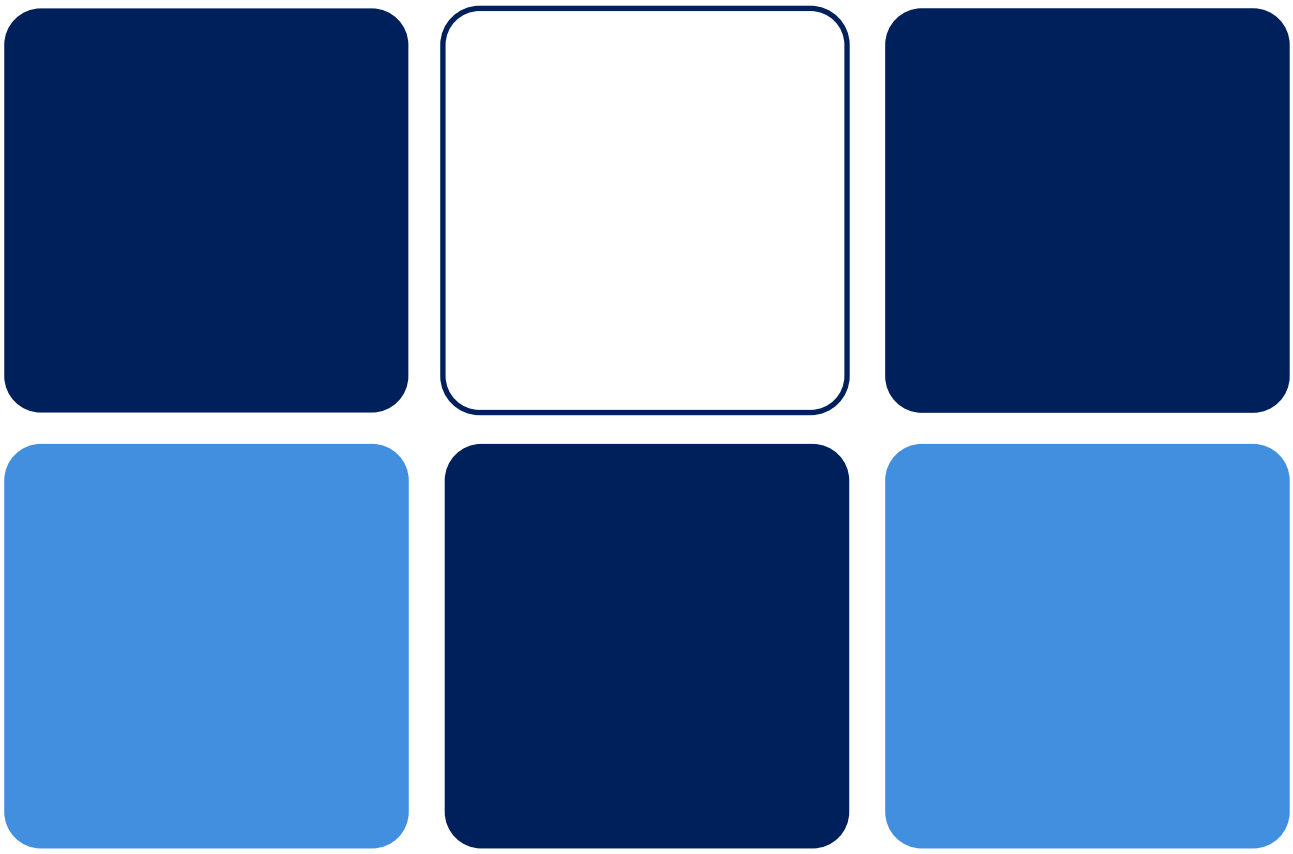
# ENVIRONMENT PLAN SUMMARY
## *Davros Extension Multi-client 3D Marine Seismic Survey*

*Prepared for* ***CGG Services (Australia) Pty Ltd***

**12 MARCH 2018**



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|---|---|---|
| J. Fitzpatrick | | 12/03/2018 |

## CGG Services (Australia) Pty Ltd Approval for Issue of Final Report

| Name | Approval | Date |
|---|---|---|
| M. Stanley | Yes | 12/03/2018 |

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# Appendices

# 1.0 Introduction

## 1.1 Background

Geophysical company CGG Services (Australia) Pty Ltd (CGG) proposes to acquire a multi-client, three-dimensional (MC3D) marine seismic survey (MSS) on the North West Shelf (NWS) offshore of Western Australia (WA) (Figure 1-1). The Davros Extension MC3D MSS (the "activity") is located entirely within offshore Commonwealth waters, and will comprise acquisition of approximately 8,072 $km^2$ of 3D seismic data across 9 exploration permits, 21 production licences, 2 retention leases, and adjacent open acreage areas (Figure 1-1). The permit areas in which the activity is planned to occur lie within Commonwealth waters, and exploration activities in these waters are subject to the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (OPGGS Act) and the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS(E) Regulations).

