Greater East Spar Installation and Commissioning EP Summary

GE-35-RI-10002.03

PROJECT / FACILITY	Greater East Spar	
REVIEW INTERVAL (MONTHS)	N/A	
SAFETY CRITICAL DOCUMENT	~~YES~~	NO

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Revision History

Revision	Author / Editor	Amendment
A	S2V Consulting	Internal Review
0	L Muir / A Crabbe	Issued for use

ACRONYMS

Abbreviation	Description
ACN	Australian Company Number
AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
AHS	Australian Hydrographic Service
ALARP	As Low as Reasonably Practicable
AMOSC	Australian Marine Oil Spill Centre
AMSA	Australian Maritime Safety Authority
APASA	Asia-Pacific Applied Sciences Association
BIAs	Biologically Important Areas
CFA	Commonwealth Fisheries Association
CMR	Commonwealth Marine Reserve
CVCs	Cameron vertical Connector
dB	Decibels
DER	Department of Environmental Regulation
DMP	Department of Mines and Petroleum (WA)
DoD	Department of Defence
DoE	Department of Energy and Environment
DoF	Department of Fisheries (WA)
DoT	Department of Transport (WA)
DPaW	Department of Parks and Wildlife (WA)
EFL	Electric Flying Leads
EF&LS	Exmouth Freight & Logistics Services
EHFL	Electric Hydraulic Flying Lead
EHU	Electro-Hydraulic Umbilical
EMBA	Environment that May Be Affected
EP	Environment Plan
EPA	Environmental Protection Authority
EPBC	Environment Protection and Biodiversity Conservation
EPO	Environmental Performance Objective
EPSs	Environmental Performance Standards
ESD	Emergency shutdown
GES	Greater East Spar

Abbreviation	Description
GHG	Greenhouse gas
HSE	Health Safety Environment
HSE MS	Health Safety Environment Management System
Hz	Hertz
IAPP	International Air Pollution Prevention
IMDG	International Maritime Dangerous Goods
IMS	Invasive Marine Species
IMT	Incident Management Team
IUCN	International Union for Conservation of Nature
JWM	Jetwave Marine
KEF	Key Ecological Feature
Khz	Kilo hertz
km	Kilometre
km/hr	Kilometres Per Hour
km^2	Square Kilometres
L	Litre
m	Metres
m/h	Metre per hour
m/s	Metres Per Second
m^3	Cubic Metres
MARPOL	International Convention for the Prevention of Pollution from Ships
MGO	Marine Gas Oil
mm	Millimetres
MNES	Matters of National Environmental Significance
MOC	Management of Change
MP	Marine Park
NEBA	Net Environmental Benefit Analysis
NMSC	National Marine Safety Committee
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NOx	Oxides of Nitrogen
NWMR	North West Marine Region
NWS	North West Shelf
NWSTF	North West Slope Trawl Fishery

Abbreviation	Description
OCNS	Offshore Chemical Notification Scheme
ODS	Ozone Depleting Substance
OPEP	Oil Pollution Emergency Plan
OPGGS (E) R	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009
OSCP	Oil Spill Contingency Plan
OSRL	Oil Spill Response Limited
OWA	Oiled Wildlife Advisors
OWRP	Oiled Wildlife Response Plan
PLEM	Pipeline End Manifold
PPA	Pearl Producers Association
PMS	Planned Maintenance System
ppm	Parts Per Million
psi	Pounds per square inch
QOA	Quadrant Oil Australia
ROV	Remote Operated Vehicle
SCS	Subsea Cooling Skid
SDS	Safety Data Sheet
SMPEP	Shipboard Marine Pollution Emergency Plan
SOLAS	Safety of Life at Sea
SOPEP	Shipboard Oil Pollution Emergency Plan
SOx	Oxides of Sulphur
SSSVs	Sub-surface Safety Valves
UTH	Umbilical Termination Heads
VI	Varanus Island
VRASS	Vessel Risk Assessment
WA	Western Australia
WAFIC	Western Australian Fishing Industry Council
WAOWRP	WA Oiled Wildlife Response Plan
WDCS	Whale and Dolphin Conservation Society
WDTF	Western Deepwater Trawl Fishery
XT	Xmas Tree

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1. INTRODUCTION

Quadrant Oil Australia Pty Ltd (QOA) is the registered operator of the Greater East Spar (GES) and existing Halyard Facilities, located approximately 49 km from Barrow Island and 116 km from the town of Onslow Western Australia. QOA is a 100% owned subsidiary of Quadrant Energy Australia Ltd (Quadrant). Quadrant proposes to develop the GES project using a subsea tie-back to link the Spar-2 XT into the existing Halyard subsea facility and the Varanus Island (VI) onshore processing facility. Chemical injection and hydraulic and electrical power will be provided via the John Brookes Wellhead Platform (**Figure 2-1**).The earliest date for commencement of the activity is August 2017 with all activity completed on or before 31st December 2017.

Following completion of the activities under this EP, operation of the facility is covered under the NOPSEMA accepted *Varanus Island Hub Operations EP (Commonwealth Waters)* (EA-66-RI-10003).

1.1 Compliance

The overall purpose of the *Greater East Spar Installation and Commissioning Plan (GE-35-RI-10002.01)* (the EP)is to comply with statutory requirements of the Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS (E) Regulations);and to ensure that the Activity is planned and conducted in line with Quadrant environmental policies and standards, including the corporate Environmental Policy. The EP was assessed and accepted by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) on 29 June 2017. The EP summary has been prepared in accordance with the requirements of regulation 11 (4) of the OPGGS (E) Regulations.

1.2 Activity durations and timing

Activities will be conducted 24 hours per day, seven days per week. It is envisaged that the total duration of all activities covered by this EP will be up to 30 days in the operational area. However with potential for weather and operational delays this could extend the project duration (installation and commissioning activities) to a period of 60 days in the operational area. Activities may not be continuous during these time frames, and the installation vessel may depart and then re-enter the Operational Area on a number of occasions.

The earliest date for commencement of the activity is August 2017 with all activity completed on or before 31st December 2017.

2. ACTIVITY LOCATION

Subsea facilities will be installed and located in Petroleum Pipeline Licence WA-21-PL. The pipeline licence area is contained within a larger 'operational area' defined in **Table 2-1** and **Figure 2-3**. The 'operational area' defines the boundary within which activities associated with installation and commissioning described in this EP will occur. The water depth within the operational area ranges between approximately 90 m to 118 m.

Table 2-1: Coordinates of the operational area

Latitude	Longitude
20° 34' 55.304" S	114° 56' 03.018" E
20° 43' 37.951" S	115° 00' 29.038" E
20° 44' 55.313" S	114° 57' 37.834" E
20° 36' 12.692" S	114° 53' 11.320" E

Existing facilities and infrastructure within the operational area include;

- 18" John Brookes pipeline to Varanus Island (part of);

- 14” East Spar pipeline from East Spar Manifold to Varanus Island (part of);
- East Spar Manifold and 14” tie-in Spool with the East Spar PLEM;
- 10” flowline between the East Spar PLEM and Halyard-1 Well;
- Halyard-1 Well;
- Halyard umbilical between Halyard-1 well and John Brookes platform (part of); and
- Spar-2 Xmas tree (XT) ready for tie-in.

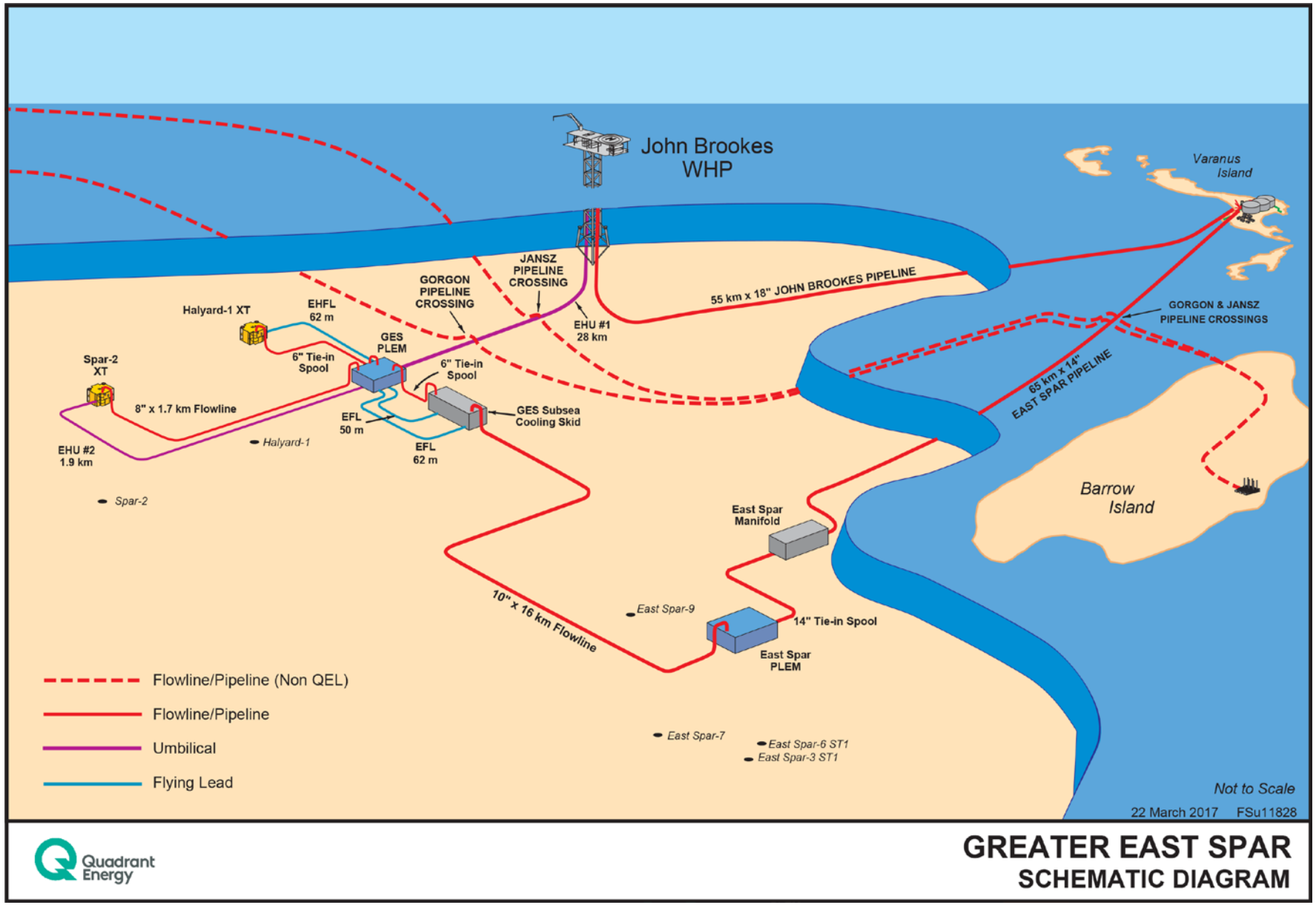

Figure 2-1: Greater East Spar Project Schematic

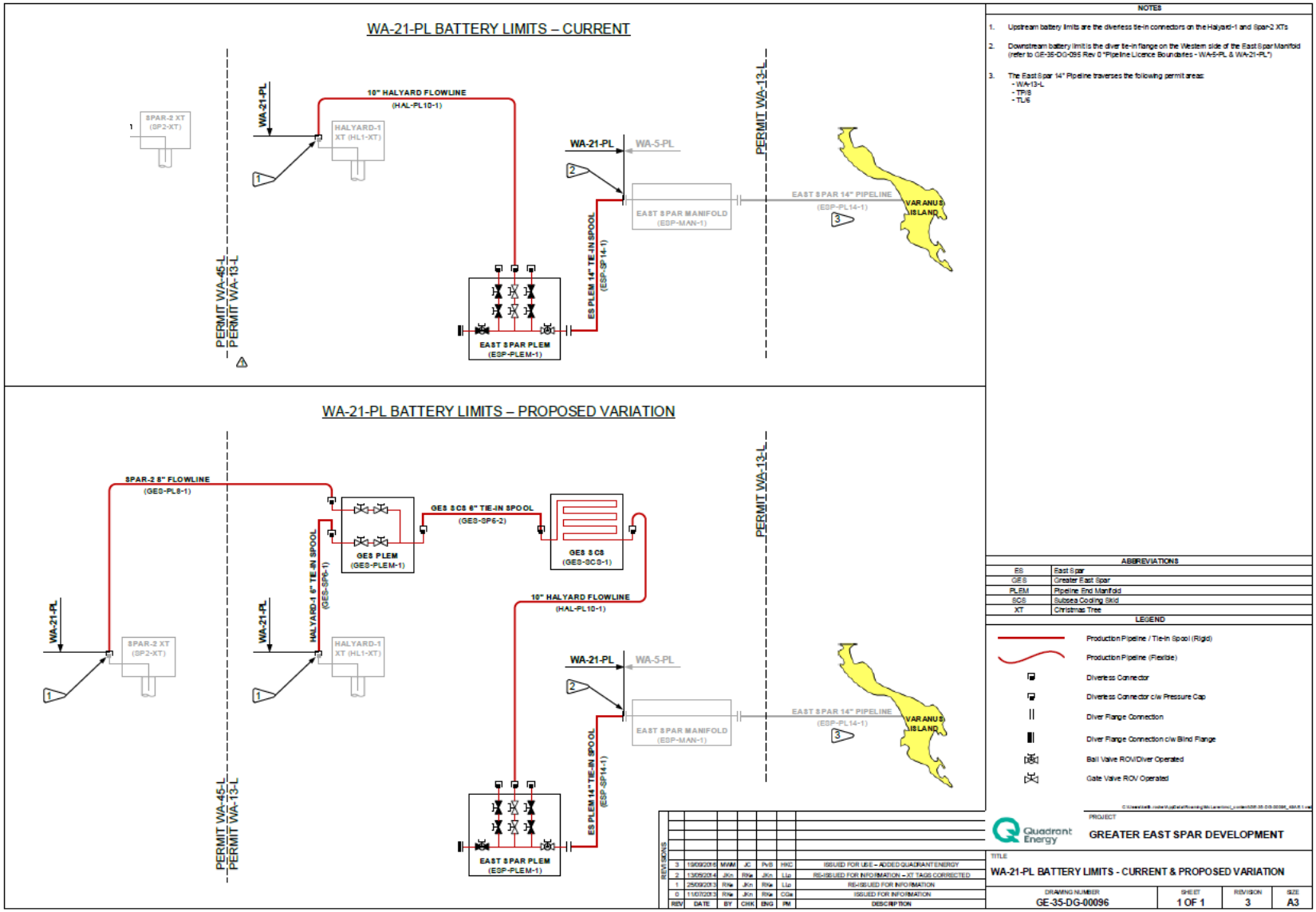

Figure 2-2: Current and proposed infrastructure in pipeline licence WA-21-PL

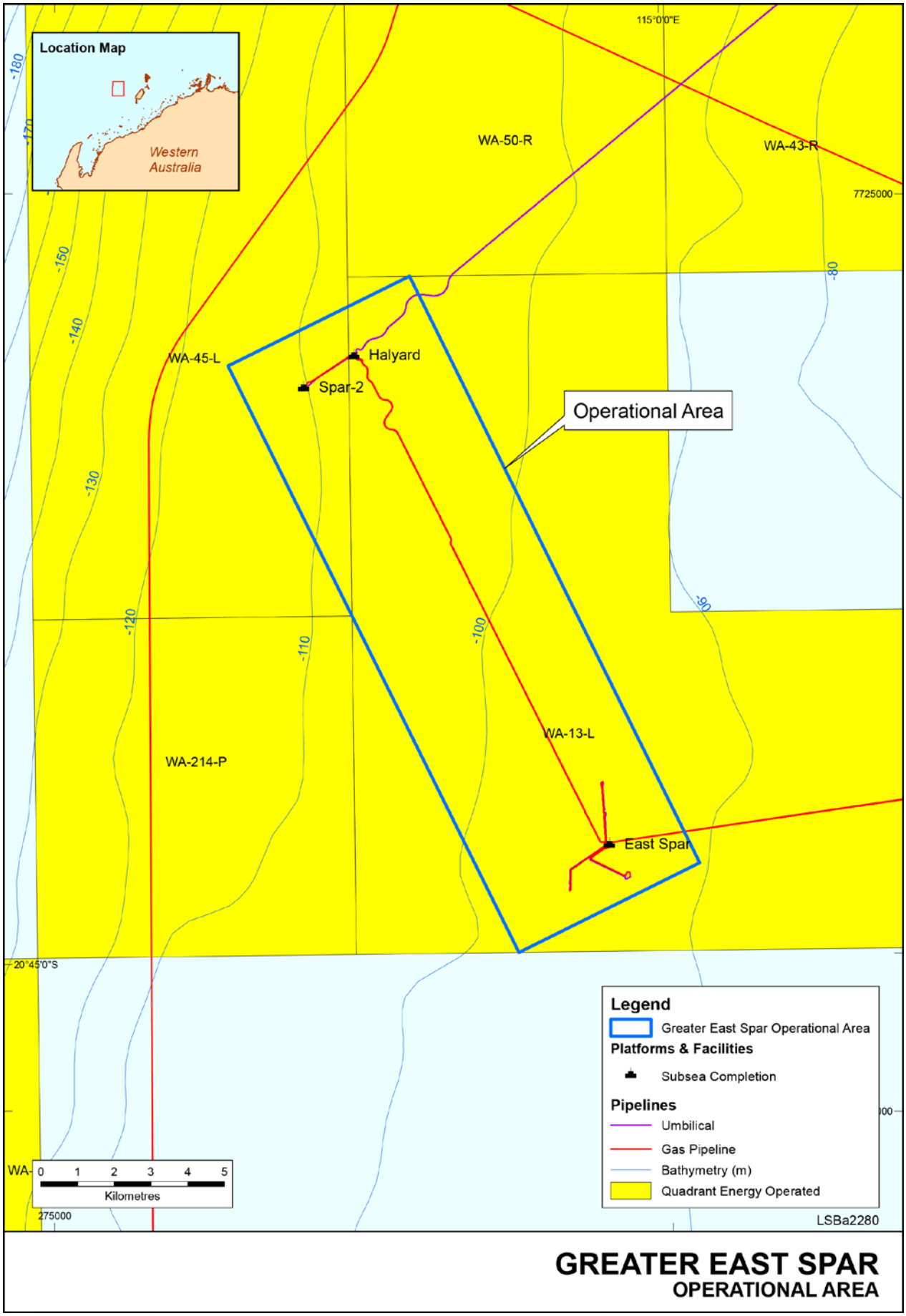

Figure 2-3: Location of the GES installation and commissioning operational area

3. DESCRIPTION OF THE ACTIVITY

3.1 Installation Activities

The Spar-2 well, located 1.7 km west southwest of Halyard-1 well, was drilled and completed in December 2010 with a 10kpsi Xmas Tree (XT), as a gas production well. The following steps are required to enable the production of gas from the Spar -2 well for processing on Varanus Island.

3.1.1 PLEM and SCS installation

A new 2-slot Pipeline End Manifold (PLEM) and Subsea Cooling Skid (SCS) will be installed adjacent to the Halyard-1 XT and the existing 16km x 10" flexible flowline to the East Spar PLEM will be disconnected from the Halyard-1 XT and reconnected to the SCS.

3.1.2 GES flowline and umbilical installation

A flexible flowline (1.7 km long, 8" diameter) and an EHU (1.9 km), will be installed connecting the GES PLEM to the Spar 2 XT. The flowline is pre-flooded with treated water (MEG and corrosion inhibitor). The umbilical lines are supplied full with hydraulic fluid and pressurised to approximately 70 bar. The umbilical has Umbilical Termination Heads (UTH) fitted on both ends.

3.1.3 Recovering and relocating the electro-hydraulic umbilical (EHU)

An EHU (28km long) currently provides chemicals, hydraulic fluid and electrical power and communications to the Halyard-1 XT from the John Brookes Platform. A 6m by 3m concrete mattress currently installed across the umbilical will be removed and laid down on the seabed nearby. If the mattress cannot be re-used, it will be left *in-situ* and a new mattress (of similar size as the currently installed one) will be used.

The EHU UTH will be disconnected from the Halyard-1 XT and parked into a purpose built parking stand which allows selected cores of the EHU to be open to sea. The contents (MEG and corrosion inhibitor) currently within the cores of the EHU (opened to sea) will be displaced by another corrosion inhibitor. This will be pumped from the John Brookes platform. The MEG/Water and corrosion inhibitor will be flushed to sea.

On completion of flushing operations the EHU UTH will be recovered to deck. Cleaning and maintenance will be performed on deck before it is redeployed to tie-in the GES PLEM. Discharges from this cleaning process will be kept on-board and disposed onshore. Concrete mattresses will then be installed.

3.1.4 Halyard 10" flowline flushing

The 10" flexible flowline will be flushed with nitrogen, followed by surfactant and treated seawater. This will occur via downline from the installation vessel to the Halyard-1 XT. The fluids will be displaced into the East Spar pipeline and will later flow through to VI. On completion of all flushing activities, an ROV will close the valves at the East Spar PLEM. On completion of all installation and commissioning activities, the valves will be opened and produced gas will push the flushing fluid to VI. The system will be isolated at the East Spar PLEM, the flowline will then be recovered and relocated as per **Section 3.1.5**.

3.1.5 Recovering and relocating the existing Halyard 10" flowline

On completion of successful flushing activities, the existing Halyard flowline will be relocated to connect the new GES SCS and the existing East Spar PLEM. Two 6m by 3m concrete mattresses currently installed across the flowline will be removed and laid down nearby. If the mattresses cannot be re-used, they will be left *in-situ* and new mattresses (of similar size as the currently installed ones) will be used.

The flowline will first be disconnected from the isolated Halyard XT and its connection end (including approximately 400m of the flowline) lifted off the seabed and placed on the vessel deck. Small volumes (approximately 2 m^3) of treated sea water and residual hydrocarbons with oil in water concentration at or below 30ppm may be discharged to sea through the open end as a result of this activity. Cleaning,

maintenance and potential modifications to the flowline will be performed before redeploying and placing on the seabed. The flowline will be placed within the operational area in Quadrant production permit WA-13-L, pending reconnection to the new SCS.

The newly-installed GES system will be subject to a leak test prior to the connection of the existing flowline. Once the first leak test is complete, the Halyard flowline will be tied into the SCS. The mattresses will then be placed on the Halyard flowline and the second leak test carried out.

3.1.6 Spool and flying lead installation

The spools for this project will be fabricated and tested onshore, including the Cameron vertical Connector (CVCs). A vessel will transport the completed spools to site and the installation vessel will lift the spools from the supply vessel. The installation vessel and ROVs will then install the spools between the structures (Note that the spools are installed suspended between the structures, they are not installed on the seabed). The CVC connections will be tested via a backseal test following installation.

