they have the opportunity to become oiled.

  Utilising hazing techniques to prevent wildlife from becoming oiled may impact fauna migratory route patterns, nesting, separate fauna within aggregations and corralling of fauna which may increase risk of predation and exposure to environmental conditions. These potential impacts are considered trivial compared to the potential oiling effects on fauna if wildlife were to get in contact with hydrocarbons ranging from irritation from inhalation of toxic vapours to death. As a result, implementing hazing techniques will result in a net environmental benefit provided hazing efforts do not inadvertently move animals into the oiled area or cause oiled animals to scatter.
- Collection of live oiled wildlife to treat in captivity:

  The collection and physical handling of live oiled wildlife has the potential to cause stress and suffering to the oiled animal. However, the removal of oiled wildlife will reduce the risk of the animal dying in the natural environment hence will reduce the impact on preying or scavenging animals that may be contaminated by the oiled carcass. Additionally, when a significant percentage of a population of a threatened or endangered species is oiled successful rehabilitation can make a difference to that species' survival. As a result, implementing the collection of oiled wildlife to treat in captivity will result in a net environmental benefit regardless of the oiled animal surviving (successful release back into nature) or being humanely euthanized (which removes the oiled carcass which is a hazard to preying or scavenging animals

Whilst the exact nature and extent of oiled wildlife would not be known until operational monitoring is implemented in the event of an oil pollution emergency, stochastic and deterministic spill modelling undertaken for a WCD provides a degree of certainty around the extent and location of the environment that may be affected at a given oiling threshold, therefore, PTTEP AA have a reasonable level of certainty to the degree that oiled wildlife may be encountered.

The extent of shoreline oiling at conservative environmental impact thresholds is detailed in ER1 above and is not duplicated within this section.

As part of the stakeholder consultation program, consultation with relevant stakeholders was conducted. There have been no objections or claims made by relevant person(s) in relation to oiled wildlife response.

Detailed Environmental Impact Assessment

Identified Value or Sensitivity Potentially Exposed to Hazard	Potential Severity / Consequence Discussion	Rating	Likelihood of Impact Occurrence	Rating	Risk
Marine Fauna	The implementation of oiled wildlife response may result in adverse impacts to listed and non-listed marine fauna. Response activities may lead to widespread sub-lethal impacts to communities, however, these impacts are considered to be negligible in comparison with the impact of oily on marine fauna.	Moderate (2)	PTTEP AA considers it unlikely that oiled wildlife response would have adverse impacts on marine fauna in addition to that caused by the oiling event.	Unlikely (B)	Low (2B)
Avifauna	The implementation of oiled wildlife response may result in adverse impacts to listed and non-listed avifauna. Response activities may lead to widespread sub-lethal impacts to communities, however, these impacts are considered to be negligible in comparison with the impact of oily on avifauna.	Moderate (2)	PTTEP AA considers it unlikely that oiled wildlife response would have adverse impacts on avifauna in addition to that caused by the oiling event.	Unlikely (B)	Low (2B)
Benthic Communities	The potential impact to nearshore benthic communities caused by oiled wildlife response is considered the same as those discussed within ER1, and as such are not replicated in this section.	Refer to ER1	Refer to ER1	Refer to ER1	Refer to ER1
Shoreline Habitats	The potential impact to shoreline habitats caused by oiled wildlife response is considered the same as those discussed within ER1, and as such are not replicated in this section.	Refer to ER1	Refer to ER1	Refer to ER1	Refer to ER1
Protected Areas	The potential impact to shoreline habitats caused by oiled wildlife response is considered the same as those discussed within ER1, and as such are not replicated in this section.	Refer to ER1	Refer to ER1	Refer to ER1	Refer to ER1
Heritage Places • Shipwrecks	The potential impact to heritage places caused by oiled wildlife response is considered the same as those discussed within ER1, and as such are not replicated in this section.	Refer to ER1	Refer to ER1	Refer to ER1	Refer to ER1

Ports & Commercial Shipping	The potential impact to ports & commercial shipping caused by oiled wildlife response is considered the same as those discussed within ER1, and as such are not replicated in this section.	Refer to ER1	Refer to ER1	Refer to ER1	Refer to ER1

Summary of Control Measures, ALARP and Acceptability

The decision context for impacts and risks associated with the implementation of oiled wildlife response is 'Type B' as defined in Section 5. As such, the demonstration of ALARP is based on assessment against industry good practice and an engineering risk assessment to further evaluate a range of control measure options.

The following good practice controls will be adopted to manage potential environmental impacts and risks to ALARP and acceptable levels:

- Western Australian Oiled Wildlife Response Plan (DPAW and AMOSC 2014) (WAOWRP)
- Kimberley Regional Oiled Wildlife Response Plan (KOWRP) (DBCA and AMOSC) (currently in draft):
  - Regional specific plan providing guidance on oiled wildlife response activities in the Kimberley region.
- NOPSEMA Oil Pollution Risk Management Information Paper Oiled Wildlife Response ((IP1488 Rev 2) (NOPSEMA 2018)
- Wildlife response operation undertaken to include:
  - Vessels used in hazing/capture clean and rehabilitate are to approach fauna from the spill toward the animals at slow speed;
  - Noise deterrent is activated only when aggregations (if present) are intact and the vessel is positioned between animals and the spill;
  - Treatment of oiled birds will involve teams of two, with at least one familiar with the behaviour of the animal and oiled wildlife response techniques; and
  - Treatment will take place at a dedicated treatment centre with adequate facilities and trained personnel to successfully rehabilitate birds.
- Western Australia State Hazard Plan for Marine Oil pollution (WestPlan MOP) (Department of Transport 2016)
- PTTEP AA Internal Requirements:
  - PTTEP AA Kimberley Shoreline Tactical Response Concept of Operations

The following additional control measures evaluated as part of the engineering risk assessment were determined to be reasonably practicable and have been incorporated into the OPEP:

- A dedicated treatment center established to treat and rehabilitate oiled birds /other wildlife.
- Additional personnel secured via contracts with specialist organisations or Universities in the event of an oil pollution emergency incident.
- Offshore hazing is implemented only when aggregations of fauna (if present) are intact, and the vessel is positioned between animals and the spill.

ALARP and Acceptability

As described above, the demonstration of ALARP for a 'Type B' decision context is based on assessment against industry good practice and analysis of alternate and/or additional control measures through an engineering risk assessment. The adoption of 'Good Practice' measures and the additional control measures identified through the engineering risk assessment above provide for multiple layers of engineering and administrative controls to manage potential environmental impacts and risks to ALARP. All acceptability criteria have been met and the potential environmental risks and impacts are determined to be acceptable.

7 ONGOING MONITORING OF ENVIRONMENTAL PERFORMANCE

Activities associated with the AC/P54 and AC/RL7 EADP are identified, planned and implemented in accordance with relevant legislation, commitments within the Environment Plan and internal PTTEP AA environment, health and safety standards and procedures. Processes are in place to verify that these controls and requirements are being implemented to manage environmental impacts and risks associated with the proposed activities to ALARP and acceptable levels.

For each environmental aspect and associated environmental risks and impacts identified and assessed in the EP specific environmental performance outcomes (EPOs), environmental performance standards (EPSs) and measurement criteria have been developed for the control measures outlined in Section 6. The specific measurement criteria provide the evidence base to demonstrate that the environmental performance standards and outcomes are achieved.

The Implementation Strategy detailed in the EP identifies the roles/responsibilities and training/competency requirements in relation to implementing controls, managing non-conformance, emergency response and monitoring, auditing, and reporting requirements during the activity.

7.1 LEGAL AND OTHER COMPLIANCE

PTTEP AA's legal department and the SSHE department receive and monitor updates to legislative requirements. An outcome of any change to legislative requirements is reflected where relevant, as new obligation or change to an existing obligation, in PTTEP AA's obligation register and/or in the PTTEP AA management systems.

Updates to matters relating to the EPBC Act, including policy statements and conservation management documentation will be achieved through subscription to automated email notifications provided by the DoEE.

PTTEP AA also has established a contract with an environmental consultancy to provide PTTEP AA quarterly updates of information that may be relevant to the activity, including updates to relevant management measures for protected species and new scientific knowledge related to the existing environment.

Refer to Section 7.6 for PTTEP AA's management of change processes which apply if a new requirement is identified.

7.2 TRAINING AND COMPETENCY

PTTEP AA will ensure all personnel will be aware of the requirements of this EP and made aware of the specific environmental sensitivities, risks and management strategies. Training and competency is assured through the following:

- Environmental Awareness Inductions provided to PTTEP AA and contractor personnel;
- PTTEP AA Corporate Training and Competence Standards;
- Emergency response training and drills (as detailed in Section 8.5)

7.3 CONTRACTOR MANAGEMENT

The requirements of this EP will be rolled out to contractors through the following processes:

1. The requirement to comply with the EP will be included in contracts for the MODU and support vessels;
2. A copy of the approved EP and OPEP will be provided to the MODU and vessel operators.
3. Contractor personnel will be required to attend the Environmental Awareness Induction (Section 7.2);
4. Relevant personnel on the support vessels will be required to attend training to support the implementation of the OPEP (Section 8.5); and

5. A review of contractor compliance with the relevant environmental performance standards will be initiated prior to the mobilisation of the MODU or support vessels and during each drilling campaign (Section 7.4.1).

7.4 AUDIT AND REVIEW

7.4.1 Assurance Activities

PTTEP AA and its contractors will undertake an assurance program consisting of periodic monitoring, audit and review during the activity. The objective of the assurance programme is to ensure that environmental performance is regularly monitored. These activities assist PTTEP AA to review environmental performance over time with a view to continuous improvement.

PTTEP AA and its contractors will undertake the following performance assurance activities:

- Readiness Reviews: Performed prior to the start of each drilling campaign to confirm PTTEP AA compliance with relevant EPSs;
- Contractor/PTTEP AA Readiness Reviews: Performed prior to mobilisation for each drilling campaign to confirm PTTEP AA and contractor compliance with relevant EPSs.
- Contractor Assurance Reviews: Performed offshore by PTTEP AA at least once during each drilling campaign to confirm drilling contractor compliance with relevant EPSs;
- Compliance Review: During each drilling campaign PTTEP AA will perform a review of compliance against EPSs which PTTEP AA will directly action; and
- Monitoring, including:
    - Weekly Environmental Inspections on the MODU of compliance against relevant EPSs, including waste management, hydrocarbon transfer and chemical management;
    - Daily reviews of chemical use and operational environmental performance; and
    - Assurance monitoring to confirm that the people, equipment and tools required to implement the OPEP and OSMP are in place. The review is performed on a minimum six-monthly basis and involves a six month look-ahead of contracts, training and equipment maintenance requirements.

7.4.2 End and Start of Campaign Reviews

A review of the outcomes of the each drilling campaign will be undertaken once completed and lessons learnt will be recorded, based on the results of environmental assurance activities (as detailed in Section 7.4.1) and environmental incident reports (described in Section 7.7).

Prior to the start of each subsequent drilling campaign, the EP and OPEP will be reviewed to assess:

- Any changes in the drilling activity;
- Any changes in legislation, including policy statements and conservation management documentation;
- Any changes to external or internal good practice measures;
- Any lessons learnt from previous campaigns; and
- A review of all control measures for Type B and Type C risks to identify any improvements, efficiencies or technological developments that may be reasonably implemented to further reduce environmental impacts and risks to ALARP.

Any changes identified will be assessed under Management of Change process (Section 7.6).

7.5 MANAGEMENT OF NON-CONFORMANCE

Should an incident or an assurance activity highlight any instances of non-conformance with the EP, an incident report will be raised and PTTEP AA will work with the contractor to review relevant

controls, systems and procedures in order to identify the source of the non-conformance and improve environmental performance.

As required, a register of actions assigned to contractors will be maintained and communicated to the relevant contractor or personnel, facilitating them to address and close out any items to an agreed timeframe.

7.6 MANAGEMENT OF CHANGE AND RISK REVIEW

PTTEP AA Management of Change (MOC) Procedure defines minimum requirements for managing permanent and temporary changes to any work process, facility or operations to ensure that any risk of hazard arising from the change is identified, assessed and controlled.

In conjunction with the Management of Change process the SSHE Risk Management Procedure provides guidance on assessing and managing changes to the EP, including guidance on when a resubmission of an EP may be required under Division 2.4 of the OPGGS(E)R.

The Environment Plan - Change Assessment Template will be used to assess and record any change which may need to be made to an EADP EP or the OPEP, and includes requirements to:

- Document the nature of the change;
- Determine whether an resubmission of the EP is required under Division 2.4 of the OPGGS(E)R;
- Assess any change in risk rating (to be assessed in alignment with the methodology presented in Section 5);
- Assess whether risks and impacts remain ALARP and at an acceptable level;
- Assess any potential impacts on stakeholders and the need for further stakeholder consultation;
- Identify an actions required to implement the change; and
- Have the change documentation approved by the PTTEP AA SSHE Manager and relevant operational personnel.

An EP change register will be maintained for the EP and the OPEP and will be used to track the closeout of any actions required to implement the change. If there is a need to reissue the EADP EP, all changes recorded in the register will be incorporated in the revision of the EADP EP.

7.7 REPORTING

7.7.1 Internal Routine Monitoring and Reporting

Internal routine monitoring and reporting will comprise:

- Daily reports, provided during each campaign to summarise daily operations and SSHE performance;
- Monthly environmental reporting, compiled during each drilling campaign.

7.7.2 External Routine Reporting

A post-operation environmental performance report will be prepared by PTTEP AA's Environmental Advisor and submitted to NOPSEMA within 3 months of the completion of each drilling campaign.

In the event that a drilling campaign is completed more than one year after the previous campaign, an environmental performance report will be provided to NOPSEMA within one year of the previous report, providing a description of activities and performance for the preceding year.

The following additional external notifications and reports will also be provided as required:

- Commencement of activity notified to NOPSEMA (at least 10 days prior to activity commencing);
- End of activity notified to NOPSEMA (within 10 days of completion of activity);

- End of environment plan notified to NOPSEMA (when all obligations under the EP are completed);
- Ballast Water Reports provided to the Maritime National Coordination Centre or via Maritime Arrivals Reporting System (MARS) 12 to 96 hours prior to the intended discharge;
- PTTEP AA annual NGERs reporting will include emissions from flaring associated with an appraisal well, should this activity be undertaken;
- A marine fauna sightings and interactions report will be completed for CSS/VSP well evaluation activities and will be submitted to the Department of Environment and Energy following the EADP.

7.7.3 Internal Incident Reporting

Incidents, near misses and hazards that have the potential to cause environmental damage shall be reported using the contractor and PTTEP AA Incident Report Forms available with the PTTEP AA Drilling Supervisor. Incidents are recorded and tracked to closure through an Incident Management System.

7.7.4 External Incident Reporting

Recordable Incidents

A recordable incident is one that breaches an environmental performance outcome or environmental performance standard of this EP and that is not a reportable incident, as per Regulation 4 of the OPPGS(E)R.

NOPSEMA will be notified of all recordable incidents monthly (as soon as practicable after the end of the calendar month and in any case no later than 15 days after the end of the calendar month) in accordance with Regulation 26B of the OPPGS(E)R.

Reportable Incidents

In accordance with the OPGGS(E)R, NOPSEMA will be notified of all reportable incidents. Under Regulation 4(1), 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”. Based on this, the potential impacts with a Moderate (2) consequence or above are those that are considered as requiring regulatory reporting as follows:

- Introduction of Invasive Marine Pest species;
- A loss of well control;
- Vessel collision resulting in large hydrocarbon spill;
- Fauna collision incident with supply vessel; and
- A moderate to significant impact to MNES.

Under the OPGGS(E)R, NOPSEMA will be notified of all reportable incidents was soon as practicable, and in any case, within two hours of the incident first occurring (or of the time the titleholder first becomes aware of the incident). A written report will be provided to NOPSEMA as soon as practicable, and in any case not later than 3 days, after the first occurrence of a reportable incident.

Should an unforeseen event occur that has caused or has the potential to cause moderate to significant environmental damage this must also be reported to NOPSEMA in accordance with the above stated timelines.

Incident reporting to other agencies

In the event of a significant impact to MNES, PTTEP AA will, in addition to notifying NOPSEMA, also provide a written notification to DoEE within three days of becoming aware of the event, and provide additional information as available, if requested by DoEE.

PTTEP AA will report any actual or suspected injury/mortality of protected marine fauna to the National Ship Strike Database.

IMS incursions will be reported to State / Territory / Cth / relevant Port Authorities / industry bodies (WA DoF, WAFIC etc).

Additional requirements related to the reporting of oil spills are detailed in the PTTE AA OPEP.

The vessels and MODUs are responsible for reporting chemical spills to water to AMSA.