## 1.2 Titleholder details

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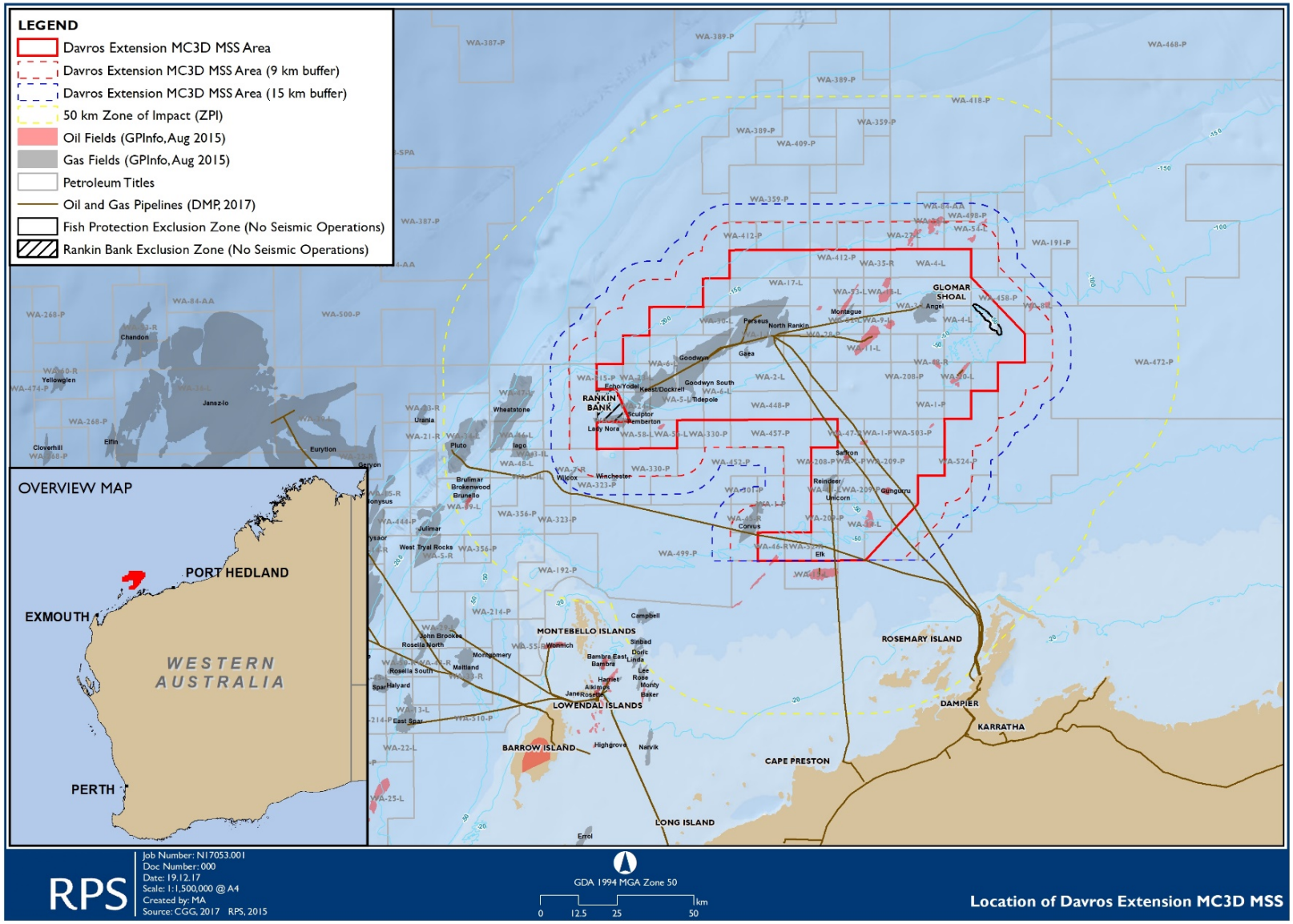