The flying leads will be overboarded on a deployment frame with the Electric Hydraulic Flying Lead (EHFL) installed between the PLEM and Halyard XT, and the Electric Flying Leads (EFL) installed from the PLEM to SCS.

The PLEM and SCS will be connected via a rigid tie-in spool. The Spar-2 XT will operate with direct flowline and umbilical connections to the PLEM. A second rigid tie-in spool will complete the connection of the Halyard-1tree into the GES PLEM. The two spools are pre-flooded with corrosion inhibitor and deployed with the ends open, therefore some egress may be expected, although seawater ingress is considered more likely.

3.1.7 Pre-commissioning

System leak testing will be completed between production wing valves in the Halyard-1 and Spar-2 XTs and the isolation valves in the East Spar PLEM. Pressure testing and electrical testing of the control system will be conducted from the John Brookes Platform by personnel on board (i.e. the vessel will not be required to be alongside the JB platform to perform this testing).

3.1.8 Cold commissioning

Communication testing with the XT, PLEM and SCS and function testing of the subsea hydraulically actuated valves will be conducted. The valves will be tested using the subsea control system with an ROV observing the operations. Some hydraulic fluids will be released during valve actuation.

3.1.9 Surveys

A pre-installation seabed survey will be completed to ensure the seabed is suitable for installation. A detailed biological seabed survey has already been completed in the project area; however, surveys prior to installation of subsea infrastructure will be conducted to check for debris and natural features (i.e. rocks or spans) and will be conducted using ROV.

On completion of the PLEM and SCS installation, spool metrology will be carried out between the two structures and the Halyard-1 XT to determine the final dimensions of the rigid tie-in spools.

Following completion of the infrastructure installation, an as-built survey will be conducted using an ROV.

3.2 **Planned activity**

3.2.1 Vessels

The activity will be carried out by an installation vessel and supported by at least one support vessel. The installation vessel will be a dynamic positioning (DP) Class 2 or 3 vessel with heavy load on-board crane and two (2) work class ROVs. The support vessel(s) will provide logistical, safety and equipment management

support and will be used on an ad-hoc basis such that it will not be in the field throughout the entire duration of the activity. The exact vessels are yet to be confirmed.

3.2.2 Logistics support

Vessel refuelling at sea may occur during the activity. Helicopters will be used to transfer crew and equipment, and assist in Health Safety Environment (HSE) or operational emergencies as required.

3.3 **Simultaneous Operations**

Following installation of the PLEM, SCS, GES flowline and umbilical, the Halyard-1 well will be shut-in and the associated Halyard flowline and East Spar pipeline will be depressurised and isolated at VI. This will allow the Halyard flowline flushing to commence. In addition, the Halyard umbilical will be isolated at the John Brookes platform, allowing the control system upgrades for Halyard to be completed on John Brookes. The John Brookes platform will remain operating and unaffected during the Halyard shutdown window.

Following completion of the installation and commissioning works, the Spar-2 well will be brought online, and the Halyard-1 well re-started.

3.4 **Emergency Activities**

This EP does not consider emergency response activities associated with other vessels or aircrafts rendering assistance to GES vessels and their crew.

4. DESCRIPTION OF ENVIRONMENT

4.1 Environment That May Be Affected (EMBA)

Spill trajectory areas, predicted by modelling, were determined for the worst case hydrocarbon spills: a vessel collision rupturing a fuel tank and releasing marine gas oil (MGO) and a subsea release of Halyard Condensate due to damaged subsea infrastructure.

Of these two scenarios, the spill trajectory area for MGO from a vessel collision has the largest spatial extent, as defined in **Table 4-1** and extends outside the operational area boundary and is classified as Environment That May Be Affected (EMBA). The spatial extent of EMBA is for the defined threshold, at which impact to fauna and/or habitat could result.

According to the spill modelling, the hydrocarbon spill from a vessel collision incident does not make any contact with shoreline. A search of the EPBC Act Protected Matters Database using the coordinates of the spill extent of the worst case spill scenario (i.e. 600 m^3 of diesel from a vessel collision) was conducted to identify the environmental values and sensitivities within the existing environment.

Three credible spill scenarios were identified to help inform the EMBA as outlined in **Table 4-1** below.

Table 4-1: Summary of largest credible hydrocarbon spill scenarios

Scenario	Hydrocarbon Type	Maximum Credible Volume	Comment
Hydrocarbon spill (MGO) from vessel collision	MGO	600 m^3	Maximum credible volume based on largest fuel tank on installation vessel.
Hydrocarbon spill (condensate) from pipeline rupture (due to dropped object)	Halyard Condensate	159 m^3	Maximum credible volume – release of full content of Halyard flowline and East Spar pipeline
Hydrocarbon spill (MGO) during refuelling	MGO	37.5 m^3	Maximum credible volume based on 15 minutes of flow at a pumping rate of 150 m^3/hr.
Non-hydrocarbon release (surface) liquid	Lube oil/chemicals	1 m^3	Stern lube oil from the vessel thruster/propeller

The worst case credible spill scenario (loss of inventory in 1 fuel tank due to vessel collision) has been modelled (**Section 6.4.1**) to identify the worst case environmental extent that may be affected by this activity. The modelling was conducted for each scenario for 3 seasonal periods including summer (October to March), transitional (September to April) and winter (May to August).

4.2 Physical environment and habitat

4.2.1 Physical environment

The GES operational area is situated within Commonwealth waters of the North-west Marine Region (DSEWPaC, 2008). The North-west Marine Region is further divided into eight provincial bioregions (DSEWPaC, 2008). The operational area and EMBA intersects the Northwest Shelf Province and Northwest Province bioregion as described below.

Northwest shelf province bioregion

The Northwest Shelf Province Bioregion is located primarily on the shelf between North West Cape and Cape Bougainville. The bioregion has a total area of 238,759 km^2 and contributes to 19.6 % of the total area of the North-west Marine Region. Water depths within the bioregion range from 0-200m, with more than 45% of the bioregion having a depth of 50-100 m (DSEWPaC, 2008).

Northwest province bioregion

The Northwest Province Bioregion is located offshore between Exmouth and Port Hedland, covering an area of 178,651 km^2 [a]nd covers 16.7% of the total NWMR. Water depths of the bioregion predominantly range from 1000 to 3000 m, with a maximum depth of 5170 m in the Exmouth Plateau (DSEWPaC, 2008).

The Northwest province lies entirely on the continental slope and is comprised of muddy sediments. A number of distinguishing topological features occur, notably the Exmouth Plateau. Significantly, this bioregion contains the steepest shelf break of the NWMR, along the Cape Range Peninsula near Ningaloo Reef (DSEWPaC, 2008). As with many other bioregions, currents are dominated by the circulation of the Indonesian Throughflow. Circulation is subject to both seasonal and inter-annual variation. The most distinguishing oceanographic feature of the Northwest Province (compared to other bioregions further north) is the strengthening of the Leeuwin current resulting from the narrowing of the continental shelf at the North West Cape (DSEWPaC, 2008).

4.2.2 Habitats

Northwest Shelf Province Bioregion

Low density benthic communities of bryozoans, molluscs and echinoids are supported within the bioregion. Sponge communities are also sparsely distributed on the shelf and are found only in areas of hard substrate. However the region between Dampier and Port Hedland is a hotspot for sponge biodiversity. Other benthic and demersal species in the bioregion include sea cucumbers, urchins, prawns and squid. Benthic and pelagic fish communities are also highly diverse and strongly depth-related with a number of hotspots identified between Port Hedland and North West Cape. Numerous migratory species including humpback whales, whale sharks and dugongs travel through the bioregion. The bioregion also supports bottlenose and Indo-Pacific humpback dolphins, turtle nesting sites including green, hawksbill, flatback and loggerhead turtles, and several seabird breeding populations including wedge-tailed shearwaters, crested, bridled and sooty terns, brown boobies and lesser frigate birds (DSEWPaC, 2008).

Northwest Province Bioregion

Benthic communities are likely to include filter feeders and epifauna. Soft bottom environments are likely to support patchy distributions of mobile epibenthos. Pelagic species occurring in the bioregion are likely to include small pelagic fish attracted to seasonal upwellings as well as larger predators such as billfish, sharks and dolphins. A number of migratory species have been recorded in the bioregion including whale sharks, cetaceans and marine turtles.

The presence of marine and coastal habitats within the EMBA is summarised in **Table 4-3**.

4.2.3 Benthic habitats

Given the operational area and the extent of the EMBA are located in northwest province bioregion, the benthic habitats within the operational area and the EMBA are expected to be similar with soft sediments and outcropping cemented sediments (hard substratum) and associated benthic fauna. Benthic primary producer habitat (e.g. areas of hard corals, seagrass or macroalgae) is unlikely to be present. The minimum depth of the water encompassed by the operational area is approximately 90 m; at these depths benthic primary production, which relies on photosynthesis for energy production is limited due to insufficient light availability.

4.2.3.1 Soft sediments and benthic fauna

Quadrant commissioned RPS to undertake a biological seabed survey for the Greater East Spar Development Project (RPS, 2011b); surveying proposed subsea infrastructure footprints and flowline corridors. The survey showed the seabed in the GES operational area to be relatively flat comprising of fine

silt and muddy sediments, with a gentle sloping gradient from east to west. These sediments were un-vegetated and densely bioturbated (< 75%). Epibenthic biota was sparse (< 5%) and included invertebrates, such as anemones, sponges and sea urchins. Neptune Geomatics also undertook a geotechnical campaign for Quadrant development activities (being Balnaves, Coniston/Novara and Greater East Spar) in 2012 (Neptune, 2012a and 2012b) which contributed to the information about the existing environment and design for the subsea infrastructure (e.g flowline and structure locations).

4.3 Protected/ significant areas

The Montebello Commonwealth marine Reserve (CMR) overlaps with the EMBA (**Figure 4-1**); the CMR's conservation values are presented below due to its close proximity and high environmental value.

Montebello Commonwealth Marine Reserve

The CMR, an IUCN VI zone (see **Table 4-2** for values), covers an area of approximately 3,413 km^2 and is designated due to the following values:

Major conservation values

- Foraging areas for migratory seabirds that are adjacent to important breeding areas**;**
- Areas used by vulnerable and migratory whale sharks for foraging;
- Foraging areas marine turtles which are adjacent to important nesting sites**;**
- Section of the north and south bound migratory pathway of the humpback whale;
- Shallow shelf environments with depths ranging from 15–150m which provides protection for shelf and slope habitats, as well as pinnacle and terrace seafloor features**;**
- Seafloor habitats and communities of the Northwest Shelf Province provincial bioregions as well as the Pilbara (offshore) meso-scale bioregion; and
- One key ecological feature for the region is the ancient Coastline (a unique seafloor feature that provides areas of enhanced biological productivity).

Summary of Ecological Values

- Geomorphology: A complex seabed and island topography consisting of subtidal and intertidal reefs, sheltered lagoons, channels, beaches and cliffs;
- Sediment quality: The sediments of the reserves are generally pristine, which is essential to the maintenance of healthy marine ecosystems;
- Water quality: The waters of the reserves are generally pristine, which is essential to the maintenance of healthy marine ecosystems;
- Coral reef communities: Undisturbed intertidal and subtidal coral reefs and bommies with a high diversity of hard corals;
- Macroalgal and seagrass communities: Extensive subtidal macroalgal and seagrass communities are important primary producers and refuge areas for fishes and invertebrates;
- Subtidal soft-bottom communities: Subtidal sand and silt habitats support a variety of fauna including burrowing invertebrates and filter-feeding communities;
- Marine mammals: Ten species of cetaceans are recorded from the reserves, with the humpback whale passing through the area during its annual migration (1 June through to 31 July (northward migration) and 1 September through to 31 October (southern migration). Dugongs are found in the shallow warm waters;

- Turtles: Green, flatback, hawksbill, loggerhead and leatherback turtles are found in the reserves, with the Western Australian hawksbill population being the largest remaining in the Indian Ocean. Four species use sandy beaches in the reserves for nesting;
- Seabirds: The reserves provide important feeding and resting areas for migrating shorebirds. Islands within the reserves are nesting areas for 15 species of seabirds;
- Finfishes: A rich finfish fauna with at least 456 species; and
- Invertebrates: A diverse marine invertebrate fauna comprising mostly tropical species.

Summary of Social Values

- Hydrocarbon exploration and production industry: The Montebello CMR is within the State's most productive petroleum area (for both oil and gas);
- Commercial fishing: The reserves are used by commercial fishers targeting a variety of finfish, sharks and beche de mer; and
- Scientific research: The undisturbed nature and wide variety habitats and communities within the reserves provide unique opportunities for scientific research.

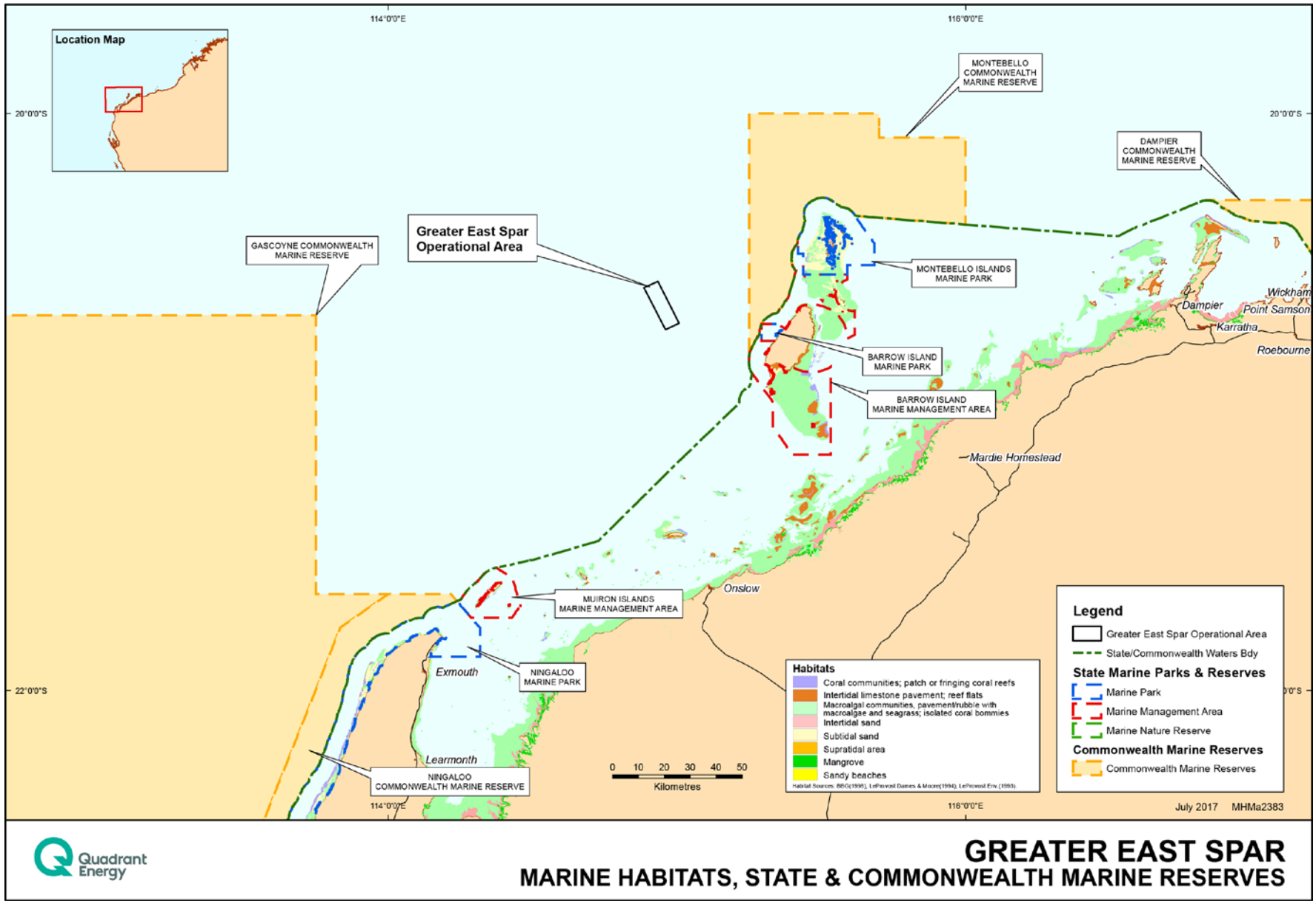

Figure 4-1: Commonwealth and State Marine Parks and Reserves in the vicinity of the operational area

Table 4-2: Australian IUCN reserve management principles (Schedule 8 of the EPBC Regulations 2000)

Category VI	IUCN principles	Evidence of addressing principles
• Montebello Commonwealth Reserve	The reserve or zone should be managed mainly for the sustainable use of natural ecosystems based on the following principles.	Yes - Addressed throughout this table
	The biological diversity and other natural values of the reserve or zone should be protected and maintained in the long term.	Yes – addressed through the control measures identified in this EP (**Section 6.3 & 6.4**)
	Management practices should be applied to ensure ecologically sustainable use of the reserve or zone.	Yes – addressed through the control measures identified in this EP (**Section 6.3 & 6.4**)
	Management of the reserve or zone should contribute to regional and national development to the extent that this is consistent with these principles.	N/A - Covered by park management (DoE)

4.3.1 Key ecological features

The Ancient Coastline KEF is in close proximity to the GES operational area, with the closest point located 402 m away from the KEF (**Figure 4-2**). The EMBA also overlaps with the following KEFs:

Ancient Coastline at 125 m Contour

The shelf of the North-west Marine Region contains several terraces and steps, which reflect the gradual increase in sea level across the shelf that occurred during the Holocene (DSEWPaC, 2012k). The most prominent of these occurs episodically as an escarpment through the Northwest Shelf Province and Northwest Shelf Transition, at a depth of approximately 125 m (DSEWPaC, 2012k). Where the ancient submerged coastline provides areas of hard substrate it may contribute to higher diversity and enhanced species richness relative to soft sediment habitat (DSEWPaC, 2012k).

The escarpment may facilitate increased availability of nutrients in particular locations off the Pilbara coast by disrupting internal waves thereby facilitating enhanced vertical mixing of water layers. Enhanced productivity may attract opportunistic feeding by larger marine life including humpback whales, whale sharks and large pelagic fish (DSEWPaC, 2012k).

Although the ancient coastline adds additional habitat types to a representative system, the habitat types are not unique to the coastline as they are widespread on the upper shelf (Falkner *et al*., 2009). The Marine Bioregional Plan for the North-west Marine Region(DSEWPaC, 2012k) states that most actions occurring along the ancient coastline at the 125 metre depth contour are unlikely to impact adversely on the ecosystem functioning and integrity of this key ecological feature.

Canyons linking the Cuvier Abyssal Plain and the Cape range Peninsula

Cape Range Peninsula and the Cuvier Abyssal Plain are linked by canyons, the largest of which are the Cape Range Canyon and Cloates Canyon. These two canyons are located along the southerly edge of Exmouth Plateau adjacent to Ningaloo Reef and are unique due to their close proximity to the North West Cape (DSEWPaC 2012).

The Leeuwin Current interacts with the heads of the canyons to produce eddies resulting in delivery of higher nutrient, cool waters from the Antarctic intermediate water mass to the shelf (Brewer et al. 2007). Strong internal tides also create upwelling at the canyon heads (Brewer et al. 2007). Thus the canyons, the Exmouth Plateau and the Commonwealth waters adjacent to Ningaloo Reef interact to create the conditions for enhanced productivity seen in this region (Sleeman et al. 2007 in DSEWPaC 2012). The canyons are also repositories for particulate matter deposited from the shelf and sides of the canyons and serve as conduits for organic matter between the surface, shelf and abyssal plains (DSEWPaC 2012).

The canyons that link the Cuvier Abyssal Plain with the continental slope off Cape Range Peninsula are believed to support the productivity and species richness of Ningaloo Reef (DSEWPaC 2012).

Continental Slope Demersal Fish Communities

The Australian continental slope provides important habitat for demersal fish communities, characterised by high endemism and species diversity. Specifically, the continental slope between North West Cape and the Montebello Trough is the most diverse slope bioregion in Australia with more than 500 fish species, 76 of which are endemic (Last et al. 2005 in DSEWPaC 2012). The Timor Province and Northwest Transition bioregions are the second-richest areas for demersal fish across the entire continental slope (DSEWPaC 2012).

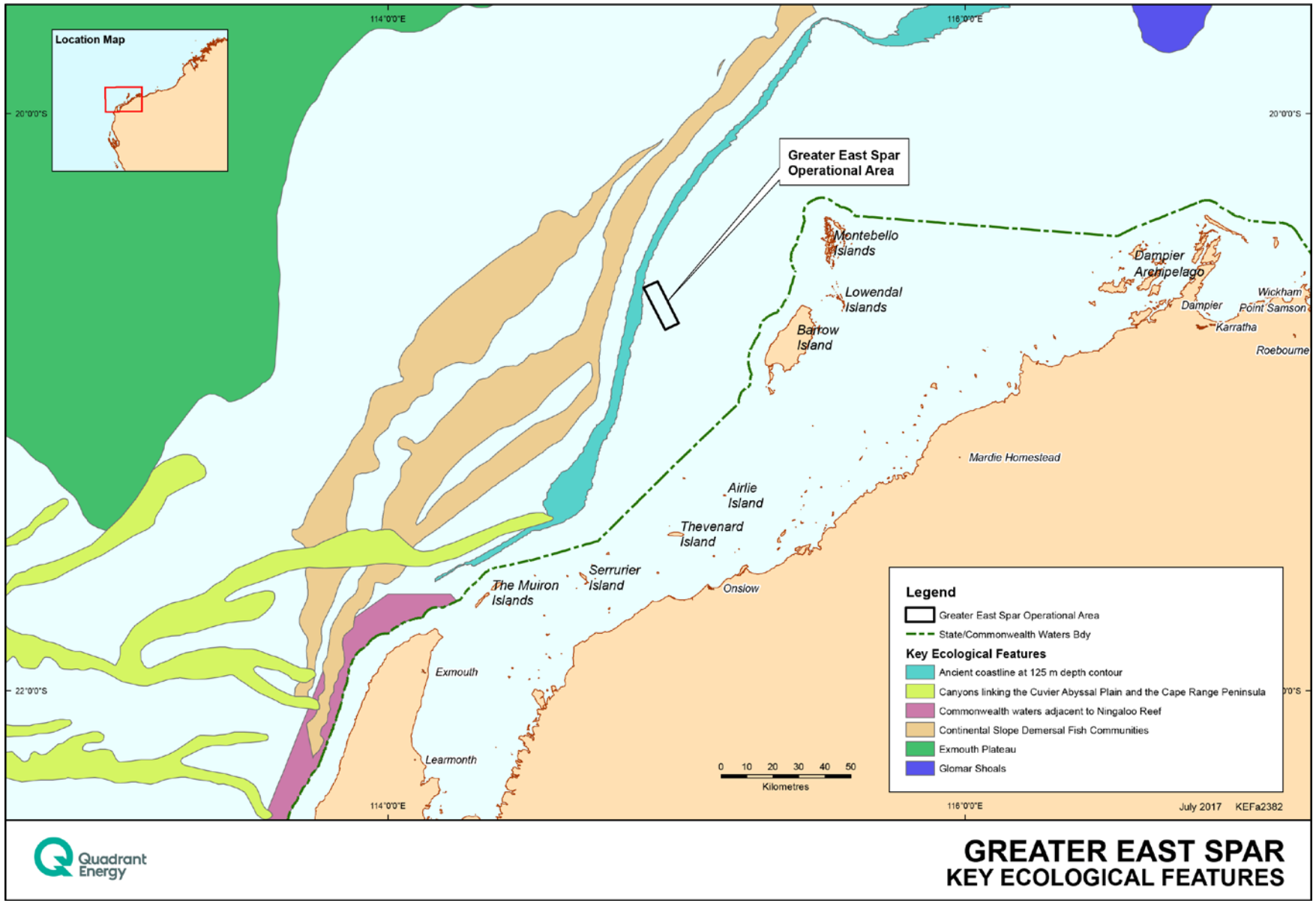

Figure 4-2: Key Ecological Features in the vicinity of the operational area

4.3.2 Threatened and migratory marine fauna

EPBC protected matters searches were conducted on the 15thMarch 2017 and 24th May 2017 for the operational area and EMBA. A list of listed threatened marine fauna and protected communities and their migratory characteristics is given in **Table 4-3.** For each species identified, the extent of likely presence is provided, including any overlap with designated Biologically Important areas (BIAs).