7.8 RECORDS AND DOCUMENT MANAGEMENT

PTTEP AA shall store and maintain the following documents or other records:

(a) The EP;

(b) Revisions to the EP;

(c) Written reports (including monitoring, audit and review reports) about environmental performance, or about the implementation strategy, under the EP;

(d) Records of emissions and discharges of drilling cuttings, drilling fluids (including completion brine) and cements to the environment in accordance with the EP;

(e) Records and copies of reports under regulations 26 and 26A of the OPGGS(E)R, relating to reportable incidents; and regulation 26B of the OPGGS(E)R, relating to recordable incidents (Section 7.7).

7.9 EP AND OPEP ROUTINE REVIEW AND UPDATE

In addition to the requirement to update the EP and OPEP on an as needs basis due to management of change requirements or end/start of campaign reviews, the EP and OPEP have been identified within the document management system as requiring review and re-issue at least every 3 years.

8 EMERGENCY RESPONSE ARRANGEMENTS

8.1 CRISIS AND EMERGENCY MANAGEMENT PLAN

PTTEP AA has prepared a Crisis and Emergency Management Plan (CEMP). The purpose of the plan is to clearly define the roles and responsibilities of the Crisis Management Team (CMT) and the Emergency Management Team (EMT) during an actual or potential incident that could create and emergency and/or crisis for PTTEP AA and its stakeholders. The plan identifies the major risks potentially impacting business operations and local communities, describes the response strategies and management organisation for a number of potential emergencies, sets out roles and responsibilities of key personnel, contains internal and external notification procedures and describes how PTTEP AA will establish communications in the event of an emergency.

8.1.1 Crisis Management Team

The PTTEP AA CMT is responsible for proactively identifying and managing strategic issues associated with an incident. The CMT comprises senior PTTEP AA personnel supported by technical specialists as required.

8.1.2 Emergency Management Team

The structure and operations of the PTTEP AA EMT are consistent with the Australasian Interagency Incident Management System (AIIMS).

The primary task of the EMT is to implement the CEMP and OPEP during an oil spill. This EMT will address tactical response issues, interface with and provide information to internal and external parties including the CMT, PTTEP AA OIM and Drilling Supervisor, contractors and the relevant regulatory authorities. They will direct the operations of field teams responding to a spill.

8.1.3 Control and Statutory Agencies

Control Agency's for spills from PTTEP AA activities in WA, NT and Commonwealth Waters are shown in Table 8-1.

Note that vessels within 500m of an oil and gas facility are considered part of the facility activities in terms of control agency required to respond. The provision of resources for any level of oil spill event response will be coordinated by PTTEP AA EMT.

In the event of Level 2 or 3 responses, PTTEP AA will require support from key response support organisations.

Table 8-1 Relevant Statutory Authorities and Combat Agencies

<table>
<tr><th rowspan="2">Spill Source/ Location</th><th rowspan="2">Spill Level</th><th colspan="2">Statutory Authority</th><th rowspan="2">Control Agency</th></tr>
<tr><th>Oil Spill Response</th><th>Wildlife</th></tr>
<tr><td colspan="5">Commonwealth Waters (Territorial Sea and Exclusive Economic Zone beyond Coastal Waters)</td></tr>
<tr><td>Oil and Gas Facility</td><td>All levels</td><td>NOPSEMA</td><td rowspan="2">DoEE</td><td>PTTEP AA</td></tr>
<tr><td>Vessels at sea</td><td>All levels</td><td>AMSA</td><td>AMSA</td></tr>
<tr><td colspan="5">NT Waters (Coastal Waters)</td></tr>
<tr><td rowspan="2">Oil and Gas Facility</td><td>Level 1</td><td rowspan="2">NT DPIR</td><td rowspan="3">NT DNER</td><td>PTTEP AA</td></tr>
<tr><td>Level 2 / 3</td><td>PTTEP AA unless otherwise agreed with NT DILP</td></tr>
<tr><td>Vessels at sea</td><td>All levels</td><td>NT DIPL</td><td>NT DILP</td></tr>
</table>

Spill Source/ Location	Spill Level	Statutory Authority		Control Agency
		Oil Spill Response	Wildlife	
WA Waters (Coastal Waters)				
Oil and Gas Facility	Level 1	WA DMIRS*	WA DBCA	PTTEP AA
	Level 2 / 3			WA DoT
Vessels at sea	All levels	WA DoT		WA DoT

8.1.4 Industry Arrangements

PTTEP AA has arrangements in place with various support organisations to ensure sufficient capacity of experienced personnel and resources in the event of a spill response. The support organisations that PTTEP AA has access to are as follows:

- Australian Marine Oil Spill Centre (AMOSC) – As a member company of AMOSC, PTTEP AA has access to AMOSC's oil spill recovery and response equipment, training, dispersant and technical capabilities along with those resources held by member companies as outlined in the AMOSPlan. PTTEP AA has executed a master service contract with AMOSC which allows for the timely call of resources. The AMOSPlan also provides a link into (AMSA) resources under the National Plan to Combat Pollution of the Sea by Oil and other Noxious and Hazardous Substances (the 'NatPlan').
- Oil Spill Response Limited (OSRL) – PTTEP AA has access to additional oil spill resources through OSRL, which is based in Singapore and Southampton. If required, PTTEP AA has access to 50% of OSRL's oil spill response equipment. Both the CEO and SSHE Manager have approval to officially request and activate support from OSRL in the event of a Level 2 or 3 spill. OSRL personnel can assist and provide technical advice to the PTTEP AA EMT as required.

8.2 OIL POLLUTION EMERGENCY PLAN

PTTEP AA has prepared the OPEP to facilitate an effective response in the event of a hydrocarbon spill to the marine environment. The OPEP provides the following key information to be used in the event of a hydrocarbon spill to the marine environment:

- First strike actions covering key actions in the first 12 hours;
- Internal and external reporting requirements;
- Structure and responsibilities of the extended response team, including the PTTEP AA EMT, and external agencies;
- Processes for determining which spill response strategies should be implemented to support a net environmental benefit (NEBA);
- Key tasks required to implement each spill response strategy and criteria for terminating the strategy;
- An overview of the content of OSMP and the triggers for initiation of the plan; and
- Information to support access to resources (people, equipment and tools).

PTTEP AA has identified the personnel, equipment and tools which must be available to support the implementation of the plan (detailed within the OPEP). The procedures in the OPEP have been developed to be consistent with those detailed in the NatPlan, WA DoT WestPlan and NT Oil Spill Contingency Plan.

8.2.1 Spill Response Strategies

For all spills, source control is undertaken to ensure no further release of hydrocarbons to the marine environment. The potential response options that may be implemented are dependent on the volume

of hydrocarbon, location of the spill event, environmental conditions at the time of the spill, and sensitivities that may be exposed. Strategies include:

- Monitor & Evaluate
- Chemical Dispersant Application
- In-Situ Burning
- Containment & Recovery
- Protection & Deflection
- Shoreline Clean-Up
- Oiled Wildlife Response
- Oily Waste Management

8.3 OPERATIONAL AND SCIENTIFIC MONITORING PROGRAM

PTTEP AA has prepared a Timor Sea Operational and Scientific Monitoring Program (OSMP) applicable to PTTEP AA's petroleum activities in the Timor Sea for use in the event of a significant oil spill (Level 2 or Level 3). The monitoring programs described within the OSMP may be conducted in both State and Commonwealth Waters.

Operational monitoring studies include the following:

O1 – Monitoring of Surface Hydrocarbon Distribution at Sea and on Shorelines;

O2 – Monitoring of Hydrocarbon Character and Fate;

O3 – Shoreline Assessment Surveys;

O4 – Monitoring of Dispersant Efficacy and Fate of Dispersed Hydrocarbons;

O5 – Monitoring of Response Activities.

Scientific monitoring studies include the following:

S1 – Marine Megafauna Assessment Surveys;

S2 – Shoreline Ecological Assessment Aerial Surveys;

S3 – Assessment of Fish for the Presence of Hydrocarbons;

S4A – Assessment of the Short-Term Effects on the Timor Sea Fish and Fisheries;

S4B – Assessment of Long Term Effects on Timor Sea Fish and Fisheries;

S5 – Offshore Shoals and Reefs Assessment Surveys;

S6 – Shoreline Ecological Surveys;

S7 – Hydrocarbon Fate and Effects Assessment.

PTTEP AA has arrangements in place with competent environmental consultants for undertaking the various scientific studies described in the OSMP. In the event of an oil spill, PTTEP AA's EMT Leader and Planning Co-ordinator, in consultation with the consultants and the EMT Environmental Advisor, will select the studies to be implemented. The EMT Leader will retain overall responsibility for the implementation of the operational monitoring studies.

8.4 CYCLONE RESPONSE PLAN

PTTEP AA has in place a Cyclone Response Plan. The purpose of the Cyclone Response Plan is to provide information about the actions to be coordinated in the event of a cyclone affecting PTTEP AA operated and contractor operated facilities. This plan provides an overview of cyclone preparedness and response coordination for evacuation of personnel from facilities operating in the EADA.

8.5 EMERGENCY RESPONSE TRAINING AND COMPETENCY

8.5.1 Emergency Response Training

As a minimum all PTTEP AA on-call duty roster personnel nominated to the EMT must be trained to an appropriate level and in appropriate procedures relevant to their role prior to joining. The competency units to achieve this for each role are in Table 8-2 below.

Table 8-2 EMT Training Level for PTTEP AA

EMT Role	Competency
EMT Leader	Coordinate Incident Response (Competency Unit: PMAOMIR418B)
Planning Coordinator	Manage Incident Response Information (Competency Unit: PMAOMIR320)
Operations Coordinator	
Logistics Coordinator	
Administration/Recorder	

PTTEP AA has determined a redundancy of 3 personnel for key positions. For externally filled roles the competency is or will be detailed in the contractual arrangement or determined by the external organisation and agreed by PTTEP AA through the contract.

Personnel from the industry oil spill response organisations, AMOSC (Core Group and staff) and OSRL, are identified for use in an extended EMT. AMOSC ensure that Core Group personnel have appropriate and valid training and competency for various oil spill response tasks. AMOSC Core Group personnel and staff undergo IMO accredited competence based training for its skill-base and re-validate their competencies every two years through additional training and exercises. This ensures personnel have appropriate training and competency for oil spill response roles in an extended EMT if required.

Operating alongside the AMOSC Core Group, the AMOSC Oiled Wildlife Response Team (OWRT) undertakes specialist Level 2 to 4 Oiled Wildlife Training undertaken by WA Department of Biodiversity, Conservation and Attractions (DBCA).

All OSRL technical staff undergo 12-week Responder Training in Southampton UK. In addition, OSRL maintains OPITO-Approved Competence Management System (ACMS).

The PTTEP AA Environmental Advisor role requires a minimum of 5 years industry knowledge, familiarity with the NEBA process and scientific monitoring requirements, knowledge of the relevant OSMPs and the specifics of the environment in which PTTEP AA petroleum activities are undertaken. Additionally, PTTEP AA has an arrangement in place with an environmental consultancy to utilise environmental advisors with relevant experience and skills, including knowledge of oil spill response and familiarity with the EP and OPEP, to supplement the Environmental Advisor in an EMT as required.

The minimum EMT qualifications and experience are summarised in Table 8-3.

Table 8-3 EMT Oil Spill Response Training Level for PTTEP AA

EMT Role	Minimum Training Level	
	Course/Qualification	**Course Refresher Frequency**
EMT Leader	Oil Spill Response Management (IMO Level III)	3 years
Planning Coordinator	Oil Spill Response Management (IMO Level II)	3 years
Operations Coordinator		
Logistics Coordinator		
Environmental Advisor	Tertiary qualification in environmental science or equivalent and a minimum of 5 years in an environmental related role in the oil and gas industry Familiarity with the NEBA process, scientific monitoring requirements, OSMPs (including initiation & termination criteria), knowledge of the specifics of the environment in which PTTEP AA petroleum activities are undertaken.	N/A

To enable an effective initial response infield the PTTEP AA representative on the MODU and support vessel crews will undergo oil spill response awareness training. Support vessel crews will undertake familiarisation training with PTTEP AA oil spill response equipment in Darwin prior to being stationed infield as the standby vessel. Oil spill response training for offshore personnel is summarised in Table 8-4.

In the event of a spill, all infield response operations will be led by trained response personnel (AMOSC core group, AMSA National response team, OSRL). These lead personnel as a minimum are to have training as specified by the NatPlan and AMOSPlan competency requirements or have participated in practical oil spill equipment deployment.

Table 8-4 Oil Spill Response Training Levels for Offshore Personnel

Site	Role	Minimum Level of Training	Currency/ Certification or Other
MODU	PTTEP AA Drilling Supervisor	• Oil observation training • Dispersant rapid testing training	Within past 3 years
Supply Vessels	Vessel Master and designated crew members	• Oil spill response awareness and familiarisation training with PTTEP AA oil spill response equipment	Within past 1 year
		• Oil observation training • Dispersant rapid testing training	Within past 3 years

8.5.2 Emergency Response Drills

Testing of OPEP response arrangements will be conducted via a drill exercise prior to the commencement of each drilling campaign and at least annually.

In the event that response arrangements are significantly modified, an assessment will be made as to the benefit of performing additional testing and, where a material benefit is identified, additional drills will be performed to test the new arrangements.

9 STAKEHOLDER CONSULTATION

9.1 OVERVIEW

PTTEP AA is committed to engaging with stakeholders in an open and transparent manner. The objectives of doing so are to:

- Maintain positive working relationships with stakeholders;
- Keep stakeholders abreast of PTTEP AA's activities;
- Seek feedback from stakeholders in order to inform decision-making processes;
- Proactively understand and manage the issues and concerns raised by stakeholders; and
- Meet relevant regulatory requirements and align with industry good practice.

This chapter outlines the stakeholder consultation undertaken to date for the AC/P54 and AC/RL7 EADP and the processes for ongoing engagement.

9.2 CONSULTATION APPROACH

PTTEP AA has developed a Stakeholder Engagement Plan (SEP), which details the process for engaging with stakeholders during the development and ongoing implementation of the EP. The stakeholder engagement approach outlined in the SEP builds on PTTEP AA's previous engagement efforts. This includes engagement undertaken as part of the 2009 Montara incident, as well as consultation undertaken as part of PTTEP AA's previous EPs, including the Montara Production Drilling EP and the Montara Operations EP.

9.3 STAKEHOLDER IDENTIFICATION

A key aspect of Regulation 11A of the OPGGS(E)R is that stakeholder consultation is to be conducted with 'relevant persons'.

PTTEP AA defines 'relevant' persons as those departments, agencies, individuals or organisations that:

- Have a function (including regulating) in the 'title blocks[3]' that may be directly affected by PTTEP AA's planned petroleum activities[4]; or
- Undertake activities in the 'title blocks' that may be directly affected by PTTEP AA's activities. This includes organisations that may have members that undertake activities in the 'title blocks'; or
- Have an interest in the 'title blocks' that may be directly affected by PTTEP AA's activities; or
- Do not have a direct interest or activity in the 'title block; however, are considered relevant for the purposes of maintaining good working relationships[5] with stakeholders.

A stakeholder mapping workshop was completed to develop a comprehensive list of relevant stakeholders (Table 9-1). The list of relevant stakeholders will be reviewed and updated as required prior to each drilling campaign.

It is recognised that the level of interest will change in the event of an emergency condition. PTTEP AA's SEP includes an expanded list of relevant stakeholder's who would be engaged in the event of a significant release of hydrocarbons.

[3] Defined based on the boundaries of the AC/P54 & AC/RL7 petroleum title blocks.
[4] As defined in *Section 3 –Description of Activities*.
[5] These stakeholders are not considered relevant persons under the OPGGS(E)R, however PTTEP AA engages with these stakeholders in an effort to maintain good working relationships and to align with industry good practice.