**Figure 1-1: Location of the Davros Extension MC3D MSS Area**

# 2.0 Description of the Activity

## 2.1 Location of the Activity

The Davros Extension MC3D MSS comprises a survey acquisition area of approximately 8,072km$^2$ (Figure 1-1). The Davros Extension MC3D MSS includes two operational area buffers around the survey acquisition area (Figure 1-1). The smaller operational buffer area of 9 km is for sail line run-ins and run-outs (required to obtain full fold coverage), soft-start procedures, streamer deployment / retrieval and maintenance, and the larger operational buffer of 15 km is for seismic vessel manoeuvring (line turns). The spatial extent of the largest operational area (15 km) is 15,289 km$^2$ and is located entirely within offshore Commonwealth waters within the North-west Marine Region (NWMR). The Davros Extension MC3D MSS and 15 km buffer area includes 21 exploration permits, 26 production licences, 5 retention leases, and adjacent open acreage areas (Figure 1-1).

The Davros Extension MC3D survey area is located approximately 54 km north of Dampier and approximately 180 km north-west of Port Hedland, at its closest points to the mainland (Figure 1-1). Rosemary Island in the Dampier Archipelago is approximately 29 km to the south-east of the survey area. The south-west corner of the survey area is approximately 55 km north-east of Trimouille Island (in the Montebello Islands group) and approximately 80 km north-east of Barrow Island. The Dampier Commonwealth Marine Reserve is approximately 36 km to the south-east of the survey area. The survey area is the area within which data will be acquired.

## 2.2 Timing of the Activity

The duration of the activity is a maximum of 150 days, and will be conducted between the beginning of November 2018 and end of June 2020, with avoidance of the period from beginning of July to end of September, in both years. Seismic operations will also be excluded in the area designated as 'habitat critical to the survival' of flatback turtles (Figure D-2) during the peak nesting period for flatbacks (November to January). The 150 day estimate is conservative and allows for some downtime due to weather, avoiding conflicts with other users and marine megafauna, and maintenance.

The timing of the activity is subject to availability of the survey vessel for conducting the survey, client data requirements, sea state conditions suitable for marine seismic acquisition, and granting of the required regulatory approvals and access authorities. The start and completion dates will be set according to vessel availability, approvals, access authorities and favourable weather forecasts.

Seismic data will be acquired over a 24-hour period, with shut downs for routine and reactive maintenance, repairs, transit and line turns, fauna and stakeholder avoidance, weather and other factors.

## 2.3 Seismic Survey Program

The technical methods and procedures of the proposed marine seismic survey are typical of 3D seismic surveys that have been conducted in Australian marine waters. No unique or unusual equipment or operations are proposed. CGG intends to use a 4,500 in$^3$ seismic array for deeper parts of the survey area, but will use a smaller array of 1,800 in$^3$ in water depths <50 m, in recognition of sensitive receptors in close vicinity to the survey area, particularly Glomar Shoal. There will be no seismic operations at all (i.e. including soft-starts) within the Rankin Bank Exclusion Zone.

CGG proposes to conduct the activity using a purpose-built seismic survey vessel. The vessel will be required to operate in accordance with CGG's Environmental Policy and this EP and will have an approved and tested Shipboard Oil Pollution Emergency Plan (SOPEP). The vessel will also be required to have all necessary certification/registration and be fully compliant with all relevant MARPOL and SOLAS convention requirements for a vessel of this size and purpose. CGG will conduct an audit prior to contracting the vessel to ensure it meets with CGG's commitments and requirements described within this EP. Seismic survey

vessel speeds will not vary across different vessels, and the expected average speed within the survey area will be 8 to 9 km/hr (approximately 4.5 knots).

One or more support vessels will accompany the seismic survey vessel to maintain a safe distance between the survey array and other vessels, to manage interactions with other vessels and fishing activity interactions, and to assist with streamer recovery if required. It is likely that the seismic survey vessel will be refuelled within the survey area from a support vessel. At sea refuelling will only take place during daylight hours and will be subject to strict control measures (procedures and equipment).

The Davros Extension MC3D MSS acquisition parameters are provided in Table 2-1.