Results of the search identified five 'threatened' species of marine fauna within the operational area, all of which are also listed as 'migratory' species (**Table 4-3**).

Table 4-3: Protected species and communities in the operational area and EMBA

Value/Sensitivity		EPBC Act Status CE = Critically Endangered E = Endangered V = Vulnerable M = Migratory	Operational Area presence	Particular values or sensitivities within Operational Area	EMBA presence	Particular values or sensitivities within EMBA	Relevant Events
Common Name	**Scientific Name**						
Protected Species and Communities: Fish and Sharks							
Whale shark	*Rhincodon typus*	V,M	✓	Foraging, feeding or related behaviour known to occur within area. Overlap with foraging BIA	✓	Foraging, feeding or related behaviour known to occur within area. Overlap with foraging BIA	Planned • Light emissions • Noise emissions • Planned operational discharges • Spill response operations Unplanned • Hydrocarbon Releases • Non-hydrocarbon releases • Marine fauna collisions • Introduction of invasive marine species
Grey nurse shark (west coast population)	*Carcharias taurus (west coast population)*	V,M	✓	Species or species habitat known to occur within area	✓	Species or species habitat known to occur within area	
Great white shark	*Carcharodon carcharias*	V, M	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	
Dwarf sawfish	*Pristis clavata*	V, M	✓	Species or species habitat known to occur within area	✓	Species or species habitat known to occur within area	
Green sawfish	*Pristis zijsron*	V, M	✓	Species or species habitat known to occur within area	✓	Species or species habitat known to occur within area	

Value/Sensitivity		EPBC Act Status CE = Critically Endangered E = Endangered V = Vulnerable M = Migratory	Operational Area presence	Particular values or sensitivities within Operational Area	EMBA presence	Particular values or sensitivities within EMBA	Relevant Events
Common Name	**Scientific Name**						
Protected Species and Communities: Marine Mammals							
Humpback whale	*Megaptera novaeangliae*	V,M	✓	Species or species habitat known to occur within area Overlap with BIA for migration	✓	Species or species habitat known to occur within area Overlap with BIA for migration	Planned • Noise emissions • Planned operational discharges • Spill response operations Unplanned • Hydrocarbon Releases • Non-hydrocarbon releases • Marine fauna collisions
Blue whale	*Balaenoptera musculus*	E,M	✓	Species or species habitat likely to occur within area	✓	Migration route known to occur within area Overlap with BIA for migration	
Sei whale	*Balaenoptera borealis*	V, M	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	
Fin whale	*Balaenoptera physalus*	V, M	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	
Southern right whale	*Eubalaena australis*	E	**X**		✓	Species or species habitat may occur within area	
Protected Species and Communities: Marine Reptiles							
Short-nosed seasnake	*Aipysurus apraefrontalis*	CE	**X**		✓	Species or species habitat may occur within area	Planned • Light emissions • Noise emissions • Planned operational
Loggerhead turtle	*Caretta caretta*	E,M	✓	Species or species habitat known to	✓	Species or species habitat known to	

Value/Sensitivity		EPBC Act Status CE = Critically Endangered E = Endangered V = Vulnerable M = Migratory	Operational Area presence	Particular values or sensitivities within Operational Area	EMBA presence	Particular values or sensitivities within EMBA	Relevant Events
Common Name	**Scientific Name**						
				occur within area		occur within area	discharges • Spill response operations Unplanned • Hydrocarbon Releases • Non-hydrocarbon releases • Marine fauna collisions
Green turtle	*Chelonia mydas*	V,M	✓	Species or species habitat known to occur within area	✓	Species or species habitat known to occur within area	
Leatherback turtle	*Dermochelys coriacea*	E,M	✓	Species or species habitat likely to occur within area	✓	Species or species habitat known to occur within area	
Hawksbill turtle	*Eretmochelys imbricata*	V,M	✓	Species or species habitat known to occur within area	✓	Species or species habitat known to occur within area	
Flatback turtle	*Natator depressus*	V,M	✓	Congregation or aggregation known to occur within area. Overlap with internesting buffer BIA	✓	Congregation or aggregation known to occur within area Overlap with internesting buffer BIA	
Protected Species and Communities: Marine Birds							
Curlew sandpiper	*Calidris ferruginea*	CE, M	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	Planned • Light emissions • Noise emissions • Planned operational discharges • Atmospheric emissions • Spill response
Red knot	*Calidris canutus*	E, M	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	
Southern giant petrel	*Macronectes giganteus*	E,M	✓	Species or species habitat may to occur within area	✓	Species or species habitat may occur within area	

Value/Sensitivity		EPBC Act Status CE = Critically Endangered E = Endangered V = Vulnerable M = Migratory	Operational Area presence	Particular values or sensitivities within Operational Area	EMBA presence	Particular values or sensitivities within EMBA	Relevant Events
Common Name	**Scientific Name**						
Eastern curlew	*Numenius madagascariensis*	CE, M	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	operations Unplanned • Hydrocarbon Releases • Non-hydrocarbon releases • Marine fauna collisions
Soft-plumaged petrel	*Pterodroma mollis*	V	**X**		✓	Species or species habitat may occur within area	
Australian fairy tern	*Sternula nereis nereis*	V	✓	Foraging, feeding or related behaviour likely to occur within area	✓	Foraging, feeding or related behaviour likely to occur within area	

4.3.2.1 Marine mammals

A search of the EPBC Act Protected Matters Database identified 29 cetacean species that may occur within the operational area and EMBA. Of these, 24 are listed as migratory and five are listed as threatened under the EPBC Act.

4.3.2.2 Fish and sharks

A search of the EPBC Act Protected Matters Database identified five threatened fish species within the operational area and two migratory species. The search also identified 30 listed marine fish.

4.3.2.3 Marine reptiles

A search of the EPBC Act Protected Matters Database identified five marine turtle species, and one seasnake listed as either critically endangered, endangered, vulnerable, which may occur within the operational area and/or EMBA. All of these species are migratory.

4.3.2.4 Marine seabirds

Of the seabird species identified from the EPBC Act Protected Matters Database searches for operational area and EMBA, six threatened marine bird species and six migratory seabird species with a recognised range within operational area and/or EMBA are identified.

4.3.3 Socioeconomic receptors

The GES operational area is located approximately 147 km west from the Port of Dampier and 100 km north from Onslow. Smaller regional settlements are further away at Point Samson and Exmouth. Socio-economic activities that may occur within the operational area and surrounds include commercial fishing, oil and gas exploration and production; and to a lesser extent, recreational fishing and tourism as summarised in **Table 4-4**.

Table 4-5 identifies the relevant State and Commonwealth fisheries that overlap the Operational Area. Active fisheries are identified in consultation with Western Australia Fishing Industry Council (WAFIC) and Department of Fisheries (DoF).

Table 4-4: Socioeconomic Activities in the vicinity of the operational area

Value/ Sensitivity	Description	Operational Area presence	Relevant events within Operational Area	Relevant Events within EMBA
Shipping	Shipping using NWS waters includes iron ore carriers, oil tankers and other vessels proceeding to or from the ports of Dampier, Port Walcott and Port Hedland; however, these are predominantly heading north from these ports. The high area of activity in the vicinity of the GES activity is due to the operations at Quadrant's John Brookes facility. The proposed operational area does not overlap any major shipping, although heavy traffic may be encountered throughout the GES operational area as commercial vessels transit around the Montebello Islands and support vessel(s) conduct operations with the offshore infrastructure	✓	<u>Planned</u> Interactions with other marine users	<u>Unplanned</u> Hydrocarbon release from vessel collision
Recreational	Within the operational area there are no known	-	N/A	N/A

fishing	natural seabed features that would aggregate fishes and which are typically targeted by recreational fishers. Given the water depths and distance from the nearest mainland, it is unlikely recreational fishing would occur in the vicinity.			
Defence	No known defence areas in the vicinity have been advised by the Department of Defence.	-	N/A	N/A
Shipwrecks	1 shipwreck (Lady Ann) overlaps with EMBA	-	N/A	Unplanned Hydrocarbon release from vessel collision
Oil and gas	Various petroleum exploration and production activities have been undertaken within the northwest shelf, however there are none in the vicinity of the operational area. Vessels servicing oil and gas operations in the region may pass through the area *en route* to facilities, however, since vessel transit is not classed as a petroleum activity, potential impacts to vessels are discussed under 'Shipping' above. Oil and gas facilities occur within the EMBA as do permits operated by other titleholders. As such, oil and gas activities could be impacted by unplanned events.	-	N/A	Unplanned Hydrocarbon release from vessel collision
Tourism	There are many sources of marine-based tourism within the environment that may be affected. Aquatic recreational activities such as boating, diving and fishing occur near the coast and Montebello Islands. These activities are concentrated in the vicinity of the population centres such as Exmouth, Dampier and Onslow. The socio-economic and heritage features in the region are of high value for the tourism industry. However, given the GES EMBA just overlaps a small portion with the Montebello CMR (**Figure 4-1**) and the operational water depths, significant impacts on high value for eco-tourism based on specific local values (whale sharks, game fish, nearshore reef snorkeling and diving) are not expected.	-	N/A	Unplanned Hydrocarbon release from vessel collision
Cultural Heritage	No known sites of Aboriginal Heritage significance within the operational area or EMBA.	-	N/A	N/A

Table 4-5: State and Commonwealth Fisheries in the vicinity of the operational area and EMBA

Value/Sensitivity	Description	Operational Area presence	EMBA presence	Relevant events within the Operational Area and EMBA
Commonwealth Managed Fisheries				
North West Slope Trawl	Extends from 114° E to approximately 125° E off the WA coast between the 200 m isobath and the outer limit of the Australian Fishing Zone (AFZ).	X	✓	Historical effort within the EMBA, targeting scampi and prawns
Western Deepwater Trawl Fishery	Demersal trawl seaward of the 200 m isobaths. No recent fishing activity.	X	✓	No active commercial fishing within the area in the past years; however fisheries overlap the EMBA and therefore fishing vessels could be encountered in low density.
Western Tuna and Billfish Fishery	Extends westward from Cape York Peninsula (142°30' E) off Queensland to 34° S off the WA west coast. It also extends eastward from 34° S off the west coast of WA across the Great Australian Bight to 141° E at the South Australian–Victorian border. No current effort on NWS	✓	✓	
Western Skipjack Tuna Fishery	No current effort on NWS	✓	✓	
Southern Bluefin Tuna	No current effort on NWS	✓	✓	
State Managed Fisheries (North Coast Bioregion)				
Pearl Oyster Managed Fishery	Mostly operate March to June Operational Area does occur within the boundaries of the fishery, but is restricted to shallow diving depths.	✓	✓	Given the water depths of the operational area, disruption to fishing activities are unlikely to occur Unplanned events which may occur in the operational area and EMBA could disrupt fishing activities, however the likelihood of these events is low.
Onslow Prawn Limited Entry Fishery	The boundaries of the OPMF are 'all the Western Australian waters between the Exmouth Prawn Fishery and the Nickol Bay prawn fishery east of 114º39.9' on the landward side of the 200 m depth isobath'.	✓	✓	Significant disruption unlikely to occur due to vast area fished.
Pilbara Demersal Scalefish Fisheries (includes trap and trawl fisheries (zone 1)	Use a combination of vessels, effort allocations (time), gear limits, plus spatial zones (including extensive trawl closures) as management measures. The Trawl Fishery lands the largest component of	✓	✓	The Fishery is seaward of the 50 m isobath and landward of the 200 m isobaths As the maximum water depth in the operational area is 118 m, significant impacts are not

Value/Sensitivity	Description	Operational Area presence	EMBA presence	Relevant events within the Operational Area and EMBA
	the catch of demersal finfish in the Pilbara (and North Coast Bioregion) comprising more than 50 scalefish species. In comparison, the trap fishery retains a subset of about 45 to 50 scalefish species, and while the Line Fishery catch comprises a similar number it also includes some deeper offshore species.			expected. Unplanned events which may occur in the operational area and EMBA could disrupt fishing activities, however the likelihood of these events is low.
State Managed Fisheries (Whole of State)				
Marine Aquarium Fish Fishery	All year Effort within the Operational Area and EMBA is unknown, but is unlikely due to the depth and the dive based method of collection	✓	✓	Disruption to fishing activities unlikely given water depths fisheries operate within. Unplanned events which may occur in the EMBA could disrupt fishing activities, however the likelihood of these events is low.
Specimen Shell Managed Fishery	All year Effort within the Operational Area and EMBA is unknown, but it is unlikely due to the depth and the dive based method of collection Unlikely to occur	✓	✓	
Beche-de-mer Fishery	All year Although permitted to fish within the Operational Area and EMBA, the fishery is restricted to shallow coastal waters suitable for diving and wading Unlikely to occur	✓	✓	
Mackerel Managed Fishery	Trolling or handline. Near-surface trolling gear from vessels in coastal areas around reefs, shoals and headlands	✓	✓	The majority of the catch is taken in the Kimberley Area and therefore disruption is unlikely
Octopus	Caught as a by-product in region.	✓	✓	Fishery is in development phase. Effort within the operational area and EMBA is unknown, but is unlikely to be significant due to effort levels and pot collection method.
Abalone Managed Fishery	The commercial fishery harvest method is a single diver working off a 'hookah' (surface-supplied breathing apparatus) using an abalone 'iron' to prise the shellfish off rocks.	✓	✓	Disruption is unlikely to occur in the operational area due to depths and method of collection. Unplanned events which may occur in the EMBA could disrupt fishing activities, however the likelihood of these events is low.

4.4 Windows of sensitivity

Timing of peak activity for threatened species and other relevant, significant sensitivities is given in **Table 4-6**.

Table 4-6: Windows of sensitivity in the vicinity of the EMBA

CATEGORY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Benthic Habitats												
Non-coral benthic invertebrates												
Fauna												
Plankton												
Fish/Sharks	Timing of spawning activity varies between species.											
Whale shark												
Short-nosed sea snake	Can occur at low density year round											
Hawksbill turtles resident adult and juveniles[1]	Widespread throughout NW Shelf waters, highest density of adults and juveniles over hard bottom habitat (coral reef, rocky reef, pipelines etc.)											
Hawksbill turtle mating aggregations[1]												
Hawksbill turtle nesting and internesting[1]												
Hawksbill turtle hatching[1]												
Flatback turtles resident adult and juveniles[1]	Widespread throughout NW Shelf waters, increased density over soft bottom habitat 10 – 60m deep, post hatchling age classes and juveniles spread across shelf waters											
Flatback turtle mating aggregations[1]												
Flatback turtle nesting and internesting[1]												
Flatback turtle hatching[1]												
Flatback turtle nesting[1]												
Green turtles resident adult and juveniles[1]	Widespread throughout the NW Shelf waters, highest density associated with seagrass beds and macro algae communities, high density juveniles in shallow waters off beaches, amongst mangroves and in creeks											
Green turtle mating aggregations[1]												
Green turtle nestingand												

CATEGORY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
internesting[1]												
Green turtle hatching[1]												
Loggerhead turtles resident adult and juveniles[1]	Widespread throughout the NW Shelf waters, increased density associated with soft bottom habitat supporting their bivalve food source, juveniles associated with nearshore reef habitat											
Loggerhead turtle mating aggregations[1]												
Loggerhead turtle nestingand internesting[1]												
Loggerhead turtle hatching[1]												
Leatherback turtles	Can occur at low density across the NWS year round											
Humpback whale migration						northern			Southern			
Blue whale migration					northern						southern	
Southern giant petrels	breeding							breeding				
Australian Fairy Tern	breeding							breeding				
Socio-economic												
Commercial Managed Fisheries												
Oil and gas												
Shipping												
Tourism/ recreational fishing (none applicable)												
KEY / NOTES												
	Peak activity, presence reliable and predictable					[1]Information provided by K. Pendoley						
	Lower level of abundance/activity/presence											
	Very low activity/presence											
	Activity can occur throughout year											

5. STAKEHOLDER CONSULTATION

Quadrant understands retaining a broad licence to operate depends on the development and maintenance of positive and constructive relationships with a comprehensive set of stakeholders across the community, Government and business sectors.

To allow an informed assessment by stakeholders of the potential impact of Quadrant's activities, Quadrant has established long-term and meaningful dialogue with those stakeholders who have demonstrated an interest in its present and planned future activities in Australia.

For the activities to be undertaken under this EP, a standardised approach is applied to identify key stakeholders for the Activity in question, beginning with a review of the stakeholder database, and of the stakeholders consulted over other recent activities in the area. In particular, the Operational Area for the Activity is used to identify relevant persons on an activity-by-activity basis, and will be used throughout the lifetime of this EP. The key stakeholders identified for the activity are based on the Operational Area and EMBA and are provided in **Table 5-1**.

5.1 Summary

Stakeholders have been informed of Quadrant's planned installation activities at Greater East Spar since 2013, and have been afforded multiple opportunities to comment on activities associated with installation since this time.

Stakeholders were informed of activities covered in this EP via an activity specific consultation package distributed by email on March 28, 2017. A wider stakeholder group was informed of the proposed project in Quadrant's Quarterly Consultation Update editions distributed in September and December 2016 and March 2017.

Quadrant is active in area, operating the Varanus Island Hub since 1993, therefore it is reasonable to expect stakeholders are familiar with Quadrant's presence in the region. Quadrant considers that consultation with regulators and key stakeholders has been adequate; all stakeholders and relevant parties have been actively engaged by Quadrant on proposed activities at Greater East Spar (further detailed in **Table 5-2**). No stakeholder has objected to the Activity covered under this EP nor claimed that the environmental impacts or risks are unacceptable.

All correspondence with external stakeholders is recorded and Quadrant will remain available before, during and after the Activity. Consultation material and feedback received will be provided to the appropriate internal Quadrant personnel when relevant.

Consultation, agreements or contracts that support Quadrant's oil spill response strategies and tactics have been put into place with agencies and organisations throughout the development of the OPEP so that roles and responsibilities are understood and accepted. These are outlined in **Table 5-3.**

Quadrant maintains a comprehensive stakeholder database with stakeholders identified through the following mechanisms:

- Regular review of all legislation applicable to petroleum and marine activities;
- Identification of marine user groups and interest groups active in the area (e.g., recreational and commercial fisheries, other oil and gas producers, merchant shipping etc.);
- Active participation in industry bodies (e.g. APPEA and Australian Marine Oil Spill Centre, AMOSC); and
- Records from previous consultation activities in the area.

For the activities to be undertaken under this EP, a standardised approach is applied to identify key stakeholders for the Activity in question, beginning with a review of the stakeholder database, and of the stakeholders consulted over other recent activities in the area. In particular, the Operational Area for the Activity is used to identify relevant persons on an activity-by-activity basis, and will be used throughout the lifetime of this EP. Identified stakeholders are listed in **Table 5-1.**

Table 5-1: Summary of stakeholders consulted

Group	Stakeholder
Marine Conservation	• Department of Fisheries (DoF) • Department of Parks and Wildlife (DPaW)
Shipping safety and security	• Australian Maritime Safety Authority (AMSA) • Department of Defence (DoD) • Department of Transport (DoT)
Adjacent regulator	• Department of Mines and Petroleum (State)
Fishing bodies	• Austral Fisheries • Australian Fisheries Management Authority (AFMA) • Australian Southern Bluefin Tuna Association (ASBTIA) • Commonwealth Fisheries Association (CFA) • Fat Marine • Marine Tourism WA • MG Kailis • Pearl Producers Association • Quest Maritime Services • Recfishwest • RNR Fisheries • Western Australian Fishing Industry Council (WAFIC) • Western Wild Fisheries • WestMore Seafoods
Karratha/Port Hedland Stakeholder Reference Group	• Chevron Australia • City of Karratha • Pilbara Port Authority

Table 5-2: Consultation summary for Activity

Stakeholder	Assessment of Consultation Undertaken
Fishing bodies	
Austral Fisheries	Austral Fisheries were provided the Greater East Spar Consultation Package on March 28, 2017 and receive all Quadrant's Quarterly Consultation Update documents. No comment on the Activity has been received to date. No action arising from this consultation for this EP.
Australian Fisheries Management Authority	AFMA were provided the Greater East Spar Consultation Package on March 28, 2017 and receive all Quadrant's Quarterly Consultation Update documents. No response regarding the Activity has been received to date. No action arising from this consultation for this EP.
Australian Southern Bluefin Tuna Industry Association (ASBTIA)	ASBTIA were provided the Greater East Spar Consultation Package on March 28, 2017 and receive all Quadrant's Quarterly Consultation Update documents. No response regarding the Activity has been received to date.
Commonwealth Fishing Association	The CFA were provided the Greater East Spar Consultation Package on March 28, 2017 and receive all Quadrant's Quarterly Consultation Update documents. No response regarding the Activity has been received to date.
Fat Marine	Fat Marine were provided the Greater East Spar Consultation Package on March 18, 2017 and receive all Quadrant's Quarterly Consultation Update documents. No response regarding the Activity has been received to date.