Table 9-1 Relevant Stakeholders

Relevant Stakeholders	
Commonwealth Government	
Australian Fisheries Management Authority	Director of National Parks
Australian Maritime Safety Authority	Department of Foreign Affairs and Trade
Department of Industry, Innovation and Science	Department of Communications and the Arts
Department of Defence	National Native Title Tribunal
Department of Immigration and Border Protection	Department of Agriculture and Water Resources
Geoscience Australia	Australian Hydrographic Service
Western Australian Government	
Department of Biodiversity, Conservation and Attractions	Department of Mines, Industry Regulation and Safety
Department of Primary Industries and Regional Development (Fisheries)	Department of Jobs, Tourism, Science and Innovation
Western Australian Museum	Department of Transport
Shire of West Kimberley	Shire of Wyndham East Kimberley
Department of Water and Environmental Regulation	
Northern Territory Government	
Department of Primary Industries and Resources (Primary Industries and Fisheries, Mines and Energy)	Department of Tourism and Culture (Parks and Wildlife Commission of the Northern Territory, Tourism NT)
Department of Infrastructure, Planning and Logistics	Department of Environment and Natural Resources
Northern Territory Environmental Protection Authority	Department of the Chief Minister
Commercial Fishing	
Fishing Associations	
Commonwealth Fisheries Association	Western Australian Fishing Industry Council
Northern Territory Seafood Council	Australian Southern Bluefin Tuna Industry Association
Pearl Producers Association	Northern Wildcatch Seafood Australia
Australian Council of Prawn Fisheries	Australian Fisheries Trade Association
Northern Prawn Fishing Industry Pty Ltd	
Commonwealth Managed Fisheries (all license holders)	
Western Tuna and Billfish Fishery	
WA State Managed Fisheries (all license holders)	
Joint Authority Northern Shark Fishery	Northern Demersal Scalefish Fishery
Mackerel Managed Fishery	
NT State Managed Fisheries (all license holders)	
Demersal Fishery	Spanish Mackerel Fishery
Recreational Fishing Industry	
Recfishwest	NT Guided Fishing Industry Association
Tourism Industry	
Kimberley Bird Watching	Kimberley Expeditions

Relevant Stakeholders	
Australian Northwest Tourism	Tourism Western Australia
Oil and Gas Industry	
Australian Petroleum Production and Exploration Association	Eni Australia Limited
Melbana Energy Limited	Total E&P Australia Production Pty Ltd
Bounty Oil & Gas NL	Murphy Australia Oil Pty Ltd
Sinopec O&G Australia (Puffin) Pty Ltd	Finder Pty Limited
Environmental Non-Governmental Organisations	
WA Conservation Council	International Fund for Animal Welfare
World Wildlife Fund	Save the Kimberley
Environs Kimberley	Australian Marine Conservation Society
Greenpeace	World Dolphin Conservation Society
The Wilderness Society	Australian Conservation Foundation
Research Organisations	
Australian Institute of Marine Science	Commonwealth Scientific and Industrial Research Organisation
Western Australian Marine Science Institute	
Indigenous Stakeholders	
Kimberley Land Council	Northern Land Council
North Australian Indigenous Land & Sea Management Alliance	
Commercial Shipping	
Darwin Port Authority	Pilbara Port Authority
Kimberley Port Authority	
Infrastructure Provider	
Nextgen Networks (Vocus Group)	Telstra

9.4 CONSULTATION TO DATE

A factsheet was distributed to all stakeholders (Table 9-1) via email or post, depending on the availability of contact details, on 20 February 2018. The factsheet provided the following information:

- An overview of the EADP (including the purpose, location, activity description, timing and duration);
- The potential environmental risks and impacts and the associated management controls;
- Contact details (telephone number, email address, postal address and website details); and
- An update on other PTTEP AA activities.

In addition, PTTEP AA encouraged stakeholders to explore its corporate webpage, as the webpage contains additional information about PTTEP AA and its operations.

The email communication was followed-up with phone and email consultation, requesting feedback from stakeholders.

9.4.1 Stakeholder Feedback

Stakeholder feedback has been recorded in the PTTEP AA Correspondence Database. A record of all relevant correspondence including phone calls, factsheets, letters, meetings and email exchanges are stored in this database (Appendix A).

PTTEP AA undertook an assessment of the merits of all feedback received from stakeholders and has incorporated the feedback into the development of the EP.

Table 9-2 summarises the key issues raised during the engagement process, and where these issues have been addressed in the EP. Most of the issues raised relate to: (1) potential interaction with or displacement of commercial fishing operations, and (2) PTTEP AA's response in the event that a hydrocarbon release occurs. Further details are provided in Appendix A.

Table 9-2 Key Issues Raised By Stakeholders During The EP Consultation Process

Key Issue Raised	Response	Relevant EP Section
Displacement: Stakeholders raised concerns about potential displacement of commercial fishers due to the establishment of a cautionary area around the MODU.	A 500 m radius Petroleum Safety Zone will be in place around the MODU during the drilling campaign, in accordance with the *Offshore Petroleum and Greenhouse Gas Storage Act 2006*. The Australian Hydrographic Service will issue a Notice to Mariners and the Petroleum Safety Zone will be noted on the Admiralty Chart covering the region. Previous drilling campaigns undertaken by PTTEP AA have included establishing a Cautionary Area. Stakeholders were advised a Cautionary Area is not planned to be in place for the drilling campaigns covered by this EP.	Section 6.1
Interaction: Stakeholders raised concerns about recreational fishing from support vessels.	PTTEP AA will communicate the sensitivities the fishing industry has raised via its 'Environmental Awareness' induction process.	Section 6.1
Interaction: Stakeholders raised concerns about the potential for interactions between commercial fishers and support vessels.	PTTEP AA will remind all contractors and sub-contractors to comply with the *Navigation Act 2012*, AMSA Marine Orders 21 (Safety and Emergency Arrangements), AMSA Marine Order 30 (Prevention of Collisions), International Convention for the Safety of Life at Sea 1974 (SOLAS) and the International Regulations for Preventing Collisions at Sea 1972 (COLREGS).	Section 6.1
Interaction/ displacement: Stakeholders sought to confirm the timing of the drilling activities minimise any potential for displacement of commercial fishers.	PTTEP AA indicated that there are a number of factors influencing the timing and duration of drilling activities including weather conditions, facility availability and other operational considerations. PTTEP AA typically conducts drilling operations outside of the tropical cyclone season (November to April). Drilling activities are expected to take approximately 35 to 100 days per well. The first exploration well (Orchid-1), is scheduled to be drilled, evaluated and abandoned in 2018. These activities are currently proposed to start in late Quarter 3, 2018. The result and learnings from Orchid-1 will be incorporated into the design of additional wells. The timing of additional wells is currently unknown and will be communicated to stakeholders once confirmed	Section 3

Key Issue Raised	Response	Relevant EP Section
Hydrocarbon release: Stakeholders sought assurances that PTTEP AA will assume responsibility for managing the impacts that may occur as a result of a hydrocarbon release.	PTTEP AA is required by NOPSEMA (as a part of PTTEP AA's license to operate offshore) to hold sufficient financial resources to ensure PTTEP AA can meet any likely clean-up costs. PTTEP AA has completed a detailed assessment of the risks and impacts that the drilling activities could have on the environment. This includes the direct and indirect risks and impacts from routine operations and emergency events. In the event of an unplanned release of hydrocarbons to the marine environment, PTTEP AA will initiate an Operational and Scientific Monitoring Program (OSMP). The purpose of the OSMP is to provide guidance on how and when monitoring studies will be undertaken to collect scientific data to inform the spill and post-spill response. <u>Additional feedback was provided to relevant stakeholders in response to NOPSEMA Opportunity to Modify and Resubmit item 4.1. As follows:</u> If there is an escape of petroleum in the offshore area in relation to petroleum activities of any petroleum industry participant including PTTEP AA, such participant is subject to relevant liabilities under the Offshore Greenhouse Gas Storage Act 2006 (OGGSA) including under the 'Polluter pays' principles enshrined under s.572C(2) of the OPGGSA. In relation to any loss or ongoing damage to other parties leading to any compensation claims by third parties, as with any other petroleum industry participant involved in an escape, PTTEP AA will be subject to liabilities which may arise from any other right of action, or other remedy available under any other applicable law, that any authority, agency or any other person may have against such participant in relation to the escape of petroleum. As with any other petroleum industry participant, PTTEP AA deals with such liabilities including its third parties liabilities with combination of its own financial resources and appropriate insurance covers. In the event of an unplanned release of hydrocarbons to the marine environment, the NOPSEMA approved Oil Pollution Emergency Plan (OPEP) and Operational	NA

Key Issue Raised	Response	Relevant EP Section
	Scientific Monitoring Program (OSMP) will be implemented. This will involve engaging with relevant stakeholders, as determined based on the nature of the release. At any time, all stakeholders are encouraged to contact PTTEP AA with queries or concerns. Stakeholders, who believe a compensation claim is appropriate, will need to seek their own legal advice.	
Hydrocarbon release: Stakeholders enquired about capabilities to respond in the event of a hydrocarbon release.	As part of PTTEP AA's commitment to continuous improvement, PTTEP AA's management culture, operational capabilities, safety processes, and environmental systems are routinely evaluated and strengthened to align with industry good practice. PTTEP AA is committed to operate safely, responsibly and sustainably to deliver maximum benefit while minimising the impact on the environment. PTTEP AA has recently increased its commitment to refresher training of the PTTEP AA emergency response team. PTTEP AA has also increased the level of external resources to support PTTEP AA's response (including environmental specialists) in the event that an unplanned release of hydrocarbons occurs. In addition, PTTEP AA has increased the response team to allow 24-hour coverage for an extended time frame. PTTEP AA has developed an Oil Pollution Emergency Plans (OPEP) for the proposed exploration and appraisal drilling program. The purpose of the OPEP is to detail the procedures and resources through which PTTEP AA will minimise the effect of a marine oil spill. The OPEP provides background on the appropriate response strategies and available oil spill response resources. The Department of Transport (DoT), Australian Marine Safety Authority (AMSA) and Australian Marine Oil Spill Centre (AMOSC) will have an opportunity to review and provide feedback on the OPEP.	Section 5 OPEP

9.5 ONGOING CONSULTATION

PTTEP AA is committed to engaging with stakeholders throughout the duration of the EADP. At all times, PTTEP AA will maintain dedicated channels for enquiries, whether related to the EP, another project or activity, or of a general nature.

Prior to each subsequent drilling campaign, stakeholders will be provided the following information:

- An overview of the drilling campaign (including the purpose, location, activity description, timing and duration);
- Contact details (telephone number, email address, postal address and website details); and
- An update on other PTTEP AA activities.

Key ongoing stakeholder consultation commitments for the EADP are outlined in Table 9-3. A number of Government agencies and organisations are identified as requiring notifications prior to, during and/or after each drilling campaign. The required notifications are summarised in Table 9-4.In addition, PTTEP AA will issue a factsheet annually, in an effort to keep stakeholders abreast of all activities and to maintain good working relationships.

PTTEP AA will undertake an assessment of the merits of all stakeholder feedback, objections or claims received throughout the duration of the EADP and endeavour to respond in an accurate and timely manner to all communications. All consultation will be recorded in the PTTEP AA Correspondence Database.

Table 9-3 Ongoing Consultation Requirements

Stakeholders	Timing	Method and Information
Acceptance Notification		
All stakeholders, excluding agencies and organisations identified in Table 9-4 that have separate regulatory or operational notification requirements.	Notification to be sent within 1 week of the EP Summary being published on NOPSEMA's website.	Email or letter notification confirming date of acceptance and including a link to the EP Summary on NOPSEMA website.
Drilling Campaign Commencement Notification		
All stakeholders, excluding agencies and organisations identified in Table 9-4 that have separate regulatory or operational notification requirements.	2 weeks prior to commencement of activities.	Email or letter notification informing stakeholders of the commencement of drilling activities.
Drilling Campaign Cessation Notification		
All stakeholders, excluding agencies and organisations identified in Table 9-4 that have separate regulatory or operational notification requirements.	Within 2 weeks of cessation of activities.	Email or letter notification informing stakeholders of the completion of drilling activities.

Table 9-4 Activity Notifications

Agency / Organisation	Timing
Drilling Campaign Commencement Notification	
Australian Hydrographic Service	Notification 4 weeks prior to commencement of activities for promulgation of a Notice to Mariners. Confirmation send to AHS prior to commencement of activities.
AMSA JRCC	24 to 48 hours prior to the commencement of activities.
Drilling Campaign Cessation Notification	
AMSA JRCC	Upon completion of activities.

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APPENDIX A - STAKEHOLDER CONSULTANT LOG

Stakeholder	Date of Correspondence	Engagement Method	Supplementary Information	To / From Stakeholder	Summary of Contact / Correspondence	Assessment of Merit	Subsequent actions undertaken
Commonwealth Government							
Australian Hydrographic Service	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Australian Fisheries Management Authority	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Australian Maritime Safety Authority	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	21/02/2018	Email	N/A	Received	Email received from AMSA. AMSA providing information on shipping in the located of the two petroleum title blocks. Commercial shipping will be encountered during the life of these drilling activities. AMSA provided PTTEP with a vessel traffic plot showing 6 months of AIS data. In addition, AMSA request that the MODU notify AMSA's Joint Rescue Coordination Centre (JRCC), 24-48 hrs prior to the commencement of operations. In addition, AMSA has requested the Australian Hydrographic Office be contacted no less than four weeks before operations commence.	N/A - Advice / request for further information only. No objection or claim made.	Updated stakeholder registry. Updated ongoing consultation section of the EP.
	23/02/2018	Email	N/A	Sent	Email sent to AMSA, acknowledging receipt of the information received. PTTEP confirming that the MODU will notify AMSA JRCC 24-48 hrs before the commencement of operations. In addition, PTTEP will contact AHO no less than 4 weeks prior to the commencement of activities.	N/A	N/A
Department of Defence	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Department of Immigration and Border Protection	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided by 20/03/2018. Stakeholders were informed that PTTEP AA is planning on submitting the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018.	N/A	N/A
Department of Agriculture and Water Resources	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Telephone	N/A	Sent	A phone call was made to DWAR, however no answer. A message was left for DWAR requesting DWAR to provide feedback on the proposed Drilling EP.	N/A	N/A

Stakeholder	Date of Correspondence	Engagement Method	Supplementary Information	To / From Stakeholder	Summary of Contact / Correspondence	Assessment of Merit	Subsequent actions undertaken
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided by 20/03/2018. Stakeholders were informed that PTTEP AA is planning on submitting the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018.	N/A	N/A
Department of Industry, Innovation and Science	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided by 20/03/2018. Stakeholders were informed that PTTEP AA is planning on submitting the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018.	N/A	N/A
Director of National Parks (Department of Environment and Energy)	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	02/03/2018	Email	N/A	Received	Email received from DNP. The DNP acknowledging receipt of the information received. The DNP has noted that the planned activities do not overlap any Australian Marine Parks. DNP does not require any further notification on the progress made in relation to this activity, unless details regarding the activity change and result in an overlap with a marine park. In planning for emergency response actions that are likely to occur within a marine parks, the DNP requests that the EP/and or OPEP considers the potential impacts on the parks values and reduced to ALARP.	N/A - No objection or claim made.	N/A
	19/03/2018	Email	N/A	Sent	Email sent to Director of National Parks - acknowledging receipt of information provided by Marine Reserves.	N/A	N/A
Department of Foreign Affairs and Trade	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided by 20/03/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018.	N/A	N/A
Department of Communications and the Arts	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided by 20/03/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018.	N/A	N/A
National Native Title Tribunal	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	21/03/2018	Email	N/A	Sent	Email received from NNTT. The NNTT does not have any further comments.	N/A	N/A
Geoscience Australia	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided by 20/03/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018.	N/A	N/A

Stakeholder	Date of Correspondence	Engagement Method	Supplementary Information	To / From Stakeholder	Summary of Contact / Correspondence	Assessment of Merit	Subsequent actions undertaken
Western Australian Government							
Department of Biodiversity, Conservation and Attractions	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Department of Primary Industries and Regional Development (Fisheries)	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Telephone	N/A	N/A	A phone call was made to DPIRD, however there was no answer. A message was left for DPIRD requesting the Department to provide feedback on the proposed Drilling EP.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided by 20/03/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018.	N/A	N/A
	20/03/2018	Telephone	N/A	N/A	A phone call was made to Senior Management Officer DPIRD, however there was no answer. A message was left for DPIRD requesting for the Department to provide feedback on the proposed Drilling EP.	N/A	N/A
	22/03/2018	Telephone	N/A	N/A	A phone call was made to Senior Management Officer DPIRD, however there was no answer. A message was left for DPIRD requesting for the Department to provide feedback on the proposed Drilling EP.	N/A	N/A
	17/04/2018	Telephone	N/A	N/A	A phone call was made to Aquatic Biosecurity Principal Management Officer (Aquatics Resources) in regards to discussing the particular commitments made in respect to biofouling risk management in the EP, however there was no answer. A message was left requesting a call back.	N/A	N/A
	18/04/2018	Telephone	N/A	N/A	A phone call was made to Aquatic Biosecurity Principal Management Officer (Aquatics Resources) in regards to discussing the particular commitments made in respect to biofouling risk management in the EP, however there was no answer. A message was left requesting a call back.	N/A	N/A
	19/04/2018	Telephone	N/A	N/A	A phone call was made to Aquatic Biosecurity Principal Management Officer (Aquatics Resources) in regards to discussing the particular commitments made in respect to biofouling risk management in the EP, however there was no answer. A message was left requesting a call back.	N/A	N/A
	19/04/2018	Telephone	N/A	N/A	A phone call was made to Principal Scientist (Aquatics Biodiversity) in regards to discussing the particular commitments made in respect to biofouling risk management in the EP, however there was no answer. A message was left requesting a call back.	N/A	N/A
	06/06/2018	Telephone	N/A	N/A	PTTEP contacted the Department by phone regarding the Department's Vessel Check Tool. PTTEP confirmed that PTTEP plans to use the tool for vessels entering WA State waters. The Department clarified that the tool should be used as a pre-entry assessment for vessels entering Australian waters within the 12 Nm limit off Western Australia (WA), or in WA Coastal Waters. The assessment should be undertaken for an initial entry for vessels arriving from overseas or interstate, but does not require additional assessment upon re-entry following being offshore at a rig or platform. PTTEP requested additional information on the Vessel Check tool methodology, scores and weightings so that an equivalent risk assessment approach could be applied to vessels entering NT waters. The Department explained that the tool is complex and details cannot be made available due to Intellectual Property rights. The Department recommended contacting Biosecurity Branch at NT Fisheries, with whom we can discuss the requirements and risk assessment tools pre-entry into NT-waters. The Department followed-up with direct contact details for the NT biosecurity branch.	N/A - Advice / request for further information only. No objection or claim made.	The information obtained from the Department was incorporated into the appropriate risk assessment sections.