**Table 2-1: Davros Extension MC3D MSS Acquisition Parameters**

| Survey Parameter | | Description |
|---|---|---|
| General Parameters | Survey area | 8,072 $km^2$ |
| | Range of survey water depths in survey area | 35 m to 271 m below lowest astronomical tide (LAT) |
| | Planned survey commencement date | Between the beginning of November 2018 and end of June 2020, with avoidance of period from beginning of July to end of September in 2019 and 2020 |
| | Survey duration | Maximum 150 days |
| Seismic Airgun Array Parameters | Airgun array volume (maximum) | 4,500 cui across majority of survey area<br>1,800 cui in water depths <50 m around Glomar Shoal |
| | Operating pressure | 2,000 psi |
| | Source level – 4,500 cui array [2] | 244.4 dB re 1 µPa ($SPL_{peak}$)<br>219.4 dB re 1 $\mu Pa^2$.s (SEL) |
| | Source level – 1,800 cui array [2] | 240.0 dB re 1 µPa ($SPL_{peak}$)<br>215.0 dB re 1 $\mu Pa^2$.s (SEL) |
| | Frequency range | 0 to 200 Hz |
| | Source depth | 5 to 9 m (±1 m) |
| | Source (shot point) interval | 18.75 or 25.0 m |
| | Line spacing | 500 to 1,000 m |
| | Number of streamers | 8 to 14 |
| | Streamer length | 8,100 m |
| | Streamer spacing | 50 to 100 m |
| | Streamer depth | 8 m at head of streamers, 50 m at tail (except in shallow waters where the tail will be at least 10 m above the seabed) |
| | Streamer type | Solid |

Note 1: survey commencement date and acquisition window timing is subject to survey vessel availability, operational constraints and prevailing weather conditions.
Note 2: Source SPL and SEL measured values provided by CGG.

# 3.0 Description of the Environment

The spatial extent of the existing environment described within this section was selected to encompass the maximum extent of potential environmental impacts associated with the Davros Extension MC3D MSS. A diesel fuel spill was identified as having the largest zone of potential influence of all credible environmental risks and impacts. Therefore, the area over which potential effects from an oil spill could occur (the ZoI) encompasses the entire extent of all other potential impacts. The survey will occur between the beginning of November and end of June 2020, with avoidance of the period from beginning of July to end of September for a maximum of 150 days, and as such, the existing environment description focuses on environmental sensitivities throughout the year.

## 3.1 Marine Habitats and Communities

### 3.1.1 Regional Benthic Communities

The deeper areas of the region are dominated by soft sediment habitats. At the continental shelf margin and shelf edge (approximately 100 to 200 m water depth), benthic habitats are composed of muddy sand with gravel, rubble, cobbles, boulders and occasional rock outcrops. Aggregations of organisms associated with these habitats are generally infaunal, with mobile and sessile epibenthic fauna associated with burrows or coarser sediment components (i.e. shell, pebbles, cobbles, boulders and emergent bedrock). Epibenthic fauna commonly found at these depths includes echinoderms, crustaceans, and sponges, bryozoans and hydroids. In shallower waters (<100 m), photosynthetic macroalgae and encrusting algae may be present. Exposed rock or lumps of hard substrate often support isolated patches of filter-feeding organisms such as gorgonians, hydrozoans, sponges, ascidians, and soft corals.

On the inner shelf, in depths of 0 to 50 m, communities of seagrass and macroalgae are important sources of primary production. On the middle and outer shelf, below the photic zone and beyond the influence of terrestrial ecosystems, primary producers are largely absent, with benthic communities largely composed of secondary producers and their predators that rely on the delivery of organic material from the photic zone above (Wilson 2013).

### 3.1.2 Glomar Shoal and Rankin Bank

Rankin Bank is located in water depths of approximately 80 m, except for the north-eastern margin of the bank where it rises steeply from 120 m. The main body of the Rankin Bank takes the form of several highly complex and rugose peaks and plateaus, reaching 19 to 40 m below the sea surface. In comparison, Glomar Shoal is larger and rises on all sides from 80 m depth to a plateau region lying at its shallowest point approximately 22 m from the surface. Glomar Shoal is a Key Ecological Feature (KEF).