Stakeholder	Assessment of Consultation Undertaken
Marine Tourism WA	MTWA were provided the Greater East Spar Consultation Package on March 28, 2017 and receive all Quadrant's Quarterly Consultation Update documents. No comment has been received to date relating to this EP; previous interaction with stakeholder has reassured Quadrant that a response would only be received in the event of concern regarding the Activity.
MG Kailis	MG Kailis were provided the Greater East Spar Consultation Package on March 28, 2017 and receive all Quadrant's Quarterly Consultation Update documents.
Pearl Producers Association	The PPA were provided the Greater East Spar Consultation Package on March 28, 2017 and receive all Quadrant's Quarterly Consultation Update documents.
Quest Maritime Services	Quest Maritime Services were provided the Greater East Spar Consultation Package on March 28, 2017 and receive all Quadrant's Quarterly Consultation Update documents. No comment on the Activity has been received to date.
Recfishwest	Recfishwest were provided the Greater East Spar Consultation Package on March 28, 2017 and receive all Quadrant's Quarterly Consultation Update documents.
RNR Fisheries	RNR Fisheries were provided the Greater East Spar Consultation Package on March 28, 2017 and receive all Quadrant's Quarterly Consultation Update documents. No comment on the Activity has been received to date.
Western Australian Fishing Industry Council	WAFIC were provided the Greater East Spar Consultation Package on March 28, 2017 and receive all Quadrant's Quarterly Consultation Update documents.
Western Wild Fisheries	Western Wild Fisheries were provided the Greater East Spar Consultation Package on March 28, 2017 and receive all Quadrant's Quarterly Consultation Update documents. No comment on the Activity has been received to date.
WestMore Seafoods	These fishers were provided the Greater East Spar Consultation Package on March 28, 2017 and receive all Quadrant's Quarterly Consultation Update documents. Gary Kessell at Westmore Seafoods also represents Shark Bay Seafood, and operates within the Western Deep Water Trawl Fishery, North West Slope Trawl Fishery, Shark Bay Prawn Fishery, Pilbara Fish Trawl, Nickol Bay Prawn Fishery and the Kimberley Prawn Fishery zones. No comment on the Activity has been received to date. No action arising from this consultation for this EP.
Karratha/Dampier Stakeholder Reference Group	
Chevron	Chevron were provided the Greater East Spar Consultation Package on March 28, 2017 and responded via email on March 29, 2017, acknowledging the email.
Pilbara Port Authority	The PPA were provided the Greater East Spar Consultation Package on March 28, 2017 and receive all Quadrant's Quarterly Consultation Update documents. An email response was received on March 29, 2017 acknowledging receipt of the email.
City of Karratha	The City of Karratha were provided the Greater East Spar Consultation Package on March 28, 2017 and receive all Quadrant's Quarterly Consultation Update documents. No comment on the Activity has been received to date.
Marine Conservation	

Stakeholder	Assessment of Consultation Undertaken
Department of Fisheries	DoF were provided the Greater East Spar Consultation Package on March 28, 2017 and receive all Quadrant's Quarterly Consultation Update documents. DoF provided formal response to Quadrant via email on May 10, 2017. Following this consultation, Quadrant has updated sections of this EP including fishing activities, fish spawning grounds in the area, pollution emergency plan advice and biosecurity.
Department of Parks and Wildlife	DPaW were provided the Greater East Spar Consultation Package on March 28, 2017 and receive all Quadrant's Quarterly Consultation Update documents.
Shipping safety and security	
Australian Hydrographic Service	The AHS were provided the Greater East Spar Consultation Package on March 28, 2017 and responded via email on March 29, 2017, acknowledging the email.
Australian Maritime Safety Authority	AMSA were provided the Greater East Spar Consultation Package on March 28, 2017 and receive all Quadrant's Quarterly Consultation Update documents. AMSA provided shipping traffic plots via email on April 6, 2017, which indicates most vessel traffic encountered would be industry traffic. Following advice from AMSA, Quadrant commits to relevant marine notices as per EPS CM-47-EPS-2 and EPS CM-47-EPS-3.
Department of Defence	The Department were provided the Greater East Spar Consultation Package on March 28, 2017 and receive all Quadrant's Quarterly Consultation Update documents. No comment on the Activity has been received to date. The AHS branch of the Department receive notifications as per CM-47.
Department of Transport	DoT were provided the Greater East Spar Consultation Package on March 28, 2017 and receive all Quadrant's Quarterly Consultation Update documents. In line with DoT's Industry Guidance Note, DoT were provided a targeted consultation package via email on April 11, 2017. DoT responded via email on May 2, 2017, with no additional requests for information. Consultation with DoT in considered closed for the purpose of this approval, however Quadrant continues ongoing consultation with DoT on all Quadrant projects as per DoT's Industry Guidance Note.
Adjacent Regulators	
State Department of Mines and Petroleum (DMP)	DMP were provided the Greater East Spar Consultation Package on March 28, 2017 and receive all Quadrant's Quarterly Consultation Update documents. DMP responded via email on March 28, 2017, acknowledging the activity would occur in Commonwealth Waters under NOPSEMA's regulation. DMP requested an update once activities were completed outlining any changes in impact to State waters outlined in Quadrant's Varanus Island operations EPs. DMP is a valued stakeholder and Quadrant commits to open on ongoing consultation before, during and after the Activity Including the provision of pre-start and cessation notifications as per DMP's Consultation Guidelines.

5.2 Ongoing Consultation

Activities covered by this EP will be consulted via three tiers, the Activity Consultation Package distributed prior to EP acceptance (sent on March 28, 2017), a Notification Package prior to activity commencement when timing and other details are confirmed, and within Quadrant's Quarterly Consultation Updates (last issued March 2017, next planned for June 2017).

5.2.1 Stakeholder notifications

Prior to mobilisation, Quadrant will provide a Quadrant Notification Package to relevant stakeholders. Stakeholders who receive this notification document will be based on Quadrant's stakeholder list at the

time, which may include additional stakeholders to those listed in **Table 5-1** if they have been identified by Quadrant, or have specifically requested the information through consultation.

5.2.2 Quarterly consultation update

Activities covered under this EP will be included in Quarterly Consultation Updates until they can be listed as a 'completed activity', with updates scheduled for approximately June, September, December and March annually.

The Greater East Spar project was including in Quadrant's Quarterly Consultation Update editions distributed in September and December 2016 and March 2017. No comments regarding GES were received in response to this consultation.

5.3 OPEP consultation

In preparing the OPEP and number of parties are identified to provide spill response services and actions to support the implementation of the OPEP. These OPEP stakeholders are identified through evaluation of the Activity and spill potential for all Quadrant oil pollution emergency plans (OPEP).

Consultation, agreements or contracts have been put into place with agencies and organisations throughout the development of Quadrant oil spill response strategies and tactics so that roles and responsibilities are understood and accepted as outlined in **Table 5-3.**

Table 5-3: OPEP Consultation summary

Engaged with		Assessment of Consultation Undertaken
Function	**Stakeholder**	
Australian Marine Oil Spill Centre (AMOSC)		Historically AMOSC reviewed Oil Spill Contingency Plans (OSCPs) and OPEPs and are satisfied with the description of their support. AMOSC now request to only view OPEPs once they are accepted by the regulator and before the activity commences. Roles and responsibilities defined in the OPEP reflect the arrangements established under contract conditions as a Participating Member of AMOSC under the AMOSC Plan.
Australian Marine Safety Authority (AMSA)		Historically AMSA reviewed OPEPs and are satisfied with the description of their support. AMSA now request to only view OPEPs once they are accepted by the regulator and before the activity commences. Roles and responsibilities defined in the OPEP reflect the arrangements established within a Memorandum of Understanding between AMSA and Quadrant. Quadrant continue to undertake an annual workshop with AMSA as required under Sections 22 and 24 of the Quadrant/AMSA MOU. This enables the open flow of information relevant to the oil spill response arrangements: *Ongoing consultation and cooperation* AMSA and the titleholder will nominate contact points for the ongoing management of this MOU. AMSA and the Titleholder agree to maintain a cooperative approach to preparing and responding to marine pollution incidents, including the open exchange of information and technical advice. AMSA will facilitate an annual workshop to provide an open forum to exchange information on best practice and review and update operational procedure.
Logistics provider	APC Logistics	APC Logistics operate under contract conditions to Quadrant. All arrangements defined in the OPEP nominating APC Logistics have been supplied by APC Logistics and reflect contracted services.

Engaged with		Assessment of Consultation Undertaken
Function	**Stakeholder**	
	Toll Logistics	Toll Logistics operate under contract conditions with Quadrant. All arrangements defined in the OPEP nominating Toll Logistics reflect contracted services.
Field support organisation	Exmouth Freight & Logistics Services (EF&LS)	EF&LS operate under contract conditions with Quadrant. All arrangements defined in the OPEP nominating EF&LS reflect contracted services.
Department of Environmental Regulation (DER) (Waste Management Branch)		The DER Waste Management Branch have reviewed and have had input in defining the Waste Management Plan contained in Quadrant OSCP/OPEPs. The waste management processes do not change between OPEPs, so the original consultation is sufficient for the OPEP.
Department of Parks and Wildlife		DPaW were contributors to development of the WA Oiled Wildlife Response Plan (OWRP) defined in the OPEP. Descriptions of the Quadrant interface with the WAOWRP contained within the OPEP are consistent with the intent of DPaW (and AMOSC) for oiled wildlife response. No further consultation is required.
Department of Transport (Hazard Management Authority)		All roles and responsibilities defined within the OPEP for DoT reflect the arrangements for the Westplan MOP as further defined by the DoT Offshore Petroleum Industry Guidance Note, Marine Oil Pollution: Response and Consultation Arrangements. Consultation was conducted with the DoT as per their Industry Guidance Note. A schedule for consultation was agreed between Quadrant and DoT in phone consultation on January 18, 2017. DoT were provided a targeted consultation package via email on April 11, 2017. DoT responded via email on May 2, 2017, with no additional requests for information. Consultation with DoT in considered closed for the purpose of this approval, however Quadrant continues ongoing consultation with DoT on all Quadrant projects as per DoT's Industry Guidance Note.
Subsea response service provider	Oceaneering	Oceaneering operate under contract conditions with Quadrant. All arrangements defined in the OPEP nominating Oceaneering reflect contracted services.
Oil Spill Response Limited (OSRL)		OSRL operate under contract conditions with Quadrant. All arrangements defined in the OPEP nominating OSRL reflect contracted services.
Vessel providers	Go Marine	Go Marine operate under contract conditions with Quadrant. All arrangements defined in the OPEP nominating Go Marine reflect contracted services.
	Jet Wave Marine (JWM)	JWM operate under contract conditions with Quadrant. All arrangements defined in the OPEP nominating JWM reflect contracted services.
	Bhagwan Marine	Bhagwan Marine operate under contract conditions with Quadrant. All arrangements defined in the OPEP nominating Bhagwan Marine reflect contracted services.
Aircraft providers	Bristows	Bristows operate under contract conditions with Quadrant. All arrangements defined in this OPEP nominating Bristows reflect contracted services.
Spill modelling provider	RPS APASA	APASA operate under contract conditions with Quadrant. All arrangements defined in the OPEP nominating APASA reflect contracted

Engaged with		Assessment of Consultation Undertaken
Function	**Stakeholder**	
		services.
Waste contractor	ToxFree	Toxfree operate under contract conditions with Quadrant. All arrangements defined in the OPEP nominating Toxfree reflect contracted services.
	North West Alliance (NWA)	NWA operate under contract conditions with Quadrant. All arrangements defined in the OPEP nominating NWA reflect contracted services.

6. ENVIRONMENTAL HAZARDS AND CONTROLS

The impact and risk assessment approach is consistent with the requirements of AS/NZS ISO 31000:2009 Risk Management – Principles and guidelines and ISO/IEC 31010 Risk management – Risk management techniques. The approach can be mapped to the requirements of the OPGGS (E) Regulations for an EP, as described by NOPSEMA (N4700-GN1074 Rev 1 2013). The key steps are illustrated in **Figure 6-1**below.

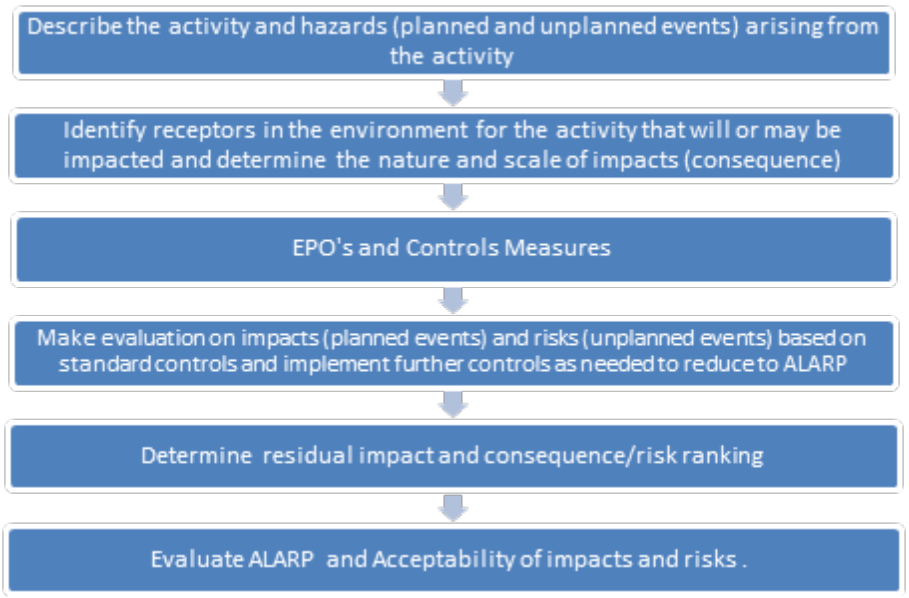

Figure 6-1: Environmental Risk and Impact Process

An assessment against the Activity was undertaken and the environmental hazards or aspects were then identified. The risk assessment identified 7 potential unplanned events and 7 planned events. Environmental aspects/hazards identified for the Activity.

The extent of actual impacts from planned events or potential impacts from unplanned events is assessed using the description of the Activity and known information on impacts (published industry reports and scientific studies) and in some circumstances predictive information such as modelling (e.g. noise and discharges modelling, oil spill trajectory and fate modelling). Impact mechanisms and thresholds for impact where relevant are determined and described, using scientific literature and modelling where required. The consequence level of the impact is then determined for each planned and unplanned event based on the severity of the impact to relevant receptor.

This process determines a consequence level based on set criteria for each receptor category and takes into consideration the duration and extent of the impact, receptor recovery time and the effect of the impact at a population, ecosystem or industry level. The consequence definitions are outlined in **Table 6-1** below.

Table 6-1: Consequence level description

Consequence Level		Consequence Level description
A	Negligible	No impact or negligible impact.
B	Minor	Detectable but insignificant change to local population, industry or ecosystem factors. Localised effect with rapid recovery
C	Moderate	Significant impact to local population, industry or ecosystem factors. Medium term recovery
D	Major	Major long-term effect on local population, industry or ecosystem factors. Slow recovery over decades
E	Critical	Complete loss of local population, industry or ecosystem factors AND/ OR major wide-spread regional impacts with slow recovery.

For unplanned events, a risk ranking is also determined using an assessment of the likelihood (likelihood ranking) of the event as well as the consequence level of the potential impact should that event occur. A description of likelihood as per Quadrant's Risk Matrix.

Table 6-2: Likelihood description

No.	Matrix	Description
5	Probable	1. Event has occurred frequently within the Company. 2. Between 1 and 10 incidents every 10 years (i.e. up to frequency 1/year).
4	Likely	1. Event has occurred frequently within the Industry. 2. Between 1 and 10 incidents every 100 years (i.e. up to frequency 10^{-1}/year).
3	Unlikely	1. Event has occurred occasionally within the Company. 2. Between 1 and 10 incidents every 1000 years (i.e. up to frequency 10^{-2}/year).
2	Very Unlikely	1. Has occasionally occurred within the Industry. 2. Between 1 and 10 incidents every 10,000 years (i.e. up to frequency 10^{-3}/ year).
1	Rare	1. Could happen under exceptional circumstances only. 2. Between 1 and 10 incidents every 100,000 years (i.e. up to frequency 10^{-4}/ year).

Risk rankings (consequence x likelihood) are assigned in accordance with Quadrant Energy's Risk Matrix as shown below.

		SEVERITY				
		1. Negligible	2. Minor	3. Moderate	4. Major	5. Critical
LIKELIHOOD	5. Probable					
	4. Likely					
	3. Unlikely					
	2. Very Unlikely					
	1. Rare					

High Risk - reduction of risk required

Medium Risk - reduction of risk required based on ALARP principle

Low Risk - deemed acceptable based on standard risk controls in place

For each planned and unplanned event a set of Environmental Performance Outcome(s) (EPO's), Environmental Performance Standards (EPS) and Measurement Criteria (MC) are identified. The definitions of the performance outcomes, standards and measurement criteria are consistent with the OPGGS (E) Regulations. For planned and unplanned events, an ALARP and Acceptability assessment is also undertaken.

6.1 ALARP Evaluation

The ALARP principle is that the residual impacts and risk shall be 'as low as reasonably practicable'. It has particular connotations as a route to reduce risks when considering law, regulation and standards.

For an impact or risk to be ALARP it must be possible to demonstrate that the cost involved in reducing the impact or risk further would be grossly disproportionate to the benefit gained. The ALARP principle arises

from the fact that infinite time, effort and money could be spent on the attempt of reducing a risk to zero. It should not be understood as simply a quantitative measure of benefit against detriment. It is more a best common practice of judgement of the balance of impact or risk and societal benefit.

For planned and unplanned events, an ALARP assessment is undertaken to demonstrate that the standard control measures adopted reduce the consequence or risk to ALARP. This process relies on demonstrating that further potential control measures would require a disproportionate level of cost/effort for the consequence or risk. If this cannot be demonstrated then further controls are implemented. The level of detail included within the ALARP assessment is based upon the nature and scale of the potential impact and risks.

6.2 Acceptability Evaluation

Quadrant considers the impacts or risks associated with the Activity to be acceptable if the following criteria are met:

1. A consequence from a planned event is ranked as A or B; or a risk of impact from an unplanned event is ranked low to medium/high;
2. An assessment has been completed to determine if further information/studies are required to support or validate the consequence assessment;
3. Performance standards are consistent with legal and regulatory requirements;
4. Performance standards are consistent with Quadrant Energy Environmental Management Policy;
5. Performance standards are consistent with stakeholder expectations, and
6. Performance standards have been demonstrated to reduce the impact or risk to ALARP

6.3 Environmental Risk Treatment Summary for Planned Events

6.3.1 Interaction with other marine users

Event: Interactions with Other marine users	Interactions with other users of the sea through undertaking the activity. Project vessels will be continually operating 24 hours a day, seven days a week for the duration of the activity. The presence of vessels in the operational area could potentially inhibit marine user groups, tourism, commercial shipping, fishing and other oil and gas activities and the presence of vessels could pose a collision risk and inconvenience to fishing practices during these operations.
Potential receptors	Marine user groups, commercial fishers, tourism, shipping traffic and other oil and gas activities
Potential Impacts	Three Commonwealth fisheries and state fisheries have zones that overlap the operational area. Potential impacts to commercial fisheries are a temporary loss of access to fishing grounds when installation vessels are in the operational area, which could potentially result in reduced catches and income. An analysis of the current fishery closures, depth range of activity, historical fishing effort data, fishing methods and consultation feedback (refer to **Section 5**) has revealed that there is a low potential for interaction with commercial fisheries. None of the Commonwealth fisheries identified in **Section 4.3.3** are likely to be active in the operational area during the proposed GES activities. For state-managed fisheries, the Pilbara Trap Managed Fishery and the Pilbara Line Fishery of the Pilbara Demersal Scalefish Fishery may access the operational area. The Pilbara Trap Managed Fishery is seaward of the 30 m isobath and landward of the 200 m isobaths; there are six licenses with the allocation consolidated onto three vessels (DoF, 2012). The Pilbara Line Fishery licensees are permitted to operate anywhere in Pilbara waters over a restricted season; there are nine licences in this fishery. Tourism activities are expected to occur infrequently in the operational area given the water depths and distance from shore. Activities such as snorkelling, diving, surfing and fishing activities may occur around the Montebello Islands, and traditional or subsistence fishing however interaction with these activities and the installation vessel are unlikely to occur. Although there may be limited tourism activity closer to these coastal locations, they are outside the EMBA. As such, impacts to tourism are not expected. There are no recognised shipping routes in or near the operational area with the nearest designated shipping routes located 55 km northwest and 65 km east. However, analysis of historical AUSREP shipping data indicates that commercial vessels do use the general area, most likely vessels in the oil and gas industry. Should commercial vessels need to deviate from planned routes to avoid project vessels, this may slightly increase transit times and fuel consumption. As the operational area is in open waters with no grounding or navigational hazards, it is not likely that any such deviation would increase the potential for vessel collision or grounding.
Impact assessment	
Receptors	**Consequence**
Socio-economic Receptors	A review of shipping data indicates that there will not be a significant disruption to commercial shipping due to the distance of the activity from the nearest shipping lane and lack of concerns raised through consultation. Vessels could be expected to divert around the operational area but this would be a temporary exclusion given the duration of the installation activity. Tourism activity in the area is expected to be low, although a minimal amount of displacement could occur due to the activity. There may be some

	commercial fishing activities occurring in the area. Marine users currently plan their activities in consideration of other petroleum activities and other marine users (fisheries and shipping) in the region. It is possible that indigenous users of the marine environment may be present, although there are no recorded seabed aboriginal sites in the waters of the Montebello and Barrow Island Reserves (DEC, 2007). Subsistence fishing and traditional hunting may occur in waters close to shorelines. Given the distance of Barrow Island and the Montebello Islands from the mainland, traditional use of this area is expected to be low. Consultation has been undertaken with indigenous users and no concerns have been raised about the activity in offshore waters. AMSA require a high level of communication during the activity therefore reducing the likelihood of interaction with other sea users.
Overall Consequence Ranking	A - Negligible
Management Control	**Effectiveness of Control**
Maritime notices	Ensure other marine users are aware of the presence of the installation vessel and the relative low mobility of vessel to suddenly change course or avoid other vessels.
Stakeholder consultation	
Exclusion zone	Exclusion zones around the installation vessel prevents other vessels from getting too close and causing damage to equipment of either party.
Navigation equipment and procedures	Reduces risk of environmental impact from vessel collisions due to ensuring safety requirements are fulfilled.

6.3.2 Seabed Disturbance

Event: Seabed disturbance	Installation and movement of the subsea infrastructure will disturb the seabed and associated benthic habitat. During the installation of GES structures, additional potential seabed disturbance (temporary) may also occur (but is not limited to) in the operational area due to: • Sedimentation as facilities are placed on the seabed; • ROV operations and ROV propeller wash; • Temporary placement of mattresses on seabed whilst relocating flowlines; • Placement of ROV baskets on the seabed; • Dropped objects (e.g. subsea infrastructure); and • Placement of survey and positioning beacons and support frames onto the seabed Sedimentation and water quality impacts (i.e. increased turbidity) could be caused by the initial placement of solid structures, deployment/retrieval/movement of equipment and ROV operations. However sediment loads are not expected to be significant. Each placement onto and lift from the seabed will cause a single brief disturbance resulting in a transient plume of sediment. <u>Installation and relocating/ laying of equipment and flowlines</u> The proposed GES activities which have the potential to disturb the seabed are installation of the GES PLEM (7.6 x 7.3m), SCS, flowline and EHU connection to Spar-2 XT; and relocating/laying of flowlines and umbilicals and flying leads placement.