Stakeholder	Date of Correspondence	Engagement Method	Supplementary Information	To / From Stakeholder	Summary of Contact / Correspondence	Assessment of Merit	Subsequent actions undertaken
Department of Water and Environmental Regulation	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided by 20/03/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018.	N/A	N/A
Department of Mines, Industry Regulation and Safety	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	23/02/2018	Email	N/A	Received	Email received from DMIRS, acknowledging receipt of the information provided. DMIRS has reviewed the information and at this stage, no further information is required. DMIRS would like to be kept informed on the exploration and appraisal drilling program (as further details become available - i.e. timing and location of additional wells).	N/A - Advice / request for further information only. No objection or claim made.	Updated ongoing consultation section of the EP.
	23/02/2018	Email	N/A	Sent	Email sent to DMIRS thanking the Department for the prompt response. PTTEP AA appreciated the Departments ongoing response to PTTEP's activities and as requested will keep DMIRS updated on the exploration and appraisal drilling program.	N/A	N/A
Department of Jobs, Tourism, Science and Innovation	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided by 20/03/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018.	N/A	N/A
Department of Transport	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	20/02/2018	Telephone	N/A	N/A	A telephone conversation was held with DoT. PTTEP AA provided DoT with background information on the activities PTTEP AA is currently involved in. PTTEP AA informed DoT that the OPEP would be provided to DoT in mid-late March 2018.	N/A	N/A
	20/02/2018	Email	N/A	Sent	Subsequent to the phone conversation, an email was sent to DoT summarising the conversation. The following points were raised: • PTTEP AA is currently developing an OPEP to support the Drilling EP and the Montara Operations EP. • The Montara Production Drilling OPEP was developed to support the drilling of H5 well to provide oil to the Montara Venture. The OPEP was accepted by NOPSEMA 24 August. A final revision, incorporated updates in response to comments from DoT and NOPSEMA, was issued to DoT on 29 August 2018. • The Montara Operations EP and OPEP were resubmitted to NOPSEMA, at their request following an inspection, on 20 September 2017. The content of the Montara Operations OPEP is the same as that in the OPEP for the 2017 drilling campaign, with minor updates to place it in context of Operations, and the content remained in alignment with your comments on the Montara Production Drilling OPEP. This document was therefore not resent to DoT for comment. The Montara Operations OPEP was accepted by NOPSEMA on December 4. The OPEP was then updated to include responses to NOPSEMA comments and a copy was issued to DoT for use on 19 December 2017.	N/A - Advice / request for further information only. No objection or claim made.	N/A
	16/03/2018	Email	N/A	Sent	Email sent to DoT requesting a meeting to discuss PTTEP AA's OPEP and to discuss the changes PTTEP AA have made and how PTTEP AA has incorporated the requirements of the new IGN. PTTEP AA is in the position to provide a copy for review at the end of March.	N/A - Advice / request for further information only. No objection or claim made.	Organised a meeting with DoT to discuss OPEP and new DoT IGN.

Stakeholder	Date of Correspondence	Engagement Method	Supplementary Information	To / From Stakeholder	Summary of Contact / Correspondence	Assessment of Merit	Subsequent actions undertaken
	19/03/2018	Email	N/A	Received	Email received from DoT - organising dates to meet and discuss OPEP.	N/A	N/A
	19/03/2018	Email	N/A	Sent	Email sent to DoT - organising dates to meet and discuss OPEP.	N/A	N/A
	19/03/2018	Email	N/A	Received	Email received from DoT - organising dates to meet and discuss OPEP.	N/A	N/A
	19/03/2018	Email	N/A	Sent	Email sent to DoT - organising dates to meet and discuss OPEP.	N/A	N/A
	27/03/2018	Face-to-face meeting	N/A	N/A	A face-face meeting was held with the DoT. The main points raised: • PTTEP AA are developing a single OPEP to cover both Montara Operations and the AC/P54 and AC/RL7 EADP (consisting of two parts; Part A: common content, Part B: supporting information relevant to spill scenarios). • PTTEP AA will be submitting an EP/OPEP to cover up to five wells in five years. • PTTEP will provide the OPEP and relevant section of the EP for the DoT review on 11/04/18. Comments provided by DoT will be included as relevant. In the final version issued - PTTEP will need to demonstrate to NOPSEMA that DoT comments have been addressed, prior to acceptance of the EP/OPEP by NOPSEMA. • Discussed the Kimberley Concept Plan • PTTEP AA confirmed that the Montara Production Drilling EP will be closed soon work under this EP has been completed (in 2017). • PTTEP AA confirmed an ALARP assessment has been performed for the response strategies. • DoT provided PTTEP AA with Appendix 6 of the DoT Offshore Petroleum Industry Guidance Note - Marine Oil Pollution: Response and consultation Arrangements provides requirements for OPEP content. • DoT have suggested to review comments/feedback provided on Montara Production Drilling EP. • DoT suggests to make it clear in the OPEP how the EMT structure aligns with the DoT IMT structure. • DoT perform an oil and gas based oil spill drill every two years. DoT inviting PTTEP AA to observe this year's drill (vessel based). • DoT requesting PTTEP to direct DoT to any unique oil spill scenarios when the OPEP is submitted for review.	N/A - Advice / request for further information only. No objection or claim made.	Follow-up email was sent to DoT with a summary of the points discussed.
	03/04/2018	Email	N/A	Sent	Email sent to DoT providing a summary of the information discussed. The main points: • PTTEP AA are developing a single OPEP to cover both Montara Operations and the AC/P54 and AC/RL7 EADP (consisting of two parts; Part A: common content, Part B: supporting information relevant to spill scenarios). • PTTEP AA will be submitting an EP/OPEP to cover up to five wells in five years. • PTTEP will provide the OPEP and relevant section of the EP for the DoT review on 11/04/18. Comments provided by DoT will be included as relevant. In the final version issued - PTTEP will need to demonstrate to NOPSEMA that DoT comments have been addressed, prior to acceptance of the EP/OPEP by NOPSEMA. • Discussed the Kimberley Concept Plan • PTTEP AA confirmed that the Montara Production Drilling EP will be closed soon work under this EP has been completed (in 2017). • DoT have suggested to review comments/feedback provided on Montara Production Drilling EP. • DoT suggests to make it clear in the OPEP how the EMT structure aligns with the DoT IMT structure. • DoT perform an oil and gas based oil spill drill every two years. DoT inviting PTTEP AA to observe this year's drill (vessel based).	N/A - Advice / request for further information only. No objection or claim made.	N/A
	06/04/2018	Email	N/A	Received	Email received from DoT, acknowledging receipt of email dated 06/04/2018.	N/A	N/A

Stakeholder	Date of Correspondence	Engagement Method	Supplementary Information	To / From Stakeholder	Summary of Contact / Correspondence	Assessment of Merit	Subsequent actions undertaken
	18/04/2018	Email	N/A	Sent	Email sent to the DoT, informing DoT that PTTEP AA's document Control Team will be transmitting a copy of the following documents for the DoT's review: • Draft PTTEP OPEP • Draft OPEP EADP EP Addendum • Extracts from the Draft AC/P54 and AC/RL7 EADP EP. PTTEP AA transmittal records show documents were transmitted to DoT on 18.04.2018.	N/A	N/A
	19/04/2018	Email	N/A	Received	Email received from DoT confirming that the Department has received copies of those documents. DoT will review and let PTTEP AA know if there are any queries.	N/A	N/A
	19/04/2018	Email	N/A	Sent	Email sent to DoT, thanking the Department for confirming the transmittal of documents. PTTEP look forward to receiving a response from the DoT.	N/A	N/A
	30/05/2018	Email	N/A	Received	Email received from DoT. The DoT undertook a review of the PTTEP AA Oil Pollution Emergency Plan (Rev 0) and supporting documentation. DoT provided comments/feedback	N/A - Advice / request for further information only. No objection or claim made.	See response to DoT on 14/06/2018.
	14/06/2018	Email	N/A	Sent	Email sent to DoT in response to DoT's email date 30/05/2018. PTTEP AA provided response to DoT's comments/feedback. In addition, PTTEP AA provided the DoT with an updated OPEP (Rev 1)), including DoT's feedback in the OPEP.	PTTEP updated OPEP and provided a response to each query/comment provided by DoT.	N/A
	19/06/2018	Email	N/A	Received	Email received from the DoT in response to PTTEP's email date 14/06/2018. DoT received PTTEP's response including the attached documents. DoT will review and provide further queries if required. DoT advised that they could take up to 6 weeks to review the OPEP under the new IGN, but DoT advised it will likely be quicker as it is a re-revision (i.e. 3 weeks).	N/A - Advice / request for further information only. No objection or claim made.	N/A - No further actions required.
Shire of Wyndham East Kimberley	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided by 20/03/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018.	N/A	N/A
Shire of West Derby/West Kimberley	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided by 20/03/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018.	N/A	N/A
Western Australian Museum	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided by 20/03/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018.	N/A	N/A
Northern Territory Government							
Department of Primary Industries and Resources (Primary Industries and Fisheries)	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A

Stakeholder	Date of Correspondence	Engagement Method	Supplementary Information	To / From Stakeholder	Summary of Contact / Correspondence	Assessment of Merit	Subsequent actions undertaken
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided by 20/03/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018.	N/A	N/A
	07/06/2018	Telephone	N/A	N/A	PTTEP contacted the Department by phone to discuss expectations for biofouling assessment and management in NT waters. The Department confirmed that as biofouling is not regulated, the NT does not have any formal requirements and do not have the tools or the resources that the WA does. The Department recommends that proponents follow the Australian guidelines (National Biofouling Management Guidance for the Petroleum Production and Exploration Industry), and inspect and clean as necessary prior to entering NT waters - the onus is on the proponent to reduce the risk. The Department advised that is may be possible to use the WA Vessel Check tool to provide an indication of the level of risk for NT waters, but the vessel journey/location would reflect a WA location. The NT department does not inspect vessels but does have powers to issue orders if IMS is identified, which could be costly.	N/A - Advice / request for further information only. No objection or claim made.	The information obtained from the Department was incorporated into the appropriate risk assessment sections.
Department of Primary Industries and Resources (Mines & Petroleum)	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided by 20/03/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018.	N/A	N/A
Department of Infrastructure, Planning and Logistics	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided by 20/03/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018.	N/A	N/A
Northern Territory Environmental Protection Authority	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided by 20/03/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018.	N/A	N/A
Department of Tourism and Culture	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided by 20/03/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018.	N/A	N/A
	15/03/2018	Email	N/A	Received	Email received from Department. The Department does not have any concerns at this stage.	N/A	N/A
Department of Environment and Natural Resources	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided by 20/03/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018.	N/A	N/A

Stakeholder	Date of Correspondence	Engagement Method	Supplementary Information	To / From Stakeholder	Summary of Contact / Correspondence	Assessment of Merit	Subsequent actions undertaken
Department of the Chief Minister	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided by 20/03/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018.	N/A	N/A
Commercial Fishing Industry							
Fishing Associations/Representative Bodies							
Commonwealth Fisheries Association	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder via WAFIC with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks. Requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Received	Email received via WAFIC - CFA satisfied that WAFIC have contacted the correct industry members. CFA will forward on to those members who may have an interest. No further comment received.	N/A	N/A
Northern Territory Seafood Council	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Pearl Producers Association	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholders via WAFIC with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	25/03/2018	Email	N/A	Sent	Follow-up email sent to PPA via WAFIC providing a summary of queries raised by other commercial fisheries operating in the region and PTTEP's response.	N/A	N/A
Western Australian Fishing Industry Council	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	08/03/2018	Email	N/A	Received	Email received from WAFIC providing feedback on the Drilling EP. The following concerns were raised: • Please confirm, what is PTTEP's communication strategy with PTTEP's contractors and sub-contractors? • Please advise if you have a clear directive to all involved that commercial fishers are permitted to enter a Cautionary Area and fish, transit or anchor? • Can you please also confirm there is a clear line of communication with support vessels operating outside of PTTEP's exclusion zone to be aware of potential commercial fishing activity and where possible, do not disrupt commercial fishing from support vessels? • Note fisher concerns re post-Montara incident legal battle by other jurisdiction fishers and concerns that should it happen again they will not be protected. • Note commercial fishing industry concern re the onus of responsibility in the event of another significant spill. • Keen to understand PTTEP's policy in relation to compensation to the commercial fishing industry in the event of another spill.	Stakeholder concern is to be addressed in the EP.	Updated risk assessment sections with information obtained from stakeholder.

Stakeholder	Date of Correspondence	Engagement Method	Supplementary Information	To / From Stakeholder	Summary of Contact / Correspondence	Assessment of Merit	Subsequent actions undertaken
	19/03/2018	Email	N/A	Sent	Email sent to WAFIC (in response to WAFIC's email on 08/03/2018). The following comments were raised: • PTTEP AA employees and contractors are required to complete an 'Environmental Awareness' induction prepared by PTTEP AA prior to mobilisation. • A 500m Petroleum Safety Zone will be in place around the MODU during the drilling campaigns, in accordance with the OPGGSA. The AHS will issue a Notice to Mariners and the PSZ will be noted on the Admiralty Chart covering the region. No Cautionary Area is planned to be in place for the drilling campaigns covered by this EP. A pre-existing 500m radius PSZ is currently in place around the Montara wellhead platform. • PTTEP AA will communicate the sensitivities you have raised via the 'Environmental Awareness' induction process, and make contractors and sub-contractors aware of the fishing industry's sensitivity to this issue. In particular, PTTEP AA will remind all employees and contractors to comply with the Navigation Act 2012, AMSA Marine Orders 21 (Safety and emergency arrangements), AMSA Marine Order 30 (Prevention of Collisions), International Convention for the Safety of Life at Sea (SOLAS) and the International Regulations for Preventing Collisions at Sea 1972 (COLREGS). Please note support vessels are planned to transit from the exploration permit AC/P54 and retention lease AC/RL7 to the port of Darwin once to three times a week. • To PTTEP AA's knowledge, APPEA has not taken a public position on fishing from O&G support/commercial vessels, although it is acknowledged that discussions between APPEA and fishery representative bodies are ongoing regarding how the industries can better work together. Nonetheless, PTTEP AA will communicate the sensitivities you have raised via the 'Environmental Awareness' induction process, and make contractors and sub-contractors aware of WAFIC's position. • Like all offshore operators, as part of its license to operate offshore, PTTEP AA is required by the regulator, NOPSEMA to hold sufficient financial resources to ensure it can meet any likely clean-up costs. It is worth noting that extensive studies undertaken by leading independent scientific research bodies after the Montara oil spill in 2009 identified no ongoing damaged to flora and fauna in the Timor Sea and in consequence, no compensation claims have been brought in Australia or any other jurisdiction in respect of damage to fisheries. PTTEP AA has always accepted full responsibility for the Montara wellhead blowout and subsequent uncontrolled flow of hydrocarbons into the Timor Sea.	N/A	N/A
	27/03/2018	Email	N/A	Received	Email received acknowledging receipt of PTTEP AA's response dated 19/03/2018. No further comments were provided.	N/A	N/A
	31/05/2018	Email	N/A	Sent	Email sent to WAFIC to provide an update on comments that were provided 19/03/2018 • Advised that the Exploration and Appraisal Drilling EP was submitted to NOPSEMA on 24/04/2018 and returned with feedback. • Advised of PTTEP AA's responsibilities under the Offshore Greenhouse Gas Storage Act 2006 (OPGGSA). • Please note provisions are not designed to cover compensation for loss and ongoing damage to other parties. • Advised of PTTEP AA's policy involving third party liabilities.	N/A - Advice / request for further information only. No objection or claim made.	N/A
	07/06/2018	Email	N/A	Received	Email received from WAFIC in response to PTTEP's email sent on 31/05/2018. WAFIC raised the following points: • Additional information provided was very helpful when considered against the two PTTEP environment plans but also very helpful to have a clear understanding of the compensation process as required via the Act which is applicable to all petroleum industry participants. • In in the event of a significant spill, we would greatly appreciate receiving information on PTTEP AA's process of what would happen after the priority of the elimination / control of the escaped petroleum and the clean-up operation and there after	N/A - Advice / request for further information only. No objection or claim made.	See response to WAFIC on 13/06/2018.