Overall Glomar Shoal is characterised by a high proportion of sand/silt (approximately 41%) and consolidated reef (approximately 44%). It is also characterised by a relatively low cover of epibenthic organisms (approximately 53%), which were dominated by algae (with only 4.5% represented by marine fauna). Hard coral cover was very low (<1%) when compared to other shoals in the region (> 10%). Due to the absence of coral reef (characterised as >10% coral cover) on Glomar Shoal, there is a low likelihood of the presence of site-attached fish.

Glomar Shoal and Rankin Bank are located in high-energy environments where localised upwelling has resulted in enhanced productivity, supporting significant populations of commercially and recreationally important fish species, including Rankin cod, brown-striped snapper, red emperor, crimson snapper, bream and yellow-spotted triggerfish.

Fish surveys over Glomar Shoal and Rankin Bank found these sites were similar in terms of patterns of total fish abundance and species richness. Both abundance and diversity increased with decreasing depth (<40 m), and with an increase in habitat rugosity (particularly in association with hard coral environments). Fish abundance was highest in the 20 to 30 m depth range and declined quickly from 30 m. The decline of fish

abundance in depths of >30 m was evident with declining levels of epibenthic cover (AIMS 2014). Fish abundance and species richness on Glomar Shoal was highest in the shallow and high rugosity reef ridge line running from the north-east through to the south-east of the site (AIMS 2014). On Rankin Bank the highest fish abundance and diversity were found in several sections of shallow water high relief reef area in the northern quadrant of the site and one high relief reef area in the south-western quadrant, both in <40 m water depth (AIMS 2014).

#### 3.1.2.1 Fish Spawning

The survey area does not include any critical spawning aggregation areas for any commercial species. The spread of fish spawning periods throughout the year (Table 3-1) indicates there are no periods of higher sensitivity with respect to fish spawning.

**Table 3-1: Commercial Fish Species Potentially Spawning in the Davros Extension MC3D Survey Area**

| Fishery | Key Target Species | Jan | Feb | Mar | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mackerel Managed Fishery | Spanish mackerel (*Scomberomorus commerson*)[1,2] | ■ | | | | | | | ■ | ■ | ■ | ■ | ■ |
| | Grey mackerel (*Scomberomorus semifasciatus*)[3] | ■ | | | | | | | | | ■ | ■ | ■ |
| North Coast Demersal Scalefish Managed Fishery - Pilbara Sector[a] | Red emperor (*Lutjanus sebae*)[1] | ■ | | ■ | | | | | | | ■ | | |
| | Goldband snapper (*Pristipomoides multidens*)[1,3] | ■ | ■ | ■ | ■ | | | | | | ■ | ■ | ■ |
| | Rankin cod (*Epinephelus multinotatus*)[1] | | | | | | | | ■ | ■ | ■ | | |
| | Bluespotted emperor (*Lethrinus punctulatus*)[4] | | | | ■ | ■ | ■ | | | | | ■ | ■ |
| | Saddletail snapper (*Lutjanus malabaricus*)[5] | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Crimson snapper (*Lutjanus erythropterus*)[4] | ■ | ■ | ■ | ■ | | | | | ■ | ■ | ■ | ■ |
| | Brownstripe snapper (*Lutjanus vitta*)[6] | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Rosy threadfin bream (*Nemipterus furcosus*)[7] | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Other[b] | Blacktip sharks (*Carcharhinus tilstoni* and *C. limbatus*)[1] | ■ | | | | | | | | | ■ | ■ | ■ |
| | Pink snapper (*Pagrus auratus*)[1] | | | | | ■ | ■ | ■ | | | | | |

aTarget species from the Pilbara Sector of the North Coast Demersal Scalefish Managed Fishery with an annual catch >75 t (Fletcher and Santoro 2014, 2015; Fletcher et al. 2017).
bAdditional fish species identified by DPIRD during consultation not targeted by either fishery likely to operate in the survey area.
Information sourced from: 1DoF 2013b; 2Mackie et al. 2003; 3Collette & Nauen 1983; 4Kailola et al. 1993; 5Allen 1985; 6Davis & West 1993; 7Russell 1990.

### 3.1.3 Protected Species

A search using the EPBC Act Protected Matters Search Tool (PMST) was conducted for the Davros Extension MC3D operational area. The species identified as “Threatened” or “Migratory” and their potential presence in the survey area are described in the following sections. Species-specific information was gathered using the DoEE Species Profiles and Threats (SPRAT) database and other peer reviewed scientific publications and recovery plans.