	Stabilisation materials recovery and placement GES installation activities may require the movement and laying of concrete mattresses (~3 of 6m x 3m mattresses) and laying of approximately 6 grout bags on the EHFL between the PLEM and Halyard XT. These activities may result in seabed disturbance due to movement and placement of materials on the seabed; however, the area of seabed affected will be small and localised and unlikely to extend beyond the area originally impacted during the laying of the flowlines, umbilicals and flying lead placement. It is intended to reuse the mattresses after the installation of flowline and EHU, therefore they would be repositioned only. However, if the mattresses cannot be re-used (e.g. mattresses breaking into pieces) and re-installed, new mattresses may be installed and the old ones will remain on the seabed in current position). The fate of the old mattresses (i.e. 1 mattress on EHU and two mattresses on Halyard flowline) left on the seabed will be considered at the end of field life during facility decommissioning planning. Dropped objects Accidental dropped objects to the seabed could occur during vessel and ROV activities such as operations including lifting of objects and equipment needed to complete installation activities. Equipment and other items lost at sea could be caused by crane failure, adverse weather, human error, rigging failure and vessel motions and potentially lead to loss of or changes to benthic habitats. For other potential risks associated with dropped objects, for instance pipeline damage, with potential for release of hydrocarbons or chemicals refer to unplanned events.
Potential receptors	Threatened / Migratory Fauna, Physical Environment/ Habitat, Socio-economic
Potential Impacts	Installation of the subsea infrastructure can cause the following impacts: • Direct physical disturbance of approximately 38,000 m^2 area of benthic and seabed habitat, including benthic fauna by infrastructure; • Indirect disturbance to benthic habitats and associated marine fauna by sedimentation; • Increased turbidity of the near-seabed water column; • Long term physical presence on seabed due to old mattresses left in situ on the seabed • Introduction of artificial habitat for benthic fauna colonization; and. • Snagging of fishing equipment on installed facilities.
Impact assessment	
Receptor	**Consequence**
Threatened / Migratory Fauna	Disturbance to the seabed may have indirect impacts to protected fauna if the disturbance leads to a reduction on habitat quality or food availability. The areas of seabed that are expected to be impacted included soft sediments with little epifauna. These sediments are un-vegetated and densely bioturbated (< 75%), epibenthic biota is sparse (< 5%) and includes invertebrates, such as anemones, sponges and sea urchins. Therefore loss of habitat is not expected. Marine invertebrates may inhabit soft sediments and can contribute to the diet of some fauna. The area of soft sediment habitat that is potentially impacted is small compared to the amount of habitat available and therefore the disturbance is not expected to affect prey availability, and therefore protected fauna species, significantly. Habitat modification is identified as a potential threat to a number of marine fauna species in relevant Recovery Plans and Conservation Advice. However the area

	potentially impacted is small compared to the size of the areas used by these species for foraging and therefore no long term impacts to these species is expected. No decrease in local population size, area of occupancy of species, loss or disruption of habitat critical or disruption to the breeding cycle of any of these protected matters is expected.
Physical Environment/ Habitat	The physical environment and habitat could be disturbed during the proposed activities. However, the area potentially impacted is small compared to the wider environment and in the majority of cases the disturbed area is expected to recolonise. As such, long term disturbance and negative impacts to the wider ecosystem are not expected.
Socio-economic Receptors	Disturbance of the seabed is unlikely to impact socioeconomic receptors such as shipping and tourism. Seabed disturbance may temporarily alter rock lobster habitat, however, this is expected to be short term and over small discrete areas with no lasting impact on rock lobster abundance or distribution and therefore impacts to commercial fisheries are not expected. No stakeholder concerns have been raised regarding this aspect.
Overall Consequence Ranking	A - Negligible
Management Control	**Effectiveness of Control**
Pre- and post-installation seabed surveys	To understand the seabed conditions and minimise any potential risks caused by subsea hazards (e.g. infrastructure) and inform final location of infrastructure
Vessel anchoring restrictions	Minimises impacts and extent of seabed disturbance
Site Selection	To define corridors for subsea infrastructure therefore reduces the risk of hydrocarbon release from damaged subsea infrastructure due to dropped objects
Installation procedures	To minimise risk of infrastructure damage due to dropped objects and ensure accurate positioning during installation
Dropped object prevention procedures	
Lifting equipment Maintenance	Ensures that lifting equipment is maintained and certified, and that lifting procedures are followed reducing probability of dropped objects occurring with the potential to result in seabed disturbance.

6.3.3 Light Emissions

Event: Light emissions	During the activity, safety and navigational lighting on the vessels will generate light emissions that may potentially affect marine fauna behaviour. Spot lighting may also be used on an as-needed basis e.g., in-sea ROV inspection, deployment and retrieval. Lighting will typically consist of bright white (i.e., metal halide, halogen, fluorescent) lights. Minimum lighting is required for safety and navigational purposes on board the vessel so it cannot be eliminated if the proposed activity is to proceed.
Potential receptors	Threatened / Migratory Fauna
Potential Impacts	Continuous lighting in the same location for an extended period of time may result in

	alterations to normal marine fauna behaviour, as discussed below for each fauna group. The combination of colour, intensity, closeness, direction and persistence of a light source are key factors in determining the magnitude of environmental impact (EPA, 2010). Given the distance of the project location and the closest turtle nesting site, e.g. 34 km and 59 km away from Barrow and Montebello Islands respectively, lights (and light glow) are not visible from the beaches or surrounding sea. *Fish* The response of fish to light emissions varies according to species and habitat. Experiments using light traps have found that some fish and zooplankton species are attracted to light sources (Meekan *et al*., 2001), with traps drawing catches from up to 90 m away (Milicich *et al*., 1992). Lindquist *et al*. (2005) concluded from a study that artificial lighting associated with offshore oil and gas activities resulted in an increased abundance of clupeids (herring and sardines) and engraulids (anchovies); these species are known to be highly photopositive. Overall, a short-term localised increase in fish activity as a result of vessel lighting is expected to occur, however with negligible impacts. *Marine turtles* Light pollution reaching turtle nesting beaches is widely considered detrimental owing to its ability to alter important nocturnal activities including choice of nesting sites and orientation/navigation to the sea by post-nesting females and hatchlings (Witherington and Martin, 2003). Light pollution is also highlighted in the Recovery Plan for Marine Turtles in Australia as a factor requiring management for successful marine turtle nesting (Commonwealth of Australia, 2013). The most significant risk posed to marine turtles from artificial lighting is the potential disorientation of hatchlings following their emergence from nests, although breeding adult turtles can also be disoriented (Rich and Longcore, 2006 in EPA 2010). Once in the ocean, hatchlings are thought to remain close to the surface, orient by wave fronts and swim into deep offshore waters for several days to escape the more predator-filled shallow inshore waters. During this period, light spill from coastal port infrastructure and ships may 'entrap' hatchling swimming behaviour, reducing the success of their seaward dispersion and potentially increasing their exposure to predation via silhouetting (Salmon *et al*., 1992). It is possible that individual flatback turtles may be encountered in the operational area, particularly due to overlap with the flatback internesting buffer zone. The potential impacts of light emissions to flatback turtles from GES activities are expected to be restricted to localised attraction and temporary disorientation but with no long term or residual impact due to the activity's short duration (i.e. between 30-60 days); and the unlikely presence of hatchlings due to the distance from the nearest shorelines. In addition, flatback internesting season only occurs in December and January (**Table 4-6**), impacts generated by GES installation activity on adult flatback turtles are expected to be minimal The WA Environmental Protection Authority (EPA) conservatively estimates there is only a light influence on marine turtles if the light source is within 1.5 km of the nesting beach (EPA, 2010). Given the project is located 34 and 59 km away from Barrow and Montebello Islands, impacts to turtles from activity lighting is considered negligible. *Seabirds* Studies conducted between 1992 and 2002 in the North Sea confirmed that artificial light was the reason that birds were attracted to and accumulated around illuminated offshore infrastructure (Marquenie et al., 2008). The light sources associated with the vessels may also provide enhanced capability for seabirds to forage at night. The installation vessel in particular will not be stationary nor in the operational area for long periods of time (maximum 60 days), and so unlikely to attract large numbers of seabirds to one fixed location. *Other marine fauna*

	There is no evidence to suggest that artificial light sources adversely affect the migratory, feeding or breeding behaviours of cetaceans. Cetaceans predominantly utilise acoustic senses to monitor their environment rather than visual cues (Simmonds *et al*., 2004), therefore impacts are thought to be unlikely.
Impact assessment	
Receptors	**Consequence**
Threatened / Migratory Fauna	Continuous lighting in the same location for an extended period of time may result in alterations to normal marine fauna behaviour. Sensitive receptors that may be impacted include fish at surface, marine turtles and mammals, and seabirds. Given that the activity will be a once off, for a limited duration, and is located ~34 km from the nearest coastline. At these distances lighting is unlikely to be at a level that could impact nesting turtles or hatchlings. Given the GES operational area is located within the flatback turtles internesting buffer BIA, individuals may occur in the operational area although large numbers are not expected. The nearest coastline is located ~34km from the operational area, therefore flatback hatchlings are not expected to be impacted by light emissions from the activities. Cetaceans, adult turtles and marine mammals are not known to be significantly attracted to light sources at sea and therefore disturbances to behaviour are unlikely to occur. Fish and birds have been shown to be attracted to artificial light sources, however, the low level of light emitted from vessels is unlikely to lead to large scale changes in species abundance or distribution. Impacts to transient fish and seabirds will therefore be limited to short-term behavioural effects with no decrease in local population size, area of occupancy of species or loss or disruption of habitat critical / disruption to the breeding cycle.
Overall Consequence Ranking	A - Negligible
Management Control	**Effectiveness of Control**
Navigation equipment and procedures	Reduces risk of environmental impact from vessel collisions due to ensuring safety requirements are fulfilled.

6.3.4 Noise emissions

Event: Noise emissions	Noise generated by the installation vessels propagating through the water column, and during metrology surveys during the activity may result in physiological or behavioural impacts to marine fauna, especially to cetacean species who use sound for navigation and communication. Helicopters will be used during the activity for crew change requirements and noise impacts generated from helicopter will also be assessed in this section.
Potential receptors	Threatened / Migratory Fauna, Physical Environment/ Habitat, Socio-economic Receptors
Potential Impacts	Reactions of cetaceans to circling aircraft (fixed wing or helicopter) are sometimes conspicuous if the aircraft is below an altitude of 300m, uncommon at 460m and generally undetectable at 600m (NMFS, 2001). Baleen whales sometimes dive or turn away during over-flights, but sensitivity seems to vary depending on the activity of the animals. The effects on cetaceans seem transient, and occasional over-flights probably have no long-term consequences on cetaceans. Observations by Richardson and Malme

	(1993) indicate that, for bowhead whales, most individuals are unlikely to react significantly to occasional single-pass low-flying helicopters transporting personnel and equipment at altitudes above 150m. Leatherwood *et al.* (1982) observed that minke whales responded to helicopters at an altitude of 230m by changing course or slowly diving. Turtle hearing is most sensitive in the frequency range of 100 – 700 Hz (DoIR, 2007), which overlaps with the sound frequencies produced by vessels and helicopters. It is likely that turtles would be able to hear these activities at distance and would experience some disturbance. Studies indicate that marine turtles may begin to show behavioural responses to received sound levels of approximately 166 dB re 1 µPa and avoidance at around 175 dB re 1 µPa (McCauley *et al.*, 2000). Acoustic survey systems (or subsea positioning systems), for instance long baseline (LBL) and ultra-short baseline (USBL) acoustic positioning systems, enable sub-metre accuracy when locating equipment near sensitive subsea infrastructure. These systems consist of a number of transducers and receivers placed strategically on the seabed, vessels, deployed equipment or ROVs. LBL transducers typically emit short pulses of medium to high frequency sound, normally within the range of 15 to 40 kHz. Typical operating energy output is between 166 and 196 dB re 1 µPa 1 m peak level, depending on the environmental conditions (Bai and Bai 2010). Modelling has previously been undertaken to determine the sound levels at increasing horizontal distance away from the source array for two geophysical sparker sound sources (Squid 2000 and Squid 500). The peak source level for the Squid 2000 and the Squid 500 were 222 dB re 1 µPa and 216 dB re 1 µPa respectively at 1 m from the array. In the four cases that were modelled, the received sound exposure levels are predicted to have dropped below 160 dB re 1 µPa2s within 20 m of the source for Squid 500 and within 40 m of the source for the Squid 2000 (Duncan and Salgado-Kent 2011). The operating output of metrology equipment is less than that expected from geophysical sparkers, therefore sound and vibrations from metrology equipment are expected to similarly quickly attenuate through the water column or more rapidly than this modelling indicates. No recognised breeding or resting area for cetaceans, turtles or shark species are known to occur in the area potentially impacted by noise emissions, although a BIA for flatback turtle internesting buffer and whale shark foraging overlaps the operational area so individuals are expected to pass through the area. Noise emitted by vessels, helicopters or during metrology surveys during the activity will be short in duration and is likely to be reduced to background levels within kilometres to tens of kilometres. As such, any potential related marine fauna behavioural impacts are expected to be temporary and short ranged and is not expected to lead to long term changes in individual behaviour (e.g. migration) or lead to changes at the population level.
Impact assessment	
Receptors	**Consequence**
Threatened / Migratory / Protected Fauna	Noise generated from vessels, metrology surveys and helicopters may result in physiological or behavioural impacts to marine fauna, especially to cetacean species who use sound for navigation and communication. Sensitive receptors that may be impacted include fish at surface, marine turtles and mammals, and seabirds. Given that the activity will be a once off, for a limited duration, marine fauna potentially affected by acoustic noise (i.e. cetaceans, turtles, sharks and fish) are expected to exhibit avoidance behaviour to noise. Avoidance behaviour is likely to be localised within the area of the activity (due to small spatial extent of proposed activities) and temporary, i.e. for the duration of the activity only. Acoustic disturbances to marine fauna due to metrology surveys are expected to be minimal as the sound levels generated are at a very high frequency and decay rapidly with distance travelled from the source.

	Noise interference identified in the Recovery Plan for Marine Turtles in Australia (2003) and Approved Conservation Advice for *Megaptera novaeangliae* (Humpback Whale) is related to seismic or piling activities where the sound emitted is at levels that could cause injury or mortality for marine turtles or humpback whale. Given the low level of noise expected from GES installation activities, vessel and helicopter activities and metrology, and the short and temporary duration of noise emissions, significant impact to threatened or migratory species are not expected. Some behavioural response may be expected from the noise levels emitted, but not at levels that could cause mortality or injury to marine fauna.
Physical Environment/ Habitat	Likely habitats to be impacted from noise in the area are benthic habitats which have non-coral invertebrates (such as sea fans and gorgonians) which are not significantly impacted by noise emissions. No decrease in local population size / area of occupancy of species / loss or disruption of habitat critical / disruption to the breeding cycle / introduction of disease is expected.
Socio-economic Receptors	Noise levels are not expected to impact on socio-economic receptors due to their low activity level within the vicinity of the operational area. Impacts to fish may result in indirect impacts to fisheries in the area. However, given the levels of fish in the commercial fisheries are at sustainable levels, the short duration of the activity, the available area for commercial fishermen to catch and the area over which commercial species spawn, impacts to fisheries are considered acceptable.
Overall Consequence Ranking	A - Negligible
Management Control	**Effectiveness of Control**
EPBC Regulations (Part 8) for interacting with cetaceans	Reduces risk of physical and behavioural impacts to cetaceans from vessels and helicopters source
Marine fauna observations undertaken	

6.3.5 Planned Operational Discharges

Event: Planned operational discharges	In order to operate the project vessels, a number of planned routine discharges to the marine environment will be required as outlined below. These discharges will occur at the sea surface. <u>Sewage</u> The volume of sewage and food waste is directly proportional to the number of persons on-board the vessels. Up to 30 -40 L of sewage/grey water will be generated per person per day. Treated sewage will be disposed in accordance with MARPOL Annex IV. <u>Food waste</u> Putrescible waste will consist of approximately 1 L of food waste per person per day. Vessels will discharge food waste in accordance with MARPOL requirements. <u>Brine</u> Brine generated from the water supply systems on-board the project vessels will be discharged to the ocean at a salinity of approximately 10% higher than seawater. <u>Cooling water</u> Seawater is used as a heat exchange medium for the cooling of machinery engines. Seawater is drawn from the ocean and flows counter-current through closed-circuit heat exchangers, transferring heat from the vessel engines and machinery to the

	seawater. The seawater is then discharged to the ocean (i.e. it is a once-through system). Deck drainage Deck drainage from rainfall or wash-down operations would discharge to the marine environment. The deck drainage would contain particulate matter and residual chemicals such as cleaning chemicals, oil and grease. Assessment of the spillage of hydrocarbons and other environmentally hazardous chemicals and liquid waste are discussed in unplanned events section. Oily water (i.e. bilge water) discharges from project vessels While in the operational area, project vessels may discharge oily water after treatment to 15 ppm in a MARPOL approved oily water filter system. Hydraulic fluids, residual hydrocarbons and treated seawater Small amounts of hydraulic fluids, residual hydrocarbons, corrosion inhibitor, biocides and treated seawater are likely to enter the subsea marine environment from GES installation and commissioning activities. Leak testing during testing of the subsea system may also occur in which case a small volume of non-toxic dye will be used to detect leaks in a subsea system. Equipment/infrastructure may also be dosed with biocide (e.g. biocide sticks) prior to hook up to the existing facility.
Potential receptors	Fish (pelagic) & sharks, marine mammals, marine turtles and seabirds
Potential Impacts	Planned non-hazardous discharges will be small and continuous, with volumes dependent on a range of variables. The discharge of non-hazardous wastes to the marine environment may result in a localised reduction in water quality. This would be expected to be temporary (minutes to hours), localised and limited to surface waters (<5 m). The discharges are expected to be dispersed and diluted rapidly, with concentrations of wastes significantly dropping with distance from the discharge point. Changes to ambient water quality outside of the operational area are considered unlikely to occur. Release of non-hazardous discharges into the sea from vessels in Australian waters is permissible under the Protection of the Sea (Prevention of Pollution from Ships) Act 1983, which reflects MARPOL Annex IV, V and I requirements respectively. The operational discharges are not expected to significantly impact the receiving environment with management controls proposed, including compliance with all MARPOL requirements. The MARPOL standard is considered to be the most appropriate standard given the nature and scale of the Activity. These standards are internationally accepted and utilised industry wide, therefore compliance with the relevant and appropriate MARPOL requirements and standards is expected to reduce the potential for environmental impacts to a level which is considered environmentally acceptable. Deteriorating water quality is identified as a potential threat to turtles in the marine turtle recovery plan, and some bird and shark species. However, the operational discharges are not expected to significantly impact the receiving environment with management controls proposed and therefore the Activity will be conducted in a manner that is considered acceptable
Impact assessment	
Receptors	**Consequence**
Threatened / Migratory / Protected Fauna	Operational discharges in the same location for an extended period of time may result in significant water quality perturbations and alteration to marine fauna behaviour. Sensitive receptors that may be impacted include fish at surface, marine turtles and mammals, and seabirds. Given that the activity will be for a limited duration, and is located 34 km from the nearest shoreline, impacts will be limited to short-term water
Physical Environment/	

Habitat	quality impacts and temporary behavioural effects observed in fish and seabirds. Impacts to water quality will be experienced in the discharge mixing zone which will be localised and will occur only as long as the discharges occur (i.e. no sustained impacts), therefore recovery will be measured in hours to days. Therefore only short term behavioural impacts are expected with no decrease in local population size / area of occupancy of species / loss or disruption of habitat critical / disruption to the breeding cycle / introduction of disease.
Socio-economic Receptors	
Overall Consequence Ranking	A - Negligible
Management Control	**Effectiveness of Control**
General chemical management procedures	Potential impacts to the environment are reduced through following correct procedures for the safe handling and storage of chemicals
Hazardous chemical management procedures	Reduces the risk of spills and leaks (discharges)of hazardous chemicals to the sea by controlling the storage, handling and clean up
Chemical selection procedure	Reduced toxicity to marine environment Only environmentally acceptable chemicals would be released to sea from flushing and testing
Flooding and testing procedures	Reduces potential impacts of poorly managed discharges
Equipment pressure tested	Reduces hydrocarbon or chemical leaks during commissioning and operation
Sewage treatment system	Reduces potential impacts of inappropriate discharge of sewage. Ensure compliance with MARPOL requirements
Waste (garbage) management procedure	Reduces probability of garbage being discharged to sea, reducing potential impacts to marine fauna. Stipulates putrescible waste disposal conditions and limitations Ensure compliance with MARPOL requirements
Oily water treatment system	Reduces potential impacts of planned discharge of oily water to the environment Ensure compliance with MARPOL requirements
Flowlines flushed to ≤30ppm oil in water concentration prior to disconnection	Reduces potential impacts of planned discharge of residual hydrocarbon
Deck cleaning product selection procedure	Reduced toxicity to marine environment Only environmentally acceptable chemicals would be released overboard

6.3.6 Atmospheric Emissions

Event: Atmospheric Emissions	The use of fuel (specifically MGO) to power vessels engines, generators, mobile and fixed plant and equipment will result in emissions of greenhouse gases (GHG) such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), along with non-GHG such as sulphur oxides (SO_x) and nitrous oxides (NO_x). Vessels may also use an incinerator for waste during the activity.