Stakeholder	Date of Correspondence	Engagement Method	Supplementary Information	To / From Stakeholder	Summary of Contact / Correspondence	Assessment of Merit	Subsequent actions undertaken
					environmental monitoring perhaps concurrent with the assessment of third party claimants.		
	13/06/2018	Email	N/A	Sent	Email sent to WAFIC, providing further information on compensation in the event of a spill. As previously, noted, in the event of an unplanned release of hydrocarbons to the marine environment, the PTTEP NOPSEMA approved Oil Pollution Emergency Plan and Operational Scientific Monitoring Program will be implemented. This will involve engaging with relevant stakeholders, as determined based on the nature of the release. At any time, all stakeholders are encouraged to contact PTTEP AA with queries or concerns. Stakeholders, who believe a compensation claim is appropriate, will need to seek their own legal advice. The process as noted above will entail any potentially affected party to seek their own legal advice.	N/A - PTTEP provided stakeholder with additional information.	N/A
Australian Southern Bluefin Tuna Industry Association	20/02/2018	Email	Factsheet	Sent	Email sent to ASBTIA via WAFIC with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	22/03/2018	Email	N/A	Received	Email received via WAFIC (in response to email dated 20/02/2018). The following comments were raised: • Seeking assurances regarding PTTEP's oil spill response capability in this isolated area of ocean. • Seeking assurances PTTEP will financially protect the southern Bluefin tuna industry should a spill event impact the SBT migration resulting in quantifiable death of fish, disruption of migration etc.	N/A	N/A
	26/03/2018	Email	N/A	Sent	Email sent to WAFIC via ASBITA. The following comments were provided to license holder: • PTTEP AA is aware the marine enviro nment of the North West Marine Region is an important area for supporting high biodiversity, and acknowledges the area as being potentially a part of the offshore/inshore fish movement and breeding area. PTTEP AA is also aware that no commercial fishing for southern Bluefin tuna is currently conducted within the AC/P54 exploration permit and AC/RL7 retention lease. PTTEP AA has completed a detailed assessment of the risks and impacts that the exploration and appraisal drilling activities could have on the environment as well as on commercial fisheries. • PTTEP AA has developed Oil Pollution Emergency Plans (OPEP) for all previous EPs. The purpose of the OPEP is to detail the procedures and resources through which PTTEP AA will minimise the effect of a marine oil spill. The OPEP provides background on the appropriate response strategies and available oil spill response resources. The Department of Transport (DoT), Australian Marine Safety Authority (AMSA) and Australian Marine Oil Spill Centre (AMOSC) have reviewed and provided feedback on PTTEP AA OPEPs to date. • PTTEP AA has recently committed to increased refresher training of the PTTEP AA emergency response team and increase the level of external resources to support PTTEP AA's response in the event of an unplanned release of hydrocarbons to the marine environment. • Like all offshore operators, as part of its license to operate offshore, PTTEP AA is required by the regulator, NOPSEMA to hold sufficient financial resources to ensure it can meet any likely clean-up costs. It is worth noting that extensive studies undertaken by leading independent scientific research bodies after the Montara oil spill in 2009 identified no ongoing damaged to flora and fauna in the Timor Sea and in consequence, no compensation claims have been brought in Australia or any other jurisdiction in respect of damage to fisheries. PTTEP AA has always accepted full responsibility for the Montara wellhead blowout and subsequent uncontrolled flow of hydrocarbons into the Timor Sea.	N/A	N/A

Stakeholder	Date of Correspondence	Engagement Method	Supplementary Information	To / From Stakeholder	Summary of Contact / Correspondence	Assessment of Merit	Subsequent actions undertaken
	31/05/2018	Email	N/A	Sent	Email sent to WAFIC to pass on to ASBTIA to provide an update on comments that were provided 26/03/2018: • Advised that the Exploration and Appraisal Drilling EP was submitted to NOPSEMA on 24/04/2018 and returned with feedback. • Advised of PTTEP AA's responsibilities under the Offshore Greenhouse Gas Storage Act 2006 (OPGGSA). • Please note provisions are not designed to cover compensation for loss and ongoing damage to other parties. • Advised of PTTEP AA's policy involving third party liabilities.	N/A - PTTEP provided stakeholder with additional information.	N/A
	07/06/2018	Email	N/A	Received	Email received via WAFIC in response to PTTEP's email sent on 31/05/2018. Stakeholder raised the following points: • Additional information provided was very helpful when considered against the two PTTEP environment plans but also very helpful to have a clear understanding of the compensation process as required via the Act which is applicable to all petroleum industry participants. • In in the event of a significant spill (from any oil and gas operators), we would greatly appreciate receiving information on PTTEP AA's process of what would happen after the priority of the elimination / control of the escaped petroleum and the clean-up operation and there after environmental monitoring perhaps concurrent with the assessment of third party claimants.	N/A - Advice / request for further information only. No objection or claim made.	See response to ASBTIA on 13/06/2018.
	08/06/2018	Email	N/A	Received	Email received from WAFIC confirming feedback dated 07/06/2018 - is applicable to all stakeholders cc'd into response including ASBTIA.	N/A - Advice / request for further information only. No objection or claim made.	N/A
	13/06/2018	Email	N/A	Sent	Email sent via WAFIC to ASBTIA, providing further information on compensation in the event of a spill. As previously, noted, in the event of an unplanned release of hydrocarbons to the marine environment, the PTTEP NOPSEMA approved Oil Pollution Emergency Plan and Operational Scientific Monitoring Program will be implemented. This will involve engaging with relevant stakeholders, as determined based on the nature of the release. At any time, all stakeholders are encouraged to contact PTTEP AA with queries or concerns. Stakeholders, who believe a compensation claim is appropriate, will need to seek their own legal advice. The process as noted above will entail any potentially affected party to seek their own legal advice. As always, if you have additional queries or comments, please do not hesitate to contact me directly or email PTTEP at communications@pttep.com.	N/A - PTTEP provided stakeholder with additional information	N/A
	14/06/2018	Email	N/A	Received	Response revised via WAFIC from ASBTIA. ASBTIA requesting to be provided with a copy of the approved Oil Pollution Emergency Plan and Operational Scientific Monitoring Program.	N/A - Advice / request for further information only. No objection or claim made.	See response to ASBTIA on 18/06/2018.
	18/06/2018	Email	N/A	Sent	Email sent via WAFIC to ASBTIA. Further to your request below seeking a copy of PTTEP AA's approved Oil Pollution Emergency Plan and Operational Scientific Monitoring Program. PTTEP are not in a position to provide the NOPSEMA approved Oil Pollution Emergency Plan and Operational Scientific Monitoring Program. Once the documents are approved, and if you are interested, PTTEP are able to meet / tele-conference and talk through the contents and answer any questions you may have.	N/A - PTTEP provided stakeholder with additional information.	N/A
	18/06/2018	Email	N/A	Received	Response received via WAFIC from ASBTIA. ASBTIA provided the following response. That is not very transparent, especially given that the OPEP and OSMP are already approved. I would have thought the written report would be sufficient for now and we can organise a meeting or teleconference if we have questions regarding the content. Is it a matter of ensuring our members sign some sort of confidentiality agreement?	N/A - Advice / request for further information only. No objection or claim made.	See response to ASBTIA on 19/06/2018.

Stakeholder	Date of Correspondence	Engagement Method	Supplementary Information	To / From Stakeholder	Summary of Contact / Correspondence	Assessment of Merit	Subsequent actions undertaken
	20/06/2018	Email	N/A	Sent	Email sent to ASBTIA via WAFIC providing further information on the OPEP/OSMP. The OPEP and OMSP are not approved; they are contained within each environment plan and will not be approved until the overarching environment plans are accepted by NOPSEMA. PTTEP AA are happy to meet with the ASBTIA to talk through the final approved documents. PTTEP AA are not in a position to release the OPEP and OSMP.	N/A - PTTEP provided stakeholder with additional information.	N/A
Australian Council of Prawn Fisheries	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Northern Prawn Fishery Industry Pty Ltd	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
License Holders in WA State Managed Fisheries (contacted via WAFIC)							
Mackerel Managed Fishery (Area 1)	22/02/2018	Email	Factsheet	Sent	Email sent via WAFIC to stakeholders with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks. PTTEP requesting feedback from stakeholders.	N/A	N/A
Northern Demersal Scalefish Fishery (Area 2)	22/02/2018	Email	Factsheet	Sent	Email sent via WAFIC to stakeholders with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks. PTTEP requesting feedback from stakeholders.	N/A	N/A
Joint Authority Northern Shark Fishery	22/02/2018	Email	Factsheet	Sent	Email sent via WAFIC to stakeholders with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks. PTTEP requesting feedback from stakeholders.	N/A	N/A
License Holders in NT State Managed Fisheries (contacted via mail)							
Demersal Fishery	20/02/2018	Letter	Factsheet	Sent	Letter sent to all license holders with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks. PTTEP AA requesting feedback from stakeholders.	N/A	N/A
Spanish Mackerel Managed Fishery	20/02/2018	Letter	Factsheet	Sent	Letter sent to all license holders with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks. PTTEP AA requesting feedback from stakeholders.	N/A	N/A
Commercial Fishing License Holders (whom provided feedback via WAFIC)							
Mareterram Bay	22/02/2018	Email	Factsheet	Sent	Email sent via WAFIC to stakeholders with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks. PTTEP requesting feedback from stakeholders.	N/A	N/A
	07/03/2018	Email	N/A	Received	Email received via WAFIC. License holders does not have any immediate concerns re operations as new to the Mackerel Managed Fishery. General issues raised: • Mareterram is the largest owner of quota in the Mackerel Managed Fishery • Mareterram is seeking insurances that PTTEP will protect commercial fishers and assume (financial) responsibility for the impact of loss of fish stock, habitat and breeding stock in the event of another oil spill? • Seeking assurance that all PTTEP staff and contractors will divert around active fishing activity.	Stakeholder concern is to be addressed in the EP. Stakeholder is to be advised of the outcome.	Updated risk assessment sections with information obtained from stakeholder.

Stakeholder	Date of Correspondence	Engagement Method	Supplementary Information	To / From Stakeholder	Summary of Contact / Correspondence	Assessment of Merit	Subsequent actions undertaken
					• Expected that there will be no recreational fishing from any support vessels associated with the project.		
	19/03/2018	Email	N/A	Sent	Email sent to license holder via WAFIC. The following comments were provided to license holder: • Like all offshore operators, as part of its license to operate offshore, PTTEP AA is required by the regulator, NOPSEMA to hold sufficient financial resources to ensure it can meet any likely clean-up costs. It is worth noting that extensive studies undertaken by leading independent scientific research bodies after the Montara oil spill in 2009 identified no ongoing damaged to flora and fauna in the Timor Sea and in consequence, no compensation claims have been brought in Australia or any other jurisdiction in respect of damage to fisheries. PTTEP AA has always accepted full responsibility for the Montara wellhead blowout and subsequent uncontrolled flow of hydrocarbons into the Timor Sea. • PTTEP AA has recently committed to increased refresher training of the PTTEP AA emergency response team and increase the level of external resources to support PTTEP AA's response (including environmental specialists) in the event of an unplanned release of hydrocarbons to the marine environment. In addition, PTTEP AA has also increased the response team to allow 24 hour coverage for an extended time-frame. • PTTEP AA employees and contractors are required to complete an 'Environmental Awareness' induction prepared by PTTEP AA prior to mobilisation. • PTTEP AA will communicate the sensitivities you have raised via the 'Environmental Awareness' induction process, and make contractors and sub-contractors aware of the fishing industry's sensitivity to this issue. In particular, PTTEP AA will remind all employees and contractors to comply with the Navigation Act 2012, AMSA Marine Orders 21 (Safety and emergency arrangements), AMSA Marine Order 30 (Prevention of Collisions), International Convention for the Safety of Life at Sea (SOLAS) and the International Regulations for Preventing Collisions at Sea 1972 (COLREGS). Please note support vessels are planned to transit from the exploration permit AC/P54 and retention lease AC/RL7 to the port of Darwin once to three times a week. • A 500m Petroleum Safety Zone will be in place around the MODU during the drilling campaigns, in accordance with the OPGGSA. The AHS will issue a Notice to Mariners and the PSZ will be noted on the Admiralty Chart covering the region. No Cautionary Area is planned to be in place for the drilling campaigns covered by this EP. A pre-existing 500m radius PSZ is currently in place around the Montara wellhead platform	N/A	N/A
	22/03/2018	Email	N/A	Received	Email received via WAFIC. License holder acknowledging receipt of email and is happy with PTTEP's response to comments raised.	N/A	N/A
	31/05/2018	Email	N/A	Sent	Email sent to WAFIC to be passed on to the licence holder to provide an update on comments that were provided 19/03/2018 • Advised that the Exploration and Appraisal Drilling EP was submitted to NOPSEMA on 24/04/2018 and returned with feedback. • Advised of PTTEP AA's responsibilities under the Offshore Greenhouse Gas Storage Act 2006 (OPGGSA). • Please note provisions are not designed to cover compensation for loss and ongoing damage to other parties. • Advised of PTTEP AA's policy involving third party liabilities.	N/A - PTTEP provided stakeholder with additional information.	N/A
	06/06/2018	Email	N/A	Received	Email received via WAFIC in response to PTTEP's email sent on 31/05/2018. Mareterram raised the following points: • Additional information provided was very helpful when considered against the two PTTEP environment plans but also very helpful to have a clear understanding of the compensation process as required via the Act which is applicable to all petroleum industry participants. • In in the event of a significant spill, we would greatly appreciate receiving information on PTTEP AA's process of what would happen after the priority of the elimination / control of the escaped petroleum and the clean-up operation and there after	N/A - Advice / request for further information only. No objection or claim made.	See response to Mareterram on 13/06/2018.

Stakeholder	Date of Correspondence	Engagement Method	Supplementary Information	To / From Stakeholder	Summary of Contact / Correspondence	Assessment of Merit	Subsequent actions undertaken
					environmental monitoring perhaps concurrent with the assessment of third party claimants.		
	08/06/2018	Email	N/A	Received	Email received from WAFIC confirming feedback dated 07/06/2018 - is applicable to all stakeholders cc'd into response including ASBTIA.	N/A - Advice / request for further information only. No objection or claim made.	N/A
	13/06/2018	Email	N/A	Sent	Email sent via WAFIC to Mareterram, providing further information on compensation in the event of a spill. As previously, noted, in the event of an unplanned release of hydrocarbons to the marine environment, the PTTEP NOPSEMA approved Oil Pollution Emergency Plan and Operational Scientific Monitoring Program will be implemented. This will involve engaging with relevant stakeholders, as determined based on the nature of the release. At any time, all stakeholders are encouraged to contact PTTEP AA with queries or concerns. Stakeholders, who believe a compensation claim is appropriate, will need to seek their own legal advice. The process as noted above will entail any potentially affected party to seek their own legal advice.	N/A - PTTEP provided stakeholder with additional information.	N/A
Zamia Bay	08/03/2018	Email	N/A	Received	Email received via WAFIC. The following concerns were raised: • Assurance of PTTEP's environmental credentials for the above projects in relation to containment of loss and protection of fish stocks, fish spawn and marine environment. • Zamia Bay fishes the last six months of the year, accordingly prefer drilling to be done in the last six months of the year. • This is an isolated fishing area - which we have limited commercial fishing activity. • Region is potentially part of the offshore/inshore fish movements and breeding area - keen to see stocks fully protected from any possible environmental damage due to an oil spill. • Make sure PTTEP staff and contractors understand that commercial fishers also have a legal right to access ocean resources.	Stakeholder concern is to be addressed in the EP. Stakeholder is to be advised of the outcome.	Updated risk assessment sections with information obtained from stakeholder.
	19/03/2018	Email	N/A	Sent	Email sent to license holder via WAFIC. The following comments were provided to license holder: • PTTEP AA is aware the marine environment of the North West Marine Region is an important area for supporting high biodiversity, and acknowledges the area as being potentially a part of the offshore/inshore fish movement and breeding area. PTTEP AA has completed a detailed assessment of the risks and impacts that the exploration and appraisal drilling activities could have on environmental values, including fisheries. • PTTEP AA employees and contractors are required to complete an 'Environmental Awareness' induction prepared by PTTEP AA prior to mobilisation. • PTTEP has always accepted full responsibility for the Montara wellhead blowout and subsequent uncontrolled flow of hydrocarbons into the Timor Sea. Following the incident, PTTEP AA undertook an environmental monitoring and research program. It was one of the most extensive monitoring studies ever undertaken in Australian waters and has created a new world-class body of data on marine eco-systems in the Timor Sea. Independent scientific studies have shown no oil from the Montara incident reached the Australian and Indonesian mainlands and that there has been little or no detectable impact from the spill on any marine eco-system or species in the Timor Sea. • PTTEP AA has developed Oil Pollution Emergency Plans (OPEP) for all previous EPs. The purpose of the OPEP is to detail the procedures and resources through which PTTEP AA will minimise the effect of a marine oil spill. The OPEP provides background on the appropriate response strategies and available oil spill response resources. The Department of Transport (DoT), Australian Marine Safety Authority (AMSA) and Australian Marine Oil Spill Centre (AMOSC) have reviewed and provided feedback on PTTEP AA OPEPs to date. • A number of factors influence the timing and duration of PTTEP AA's drilling activities including the weather conditions, facility availability, and other operational considerations. PTTEP AA typical conducts drilling operations outside of the tropical cyclone season (November to April). The first exploration well (Orchid-1), is scheduled to	N/A	N/A