#### 3.1.3.1 Cetaceans

The NWMR supports internationally significant populations of numerous Threatened and Migratory cetaceans. A search of the EPBC Act PMST identified 26 cetacean species that may occur in the ZoI Davros

Extension MC3D survey area. Of these, the sei whale (*Balaenoptera borealis*), the blue whale (*Balaenoptera musculus*), the fin whale (*Balaenoptera physalus*) and the humpback whale (*Megaptera novaeangliae*) are listed as Threatened and Migratory. Six other cetacean species are listed as Migratory, and may be seasonally present in the area (Table 3-2).

**Table 3-2: EPBC Act Listed Marine Mammals Potentially Occurring in the Davros Extension MC3D Survey Area**

| Scientific Name | Common Name | EPBC Act Listing |
|---|---|---|
| *Megaptera novaeangliae* | Humpback whale | Vulnerable, Migratory |
| *Balaenoptera borealis* | Sei whale | Vulnerable, Migratory |
| *Balaenoptera musculus* | Blue whale | Endangered, Migratory |
| *Balaenoptera physalus* | Fin Whale | Vulnerable, Migratory |
| *Balaenoptera bonaerensis* | Antarctic minke whale | Migratory |
| *Balaenoptera edeni* | Bryde's whale | Migratory |
| *Orcinus orca* | Killer whale / orca | Migratory |
| *Physeter microcephalus* | Sperm whale | Migratory |
| *Sousa chinensis* | Indo-Pacific humpback dolphin | Migratory |
| *Tursiops aduncus* (Arafura/Timor Sea) | Indo-Pacific bottlenose dolphin / spotted bottlenose dolphin | Migratory |

#### 3.1.3.1.1 Humpback Whale

The southern part of the survey area lies within the mapped 'species core range', i.e. humpback whales travel through this area on a seasonal basis as part of their migratory movements (Figure B), although the migrating whales are largely confined to within 50 km of the coast (DotE 2015c). Peak northward migration across the North West Shelf is identified as from late July to early August, and peak southward migration from late August to early September (DotE 2015c). Although there is no real recognised southbound peak migration period, Jenner et al. (2001) used data from 1990 to 1994 to estimate the peak period off Dampier as the period between the last week of August and the first week of September, when animals were likely to pass to the north of the Montebello Islands. There is potential for encounters with humpback whales within or in the vicinity of the survey area; however this is limited given the survey area does not overlap any confined migratory pathway, or any known feeding, calving or resting areas.

Humpback whales are most likely to be present in the survey area during the northbound migration which peaks at the Dampier Archipelago in late July to early August (Jenner et al. 2001, RPS 2010b). Northbound migrating whales generally remain within the 200 m bathymetric contour, with individuals moving into more coastal waters through certain areas such as Exmouth and the Kimberley coast. During the southbound migration, most whales travel closer to the coast, believed to be due to the high proportion of females with calves (Double et al. 2010) (Figure B) and are less likely to travel through the survey area. The southbound migration peaks in late August and early September from Broome to Camden Sound and mid-September in the Exmouth Gulf (Table 3-3).

The Conservation Advice for the humpback whale (DotE 2015c) and a search of the EPBC Act database identified humpback whales (classified as Vulnerable and Migratory species), may transit the waters of the proposed survey area. The NCVA (DoEE, 2017) indicates that there is a migratory BIA and no known feeding, breeding or resting BIA within the proposed survey area.

**Table 3-3: Critical Periods for Migrating Humpback Whales in the Vicinity of the Davros Extension MC3D Survey Area (Jenner et al. 2001)**

| | | Jul | | | Aug | | | Sep | | |
|---|---|---|---|---|---|---|---|---|---|---|
| North West Cape to Port Hedland | Northbound migration peak | | | | | | | | | |
| | Southbound migration peak | | | | | | | | | |

#### 3.1.3.1.2 Sei Whale

The Conservation Advice for the sei whale (DotE 2015a) and a search of the EPBC Act database identified sei whales (classified as Vulnerable and Migratory species), may transit the waters of the proposed survey area. However, the NCVA (DoEE, 2017) indicates that there are no known BIA (feeding, breeding or resting areas) within the proposed survey area.

It is considered unlikely that sei whales would occur in the vicinity of the operational area. No known migration, aggregation or breeding areas are located within the vicinity of the operational area.