	Vessels may utilise ozone-depleting substances (ODS) in closed-system rechargeable refrigeration systems.
Potential receptors	Seabirds and humans
Potential Impacts	Hydrocarbon combustion may result in a temporary, localised reduction of air quality in the environment immediately surrounding the discharge point during the activity. Non-GHG emissions, such as NO_X and SO_X, and GHG emissions can lead to a reduction in local air quality which can impact humans and seabirds in the immediate vicinity and add to the national GHG loadings. As Quadrant's proposed installation activity will occur in offshore waters, the combustion of fuels and incineration in such remote locations will not impact on air quality in coastal towns, the nearest being Onslow (100 km to the south). The quantities of gaseous emissions are relatively small and will quickly dissipate into the surrounding atmosphere. Accidental release and fugitive emissions of ODS has the potential to contribute to ozone layer depletion. Air emissions will be similar to other vessels operating in the region for both petroleum and non-petroleum activities. Maintenance of refrigeration systems containing ODS is on a routine, but infrequent basis, and with controls implemented, the likelihood of an accidental ODS release of material volume is considered rare.
Impact assessment	
Receptors	**Consequence**
Threatened / Migratory / Protected Fauna	Short term behavioural impacts to seabirds could be expected if they overfly the location; they may avoid the area. No decrease in local population size / area of occupancy of species / loss or disruption of habitat critical / disruption to the breeding cycle / introduction of disease.
Socio-economic Receptors	As Quadrant's proposed activity occurs in offshore waters, the combustion of fuels in such remote locations will not impact on air quality in coastal towns. The quantities of gaseous emissions are relatively small and will under normal circumstances, quickly dissipate into the surrounding atmosphere. The highly dispersive nature of local winds (i.e. strong and consistent) is expected to reduce potentially harmful or 'noticeable' gaseous concentrations within a short distance from the vessels.
Overall Consequence Ranking	A - Negligible
Management Control	**Effectiveness of Control**
Waste incineration	Reduces potential impact of inappropriate waste incineration to the environment
Fuel use	Reduces potential impacts of sulphur discharge into the environment
Air pollution prevention certification	Reduces probability of potential impacts to air quality due to ODS emissions, high NOx, SOx and incineration emissions.
Ozone-depleting substance handling procedures	Reduces probability of potential impacts to air quality due to ODS emissions

6.3.7 Spill Response Operations

Event: Spill response operations	In the event of a hydrocarbon spill, response strategies will be implemented where possible to reduce environmental impacts to ALARP. The selection of strategies will be undertaken through the Net Environmental Benefit Analysis (NEBA) process, outlined in the OPEP. Spill response will be under the direction of the relevant Controlling Agency, as defined within the OPEP (Section 2.2), which may be Quadrant and/or another agency. In all instances, Quadrant will undertake a 'first-strike' spill response and will act as the Controlling Agency until the designated Controlling Agency assumes control. The response strategies deemed appropriate for the worst case oil spill scenarios identified for the Activity comprise: • Source control; • Operational monitoring; • Mechanical dispersion; • Oiled wildlife response; • Scientific monitoring • Waste management. Given spill response operations will be within offshore waters using vessels and aircraft, the type of impacts are consistent with vessel and aircraft operations described within this EP for the routine operations. The greatest potential for impacts additional to those described for routine operations is from oiled wildlife response operations where disturbance and handling of wildlife may be undertaken intentionally.
Potential receptors	Threatened / Migratory / Protected Fauna - fish, marine mammals, marine turtles and seabirds
Potential Impacts	Wildlife response operations has the potential to impact the environment through these mechanisms: • Disruption to wildlife behaviour; and • Physical interaction with wildlife resulting in injury or death. Hazing and other response actions have the potential to disrupt the behaviour of local fauna populations. Migratory / breeding populations have the highest potential for impact. In the event that migratory or breeding fauna populations have been identified as having the potential to be oiled, a NEBA will be undertaken to determine the best method of management. Pre-emptive capture and post oiling capture / cleaning and rehabilitation has the potential to result in injury or death of fauna, and it is likely that only hazing would be selected as a response strategy.
Impact assessment	
Receptors	**Consequence**
Threatened / Migratory / Protected Fauna	There is the potential for marine fauna to be affected. If hazing or capturing are not managed appropriately to the species, then there is the potential to cause a net environmental impact to species. However, if control measures are implemented, then it is likely that the risk of further impact from these operations will be outweighed by the impact of the spill event. However, although disturbance could occur during a critical lifecycle stage (migration), it is not expected to expose entire local populations and subsequently is unlikely to result in a long term decline in the local population and not during critical lifecycle activity. No decrease in local population size / area of occupancy of species / loss or disruption of habitat critical / disruption to the breeding cycle / introduction of disease is expected.
Overall	A - Negligible

Consequence Ranking	
Management Control	**Effectiveness of Control**
Competent IMT and Oil Spill Responder personnel	Ensures that spill response strategy selection and operational activities consider the potential for additional environmental impacts.
Use of competent vessel crew/personnel	Reduces potential for environmental impacts from vessel usage
Spill response activities selected on basis of a Net Environmental Benefit Analysis (NEBA)	Provides a systematic and repeatable process for evaluating strategies with net least environmental impact.
Noise and atmospheric emissions	
Support vessel and aircraft compliance with EPBC Act Regulation 8 (cetacean interactions)	Reduces potential for behavioural disturbance to cetaceans
If required under MARPOL, Vessels will maintain a current International Air Pollution Prevention (IAPP) Certificate.	Reduces level of air quality impacts
Operational discharges and waste	
Vessels meet applicable MARPOL sewage disposal requirements	Reduces potential for water quality impacts
Vessel meet applicable MARPOL requirements for oily water (bilge) discharges	Reduces potential for water quality impacts
Ballast water management plan for international vessels	Improve water quality discharge to marine environment to ALARP Reduce risk of introduced marine species
Compliance with controlled waste,	Ensures correct handling and disposal of oily wastes

unauthorised discharge and landfill regulations	
Physical presence and disturbance	
Support vessel and aircraft compliance with EPBC Act Regulation 8 (cetacean interactions)	Reduces potential for behavioural disturbance to cetaceans
Vessel Risk Assessment Score sheet (VRASS) completed for interstate and international spill response vessels (only).	Reduce risk for introduction of invasive marine species as part of vessel biofouling
VRASS for all spill response vessels	Small reduction in IMS risk given most vessels are local and already operate in the region Greatest risk is international and interstate vessels
Adhere to WA Oiled Wildlife Response Plan and Pilbara Regional Oiled Wildlife Response Plan	Oiled wildlife hazing, capture, handling and rehabilitation meet minimum standards as outlined within the WA Oiled Wildlife Response Plan
Disruption to other users of marine and coastal area and townships	
Stakeholder consultation	Early awareness of spill response activities which reduces potential disruption

6.4 Environmental risk treatment summary – Unplanned events

Quadrant's environmental risk identification procedure identified seven potential sources of environmental impacts associated with the unplanned events.

6.4.1 Marine Gas Oil Release from Vessel Collision (Surface)

Event: Hydrocarbon spill from a ruptured vessel fuel tank as result of a collision	There is a possibility of a vessel collision occurring between the vessels (either project and support vessels, or 3rd party) within the operational area. There is also a possibility of a collision between the project/ support vessels with John Brookes platform, which is located within the operational area. The worst-case environmental incident resulting from a vessel collision is the rupturing of a vessel fuel tank resulting in the release of marine gas oil (MGO) to the environment. Vessel collision could occur due to factors such as human error, poor navigation, vessel equipment failure or poor weather. A maximum credible spill volume has been determined based on technical guidance provided by AMSA (AMSA, 2015). This guidance states that for a vessel other than an oil tanker, the maximum credible spill from a collision can be determined from the volume of the largest single fuel tank.

	In reviewing the general arrangements and fuel tank capacities of typical vessels likely to be utilised for the GES project, the largest single fuel tank capacity identified was no greater than ~370 m^3 of MGO for a project vessel.
Potential receptors	Fish, sharks, marine mammals, marine reptiles and seabirds
Potential Impacts	Spill of MGO as a result of refuelling would result in a localised reduction in water quality that may be harmful to marine fauna in surface waters and upper layers (~1 m) of the water column. • Surface MGO is not predicted to contact any of the shoreline (receptor) locations during any season, • No receptor is predicted to be contacted by entrained oil plumes with a concentration greater than 500 ppb • Dissolved aromatic hydrocarbon concentrations and dosage are not predicted to exceed the environmentally sensitive thresholds of 100 ppb and 9,600 ppb.hr at any sensitive location in any season. The potential impacts to the environment will be greatest in the immediate vicinity of the spill when the toxic aromatic components of the fuel will be at their greatest concentration and when the hydrocarbon is at its thickest on the surface of the receiving waters. The potential sensitive receptors in the immediate areas of the spill will include fish, cetaceans, marine reptiles and seabirds at the sea surface, which may ingest the MGO or become coated. Entrained MGO may pose different risks to habitats and fauna compared to a surface slick. However, as a result of the dilution of entrained oil in the water column, toxic impacts of entrained MGO are likely to be less than that of a surface slick. As the entrained hydrocarbons will be in the surface waters only, the extent of entrained hydrocarbons is predicted to be the same as that as the surface hydrocarbon spread. *Toxic effects* The short exposure times likely to be experienced by potential receptors, minimal impacts from exposure to toxic hydrocarbons are anticipated and the rapid evaporation and loss of the more toxic aromatic components of the MGOresults in a reducing toxicity threat to marine fauna with time. Passive / low mobility fauna such as plankton and small fish in the surface water are most likely to be affected by the MGO. Significant impacts to larger marine fauna species such as marine mammals, fish (sharks), marine reptiles and seabirds are unlikely (but possible) given the relatively small area of impact anticipated and the short duration of the spill. *Physical effects* In the immediate spill area, marine fauna interacting with surface waters may be exposed to hydrocarbons on the surface at concentrations about the threshold of 10 g/m^2used for oiling impacts to sensitive receptors, but given the low adhesive potential of the hydrocarbon, significant impacts are not anticipated. Impacts are not expected to be significant at the sea surface with the high volatility and low adhesive potential of the hydrocarbon resulting in low persistence in the environment. Details of environmental impacts of entrained and surface MGO on sensitive receptors found within the EMBA are presented in **Table 6-3**.
Impact assessment	
Receptors	**Consequence**
Threatened / Migratory / Protected Fauna	In the event of a vessel collision, the volume of hydrocarbons released would be a finite amount limited to the maximum credible spill of a full tank inventory release. Given the nature of the MGO and the distance from shorelines, dilution and dispersion from natural weathering processes such as ocean currents indicate that the extent of exposure will be limited in area and duration. The susceptibility of marine fauna to hydrocarbons is dependent on hydrocarbon type

	and exposure duration however given that exposures would be limited in extent and duration, exposure to marine fauna from this hazard is not expected to result in a fatality. Habitat modification/degradation/disruption/loss, deteriorating water quality and marine pollution are identified as potential threats to a number of marine fauna species in relevant Recovery Plans and Conservation Advice. With the controls in place, in line with the relevant actions prescribed in Recovery Plan for Marine Turtles and Conservation Advice for Humpback Whales and Whale Sharks, the Activity will be conducted in a manner that reduces potential impacts to ALARP and of acceptable level. In addition, the Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves states that DPaW should '*Ensure that important seabird and shorebird breeding and feeding areas are not significantly affected by human activities*'. The low shipping and fishing activity expected in the direct area of the activity and the management controls in place are considered to result in a low risk of a collision occurring. In the unlikely event that a collision did occur within the operational area, the potential impacts to the environment would be greatest several kilometres from the spill when the toxic aromatic components of the fuel will be at their highest concentration and when the hydrocarbon is at its thickest on the surface of the receiving waters. The MGO will also rapidly lose toxicity with time and spread thinner as evaporation continues. The potential sensitive receptors in the surrounding areas of the spill will include fish, marine mammals, marine reptiles and seabirds at the sea surface (**Table 6-3**). Marine habitats may also be impacted as discussed in **Section0.** There would be no shoreline contact at the defined thresholds (e.g. more than 10 g/m^2 and greater than 500ppb). Indigenous users may be impacted in the event that a land based response is required, however consultation will ensure potential impacts are reduced to acceptable levels. Given that a vessel collision hydrocarbon spill would not result in a decreased population size at a local or regional scale, it is expected that a spill of this nature would result in a **minor** consequence.		
Likelihood	A hydrocarbon release resulting from a vessel collision is unlikely to have widespread ecological effects given the nature of the hydrocarbons on-board, the finite volumes that could be released, the depth and transient nature of marine fauna in this area. Deteriorating water quality is identified as a potential threat to turtles in the marine turtle recovery plan, and some bird and shark species. Habitat modification/degradation/disruption, pollution and/or loss of habitat are also identified as threats to sharks, birds, cetaceans and turtles in conservation management and recovery plans. However, the potential hydrocarbon releases as a result of vessel collision are not expected to significantly impact the receiving environment with management controls proposed. Additionally, long term impacts resulting in complete habitat loss or degradation are not considered likely given the controls proposed to prevent releases and therefore the Activity will be conducted in a manner that is considered acceptable. The likelihood of a hydrocarbon release occurring due to a vessel collision is limited given the set of mitigation and management controls in place for this program. Subsequently the likelihood of a vessel collision releasing hydrocarbons to the environment which results in a minor consequence is considered to be **rare**.		
Likelihood Ranking	2- Rare	**Consequence ranking**	B - Minor
Residual risk	Low		
Management Control	**Effectiveness of Control**		
Maritime notices	Ensure other marine users are aware of the presence of the installation vessel and the relative low mobility of vessel to suddenly change course or avoid other vessels.		

Exclusion zone	Exclusion zones around the vessel prevents other vessels from getting too close and causing damage to equipment of either party.
Dynamic positioning	Prevents unintentional movements by vessel decreasing risk of collision, reducing the risk of hydrocarbons being discharged to the marine environment
Navigation equipment and procedures	Reduces risk of environmental impact from vessel collisions due to ensuring safety requirements are fulfilled.
Oil pollution emergency plan (OPEP)	Implements response plans to deal with an unplanned hydrocarbon release quickly and efficiently in order to reduce impacts to the marine environment.
Project and support vessel spill response plans	

Table 6-3: Impacts of entrained and surface MGO on sensitive receptors found within the EMBA

Receptor	Impacts of MGO	
	Entrained and dissolved aromatic hydrocarbons	**Surface**
Marine fauna		
Plankton (including zooplankton; fish and coral larvae)	There is potential for localised mortality of plankton due to reduced water quality and toxicity. Effects will be greatest in the upper 10 m of the water column and areas close to the spill source where hydrocarbon concentrations are likely to be highest.	Surface MGO will have no impact on plankton.
	The installation activities have potential to overlap with spawning of some fish species given the year round spawning of some species. In the unlikely event of a spill occurring, fish larvae may be impacted by MGO entrained in the water column. However, following release, the MGO will rapidly evaporate and disperse in the offshore environment, reducing the concentration and toxicity of the spill. Given duration of fish spawning periods, lack of suitable habitat for aggregating fish populations near the surface, combined with the quick evaporation and dispersion of MGO, impacts to overall fish populations are not expected to be significant.	
Marine mammals	Lethal or sub-lethal physical and toxic effects such as irritation of eyes/mouth and potential illness.	At risk of direct contact with MGO due to chance of surfacing within slick. Effects include irritation of eyes/mouth and potential illness. Surface respiration could lead to accidental ingestion of hydrocarbons or result in the coating of sensitive epidermal surfaces.
	Ten migratory cetacean species were identified by the EPBC Protected Matters search (**Section** 4). Of these, two are listed as threatened and three as vulnerable: Humpback whale: The GES operational area overlaps the humpback whale migration BIA and the GES activity may overlap with the humpback whale migratory period. In the unlikely event of an MGO spill, migrating humpback whales or female whale and calf resting at Montebello Island may encounter entrained and surface MGO. However, given the rapid evaporation of MGO, significant numbers are not expected to be impacted. Blue whales: The project EMBA overlaps with the blue whale migratory path. Since blue whales show preference for water depths > 500 m, a small number of individuals may encounter entrained or surface MGO. However, the absence of any known feeding, resting or breeding areas in operational or EMBA means significant numbers are unlikely to be impacted. Southern Right whales: the project operational or EMBA does not overlap with Southern Right Whale migration path. In the unlikely event of an MGO spill, transient individuals may encounter entrained and surface MGO. However, the absence of any known feeding, resting or breeding areas means significant numbers are unlikely to be impacted. Fin whale: Fin whales have a worldwide distribution generally in deeper waters and their distribution in Australia is not clear due to the sparsity of sightings. Given the absence of any known feeding, resting or breeding areas, significant numbers are unlikely to be impacted. Sei whale: Sei whales move between Australian waters and Antarctic feeding areas however they are only infrequently recorded in Australian waters (Bannister *et al*. 1996) and their movements and distribution in Australian waters is not well known (DoE 2014a). Given the absence of any known feeding, resting or breeding areas, significant numbers are unlikely to be impacted. Other migratory cetaceans may encounter either surface or entrained MGO, however, the absence of any known feeding, resting or breeding areas	

	means significant numbers are unlikely to be impacted.	
Marine reptiles	Lethal or sub-lethal physical and toxic effects such as irritation of eyes/mouth and potential illness.	At risk of direct contact with MGO due to chance of surfacing within slick. Effects include irritation of eyes/mouth and potential illness. Surface respiration could lead to accidental ingestion of hydrocarbons or result in the coating of sensitive epidermal surfaces
	Six species of threatened marine reptile were identified as possibly being impacted by a spill. Short-nosed seasnake, flatback, hawksbill, leatherback, green and loggerhead turtles are widely dispersed at low densities across the NWS and in the unlikely event of a MGO spill occurring, individuals traversing open water may come into contact with entrained or surface MGO. The project operational area overlaps with the flatback turtles internesting area. However, given the distance to turtle nesting beaches (59 km) should a spill occur during hatchling season, and the results of the spill modelling indicating no shoreline contacts at or above defined thresholds it is unlikely that hatchlings could be impacted. Therefore the risk of hatchlings or transient adults encountering MGO is likely to be very low.	
Seabirds	Lethal or sub-lethal physical and toxic effects such as irritation of eyes/mouth and potential illness. May encounter entrained MGO while diving and foraging.	Particularly vulnerable to surface MGO. As most fish survive beneath floating slicks, they will continue to attract foraging seabirds, which typically do not exhibit avoidance behaviour. Smothering can lead to reduced water proofing of feathers and ingestion while preening. In addition, MGO can erode feathers causing chemical damage to the feather structure that subsequently affects ability to thermoregulate and maintain buoyancy on water.
	Six threatened species, as identified by the EPBC Protected Matters database search, may be encountered during the project activities and may have foraging or feeding habitat in the vicinity of the EMBA. The Australian fairy tern has foraging habitat in the area and so may be impacted by surface and entrained diesel while foraging (dive and skim feeding). Higher numbers would be expected during the breeding period of July to September. Due to the quick evaporation and dispersion of MGO, significant impacts are not anticipated. While the Southern giant petrel, Eastern Curlew, Red Knot, Soft-plumaged Petrel and Curlew Sandpiper may occur in the area, no BIAs are designated for breeding or foraging within the EMBA so significant numbers are not expected and any impacts would be limited to transient individuals. Therefore the risk of surface and entrained diesel to seabirds is considered low.	
Fish and sharks	Hydrocarbon droplets can physically affect fish and sharks exposed for an extended duration (weeks to months). Smothering through coating of gills can lead to the lethal and sub-lethal effects of reduced oxygen exchange, and coating of body surfaces may lead to increased incidence of irritation and infection. Fish may also ingest hydrocarbon droplets or contaminated food leading to reduced growth. The project operational area overlaps with the whale shark foraging BIA. However, given the distance to whale shark aggregation location (Ningaloo Marine Park, 128 km southwest of GES operational area) and activity being conducted outside the main	While fish and sharks do not generally break the sea surface, individuals may feed at the surface. However, since the MGO is expected to quickly dispersed and evaporated (modelling results indicate approximately 40-50% by mass is predicted to evaporate over the first two days), and the low frequency of breaches at the surface, the probability of prolonged exposure to a surface slick by fish and shark species is low.

	whale shark aggregation period (May – June) significant impacts to whale shark are not expected should a spill occur. There is potential for localised mortality of fish eggs and larva due to reduced water quality and toxicity. Effects will be greatest in the upper 10 m of the water column and areas close to the spill source where hydrocarbon concentrations are likely to be highest and therefore demersal fish communities are not expected to be impacted.	
	The NWS supports a diverse assemblage of fish, including 456 species of finfish, particularly in shallower water near the mainland and islands. Threatened species identified by the EPBC protected matters search include the great white shark, whale shark, grey nurse shark and green and dwarf sawfish which may be present in the affected area. However given the absence of critical habitat for most of these species, significant numbers are not expected to be impacted. The only BIA overlapping the GES operational area and EMBA is for the whale shark. While this is for foraging it is not for high density prey where congregations are expected so impacts would be limited to transient migrating individuals. Grey nurse sharks could be present at low densities all year round within the operational area and EMBA, however, the absence of any known feeding, resting or breeding areas means significant numbers are unlikely to be impacted if an unplanned release were to occur.	
Socioeconomic		
Fisheries	Entrained MGO can have toxic effects on fish (as outlined above) reducing catch rates and rendering fish unsafe for consumption.	In addition to the effects of entrained oil, exclusion zones surrounding a spill can directly impact fisheries by restricting access for fishermen.
	Both entrained and surface MGO have the potential to lead to temporary financial losses.	
Tourism	There are many sources of marine-based tourism within the environment that may be affected. Aquatic recreational activities such as boating, diving and fishing occur around the Montebello Islands but are concentrated in the vicinity of the population centres such as Exmouth, Dampier and Onslow. In the waters immediately surrounding the operational area, tourism activities are expected to be low, however exclusion zones surrounding a spill will reduce access for vessels for the duration of the response undertaken for spill clean-up (if applicable).	
Shipping	Entrained oil will have no effect on shipping.	Exclusion zones surrounding a spill will reduce access for shipping vessels for the duration of the response undertaken for spill clean-up (if applicable); vessel may have to take large detours leading to potential delays and increased costs.
Defence	The level of defence activities carried out in the vicinity of operational area is low , if any, and therefore interference of defence activities due to a MGO spill are likely to be minimal.	
Shipwrecks	Surface oil will have no impact on shipwrecks. Entrained oil from a vessel collision will remain in the surface waters and is therefore unlikely to have an impact on shipwrecks.	
Indigenous	The level of activities undertaken by indigenous users is expected to be low, if any, therefore interference due to an MGO spill are likely to be minimal, however in event there is a requirement for land based response activities/ disturbance relevant representatives (identified in **Section 5**)	

	will be contacted as outlined in the OPEP Section 20.
Existing oil and gas activity	Exclusion zones surrounding spills will reduce access potentially leading to delays to work schedules with subsequent financial implications. Chevron undertake a number of activities on Barrow Island and therefore may be impacted in the event of an unplanned spill event through exclusion from undertaking activities.
Protected areas	Protected areas are described in **Section 4.2.3** but are summarised below. **Montebello CMR** Includes habitat for foraging and breeding for seabirds and marine turtles.
	As discussed above, marine mammals, seabirds, sharks and reptiles are at risk of direct contact with MGO due to chance of surfacing within slick. Effects include irritation of eyes/mouth and potential illness. Surface respiration could lead to accidental ingestion of hydrocarbons or result in the coating of sensitive epidermal surfaces.
KEFs	KEFs are described in **Section 4.3.1** but are summarised below **Ancient Coastline at 125m Contour** Contributes to higher diversity and enhanced species richness relative to soft sediment habitat Attracts opportunistic feeding by larger marine life including humpback whales, whale sharks and large pelagic fish **Canyons linking the Cuvier Abyssal Plain and the Cape range Peninsula** Supports the productivity and species richness of Ningaloo Reef **Continental Slope Demersal Fish Communities** Provides important habitat for demersal fish communities, characterised by high endemism and species diversity
	A loss of MGO to the marine environment would result in a localised reduction in water quality in the upper surface waters of the water column. There will be no shoreline contact above the defined thresholds.