Stakeholder	Date of Correspondence	Engagement Method	Supplementary Information	To / From Stakeholder	Summary of Contact / Correspondence	Assessment of Merit	Subsequent actions undertaken
					be drilled, evaluated and abandoned in 2018. These activities are currently proposed to start in late Quarter 3, 2018 and are expected to take approximately 35 to 100 days. The results of the learnings from Orchid-1 will be incorporated into the design of additional wells. • PTTEP AA acknowledges that Zamia Bay conducts fishing activities in the last six months of the year. However, it is PTTEP AA's understanding that Zamia Bay does not operate more than 100nm from the coast, and the proposed drilling activities will be completed more than 120nm from the coast. PTTEP AA is also aware that fishing in the Mackerel Managed Fishery is typically conducted in shallow waters to approximately 70m. The proposed drilling activities will be completed in water depths of 115-230m. • PTTEP AA will communicate the sensitivities you have raised via the 'Environmental Awareness' induction process, and make contractors and sub-contractors aware of the fishing industry's sensitivity to this issue. In particular, PTTEP AA will remind all employees and contractors to comply with the Navigation Act 2012, AMSA Marine Orders 21 (Safety and emergency arrangements), AMSA Marine Order 30 (Prevention of Collisions), International Convention for the Safety of Life at Sea (SOLAS) and the International Regulations for Preventing Collisions at Sea 1972 (COLREGS). Please note support vessels are planned to transit from the exploration permit AC/P54 and retention lease AC/RL7 to the port of Darwin once to three times a week. • A 500m Petroleum Safety Zone will be in place around the MODU during the drilling campaigns, in accordance with the OPGGSA. The AHS will issue a Notice to Mariners and the PSZ will be noted on the Admiralty Chart covering the region. No Cautionary Area is planned to be in place for the drilling campaigns covered by this EP. A pre-existing 500m radius PSZ is currently in place around the Montara wellhead platform. • Like all offshore operators, as part of its license to operate offshore, PTTEP AA is required by the regulator, NOPSEMA to hold sufficient financial resources to ensure it can meet any likely clean-up costs. It is worth noting that extensive studies undertaken by leading independent scientific research bodies after the Montara oil spill in 2009 identified no ongoing damaged to flora and fauna in the Timor Sea and in consequence, no compensation claims have been brought in Australia or any other jurisdiction in respect of damage to fisheries.		
	31/05/2018	Email	N/A	Sent	Email sent to WAFIC to be passed onto the licence holder to provide an update on comments that were provided 19/03/2018 • Advised that the Exploration and Appraisal Drilling EP was submitted to NOPSEMA on 24/04/2018 and returned with feedback. • Advised of PTTEP AA's responsibilities under the Offshore Greenhouse Gas Storage Act 2006 (OPGGSA). • Please note provisions are not designed to cover compensation for loss and ongoing damage to other parties. • Advised of PTTEP AA's policy involving third party liabilities.	N/A - PTTEP provided stakeholder with additional information.	N/A
	07/06/2018	Email	N/A	Received	Email received via WAFIC in response to PTTEP's email sent on 31/05/2018. Mareterram raised the following points: • Additional information provided was very helpful when considered against the two PTTEP environment plans but also very helpful to have a clear understanding of the compensation process as required via the Act which is applicable to all petroleum industry participants. • In in the event of a significant spill, we would greatly appreciate receiving information on PTTEP AA's process of what would happen after the priority of the elimination / control of the escaped petroleum and the clean-up operation and there after environmental monitoring perhaps concurrent with the assessment of third party claimants.	N/A - Advice / request for further information only. No objection or claim made.	See response to Zamia Bay on 13/06/2018.

Stakeholder	Date of Correspondence	Engagement Method	Supplementary Information	To / From Stakeholder	Summary of Contact / Correspondence	Assessment of Merit	Subsequent actions undertaken
	13/06/2018	Email	N/A	Sent	Email sent via WAFIC to Zamia, providing further information on compensation in the event of a spill. As previously noted, in the event of an unplanned release of hydrocarbons to the marine environment, the PTTEP NOPSEMA approved Oil Pollution Emergency Plan and Operational Scientific Monitoring Program will be implemented. This will involve engaging with relevant stakeholders, as determined based on the nature of the release. At any time, all stakeholders are encouraged to contact PTTEP AA with queries or concerns. Stakeholders, who believe a compensation claim is appropriate, will need to seek their own legal advice. The process as noted above will entail any potentially affected party to seek their own legal advice.	N/A - PTTEP provided stakeholder with additional information.	N/A
Brown Dog Fishing	22/02/2018	Email	Factsheet	Sent	Email sent via WAFIC to stakeholders with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks. PTTEP requesting feedback from stakeholders.	N/A	N/A
	07/03/2018	Email	N/A	Received	Email received via WAFIC. The following concerns were raised: • What is PTTEP's policy on 'no fishing from support vessels'? • What processes do PTTEP have in place to quantitatively assess any damage to fish stocks in the event of another spill? • What lessons have been learned by PTTEP from the Montara incident (especially emergency response)? • Please ensure all PTTEP staff, contractors and sub-contractors are aware of the difference between exclusion zones and cautionary areas. • What is PTTEP's communication policy with all staff and vessel crew re interacting and protecting the rights of active commercial fishers.	Stakeholder concern is to be addressed in the EP. Stakeholder is to be advised of the outcome.	Updated risk assessment sections with information obtained from stakeholder.
	20/03/2018	Email	N/A	Sent	Email sent to stakeholder via WAFIC. The following points were raised: • PTTEP AA employees and contractors are required to complete an 'Environmental Awareness' induction prepared by PTTEP AA prior to mobilisation. • PTTEP AA will communicate the sensitivities you have raised via the 'Environmental Awareness' induction process, and make contractors and sub-contractors aware of the fishing industry's sensitivity to this issue. In particular, PTTEP AA will remind all employees and contractors to comply with the Navigation Act 2012, AMSA Marine Orders 21 (Safety and emergency arrangements), AMSA Marine Order 30 (Prevention of Collisions), International Convention for the Safety of Life at Sea (SOLAS) and the International Regulations for Preventing Collisions at Sea 1972 (COLREGS). Please note support vessels are planned to transit from the exploration permit AC/P54 and retention lease AC/RL7 to the port of Darwin once to three times a week. Please note a pre-existing 500m radius Petroleum Safety Zone is currently in place around the Montara wellhead platform. • PTTEP has always accepted full responsibility for the Montara wellhead blowout and subsequent uncontrolled flow of hydrocarbons into the Timor Sea. Following the incident, PTTEP AA undertook an environmental monitoring and research program. It was one of the most extensive monitoring studies ever undertaken in Australian waters and has created a new world-class body of data on marine eco-systems in the Timor Sea. Independent scientific studies have shown no oil from the Montara incident reached the Australian and Indonesian mainlands and that there has been little or no detectable impact from the spill on any marine eco-system or species in the Timor Sea. • PTTEP AA has developed Oil Pollution Emergency Plans (OPEP) for all previous EPs. The purpose of the OPEP is to detail the procedures and resources through which PTTEP AA will minimise the effect of a marine oil spill. The OPEP provides background on the appropriate response strategies and available oil spill response resources. The Department of Transport (DoT), Australian Marine Safety Authority (AMSA) and Australian Marine Oil Spill Centre (AMOSC) have reviewed and provided feedback on PTTEP AA OPEPs to date. • PTTEP AA has recently committed to increased refresher training of the PTTEP AA emergency response team and increase the level of external resources to support PTTEP AA's response (including environmental specialists) in the event of an unplanned release	N/A	N/A

Stakeholder	Date of Correspondence	Engagement Method	Supplementary Information	To / From Stakeholder	Summary of Contact / Correspondence	Assessment of Merit	Subsequent actions undertaken
					of hydrocarbons to the marine environment. In addition, PTTEP AA has also increased the response team to allow 24 hour coverage for an extended time-frame. • In the event of an unplanned release of hydrocarbons to the marine environment, the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) approved OPEP will be initiated. In addition, PTTEP AA will initiate an Operational and Scientific Monitoring Program (OSMP). The purpose of the OSMP is to provide guidance on how and when monitoring studies will be undertaken to collect scientific data to inform the spill and post-spill response. The studies will be selected based on the characteristics of the spill including trajectory. • The Montara Action Plan (MAP), which was developed by PTTEP AA in close consultation with the Australian Government following the spill, has guided PTTEP AA's improvements in recent years. The plan addressed the root causes of the incident as identified in the Borthwick Report. The development and implementation of PTTEP AA's revised governance and operating systems, processes and standards were validated by five independent reviews commissioned by the Australian Government, which occurred over a 28 month period. The MAP was closed out by the (then) Resources Minister in June 2013 stating that he was satisfied that "best practice" was in place for Montara. As part of PTTEP AA's commitment to continuous improvement, PTTEP AA's management culture, operational capabilities, safety processes, and environmental systems are routinely evaluated and strengthened to align with industry good practice. PTTEP maintains open and regular communication with the Federal Government on the company's operational plans and continues to share the lessons learned from the Montara incident with the industry.		
Northern Wildcatch Seafood Australia	22/02/2018	Email	Factsheet	Sent	Email sent via WAFIC to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks. PTTEP requesting feedback from stakeholders.	N/A	N/A
	23/03/2018	Email	N/A	Sent	Email sent via WAFIC to NWSA, requesting feedback. Attached was a summary of queries raised by other commercial fishers and PTTEPs response.	N/A	N/A
	28/03/2018	Email	N/A	Received	Email received via WAFIC from NWSA. NWSA does not have anything to add. PTTEP have their rights as an existing producer and limited down hole seismic will occur in this instance. NWSA concerns are in regards to seismic.	N/A	N/A
GNTM Pty Ltd/ Emgekay Investments	22/02/2018	Email	Factsheet	Sent	Email sent via WAFIC to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks. PTTEP requesting feedback from stakeholders.	N/A	N/A
	23/03/2018	Email	N/A	Sent	Follow-up email sent to license holder via WAFIC providing a summary of queries raised by other commercial fisheries operating in the region and PTTEP's response.	N/A	N/A
Lenden Nominees Pty Ltd	22/02/2018	Email	Factsheet	Sent	Email sent via WAFIC to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks. PTTEP requesting feedback from stakeholders.	N/A	N/A
	23/03/2018	Email	N/A	Sent	Follow-up email sent to license holder via WAFIC providing a summary of queries raised by other commercial fisheries operating in the region and PTTEP's response.	N/A	N/A
Northfish Holdings Pty Ltd/Atlantis Fisheries Consulting Group	22/02/2018	Email	Factsheet	Sent	Email sent via WAFIC to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks. PTTEP requesting feedback from stakeholders.	N/A	N/A
	23/03/2018	Email	N/A	Sent	Follow-up email sent to license holder via WAFIC providing a summary of queries raised by other commercial fisheries operating in the region and PTTEP's response.	N/A	N/A
Simpson Seafood Pty Ltd	22/02/2018	Telephone	N/A	Sent	Telephone conversation between license holders and WAFIC. License holders has no feedback for PTTEP as license holder is in the process of selling mackerel quota.	N/A	N/A
	23/03/2018	Email	N/A	Sent	Email sent to license holder via WAFIC confirming conversation had on the phone. License holder has no feedback for PTTEP as in the process of selling mackerel quota.	N/A	N/A

Stakeholder	Date of Correspondence	Engagement Method	Supplementary Information	To / From Stakeholder	Summary of Contact / Correspondence	Assessment of Merit	Subsequent actions undertaken
Uptop Fisheries/Ocean Wild Tuna	22/02/2018	Email	N/A	Sent	Email sent via WAFIC to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks. PTTEP requesting feedback from stakeholders.	N/A	N/A
	23/03/2018	Email	N/A	Sent	Follow-up email sent to license holder via WAFIC providing a summary of queries raised by other commercial fisheries operating in the region and PTTEP's response.	N/A	N/A
Specimen Shell (License Holders)	25/02/2018	Telephone	N/A	Sent	Telephone conversation between license holders and WAFIC. License holders confirmed that they are not operating remote controlled underwater vehicles anywhere in the vicinity of the EADP.	N/A	N/A
	25/03/2018	Email	N/A	Sent	Email sent to license holder via WAFIC, documenting conversation on the phone. License holders confirmed that they are not operating remote controlled underwater vehicles anywhere in the vicinity of the EADP.	N/A	N/A
Recreational Fishing							
Recfishwest	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided by 20/03/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018.	N/A	N/A
NT Guided Fishing Association	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Tourism Industry							
Australian Northwest Tourism	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Tourism Western Australia	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Kimberley Bird Watching	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A

Stakeholder	Date of Correspondence	Engagement Method	Supplementary Information	To / From Stakeholder	Summary of Contact / Correspondence	Assessment of Merit	Subsequent actions undertaken
Kimberley Expeditions	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Oil and Gas Industry							
APPEA	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Finder Pty Limited	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Melbana Energy Limited (Vulcan Exploration)	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Eni Australia Limited	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Total E&P Australia Production Pty Ltd	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Murphy Australia Oil Pty Ltd	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A

Stakeholder	Date of Correspondence	Engagement Method	Supplementary Information	To / From Stakeholder	Summary of Contact / Correspondence	Assessment of Merit	Subsequent actions undertaken
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Sinopec O&G Australia (Puffin) Pty Ltd	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Bounty Oil & Gas NL	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Community/Environmental Non-Governmental Organisations							
WA Conservation Council	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
World Wildlife Fund	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
The Wilderness Society	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Environs Kimberley	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A

Stakeholder	Date of Correspondence	Engagement Method	Supplementary Information	To / From Stakeholder	Summary of Contact / Correspondence	Assessment of Merit	Subsequent actions undertaken
International Fund for Animal Welfare	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Save the Kimberley	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Australian Marine Conservation Society	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
World Dolphin Conservation Society	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Australian Conservation Foundation	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Greenpeace	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Research Organisations							
Australian Institute of Marine Science	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A

Stakeholder	Date of Correspondence	Engagement Method	Supplementary Information	To / From Stakeholder	Summary of Contact / Correspondence	Assessment of Merit	Subsequent actions undertaken
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
CSIRO	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Western Australian Marine Science Institute	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Indigenous Stakeholders							
Kimberley Land Council	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Northern Land Council	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
North Australian Indigenous Land & Sea Management Alliance	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Commercial Shipping							
Darwin Port Authority	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in	N/A	N/A

Stakeholder	Date of Correspondence	Engagement Method	Supplementary Information	To / From Stakeholder	Summary of Contact / Correspondence	Assessment of Merit	Subsequent actions undertaken
					Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.		
Kimberley Port Authority (Port of Broome)	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Pilbara Port Authority	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Infrastructure Provider							
Telstra	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
Nextgen Networks (Vocus Group)	20/02/2018	Email	Factsheet	Sent	Email sent to stakeholder with information on the exploration and appraisal drilling EP. Attached was a fact sheet with information on the potential environmental impacts and risks (and associated management controls). PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Sent	Email sent to stakeholder requesting feedback on the information provided on 20/02/2018. Stakeholders were informed that PTTEP AA is planning on submitted the EP to NOPSEMA in Quarter 2, 2018 and drilling activities are proposed to commence in Quarter 3, 2018. PTTEP AA requesting feedback from stakeholders by 20/03/2018.	N/A	N/A
	15/03/2018	Email	N/A	Received	Email received from Nextgen Networks - stakeholder has reviewed the information provided. Nextgen own the North West Cable System (an undersea optical fibre network) providing critical communications. Nextgen has undertaken an assessment and understands PTTEP's operations are well clear of the assets - a KMZ file was attached.	N/A - Advice / request for further information only. No objection or claim made.	N/A
	16/03/2018	Email	N/A	Sent	Email sent to stakeholder acknowledging receipt of the information provided. PTTEP informing Nextgen that drilling activities will be conducted more than 70 km from the North West Cable System.	N/A	N/A

APPENDIX B – FRENCH MCKAY TECHNICAL NOTE ON OIL SPILL THRESHOLDS

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RPS Australia West Pty Ltd ABN 42 107 962 872
A member of the RPS Group Plc

Attn: Rebecca McGrath
PTTEP Australasia
Level 1, 162 Colin Street
West Perth WA 6005
Australia

Date: 11 July 2018
Our ref: MAQ0727J

Dear Rebecca

Expert Opinion on Aquatic Toxicity Thresholds for Oil Spill Risk Assessment:

Regarding your request for an expert opinion on aquatic toxicity thresholds for oil spill risk assessment, Dr. Deborah French-McCay (RPS - Director of Research and Model Development; Pollutant Fates and Effects Modelling) has prepared the technical note below which provides the appropriate thresholds for a conservative oil spill risk assessment. In addition, this technical note has considered previous thresholds adopted for oil spill risk assessments and provided comments as to why those thresholds were too conservative.

Dr French-McCay (formerly Dr. French) specializes in quantitative assessments and modelling of aquatic ecosystems and populations, oil and chemical transport and fates, and biological response to pollutants. Her population modelling work includes models for plankton, benthic invertebrates, fisheries, birds and mammals. She has developed water quality, food web and ecosystem models for freshwater, marine and wetland ecosystems. She is an expert in modelling oil and chemical fates and effects, toxicity, exposure and the bioaccumulation of pollutants by biota, along with the effects of this contamination. These models have been used for impact, risk, and natural resource damage assessments, as well as for studies of the biological systems. She has provided expert testimony in hearings regarding environmental risk and impact assessments. For an abbreviated list of relevant publications please see her profile attached at the end of this document.

Yours sincerely
RPS
Nathan Benfer
Technical Lead

Aquatic Toxicity Thresholds for Oil Spill Risk Assessments

Deborah French-McCay
RPS Ocean Science, South Kingstown, Rhode Island, U.S.A.
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July 10, 2018

Summary

Oil spill modelling using the SIMAP model provides output for two types of water column concentration data: (1) dissolved hydrocarbons and (2) total hydrocarbons (THC) in entrained oil droplets. The purpose of this technical note is to describe these two hydrocarbon components and identify appropriate thresholds for use in oil spill risk assessments.

As described in detail below, toxicity is related to the bioavailability of hydrocarbons. Soluble and semi-soluble hydrocarbons dissolve and therefore become bioavailable (i.e., able to be taken up by aquatic organisms). In relatively fresh oil, some of the hydrocarbons in entrained oil droplets are soluble/semi-soluble hydrocarbons that may later dissolve and become bioavailable. However, as oil weathers, these potentially toxic components diminish to the point where the THC in entrained droplets is effectively non-toxic. Therefore, the focus of a risk assessment is typically on the dissolved hydrocarbon exposure.

For the dissolved hydrocarbons, thresholds based on acute lethality (LC50s, i.e., lethal concentrations for 50% of test organisms) generally range from about 10 ppb (960 ppb-hours) for sensitive early life history stages to 300 ppb (28,800 ppb-hours), or more for less sensitive species and older life stages. For sub-lethal effects, a threshold (PNEC) of 1 ppb (or 96 ppb-hours) is conservatively protective of aquatic biota.

If THC in entrained oil droplets is to be evaluated as a risk, 100 ppb (9,600 ppb-hours) would be an extremely conservative sublethal threshold (PNEC), 1,000 ppb (1 ppm or 96 ppm-hours) would be sufficiently conservative for oil droplets of all oil types and all weathering states for sensitive species or early life stages. A higher threshold, 30 ppm (2,880 ppm-hours) would be appropriate for protecting less sensitive species and older life stages of all species.

1 Oil Hydrocarbon Components and Toxicity

Oil is a mixture of thousands of hydrocarbons of varying physical, chemical, and toxicological characteristics, and therefore, varying fates and impacts on organisms. As oil weathers, its composition changes. When oil is floating, the volatile components evaporate rapidly, and the oil becomes more viscous as a result. Some of the semi-soluble hydrocarbons, which are less volatile, dissolve from the floating oil into the water column. Floating oil may be entrained into the water column by breaking waves, or oil may be released under water. Soluble and semi-soluble hydrocarbons dissolve from subsurface oil droplets, weathering the oil and making the hydrocarbons more available to microorganisms. The uptake of hydrocarbons by microorganisms, referred to as biodegradation, reduces water column concentrations, and therefore toxic effects.

1.1 Dissolved Hydrocarbons

Dissolved hydrocarbons are taken up into organisms directly through external surfaces and gills, as well as through the digestive tract. Thus, soluble and semi-soluble hydrocarbons are bioavailable, whereas insoluble compounds in oil are not bioavailable to aquatic organisms. Laboratory studies have shown that the

dissolved hydrocarbons exert the most effects on aquatic biota (Carls et al. 2008; Nordtug et al. 2011; Redman 2015). The volatilization rates of hydrocarbons from surface slicks are faster than the dissolution rates. Thus, dissolution from oil droplets in the water column is the main source of concentrations dissolved in the water.

The most toxic components of oil to water-column and benthic organisms are lower-molecular-weight compounds, which are both volatile and soluble in water. The polynuclear aromatic hydrocarbons (PAHs) exert the most toxic effects because they are semi-soluble and not highly volatile, so they persist in the environment long enough for significant exposure to occur (Anderson et al., 1974, 1987; Neff and Anderson, 1981; Malins and Hodgins, 1981; McAuliffe, 1987; NRC 2003, 2005). The monoaromatic hydrocarbons (MAHs), including BTEX (benzene, toluene, ethylbenzene, and xylenes), and the soluble alkanes also contribute to toxicity, but these compounds are highly volatile, so exposures of aquatic biota are minimal or negligible except when light oils are discharged at depth where volatilization does not occur (French-McCay 2002).

Within the soluble and semi-soluble hydrocarbons, toxicity is inversely related to solubility, typically quantified by the octanol-water partition coefficient (Kow), a measure of hydrophobicity (Nirmalakhandan and Speece 1988; Hodson et al. 1988; Blum and Speece 1990; McCarty 1986; McCarty et al. 1992a, b; Mackay et al. 1992; McCarty and Mackay 1993; Verhaar et al. 1992, 1999; Swartz et al. 1995; French-McCay 2002; McGrath et al 2009). The range of LC50s varies from ~10 mg/L (ppb) for 3-ring PAHs (which are semi-soluble) to ~10-100 mg/L (ppm) for the highly soluble BTEX compounds (French-McCay 2002). Thus, the toxicity of an oil hydrocarbon mixture is strongly related to the chemical composition, which varies as the oil weathers since the soluble and semi-soluble hydrocarbons are all volatile to varying degree.

1.2 THC in Entrained Hydrocarbons

Because only some of the compounds in oil are measured individually, and the desire to be inclusive of effects from hydrocarbons in oil droplets (e.g., the entrained droplets in SIMAP model outputs) as well as the dissolved phase, aquatic toxicologists have attempted to use THC as a metric for evaluating toxicity of oil exposures. However, given the complexities described above, among others related to experimental design and conditions, development of lethal toxicity values (e.g., LC50s) or sublethal thresholds based on total hydrocarbons (THC) is problematic. The hydrocarbon compositions in exposure media are highly variable, leading to estimated toxicity thresholds that range over many orders of magnitude. In addition, there are a number of measurement techniques used to estimate total hydrocarbons in experimental media, and each of these only measures a portion of the hydrocarbons in oil (Redman et al. 2012; Redman and Parkerton 2015; Yang et al. 2017). The most recent guidance (Redman and Parkerton 2015) recommends measuring BTEX and C5–C9 aliphatics (“volatiles”) using purge-trap GC–MS (Gas Chromatograph-Mass Spectrometer), analysis of parent and alkyl PAHs using GC–MS (with target analytes including C0–C4 alkyl decalins and C0–C4 alkyl phenols), and C9–C40 saturate hydrocarbons by GC/FID. Measurements of C8 to C50 hydrocarbons in oils by Yang et al. (2017) identified only 20-30% of the compounds, the remainder of the total petroleum hydrocarbon (TPH) being the unresolved complex mixture (UCM). Older studies often did not include this detail and range of analyses. Mass recoveries (using the presently-recommended methods) for gasoline, kerosene, and gas oil are typically >95%, whereas the mass recoveries for heavier substances in crude oils and heavier refined products are often <50%. This uncharacterized mass is due to high-molecular-weight alkanes, asphaltenes, resins, and other large molecules that are either not eluted from chromatographic columns or not well-resolved by gas chromatographic techniques that are available (Redman et al 2012; Yang et al. 2017). In the discussion below THC will refer to the true total hydrocarbon content of oil, whereas TPH will be used to refer to the measured portion of the THC.

2 PAH-Based Threshold for Dissolved Hydrocarbons

Because most of the toxicity from dissolved hydrocarbons is due to PAHs, particularly in surface waters (see above), PAH-based lethal and sublethal thresholds are typically used to evaluate the risks of oil contamination. In many bioassays, measured total PAH concentrations have been used to quantify toxicity endpoints, with the understanding that the measured PAH concentrations reflect the effects of any dispersants applied (which increase concentrations in the water, Bejarano et al. 2014) and other unmeasured constituents associated with the PAHs are contributing to the observed toxicity (Bejarano et al. 2017; Forth et al. 2017), although with less effect (French-McCay 2002).

PAH concentrations on the order of tens to hundreds of micrograms per liter (µg/L) have been shown to be acutely toxic to aquatic biota (French-McCay 2002, 2016). French-McCay (2002) reviewed available laboratory oil and PAH acute bioassay data, finding that 95% of species and life stages exhibited 50% mortality between 6 and 400 µg/L total PAH concentration. Based on this result, the 6 ppb (µg/L) total PAH value would be protective of 97.5% of species and life stages. Early life history stages of fish appear to be more sensitive than older fish stages and invertebrates. Bioassay data compiled by French-McCay (2002) indicate that 96+-hour LC50s (Lethal Concentrations to 50% of exposed biota) of juvenile and adult fish are >100 mg/L. Bejarano et al. (2017) developed species sensitivity distributions (SSDs) for acute bioassay tests using water accommodated fraction (WAF, which includes all compounds dissolved from oil in a variety of media preparations; see Singer et al. (2000) for a review of these preparations and further discussion below) exposures, finding the 5th percentile sensitivity (Hazardous Concentration for 5%, HC5, which is protective of 95% of species and life stages) for lethality to range from 28 µg/L to 282 µg/L total PAH concentration for fish and invertebrates from a wide variety of latitudes and habitats, a range similar to that predicted by French-McCay (2002). Note that in recent years the 5th percentile for a range of species sensitivities in toxicity tests has come to be used in practice for developing thresholds, and this is termed the HC5. Thus, for acute lethality and to the nearest order of magnitude (given uncertainties), total PAH LC50s generally range from about 10 µg/L for sensitive early life history stages to 300 ppb or more for less sensitive species and older life stages.

Sublethal effects may occur at lower concentrations. For PAHs, USEPA (2003, 2008) has derived and used a factor 10 to estimate a sublethal effects threshold (Final Chronic Value, FCV, or Predicted No Effect Concentration, PNEC) based on a lowest acute toxicity-based endpoint such as the HC5 based on 96-hour LC50 tests. In a recent study by McGrath et al. (2018), the acute-to-chronic ratio (ACR) for hydrocarbons was found to average 5.22 (range 1.7-12 for the 10th and 90th percentiles of the observations, including consideration of one high outlier), therefore, the factor 10 is conservatively protective. Thus, the sublethal effects threshold (PNEC) for PAHs would be 1 µg/L (ppb). Further details are available in French-McCay (2009) and French-McCay et al. (2018). The 1 µg/L (1 ppb) total PAH threshold has been used in many environmental risk assessment studies (e.g., French McCay et al., 2005, 2012; NOAA, 2013).

3 THC-Based Threshold for Entrained Droplets

The concentrations of entrained droplets output by SIMAP represent hydrocarbons that are not bioavailable. The soluble and semi-soluble fractions dissolve from the droplets over time, and a potential effects analysis based on the dissolved hydrocarbons characterizes their risk. However, to satisfy concerns that entrained droplet hydrocarbons might infer some risk, THC-based thresholds are developed.

In addition to considering the PAHs, Bejarano et al. (2017) developed SSDs using measured TPH (aromatic and aliphatic hydrocarbons [C9-C44], which includes parent and alkylated homologue PAHs and/or parent naphthalene) as a metric. The range of HC5s was found to be 1 to 560 mg/L as TPH for WAF preparations from crude oils with API densities ranging from 25 to 44. The HC5 for light refined Group. 2 fuel oil (API 35 –

45) was 0.5 mg/L TPH. The TPH HC5 decreased with higher API (lower oil density), i.e., with oils that have a higher percentage of light hydrocarbons (C9-C44) including PAHs. Note that the TPH measurements were on WAF media, which are preparations that purposely select for the soluble hydrocarbons and remove the insoluble larger hydrocarbons in the oil (Redman and Parkerton 2015). WAFs included aqueous exposure media prepared by physical (low energy water accommodated fraction, LEWAF; and moderate energy WAF or MEWAF) or chemically enhanced oil dispersion (chemically enhanced water accommodated fraction, CEWAF). Thus, the TPH measurements of the WAF media are on a portion of the oil, not the full oil. This is demonstrated by the ratios of measured TPH to PAHs, where they were both measured on the same WAFs. The ratios were 35-40 for LEWAF and MEWAF preparations and 14 for CEWAF preparations (Table 1). These ratios are far lower than the typical percentage of PAH in crude oils, which is 1% for PAH/THC (or ratio of 100; French-McCay 2002; Forth et al. 2017). Therefore, these TPH measurements reflect only a small percentage of THC, less than 40% of the oil, and for CEWAFs about 15% of the oil. Other analyses of crude oils indicate similar percentages (e.g., Forth et al. 2017). Therefore, the TPH HC5s derived by Bejarano et al. (2017) should be multiplied by a factor 3-7, based on the measured TPH/PAH ratios (French McCay 2002, Forth et al. 2017), to correct for the missing hydrocarbons in the oil since the SIMAP model outputs are for all the hydrocarbons in oil, not just the measurable ones. This yields THC lethal thresholds of 3-28 mg/L (ppm, Table 1), based on the Bejarano et al. (2017) review. Similar adjustments should be made for TPH-based thresholds, depending upon the methods used.

This limitation also exists for TPH thresholds presented in Smit et al. (2009), which has been used as a proxy THC threshold for oil spill modelling in the past. However, the TPH/PAH ratio is not provided in that paper, so the same correction calculations cannot be carried out. Furthermore, the thresholds developed in Smit et al. (2009) are for no-observed-effect concentrations (NOECs) based on sublethal effects of chronic exposures of 7 to 183 days (e.g., the lowest test NOEC was for a 33-day exposure). As discussed in the next section, such long exposure times do not occur in open waters after oil spills and effects concentrations are much higher for short-term exposures.

Table 1 Measured total PAH and TPH for lethal effects thresholds based on WAF preparations of oil where 95% of species would be protected. The loss-corrected TPH accounts for the fraction of the parent oil not included in the WAF preparation.

Media	PAH (µg/L)	TPH (µg/L)	TPH/PAH	Loss-Corrected TPH (i.e. THC) (mg/l)
WAF + MEWAF light crude oils	27.6	956	35	2.7
WAF + MEWAF medium crude oils	74.9	2,935	39	7.5
CEWAF medium crude oils	282	3,907	14	27.9

The ANZECC 2000 guidelines and derivation of a TPH-based sublethal threshold include a review of a few studies available at the time but depend on the analysis by Tsvetnenko (1998) for a threshold. Tsvetnenko (1998) followed US EPA methods (Stephan et al. 1985; US EPA 1994) to develop SSDs and HC5s but did not recognize that TPH measurements of Water Soluble Fractions (WSF) and WAFs do not represent the same composition as the THC in the field. They are biased towards a mix of soluble and semi-soluble components that are the toxic components of the oil (as explained above). Tsvetnenko (1998) developed a lethal HC5 for TPH of 168 µg/L (ppb), and then applied an ACR of 25 to obtain a sub lethal threshold of 7 µg/L (ppb) as TPH. Even if it were assumed that TPH measurements on WSF/WAF media were representative of THC (which they are not), the HC5 of 168 µg/L should be corrected (upward) for the

fraction of the THC of the source oil actually measured by the TPH analyses used and should not be corrected (downward) for the volatilization loss (in table 8.3.24, ANZECC 2000 appears to have lowered the TPH toxicity values by a factor of 10, based on Hamoda et al. 1989). The needed data are not available, but likely the correction would be an order of magnitude, given the time and nature of those TPH measurements and apparent volatilization in the experiments. However, it is more appropriate to use recent data where better analytical methods were used, if TPH is to be the basis of a threshold.