6.4.2 Condensate Release Due To Damaged Subsea Infrastructure (Halyard-1 Flowline and East Spar Pipeline)

Event: Condensate Release Due To Damaged Subsea Infrastructure (Halyard-1 Flowline and East Spar Pipeline)	Accidental dropped objects could occur from operations including lifting/moving of objects and equipment needed to complete installation and commissioning activities. Equipment and other items lost at sea could be caused by crane failure, adverse weather, human error, rigging failure, unsecured equipment on deck and vessel motions, see **Section 6.3.2**(Seabed disturbance – installation of subsea infrastructure) for description and management controls for seabed disturbance, dropped objects and impacts to benthic communities. During the GES installation and commissioning activities a hydrocarbon release of gas and condensate, due to damage to the Halyard 10" flowline, could occur through a dropped object incident – namely the subsea structures (40 Te PLEM and 100 Te SCS) dropped during installation onto the Halyard 10" flowline (there is about 20 m separation distance at closest point). The maximum credible spill from a damaged (ruptured) Halyard flowline has been determined based on spill volume guidance produced by AMSA (AMSA, 2015). AMSA stipulates a worst case offshore pipeline rupture as 1 hour of maximum flow + the entire pipeline inventory. A loss of containment at Halyard flowline would escalate to a loss that would be detected and result in an almost instantaneous emergency shutdown (ESD) due to the pressure drop in the flowline and the presence of an automated ESD system. For this reason the worst case spill has been determined from the inventory of the isolatable section, including the Halyard flowline and the East Spar pipeline volumes between ESD valves at the wellhead and at Varanus Island. This calculation provides a worst case condensate volume of 159 m^3.
Potential receptors	Fish , sharks, marine mammals, marine reptiles and seabirds
Potential Impacts	Hydrocarbon spills can cause chemical (e.g. toxic) and physical (e.g. coating of emergent habitats, oiling of wildlife at sea surface) impacts to marine species and a decline in water quality. The severity of the impact of a hydrocarbon spill depends on the magnitude of the hydrocarbon spill (i.e. extent, duration) and sensitivity of the receptor. The magnitude of potential environmental impact from a condensate release (which behaves in a similar manner in the marine environment to MGO) is dependent on multiple factors including hydrocarbon type, release volume and rate, and ocean and weather conditions as discussed in **Section 6.4.1**. An assessment of the sensitive environmental receptors at risk from a Halyard condensate release has been determined based on a literature review and trajectory and fate modelling described above. **Section** 4 includes a description of biological environment present in the operational and/or spill trajectory area. Fundamentally, such receptors are likely to be the same or similar to those described in **Section 6.4.1** and include: • Plankton; • Invertebrates (pelagic); • Pelagic fish (including those targeted by commercial and recreational fishers); • Marine mammals; • Whale sharks; • Marine turtles; • Seabirds; and • Commercial fisheries. Modelling shows a high rate of dispersion of condensate released at the seabed and a high

	rate of evaporation for the relatively small proportion that expresses at sea surface. The spatial extent of impacts from entrained oil and dissolved aromatic hydrocarbons around the release site is predicted to be within a scale of ~30 km. Ecosystem recovery would be expected within weeks to months of return to normal water quality conditions. It is reasonable to conclude that the greatest ecological response will occur in the highest concentration zones of non-degraded hydrocarbons. Based on APASA (2013a) and APASA (2013d) modelling results and an understanding of environmental receptors that could be affected the following assessment is provided for a potential condensate release: • The relatively short persistence of condensate at any location and its limited propensity to affect deeper habitats reduces the scope of potential effects to environmental receptors (particularly benthic habitats) and socioeconomic receptors (notably tourism operations near the coastline, e.g. whale shark watching operators); • Benthic habitats are predominately soft sediments and outcropping cemented sediments (hard substratum) with associated benthic fauna; with the epifauna and infauna unlikely to be restricted on a regional scale (Neptune Geomatics, 2010; RPS, 2010a, 2011a, 2011c); • No emergent, shoreline or shallow water habitats are predicted to be contacted by hydrocarbons at the defined impact thresholds; • GES operational area overlaps with flatback turtles internesting BIA, whale shark foraging BIA and humpback whale migration BIA. However large numbers of encounters are not expected due to distance to whale shark aggregation location and turtle nesting beaches (128 km and 59 km away respectively), activity conducted outside whale shark aggregation period (i.e. May-June), and water depths of the operational area (i.e. 50m - 118m). • Other EPBC Act-listed threatened and migratory species (e.g. blue whales, marine turtles and seabirds) are known or likely to transit the modelled hydrocarbon-effected water mass. Notwithstanding this, the potentially affected area is not known to contain habitat or be an aggregation area of critical importance to these species; • Recovery of marine fauna or benthic habitats exposed to hydrocarbons and experiencing sub-lethal impacts would be expected within weeks to months of return to normal water quality conditions; • Marine fauna that surface to breathe and seabirds potentially at risk from surface hydrocarbons have widespread distributions and, given the relatively localised and short-lived nature of the condensate, long-term consequences to populations are unlikely; and • Impacts to fish can have a subsequent impact on commercial fisheries and also a disruption to fishery activity during the release event and clean-up activities.
Impact assessment	
Receptors	**Consequence**
Marine fauna – Fish, cetaceans, marine mammals, marine reptiles; Protected areas and socio-economic receptors	In the event of a hydrocarbon release due to flowline rupture, the volume of hydrocarbons released would be a finite amount limited to the maximum credible spill of a full content of the ruptured pipeline/ flowline. Given the nature of the Halyard condensate and the distance from shorelines, dilution and dispersion from natural weathering processes such as ocean currents indicate that the extent of exposure will be limited in area and duration. The susceptibility of marine fauna to hydrocarbons is dependent on hydrocarbon type and exposure duration however given that exposures would be limited in extent and duration, exposure to marine fauna from this hazard is not expected to result in a fatality. Habitat modification/degradation/disruption/loss, deteriorating water quality and marine pollution are identified as potential threats to a number of marine fauna species in relevant

	Recovery Plans and Conservation Advice. With controls in place, the Activity will be conducted in a manner that reduces potential impacts to ALARP and of acceptable level. In addition, the Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves states that DPaW should '*Ensure that important seabird and shorebird breeding and feeding areas are not significantly affected by human activities*'. The potential impacts of a hydrocarbon release on seabird breeding and feeding areas are discussed in **Table 6-3**. In the unlikely event that a dropped object did occur resulted in hydrocarbon release from ruptured flowline within the operational area, the potential impacts to the environment would be greatest several kilometres from the spill when the toxic aromatic components of the fuel will be at their highest concentration and when the hydrocarbon is at its thickest on the surface of the receiving waters. Like MGO, Halyard condensate will also rapidly lose toxicity with time and spread thinner as evaporation continues. The potential sensitive receptors in the surrounding areas of the spill will include fish, marine mammals, marine reptiles and seabirds at the sea surface, as discussed in **Table 6-3**. There will be no shoreline contact in any season at the defined thresholds. Given that a hydrocarbon spill due to pipeline rupture would not result in a decreased population size at a local or regional scale, it is expected that a spill of this nature would result in a **minor** consequence.		
Likelihood	A hydrocarbon release resulting from a pipeline/ flowline rupture caused by dropped object is unlikely to have widespread ecological effects given the nature of the Halyard condensate and the safety design of the production system, the finite volumes that could be released, the depth and transient nature of marine fauna in this area. Deteriorating water quality is identified as a potential threat to turtles in the marine turtle recovery plan, and some bird and shark species. Habitat modification/degradation/disruption, pollution and/or loss of habitat are also identified as threats to sharks, birds, cetaceans and turtles in conservation management and recovery plans. However, the potential hydrocarbon releases as a result of pipeline/ flowline rupture caused by dropped object are not expected to significantly impact the receiving environment with management controls proposed. Additionally, long term impacts resulting in complete habitat loss or degradation are not considered likely given the controls proposed to prevent releases and therefore the Activity will be conducted in a manner that is considered acceptable. The likelihood of a hydrocarbon release occurring due to pipeline/ flowline rupture caused by dropped object is limited given the set of mitigation and management controls in place for this program. Subsequently the likelihood of a pipeline/ flowline rupture releasing hydrocarbons to the environment which results in a minor consequence is considered to be **rare**.		
Likelihood Ranking	2- Rare	**Consequence ranking**	B - Minor
Residual risk	Low		
Management Control	**Effectiveness of Control**		
Pre-installation seabed survey by ROV	Ensures any subsea hazards that may cause pipeline/ flowline rupture during installation or relocation of infrastructure resulting in hydrocarbon release are identified		
As-built drawings and survey	ROV survey to establish the as-found and as-built condition of the subsea infrastructure to minimise risk of pipeline/ flowline leakage		
Dropped object prevention procedures	Minimises drop risk during lifting operations that may cause pipeline/ flowline rupture resulting in hydrocarbon release		

Dynamic positioning	Prevents unintentional movements by vessel, decreasing risk of dropped object reducing the risk of hydrocarbons being discharged to the marine environment
Oil pollution emergency plan (OPEP)	Implements response plans to deal with an unplanned hydrocarbon release quickly and efficiently in order to reduce impacts to the marine environment.
Project and support vessel spill response plans	
Installation procedures	Adhering to installation procedures (e.g. setting a pre-determined distance clear of subsea infrastructure), using acoustic positioning devices (metrology equipment) and approval of critical lifts helps prevent damaging of subsea infrastructures which resulting in hydrocarbon release
Lifting equipment Maintenance	Ensures that lifting equipment is maintained and certified, and that lifting procedures are followed reducing probability of dropped objects occurring with the potential to result in hydrocarbon spills.
Halyard-1 xmas tree automatic shut in equipment	In the event of low pressure resultant from a pipeline rupture, Halyard-1 production will be automatically shut in therefore limiting the release of hydrocarbons

6.4.3 Minor Hydrocarbon Release (Surface)

Event: Minor Hydrocarbon Release (surface)	A minor spill (~37.5 m^3) of MGO could occur during refuelling resulting in a loss of hydrocarbons to the marine environment at sea surface. Spills of MGO during refuelling events have the potential to cause impacts to the marine environment through a reduction in water quality and marine fauna exposure. Spills during refuelling can occur through several pathways, including fuel hose breaks, coupling failure or tank overfilling. Spills resulting from overfilling will be contained within the vessel drains and slops tank system. In the event that the refuelling hose is ruptured, the fuel bunkering activity will cease by turning off the pump; the fuel remaining in the transfer line will escape to the environment as well as fuel released prior to the transfer operation being stopped. The AMSA (2015) *Technical Guidelines for Preparing Contingency Plans for Marine and Coastal Facilities* provides guidance for calculating a maximum credible spill volume for a refuelling spill. The guidance provided by AMSA (2015) for a refuelling spill under continuous supervision is considered appropriate given refuelling will be constantly supervised. The maximum credible spill volume during refuelling is calculated as: transfer rate (150 m^3/ hr) x 15 minutes of flow. The detection time of 15 minutes is seen as conservative but applicable following failure of multiple barriers followed by manual detection and isolation of the fuel supply. Minor accidental loss of other hydrocarbon based liquids (e.g. used lubricating oils, cooking oil, and hydraulic oil) to the marine environment could also occur via tank pipework failure or rupture, hydraulic hose failure, inadequate bunding and/or storage, insufficient fastening or inadequate handling which could result in impacts to water quality and hence sensitive environmental receptors.
Potential receptors	Marine fauna – Fish, cetaceans, marine mammals, marine reptiles; Protected areas and socio-economic receptors
Potential Impacts	Refer to **Section 6.4.1** (Hydrocarbon spill from a vessel collision) for potential impacts from a MGO spill.
Impact assessment	

Receptors	Consequence		
Marine fauna – Fish, cetaceans, marine mammals, marine reptiles, benthic fauna.	In the event of a minor hydrocarbon spill, the quantities would be limited to approximately 37.5 m^3. The small volumes and dilution and dispersion from natural weathering processes such as ocean currents indicate that the extent of exposure will be limited in area and duration (5 km over 6 hours). The number of receptors present at the activity location are expected to be limited to a small number of transient individuals. The susceptibility of marine fauna to hydrocarbons is dependent on hydrocarbon type and exposure duration however given that exposures would be limited in extent and duration, exposure to marine fauna from this hazard is considered to be low. As the MGO is a moderately volatile substance, the impacts to receptors will decline rapidly with time and distance at the sea surface. Rapid dilution at depth would also result in the impacts to receptors declining rapidly with time and distance. Deteriorating water quality and marine pollution are identified as potential threats to a number of marine fauna species in relevant Recovery Plans and Conservation Advice. With the controls in place, the Activity will be conducted in a manner that reduces potential impacts to ALARP and of acceptable level. For marine mammals that may be exposed to the more toxic aromatic components of the marine diesel, chemical effects are considered unlikely since these species are mobile and therefore not be constantly exposed for extended durations that would be required to cause any major toxic effects. Although humpback and blue whales may be exposed, this event is not expected to interfere with their migration activity. Toxic impacts are not expected to the benthic community due to the water depths. Near the sea surface, fish are able to detect and avoid contact with surface slicks and as a result, fish mortalities rarely occur in open waters from surface spills (Kennish, 1997; Scholz *et al*., 1992). Pelagic fish species are therefore generally not highly susceptible to impacts from hydrocarbon spills. In offshore waters near to the release point, pelagic fish are at risk of exposure to the more toxic aromatic components of the marine diesel. Pelagic fish in offshore waters are highly mobile and comprise species such as tunas, sharks and mackerel. Due to their mobility, it is unlikely that pelagic fish would be exposed to toxic components for long periods in this spill scenario. The more toxic components would also rapidly evaporate and concentrations would significantly diminish with distance from the spill site, limiting the potential area of impact. Deteriorating water quality is identified as a potential threat to turtles in the marine turtle recovery plan, and some bird and shark species. However, the potential minor hydrocarbon releases are not expected to significantly impact the receiving environment with management controls proposed to prevent releases and therefore the Activity will be conducted in a manner that is considered acceptable. Given that a small hydrocarbon spill would not result in a decreased population size at a local or regional scale, it is expected that a spill of this nature would result in a **negligible** consequence.		
Likelihood	The likelihood of a small hydrocarbon release occurring is limited given the set of management controls in place for this activity. The likelihood of a refuelling incident with subsequent release to the marine environment is considered to be **unlikely**.		
Likelihood Ranking	4- Unlikely	**Consequence ranking**	A –Negligible
Residual risk	Low		
Management Control	**Effectiveness of Control**		
Bulk refuelling transfer	Prevents probability of unplanned hydrocarbon spills or leaks occurring during bunkering leading to negative impacts to the marine environment.		

procedures	
Fuel use	Reduces the potential impacts to marine environment in the event of unplanned hydrocarbon spills or leaks during bunkering
Deck drainage	Reduces potential for hydrocarbon release to the marine environment during refuelling
Oil pollution emergency plan (OPEP)	Implements response plans to deal with an unplanned hydrocarbon release quickly and efficiently in order to reduce impacts to the marine environment.
Project and support vessel spill response plans	

6.4.4 Non-hydrocarbon and chemicals release (surface)- liquid

Event: Non-hydrocarbon and chemicals release (surface)-liquid	Hazardous liquids including miscellaneous chemicals and waste streams (cleaning and cooling agents, stored or spent chemicals and leftover paint materials) are used or stored on board the vessel during the activity. The main engines and equipment such as pumps, cranes, winches, power packs and generators require MGO for fuel and a variety of hydraulic fluids and lubricating oils for efficient operation and maintenance of moving parts. These products are present within the equipment and also held in storage containers and tanks on the vessels, small hydrocarbon leaks could occur and potential impacts are covered under **Sections6.4.1, 6.4.2**and**6.4.3**, chemical leaks are discussed further here. Seal oil could potentially leak from the vessel thruster/propeller stern tube directly to sea as a result of leaking seals or mechanical damage. The header tank for stern tube oil is approximately 1 m^3 and is equipped with limit switches in the event of a leak, thus preventing complete loss. Outside the vessel, the largest credible spill would be release of <1 m^3 of stern tube oil (non-hydrocarbon based lube oil) from the vessel thruster/propeller stern tube. ROV operations can result in unplanned discharges (of hydraulic fluids) directly to the marine environment due to equipment failure, ROV interactions with the vessel thrusters and/or accidental contact with sub-sea infrastructure. The largest credible hydrocarbon spill from ROV operations would be an accidental release of approximately 30 L of hydraulic fluid from the deployed ROV. The presence of pipeline preservation chemicals and chemical dye (refer to **Section 3**) used in treated water represents a potential spill risk during chemical storage and handling e.g. due to tank damage, or human error. Rupture of the pumping hose used to transfer these chemicals may occur due to dropped object, vessel motion, hose failure or loss of vessel position. Accidental loss of liquid wastes to the marine environment could occur via tank pipework failure or rupture, inadequate bunding and/or storage, insufficient fastening or inadequate handling may result in impacts to water quality and hence sensitive environmental receptors.
Potential receptors	Fish, sharks, marine mammals, marine reptiles and seabirds including benthic habitats from vessel spills
Potential Impacts	Environmentally hazardous chemicals, hydrocarbon and liquid wastes lost to

	the marine environment may lead to contamination of the water column in the vicinity of the vessel. The potential impacts would most likely be highly localised and restricted to the immediate area surrounding the spill, with rapid dispersal to concentrations below impact thresholds likely to occur in the open area of ocean. The changes to water quality that may result could potentially lead to short-term impacts on marine fauna (e.g. pelagic/benthic fish, epifauna, cetaceans, marine reptiles and seabirds), with chronic impacts not expected owing to the short exposure times likely. The area that may be affected by this risk for the majority of spilt material would most likely be restricted to a small area within the operational area. Hydraulic fluids and lubricating fluids behave similarly to MGO when spilt in the marine environment (for information on MGO behaviour in the marine environment refer to **Section 6.4.1** although lubricating oils are more viscous and so the spreading rate of a slick of these oils would be slightly slower. Hydraulic fluids are medium oils of light to moderate viscosity and have a relatively rapid spreading rate and, like diesel, will dissipate quickly, particularly in high sea states. Discharge hazardous chemicals from spills is unlikely to have widespread ecological effects given the nature of the chemicals on-board, the small volumes that could be released, and the depth and exposure of the location. There is no emergent or inter-tidal habitat that could be impacted by a surface spill and the benthic habitat is predominately bare sand, with a very sparse assemblage of filter feeding and deposit feeding invertebrates (Neptune Geomatics, 2010; RPS, 2010a, 2011a, 2011c), any spilled material is unlikely to reach any of the demersal species or benthic habitats at the seabed. Physical coating of marine fauna by entrained or surface hydrocarbons, and sub-lethal or lethal effects from toxic chemicals, is considered unlikely given the expected low concentrations and short exposure times.
Impact assessment	
Receptors	**Consequence**
Marine fauna – Fish, marine mammals, dugong, marine reptiles, seabirds	In the event of a non-hydrocarbon liquid spill, the quantities would be limited to approximately 1m^3 of stern oil. The small volumes, dilution and dispersion from natural weathering processes such as ocean currents indicate that the extent of exposure will be limited in area and duration. The susceptibility of marine fauna to chemicals is dependent on the type and exposure duration however given that exposures would be limited in extent and duration, exposure to marine fauna from this hazard is not expected to result in a fatality. Impacts from small volumes (1 m^3) discharged to the marine environment to water quality would be short-term and localised, due to the nature and behaviour of the chemicals / liquid wastes identified as being at risk of spilling; only pelagic fauna present in the immediate vicinity of the spill would likely be at risk of impact. Deteriorating water quality and marine pollution are identified as potential threats to a number of marine fauna species in relevant Recovery Plans and Conservation Advice. The above information demonstrates that the Activity will be conducted in a manner that reduces potential impacts to ALARP and of acceptable level. The lack of significant habitat within the operational area indicates that only a small number of marine fauna has the potential to be exposed to a small hydrocarbon spill given the transient nature of fauna in this area.