Because PAHs are the most toxic components of oil and crude oils typically contain about 1% PAHs by mass (French-McCay 2002; Forth et al. 2017), the sublethal concentration threshold (PNEC) expressed as total hydrocarbon concentration (THC, not TPH) based on the most toxic components would be ~100 µg/L (100 ppb) for fresh oil. However, as oil weathers, PAHs are lost to volatilization and degradation. Thus, the whole-oil threshold of 100 ppb is appropriate for fresh oil and conservative (highly protective of aquatic resources) for weathered oil. An exposure concentration of 1,000 ppb (1 ppm or 1 mg/L) of (total) oil hydrocarbons was deemed a low level of concern for sensitive life stages in marine organisms by Kraly et al. (2001). The 1 mg/L concentration is at the low end of the range where sub-lethal impacts from acute exposure have been observed (NRC, 2005). Based on the review of toxicity studies by Bejarano et al. (2017), a THC lethal threshold of 3-28 mg/L (or 3-30 mg/L with rounding, given uncertainties) would be appropriate for a range of oils and states of weathering for species from all geographical areas globally.

4 Duration of Exposure

An additional consideration is that LC50s and other lethal toxicity endpoints (e.g., Effects Concentration to 50% of normal function, EC50) vary considerably with exposure duration over the range of several hours to several days (Sprague, 1969; Abel, 1980; Mancini, 1983; Bailey et al., 1985; McAuliffe 1987; McCarty et al. 1992a, b). Effects thresholds are an order of magnitude higher for a few hours of exposure than they are for several days of exposure (McCarty et al. 1992a, b; French-McCay 2002; Bejarano et al. 2014) due to the accumulation of toxicant over time up to a critical tissue concentration that causes mortality. The accumulation is slower for more hydrophobic (i.e., less soluble) compounds (Veith et al., 1983; Abernethy et al. 1986, 1988; Verhaar et al., 1992, 1999; DiToro et al. 2000; DiToro and McGrath 2000) and at colder temperatures (see reviews in McCarty et al. 1992a, b; Verhaar et al., 1992; French-McCay 2002). Thus, the LC50s for PAHs are more variable with duration of exposure than are the LC50s for BTEX.

Most bioassays are for 48 to 96 hours of exposure in order for the toxicant to accumulate in the tissues of the exposed organisms, where they may have adverse effects. Swartz et al. (1995) argued that bioassays for PAHs should be to at least 10 days of exposure in order to allow sufficient time for the PAHs to be taken up into the organisms and reach steady state between uptake and depuration. The focus on Swartz et al.'s (1995) study was PAH contamination in sediments. For long, essentially infinite exposure durations, the measured lethal endpoints are termed incipient LC50s (or other percentage mortality levels; McCarty et al. 1992a, b; Verhaar et al., 1992; French-McCay 2002). The >48-hour and incipient LC50s are conservatively low for shorter-duration exposures (French-McCay 2002).

For most oil spills, exposures of water column biota to concentrations above potential thresholds of concern are typically on time scales of minutes to hours, even for spills lasting weeks or months because of the varying movements of the oil in the water, dilution and losses to biodegradation and volatilization. Furthermore, the concentrations vary in time over the short exposure periods (McAuliffe et al. 1980, 1981; McAuliffe 1987; Lunel 1994; French McCay 2002, 2004; Bejarano et al. 2014). Thus, the use of LC50s for >48 hours of exposure, or chronic endpoints for longer exposure times, as thresholds for oil spills is highly conservative. Acute aquatic toxicity thresholds would be sufficiently conservative for oil spills in open water systems (as opposed to ponds or other contained systems). There is no need for an ACR correction for evaluating acute toxicity to aquatic biota from oil spills in open waters.

In the ANZECC 2000 guidelines, no observable effects concentrations (NOECs) after long exposure durations are recommended. This is highly protective for chronic steady state concentrations of toxicants. Again, since oil spill water column exposures are acute, and durations of exposure are for hours and not days, acute toxicity data (e.g., Final Acute Value, FAV) should be used and there should be no ACR conversion.

Another approach would be to use a dose metric as a threshold. The LC50s quoted above are typically for 96 hours of exposure. Thus, the 1 ppb PAH sublethal threshold would be equivalent to 96 ppb-hours of exposure. The highly conservative 100 ppb THC sublethal threshold would be equivalent to 9600 ppb-hours (9.6 ppm-hours) of exposure. However, a higher sublethal threshold of 1,000 ppb (96 ppm-hours) would be more realistic for THC. Model results could be integrated to calculate the ppb-hours of exposure, therefore addressing the duration of exposure issue.

5 Conclusion

It should be clarified that the SIMAP model outputs two types of concentration data: (1) dissolved hydrocarbon concentrations, which are primarily composed of PAHs in surface waters where volatilization has depleted the BTEX and soluble alkanes, and (2) THC in oil droplets which contain diminishing amounts of PAHs over time (and essentially no BTEX or soluble alkanes). The bioavailable hydrocarbons are those that are dissolved, not the THC in droplets. Thus, the focus of a risk assessment should be on the dissolved hydrocarbon exposure. For the dissolved hydrocarbons, the 1 ppb PAH threshold is conservatively protective of aquatic biota. If THC in oil droplets is to be evaluated as a risk, 100 ppb would be an extremely conservative threshold, and 1 ppm would be sufficiently conservative for oil droplets of all oil types and all weathering states.

It should be noted that toxicity is determined by the specific mix of hydrocarbon concentrations in the exposure medium and the toxicity of each component. Use of a THC threshold does not address the complexities of the mixture of hydrocarbons of various toxicities. Further, TPH measurements do not capture those nuances. For these reasons, recent evaluations of the aquatic effects of oil have focused on the most toxic and bioavailable components (i.e., dissolved hydrocarbons) and have not used TPH as a metric.

Finally, there is no demonstrable relationship of sensitivity to oil hydrocarbons with latitude. The species included in the Bejarano et al. (2017) review were from a range of latitudes. Bejarano et al. (2017) showed that there were no significant differences between sensitivities of high latitude versus low latitude species. Similarly, French-McCay et al. (2018) found no latitudinal relationship for PAH sensitivity. Thus, the analyses summarized here would apply to Australian waters, as well as other aquatic environments world-wide.

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Areas of Expertise:

Dr. French McCay (formerly Dr. French) specializes in quantitative assessments and modeling of aquatic ecosystems and populations, oil and chemical transport and fates, and biological response to pollutants. Her population modeling work includes models for plankton, benthic invertebrates, fisheries, birds and mammals. She has developed water quality, food web and ecosystem models for freshwater, marine and wetland ecosystems. She is an expert in modeling oil and chemical fates and effects, toxicity, exposure and the bioaccumulation of pollutants by biota, along with the effects of this contamination. These models have been used for impact, risk, and natural resource damage assessments, as well as for studies of the biological systems. She has provided expert testimony in hearings regarding environmental risk and impact assessments.

Experience Includes:

RPS ASA **1984-present**

Oil and Chemical Spill Fate, Impact and Natural Resource Damage Assessment (NRDA)

- Principal investigator/project manager for the Natural Resource Damage Assessment Model for Coastal and Marine Environments (NRDAM/CME) and the Natural Resource Damage Assessment Model for Great Lakes Environments (NRDAM/GLE) which are used in "Type A" assessments of damages due to spills of toxic substances under US regulations (Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 and of oils under the Oil Pollution Act of 1990 (OPA)).
- Developed biological effects model components of the NRDAM/CME, NRDAM/GLE, and ASA's derivative model SIMAP, which estimate pollutant-induced losses in productivity, fisheries yield and wildlife.
- Developed aquatic toxicity model and supporting toxicological database such that mortality is a function of concentration, time and temperature of exposure; this toxicity model forms part of the NRDAM/CME, NRDAM/GLE and other model systems (e.g., SIMAP, CHEMMAP) developed by Applied Science Associates, Inc.
- Principal developer of the physical fates model component of the NRDAM/CME, NRDAM/GLE, and ASA's derivative models SIMAP and CHEMMAP, which estimate oil and chemical distribution and concentrations over time after a spill.
- Developed the restoration model components of the NRDAM/CME and NRDAM/GLE, which determine appropriate restoration actions and approximates costs.
- Principal Investigator in the development of biological databases for fishery species and wildlife by habitat and season for 77 coastal, 11 Great Lakes and 10 inland freshwater biological provinces of the United States. These data support the NRDA models.
- Principal Investigator in the development of a Primary Restoration Guidance Manual which evaluates feasibility, effectiveness and success, and costs of restoration of wetland and aquatic natural resources. This supports NOAA's OPA NRDA regulations.
- Provided technical support and modeling to federal and state trustees to estimate fates, injuries and natural resource damages resulting from spills:
  - World Prodigy oil spill in Narragansett Bay, June 1989 (modeled fates, injuries, damages); the damage assessment was used by the R.I. Attorney General's office to successfully negotiate a settlement with the responsible party.
  - Vista Bella Oil Spill of 6 March 1991 in Caribbean Sea
  - Bouchard oil spill, August 1993, at the entrance to Tampa Bay. Provided technical support to federal public trustees in developing a natural resource damages claim (modeled fates and injuries)
  - Caustic soda spill, Barge Cynthia M, March 1994 (modeled fates and injuries)
  - Morris J. Berman No.6 fuel oil spill, January 1994, in San Juan, Puerto Rico.

- North Cape oil spill, January 1996, Rhode Island – technical support, modeling of fates and injuries, restoration scaling, Chair of Technical Working Group assessing injuries and restoration alternatives for marine resources
- May 1997 Lake Barre, Louisiana, oil pipeline break (modeled fates, injuries; restoration scaling)
- September 1997 Platform Irene, California, oil pipeline break (modeled fates and injuries)
- November 1997 Kure spill in Humboldt Bay, California, for State Natural Resource Trustees (modeled trajectory/fate)
- Alafia River phosphoric acid spill of December 1997 (injury quantification and restoration scaling)
- Sept. 1998 Command spill, San Francisco, California, for State Natural Resource Trustees (modeled trajectory/ fate)
- February 1999 New Carissa spill in Oregon (modeled fates and injuries)
- Chalk Point (Pepco) oil spill in the Patuxent River, MD, April 2000 (injury quantification and restoration scaling)
- Penn oil spill in Narragansett Bay, July 2000 (modeled fates and injuries)
- November 2000 Westchester oil spill in the Mississippi River (modeled fates and injuries)
- 23 oil spill cases in Florida (injury quantification and restoration scaling); for State Natural Resource Trustees who successfully submitted claims to the National Pollution Fund Center (USCG OPA fund)
- Ever Reach Spill of 30 September 2002 in Charleston Harbor, SC
- April 2003 Bouchard 120 oil spill in Buzzards Bay, Massachusetts
- Mosaic acidic process water release of September 2004 in Hillsborough Bay, FL
- Citgo Refinery Spill of 21 June 2006 in the Calcasieu River, Louisiana
- Deepwater Horizon oil spill of April-July 2010; Lead for NOAA of Water Column Technical Working Group which evaluated impacts to marine fish and invertebrates; modeling analyses of spill fates and biological effects for quantification of injuries
- Several on-going spill cases (still confidential)

- Provides technical support to NOAA's Office of Response & Restoration / Assessment & Restoration Division and state trustees in on-going natural resource damage assessment cases.
- Provided training to federal and state trustees, industry, and private parties on use of modeling for NRDA, impact and risk assessment.

Modeling and Analysis of Pollutant Fates and Effects, Ecological Risk Assessment

- Project Manager and model developer for ASA's spill fates and biological effects model systems: SIMAP for oil spills and CHEMMAP for chemical spills. These models are used for impact and risk assessment, as well as natural resource damage assessment.
- Developer of Orimulsion fates model in ASA's SIMAP model system. Used this model to perform an ecological risk assessment for the importation of Orimulsion into Tampa Bay, Florida, as compared to the present risk using No. 6 fuel oil, and testified in permit hearings (client: Florida Power and Light). Model also used for an ecological risk assessment for permit applications by a power plant in New Brunswick Canada for conversion from No. 6 fuel oil to Orimulsion.
- RPS ASA project manager for a contract to BOEM to model surface oil spills for the 26 U.S. Outer Continental Shelf planning areas, including the Gulf of Mexico and Arctic with the results used as the basis for estimating oil spill-related costs in their Offshore Environmental Cost Model (OECM).
- Used modeling to estimate impacts resulting from hypothetical spills of the cargo of a ship carrying hazardous wastes to be incinerated at sea; applied to several coastal areas (Gulf of Mexico and North Atlantic) and 10 possible wastes; analyzed worst case and most likely scenarios and performed sensitivity analysis.
- Oil modeling analysis for the Environmental Impact Assessment for the El Segundo Marine Technical Lease Renewal.
- Assessment of potential oil spill impacts and natural resource damages for oil platform spills off the coast of Florida, involving conditional probability (trajectory) modeling and worst case analysis. Testified, hearings, Coastal Petroleum.
- Principal investigator for modeling fates and ecological risks of discharges associated with the use of chemical products used in deep water oil and gas operations in the Gulf of Mexico (MMS project, as subcontractor to A.D. Little).
- Principal investigator for modeling analysis of potential spills resulting from groundings in San Francisco Bay in an ecological risk assessment and cost analysis for natural resource damages, response costs and socioeconomic costs (client: Army Corps of Engineers, San Francisco District).
- Principal investigator for modeling analysis of potential spill impacts and costs in Washington state waters as part of a cost-benefit analysis for the Washington Department of Ecology's rulemaking regarding spill response requirements
- Principal investigator for modeling of spills in US waters with and without dispersant use, for use in a Programmatic Environmental Impact Statement, US Coast Guard rulemaking on response equipment regulations

- Principal investigator for preparation of an Environmental Assessment of hazardous material spill response equipment regulations, a US Coast Guard rulemaking under OPA90
- Principal investigator for the oil spill fates and effects modeling of subsurface spills from more than 40 World War II-era shipwrecks to assess risks to ecological and socioeconomic resources of concern. Areas modelled include the U.S. Atlantic and Pacific coasts, Gulf of Mexico, and U.S. Pacific Territories.

Fisheries Modeling and Impact Assessment

- Developed population and fisheries model with spatial resolution for eggs, larvae, juvenile and adults; an associated transport model used to distribute eggs and larvae
- Applied spatially resolved population and fisheries model to sea scallops and Atlantic cod on Georges Bank; estimated potential impacts of oil development on populations and fisheries
- Developed LARVMAP model, which simulates active (directional swimming or sinking) and passive (by currents) movements of eggs, larvae, and other life stages of aquatic biota; used for evaluating potential impacts of development, entrainment and impingement
- Assessed potential impacts of ichthyoplankton entrainment in seawater intakes and from pipeline and LNG terminal construction and operation, for Environmental Impact Statements for proposed LNG projects: two in the Gulf of Mexico, one in Mount Hope Bay, Massachusetts, and one in Puerto Rico.

Ecological Evaluations for Marine Spatial Planning and Alternative Energy Siting Assessments

- Developed framework for modeling ecological values of marine biological resources, applied to the marine offshore area considered by the Rhode Island Ocean Special Area Management Plan (RI Ocean SAMP). The definition of "ecological value" was based on that used in other recent marine spatial planning valuation efforts, i.e., the intrinsic value of biodiversity without reference to anthropogenic use. Synthesized spatial distribution data were gathered from various studies performed by University of Rhode Island (URI) researchers as input to the Ecological Value Map (EVM) modeling effort. Weighting schemes were applied to normalized mapped data and the modified results summed to compute EVMs that reflect protection status, global importance of the resources, uncertainty of the data and potential impacts of developments.
- Under funding from Bureau of Ocean Energy, Management, Regulation and Enforcement (BOEMRE), and in partnership with the University of Rhode Island, developed a conceptual framework and approach for cumulative environmental impact evaluation of offshore renewable energy development, as part of a larger framework for a site evaluation tool for decision makers. This extends the work on the RI Ocean SAMP to include consideration of cumulative impacts and a framework for application to offshore waters of the US. Socioeconomic uses and values are also included in the framework.

Selected Publications and Conference Proceedings

- French-McCay, D., D. Crowley, J. Rowe, M. Bock, H. Robinson, R. Wenning, A. H. Walker, J. Joeckel, and T. Parkerton. 2018. Comparative Risk Assessment of Spill Response Options for a Deepwater Oil Well Blowout: Part I. Oil Spill Modeling. Mar. Pollut. Bull. https://doi.org/10.1016/j.marpolbul.2018.05.042.
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