	Deteriorating water quality is identified as a potential threat to turtles in the marine turtle recovery plan, and some bird and shark species. However, the potential non-hydrocarbon releases of liquids are not expected to significantly impact the receiving environment with management controls proposed to prevent releases and therefore the Activity will be conducted in a manner that is considered acceptable. Given that a small chemical spill would not result in a decreased population size at a local or regional scale, it is expected that a spill of this nature would result in a **negligible** consequence.		
Likelihood	A small non-hydrocarbon liquid release is unlikely to have widespread ecological effects given the nature of the chemicals on-board, the small volumes that could be released, the depth and transient nature of marine fauna in this area and the prevention and management procedures in place to clean up a spill. Quadrant recorded 42 non-hydrocarbon spills and leaks from equipment and machinery in 2015 (due to split hoses, small leaks, or handling errors). Most of the spills and leaks reported occurred within bunded areas, were all less than 100 L and cleaned up immediately. The likelihood of a small non-hydrocarbon release occurring is limited given the set of mitigation and management controls in place for this program. Subsequently the likelihood of releasing non-hydrocarbon liquids to the environment which results in a negligible consequence is considered to be **unlikely**.		
Likelihood Ranking	4- Unlikely	**Consequence ranking**	A –Negligible
Residual risk	Low		
Management Control	**Effectiveness of Control**		
General chemical management procedures	Potential impacts to the environment are reduced through following correct procedures for the safe handling and storage of chemicals		
Hazardous chemical management procedures	Reduces the risk of spills and leaks (discharges) to the sea by controlling the storage, handling and clean-up of hazardous chemicals		
Chemical selection procedure	Reduced toxicity to marine environment Only environmentally acceptable flushing and testing chemicals would be released in the event of an accidental discharge to sea		
Dropped object prevention procedures	Minimises dropped object risk during vessel lifting operations that may cause secondary spill (discharges) resulting in reduction in water quality		
Deck cleaning product selection procedure	Improve water quality discharge (reduce toxicity) to the marine environment		
Maritime Dangerous Goods Code	Dangerous goods managed in accordance with International Maritime Dangerous Goods Code (IMDG Code) to reduce the risk of an environmental incident, such as an accidental release to sea or unintended chemical reaction		
Lifting equipment maintenance	Ensures that lifting equipment is maintained and certified, and that lifting procedures are followed reducing probability of dropped objects occurring with the potential to result in hydrocarbon spills.		
ROV inspection and maintenance procedures	Minimises the risk of hydraulic fluid release to see		

6.4.5 Non-Hydrocarbon Release (Surface) – Solid

Event: Non-Hydrocarbon Release (Surface) – Solid	Non-hazardous solid wastes including paper, plastics and packaging, and hazardous solid wastes such as batteries, fluorescent tubes, medical wastes, and aerosol cans may be dropped unintentionally to the marine environment, potentially impacting on sensitive receptors. Release of these waste streams may occur as a result of overfull and/or uncovered bins, incorrectly disposed items or spills during transfers of waste. Dropped objects/lost equipment such as PLEM or SCS could also result in seabed disturbance.
Potential receptors	Benthic habitats Marine fauna – marine mammals, dugong, marine turtles, seabirds and fish. Socioeconomic – other sea users (fisheries, shipping, oil and gas operators)
Potential Impacts	Non-hazardous solids such as plastics have the potential to smother benthic environments and harm marine fauna through entanglement or ingestion. Marine turtles and seabirds are particularly at risk from entanglement. Marine turtles may mistake plastics for food; once ingested, plastics can damage internal tissues and inhibit physiological processes, which can both potentially result in fatality. Marine debris has been highlighted as threat to marine turtles, humpback whales and whale sharks in the Marine Turtle Recovery Plan (Commonwealth of Australia, 2013), Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) and Approved Conservation Advice for *Rhincodon typus* (whale shark). The Recovery plan and Approve Conservation Advice have specified a number of recovery actions to help combat this threat. Of relevance to this Activity is the legislation for the prevention of garbage disposal from vessels. Release of hazardous solids (e.g. wastes such as batteries) may result in the pollution of the immediate receiving environment, leading to detrimental health impacts to marine flora and fauna. Physiological damage can be through ingestion or absorption may occur to individual fish, cetaceans, marine reptiles or seabirds. The area of potential disturbance due to a non-buoyant dropped object would be restricted to the operational area. The seabed within the operational area is primarily soft sediments with little epifauna; this habitat type is widely distributed and well represented in the NWS region. While soft sediment benthic habits will not be destroyed, disturbance of the communities on and within them (i.e. the epifauna) will occur in the event of a dropped object and depressions may remain on the seabed for some time after removal of the dropped object as it gradually infills over time. Dropped objects could also impact water quality and lead to potential injury to fauna depending on the contents of the object e.g. a drum containing chemicals. Impacts from lost liquid materials / wastes are discussed in **Section6.4.4**.
Impact assessment	
Receptors	**Consequence**
Marine Fauna- cetaceans, marine turtles, seabirds and fish.	In the event of a non-hazardous or hazardous solid waste loss, the quantities would be limited. This waste stream could cause localised impacts to water quality and the benthic environment if the solid can degrade, leading to impacts on localised flora and fauna species. Ingestion of solid wastes could occur in small quantities. Only small volumes of this waste stream would be generated during the activity, as a result, any accidental loss to the environment would be small in size. Any impacts would be restricted to a small number of individuals in the close proximity to the release, if any. As such there is the potential for short term behavioural impacts only to a small proportion of a local population and not during critical lifecycle activity for cetaceans, marine turtles or fish. Marine debris is identified as a potential threat to a number of marine fauna species in relevant Recovery Plans and Conservation Advice. The above information demonstrates that the Activity will be conducted in a manner that reduces potential impacts to ALARP

	and of acceptable level. In addition, the Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves states that DPAW should '*Ensure that important seabird and shorebird breeding and feeding areas are not significantly affected by human activities*'. The potential impacts of unplanned solid discharges (e.g. litter) on seabird breeding and feeding areas are discussed above. The limited quantities associated with this event indicate that even in a worst case release of solid waste, the number of fatalities would be limited to individuals and is not expected to result in a decrease of the local population size and the consequence level is therefore negligible.		
Physical Environment – Seabed disturbance	In the event of a dropped object, the seabed is expected to be damaged by the object. The extent of the impact is limited to the size of the dropped object and given the size of standard materials transferred, any impact is expected to be very small. Surveys of previous seabed disturbances from drilling activities indicate that recovery of benthic fauna in soft sediment substrates occurs between 6-12 months after the activity ceases (URS, 2001). Subsequently any impacts are short term in duration. Any impact to seabed through dropped objects would result in a negligible reduction in habitat area/function impacted.		
Socio-economic – Interference from a buoyant object	In the event of a release of a buoyant object that cannot be recovered, it could present an obstacle to other sea users or have aesthetic impacts to tourism. Eventually the buoyant object may become non-buoyant and sink to the seabed where it may degrade over time. The time taken for this is dependent on the material released and any impacts to marine fauna and the seabed are described above. Given the likely size of buoyant equipment and it will drift with the currents, it is considered unlikely to present a significant hazard to other sea users or significant aesthetic impact and the consequence level is therefore negligible.		
Likelihood	A set of mitigation and management controls and checks have been proposed to ensure that the risks of dropped objects, lost equipment or release of solid waste to the environment has been minimised. The likelihood of transient marine fauna occurring in the operational area is limited and given the controls in place, the likelihood of releasing non-hydrocarbon solids to the environment resulting in a negligible consequence is considered likely (assumes potential for a single loss of solid waste incident during the GES operational activity).		
Likelihood Ranking	4- Unlikely	**Consequence ranking**	A –Negligible
Residual risk	Low		
Management Control	**Effectiveness of Control**		
Waste (garbage) management procedure	Reduces probability of waste being discharged to sea, reducing potential impacts to marine fauna. Ensure compliance with MARPOL requirements		
Dropped object prevention procedures	Impacts to environment are reduced by preventing dropped object and by retrieving dropped objects where possible		
Maritime Dangerous Goods Code	Dangerous goods managed in accordance with International Maritime Dangerous Goods Code (IMDG Code) to reduce the risk of an environmental incident, such as an accidental release to sea or unintended chemical reaction		
Lifting equipment Maintenance	Ensures that lifting equipment is maintained and certified, and that lifting procedures are followed reducing probability of dropped objects occurring.		

6.4.6 Marine Fauna Collisions

Event: Marine Fauna Collisions	There is the potential for vessels/equipment from the vessels involved in the activity to collide with marine fauna including cetaceans, fish, marine reptiles and seabirds. The main collision risk associated with the activity is through vessel collision or equipment collision with large, slow moving cetaceans; potentially resulting in severe injury or mortality.
Potential receptors	Benthic habitats, fish, sharks, marine mammals, marine reptiles and seabirds
Potential Impacts	Cetaceans are naturally inquisitive marine mammals that are often attracted to vessels underway; for example, dolphins commonly 'bow ride' with vessels. Marine fauna in surface waters that would be most at risk from vessel collision include marine mammals, marine turtles and whale shark. The GES Operational Area overlaps with flatback turtles internesting buffer BIA, whale shark foraging BIA and humpback whale migration BIA. Approved The worst potential impact from vessel collision would be mortality or serious injury of an individual. Collisions between vessels and cetaceans are most frequent on continental shelf areas where high vessel traffic and cetacean habitat occur simultaneously (WDCS, 2006). The most commonly sighted whale in continental shelf waters of the region is the humpback whale. Based on the proposed timing for the works, water depths and migration pathways it is unlikely that there will be significant interactions with humpback whales migrating northerly during the GES installation and commissioning activities. Higher numbers may be encountered in the GES operational area during humpback whale southern migration, however significant number is not expected given the water depths at the operational area approximately 50 – 115 m. Given the width of the blue whale migration corridor in the region (> 200 km) and depth range (between 300 m and 850 m) it is highly unlikely that there will be significant interactions with pygmy blue whales during the GES activities. Given the GES operational area overlaps with whale shark foraging BIA, individuals may be encountered during the GES activities. However, large numbers of whale shark encounters are not expected because the proposed GES activities occurs outside the main whale shark aggregation period (May-June) at Ningaloo and the distance to the Ningaloo Marine Park where they aggregate is approximately 128 km southwest of the operational area. It is possible that individual flatback turtles may be encountered in the operational area, particularly due to overlap with the flatback internesting buffer zone. However, given the depth of water, lack of suitable habitat and distance to the closest nesting beaches (Montebello Islands are approximately 59 km from the operational area), large numbers of turtle encounters are not expected. Marine turtle mortality due to boat strike has been identified as an issue in Queensland waters in the Marine Turtle Recovery Plan (Commonwealth of Australia, 2013). However, turtles appear to be more vulnerable to boat strike in areas of high urban population where incidents of pleasure crafts are higher. WA turtle populations have not been highlighted as those most affected by boat strike, possibly due to the relatively low human population density of the NWS coast line. Given that the project and support vessels will move slowly (<5 knots) within

	the operational area, the risk of collision with marine fauna is extremely low.
Impact assessment	
Receptors	**Consequence**
Marine fauna – Fish, cetaceans, marine reptiles, seabirds	In the event of a collision with marine fauna, there is the potential for injury or death to an individual. The number of receptors present at the operational area are expected to be limited to a small number of transient individuals, no significant areas of habitat are present in the immediate vicinity of the operational area. Boat strike and vessel disturbance are identified as potential threats to a number of marine fauna species in relevant Recovery Plan and Conservation Advice. The above information demonstrates that the Activity will be conducted in a manner that reduces potential impacts to ALARP and of acceptable level. In addition, the Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves states that DPAW should '*Maintain records of the incidence of entanglement, boat collisions and stranding of marine mammals in the reserves*' and '*Maintain a database of turtle mortality and incidents of entanglement in the reserves*'. Additionally, the Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves states that relevant industry activities should be undertaken at times and places that do not conflict with humpback whale migration through the reserves. With controls in place ensuring the vessel is compliant with EPBC Regulations, the risk of marine fauna collision is reduced. As such there is the potential for death or injury of EPBC listed individual species, however as they would represent a small proportion of the local population it is not expected that it would result in a decreased population size over what would usually occur due to natural variation, at a local or regional scale, It is expected that the loss of an individual would be a minor consequence.
Likelihood	The Australian National Marine Safety Committee (NMSC) reports that during 2009, there was one report of a vessel collision with a marine animal (species not defined) (NMSC, 2010). As the GES installation and commissioning occur within humpback whale southerly migration season, migrating individuals may traverse the operational area. No known aggregation areas occur within the operational area and therefore concentrations of milling individuals are unlikely. Pygmy blue whales may be encountered in the operational area. Tagging surveys have shown pygmy blue whales migrating northward relatively near to the Australian coastline (100 km) until reaching North West Cape after which they travelled offshore (240 km) to Indonesia. Passive acoustic data documented pygmy blue whales migrating along the Western Australian shelf break (Woodside, 2012). The National Conservation Values Atlas has identified the pygmy whale migration pathway on the continental shelf edge at depth of 500 to 1,000 m (McCauley & Jenner 2010). Breeding areas have not yet been identified however it is likely that pygmy blue whales calve in tropical areas of high localised production such as deep offshore waters of the Banda and Molucca Seas in Indonesia (Double *et al*. 2014). There are no known breeding areas of significance to blue whales in waters from Busselton to the Northern Territory border. Vessels will be moving very slowly whilst inside the operational area, posing a low risk of collision with marine fauna. In addition, the noise generated from vessel operations will deter marine fauna from coming in close proximity to

	vessels. Subsequently the likelihood of a collision with marine fauna resulting in a minor consequence is considered to be rare.		
Likelihood Ranking	2- Rare	**Consequence ranking**	B – Minor
Residual risk	Low		
Management Control	**Effectiveness of Control**		
Procedures for interacting with cetaceans	Reduces risk of vessel collision with cetaceans (and causing harm) by limiting speeds and approach distances in the presence of cetaceans and other marine fauna Ensures compliance with reporting requirements		
Marine fauna observations			
Constant bridge watch	Monitoring of surrounding marine environment to identify potential collision risks (and reducing harm) to cetaceans and other marine fauna		

6.4.7 Introduction of Invasive Marine Species (IMS)

Event: Introduction of IMS	IMS have been introduced and translocated around Australia by a variety of natural and human means including biofouling and ballast water. Invasive marine species (IMS) can be introduced into the operational area and surrounds by vessels carrying IMS on external biological fouling, internal systems (sea chests, seawater systems etc.), on marine equipment (e.g. mooring lines), or through ballast water exchange. Cross contamination between vessels can also occur.
Potential receptors	Marine fauna - fish; benthic habitats; socio-economic - fisheries
Potential Impacts	IMS are marine plants, animals and algae that have been introduced into a region that is beyond their natural range but have the ability to survive, and possibly thrive (DAFF, 2011). The majority of climatically compatible IMS to the NWS are found in south-east Asian countries. Some IMS pose a significant risk to environmental values, biodiversity, ecosystem health, human health, fisheries, aquaculture, shipping, ports and tourism (DAFF, 2011; Wells *et al.*, 2009). When IMS achieve pest status, they are commonly referred to as introduced marine pests or IMPs. IMPs can cause a variety of adverse effects in a receiving environment, including: • over-predation of native flora and fauna; • out-competing of native flora and fauna for food; • human illness through released toxins; • depletion of viable fishing areas and aquaculture stock; • reduction of coastal aesthetics; and • damage to marine and industrial equipment and infrastructure. Species of concern are those that are not native to the region; are likely to survive and establish in the region; and are able to spread by human mediated or natural means. Species of concern vary from one region to another depending on various environmental factors such as water temperature, salinity, nutrient levels and habitat type. These factors dictate their survival and invasive capabilities. It is recognised that artificial, disturbed and/or polluted habitats in tropical regions are susceptible to introductions which is why ports are often areas of higher IMS risk (Neil *et*

	al., 2005). However, in Australia there are limited records of detrimental impact from IMS compared to other tropical regions (such as the Caribbean). Following their establishment, eradication of IMS populations is difficult, limiting management options to ongoing control or impact minimisation. Case studies in Australia indicate that from detection to eradication this can take approximately 4 weeks (Bax 1999). However this is dependent on the environmental conditions and species. For this reason, increased management requirements have been implemented in recent years by Commonwealth and State regulatory agencies. Biofouling on vessel hulls and other external niche areas, biofouling on internal niches and biofouling on equipment routinely immersed in water all pose a potential risk of introducing IMS into Australia. The potential biofouling risk presented by the project/ support vessels will relate to the length of time that these vessels have already been operating in Australian waters or, if they have been operating outside Australian waters, the location/s of the operations they have been undertaking, the length of time spent at these location/s, and whether the vessels have undergone hull inspections, cleaning and application of new anti-foulant coating prior to returning to operate in Australia.		
Impact assessment			
Receptors	**Consequence**		
Marine fauna - fish; benthic habitats; socio-economic - fisheries	Ballast water is responsible for 20–30% of all marine pest incursions into Australian waters, however, research indicates that biofouling (the accumulation of aquatic micro-organisms, algae, plants and animals on vessel hulls and submerged surfaces) has been responsible for more foreign marine introductions than ballast water (DAFF, 2011). IMS, if they successfully establish, can out-compete native species for food or space, preying on native species or changing the nature of the environment and can subsequently impact on fisheries or aquaculture. If an IMS is introduced, they have been known to colonise areas outside of the areas they are introduced to. In the event that an IMS is introduced into the operational area, given the lack of diversity and extensiveness of similar benthic habitat in the region, there would only be a minor reduction in the physical environment. No threatened ecological communities are present in the area that could be affected. The overall consequence level was assessed as **moderate**.		
Likelihood	The pathways for IMS introduction are well known, and subsequently standard preventative measures are proposed. The ability for invasive marine species to colonise a habitat is dependent on a number of environmental conditions. It has been found that highly disturbed environments (such as marinas) are more susceptible to colonisation than open water environments where the number of dilutions and the degree of dispersal are high (Paulay *et al*., 2002). Given the depth of the operational area (50-118 m), it is unlikely that an IMS would be able to successfully translocate from the operational area to surrounding shallower habitats. With controls in place to reduce the risk of introduction of IMS the likelihood of introducing an IMS is considered **unlikely**.		
Likelihood Ranking	4 - Unlikely	**Consequence ranking**	C – Moderate
Residual risk	Medium		
Management Control	**Effectiveness of Control**		
Biofouling vessel risk assessment (VRASS)	The risk of introducing IMS are reduced due to assessment procedure		
Anti-foulant	The risk of introducing IMS are reduced due to anti-foulant systems		

system	
Ballast water management plan	Reduces the risk of introducing IMS through procedures managing ballast water exchange and identifying high risk ballast water

7. MANAGEMENT APPROACH

The GES activity will be managed in compliance with all measures and controls detailed within the EP accepted by NOPSEMA under the OPGGS (E) Regulations, other environmental legislation and Quadrant's Management System (e.g. Environmental Management Policy).

The objective of the EP is to ensure that potential adverse environmental impacts associated with unplanned events and planned events associated with the survey, are identified and assessed, and to stipulate mitigation measures to avoid and/or reduce any adverse impacts to the environment to ALARP.

The EP details specific performance objectives, standards and procedures, and identifies the range of controls to be implemented (consistent with the standards) to achieve the performance objectives. The EP also identifies the specific measurement criteria and records to be kept to demonstrate the achievement of each performance objective.

As described in the EP, the implementation strategy includes the relevant details of the following:

1. Environmental Management System;
2. Environmental management policy;
3. Leadership, Accountability and Responsibility;
4. Workforce training and competency;
5. Hazard Identification, Risk and Impact Assessment and Controls;
6. Environmental performance standards and outcomes;
7. Workforce involvement and stakeholder communications;
8. Information management and document control; and
9. Operations management.

During the period that activities described in the EP are undertaken, Quadrant will ensure environmental performance is managed through an inspection and monitoring regime undertaken by Quadrant representatives or delegates based on the vessels.

Environmental compliance of an activity with the EP (and the EPO's) is measured using planned and systematic audits or inspections to identify weaknesses and non-conformances in the system and processes so that they can be identified. Improvement opportunities identified through monitoring, audits and incident investigations are implemented in a controlled manner and communicated to all relevant workforce, contractors and relevant third parties. Audits and inspections are in place to identify possible incidents and actions taken to prevent them from happening.

Non-conformances found are addressed and resolved by a systematic corrective action process and are reported to NOPSEMA where relevant.

Senior Quadrant and vessel contractor personnel will be accountable for ensuring conformance with environmental performance outcomes and standards and all personnel will be empowered to 'stop-the-job' to ensure the activity is being implemented in an environmentally responsible manner. The EP identifies specific responsibilities for each role during the activity.

Incident notification and reporting to NOPSEMA and other regulators will be conducted as per the OPGGS(E)R, as detailed within the EP. Reported HSE incidents and hazards will be communicated to personnel during daily operational meetings.

7.1 Management of Change

Quadrant's Environmental Management of Change Procedure (EA-91-IQ-10001) (MOC) process provides a systematic approach to initiate, assess, document, approve, communicate and implement changes to EPs and OPEPs (currently in force) whilst meeting the requirements of the OPGGS (E) R.

The MoC process considers Regulation 7, 8 and 17 of the OPGGS(E) Regulations, and determines if a proposed change can proceed and the manner in which it can proceed, or if a revision of the EP and OPEP needs to besubmitted to NOPSEMA for a determinationon whether it can proceed. For a change to proceed, the associated environmental impacts and risks must be demonstrated to be acceptable and as ALARP. Additional stakeholder consultation may be required depending on the nature and scale of the change.

Accepted MoCs become part of the in force EP or OPEP, will be tracked on a register and made available on Quadrant's intranet. Where appropriate, Quadrant's environmental complianceregister will be updated to ensure control measure or environmental performance standard changes are communicated to the workforce and implemented.

8. HYDROCARBON SPILL RESPONSE ARRANGEMENTS

In the event of a hydrocarbon spill, oil spill response strategies will be implemented where possible to reduce environmental impacts. The selection of strategies will be undertaken through the Net Environmental Benefit Analysis (NEBA) process, outlined in the OPEP.

The following response strategies may be applicable to the identified credible spill scenarios:

- Operational Monitoring, including:
  - Vessel surveillance;
  - Aerial surveillance;
  - Tracking buoys;
  - Satellite imagery;
  - Oil characterisation;
  - Operational water quality monitoring; and
  - Spill fate modelling.
- Source Control activities
- Mechanical Dispersant plan; and
- Wildlife response operations including hazing and capture and rehabilitation.

8.1 Preparedness and Implementation of Response Arrangements

Project and support vessels are required to have and implement incident response plans, such as an emergency response plan and SMPEP/ SOPEP. Regular incident response drills and exercises (e.g. as defined in emergency response plan, SMPEP/ SOPEP etc.) will be carried out on installation vessels and support vessels to refresh the crew in using equipment and implementing incident response procedures.

Quadrant will implement the GES Installation and Commissioning Oil Pollution Emergency Plan (GE-35-RI-10003) in the event of a significant hydrocarbon spill (Tier 2 or 3). To maintain a state of oil spill preparedness, personnel with OPEP responsibilities will be made aware of their obligations, oil spill response equipment will be maintained, contracts with critical equipment and personnel suppliers will be managed, and agreements will be in place with national regulatory agencies for support in oil spill response. Quadrant will also implement its oil spill response exercise and training schedule. Further information on oil spill response is provided in the OPEP.

A communications test for the activity is completed prior to commencement of the installation.

8.2 Net Environmental Analysis Benefits (NEBA)

During any response incident, there is a documented decision making process to ensure that response strategies are identified and evaluated prior to implementation via the Incident Action Plan (IAP). The Incident Control Team use a Net Environmental Benefit Analysis (NEBA) process to inform the development and refinement of the IAPs, to ensure the most effective response strategies with the least detrimental environmental impacts are identified, documented and executed. The Environmental Team Lead is responsible for reviewing the priority receptors identified within the EP and the OPEP, and with real time knowledge of the fate and transport of the spill, apply the NEBA.

The application of the NEBA is to:

- Identify sensitivities within the area potentially affected by a spill at that time of the year;
- Assist in prioritising and allocating resources to sensitivities with a higher ranking; and
- Assist in determining appropriate response strategies.

8.3 Oil Spill Response Resources

Oil spill response equipment and resources are a combination of Quadrant, AMOSC (Australian Marine Oil Spill Centre Pty Ltd), AMSA, DoT, National Plan (NatPlan), OSRL (Oil Spill Response Limited), and other operator resources available through the AMOSPlan mutual aid arrangements. Under the Memorandum of Understanding (MOU) between AMSA and Quadrant, AMSA will provide all resources available through NatPlan to support a Quadrant spill response.

In the event of an oiled wildlife response, Quadrant will activate the West Australian Oiled Wildlife Response Plan (WAOWRP) and work with DPaW in determining resources and capability requirements. DPaW and Industry (AMOSC) Oiled Wildlife Advisors (OWAs) ensure minimum standards for oiled wildlife response, as outlined within the WAOWRP, are met and ensure timely mobilisation of appropriate resources (equipment and personnel) through communication with the wildlife logistics team. Quadrant are able to access:

- AMOSC core group responders;
- DPaW staff and approved volunteers/subject matter experts;
- Additional local resources under current contracts and suppliers; and
- Access international support through Wildlife Response Services.

During and post-spill scientific response monitoring activities require resources external to Quadrant and include specialist technical capabilities. If additional support is required, Quadrant has Master Service Agreements with other service providers to support scientific response monitoring activities.

9. CONTACT DETAILS

Further information about the GES installation activity can be obtained from:

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