#### 3.1.3.1.3 Fin Whale

The Conservation Advice for the fin whale (DoTE 2015b) and a search of the EPBC Act database identified fin whales (classified as Vulnerable and Migratory species), may transit the waters of the proposed survey area. However, the NCVA (DoEE, 2017) indicates that there are no known BIA (feeding, breeding or resting areas) within the proposed survey area.

It is considered unlikely that fin whales would occur in the vicinity of the operational area. No known migration, aggregation or breeding areas are located within the vicinity of the operational area (DoEE 2017b).

#### 3.1.3.1.4 Pygmy Blue Whale

During their northern migration, tagged whales have been recorded between 40 and 100 km from the coastline in March and April. From North West Cape, tagged individuals continued to travel northwards and further offshore (238.0 ±13.9 km) in May towards the Savu and Timor seas (Double et al. 2014).

The southern migration down the Western Australian coast occurs between September and late December (McCauley and Jenner 2010, Double et al. 2014). Individuals have been recorded passing along the shelf edge at depths of 500 to 1,000 m, moving faster on the southern migration to reach feeding grounds and coming in close to the coast in the Exmouth to the Montebello Islands area (McCauley and Jenner 2010).

The Conservation Management Plan for the Blue Whale (2015 - 2025) (Commonwealth of Australia 2015) identifies two BIAs within or in the vicinity of the survey area. The survey area is outside of the BIA for migrating pygmy blue whales (Figure B), however the whole of the survey area lies within an area where pygmy blue whales are known to be present (Commonwealth of Australia 2015).

No known feeding aggregation or breeding areas are located within the vicinity of the survey area. Therefore, this species is unlikely to be encountered during the survey.

#### 3.1.3.1.5 Antarctic Minke Whale

The distribution of Antarctic minke whales (*Balaenoptera bonaerensis*) along the west coast of Australia is currently unknown, however, it is likely that they do not migrate as far north as dwarf minke whales (to 11°S) (DoEE 2017d). The southern distribution of Antarctic minke whales extends down to approximately 65°S in the Australian Antarctic Territory (DoEE 2017d). It is possible that Antarctic minke whales may transit through the survey area, however no BIAs have been identified in the region and it is not likely that the area is used for feeding, breeding or resting.

#### 3.1.3.1.6 Bryde's Whale

No specific feeding or breeding grounds, or migration patterns of Bryde's whales (*Balaenoptera edeni*) have been documented in Australian waters (DoEE 2017e). The nearest known area of aggregation for this species is near Ningaloo Reef. It is unlikely that Bryde's whales will be encountered in the survey area.

#### 3.1.3.1.7 Killer Whale

There are no breeding grounds or important foraging areas for the killer whale (*Orcinus orca*) within the vicinity of the survey area. Killer whales may occasionally transit through the survey area, however, significant numbers are not expected, as there are no known feeding, breeding or resting areas present.

#### 3.1.3.1.8 Sperm Whale

There is little information regarding important areas for sperm whales (*Physeter macrocephalus*) off the coast of northern Western Australia and no BIAs have been identified in the vicinity of the survey area. It is possible that this species will occasionally transit through the survey area.

#### 3.1.3.1.9 Indo-Pacific Humpback Dolphin

Indo-Pacific humpback dolphins (*Sousa chinensis*) are known to occur along the northern coastline of Australia, extending to Exmouth Gulf on the west coast, and the Queensland/ NSW border region on the east coast (DSEWPaC 2012a). There is no BIA for Australian humpback dolphins in or around the operational area.

#### 3.1.3.1.10 Indo-Pacific Bottlenose Dolphin

The Indo-Pacific bottlenose dolphin (*Tursiops aduncus*) is generally considered to be a warm water subspecies of the spotted bottlenose dolphin, occurring in shallow (often <10 m deep) inshore waters (DSEWPaC 2012a). The known distribution of the Indo-Pacific bottlenose dolphin extends from Shark Bay north to the western edge of the Gulf of Carpentaria in Australia (Commonwealth of Australia 2012a). There is no BIA for Indo-Pacific bottlenose dolphins in or around the operational area.

### 3.1.3.2 Fish, Sharks and Rays

A search of the EPBC Act PMST indicated that 27 listed teleost fish might occur within the vicinity of the Davros Extension MC3D survey area. All of these species are from two families, Syngnathidae (seahorses, seadragons and true pipefishes) and Solenostomidae (false pipefishes, ghost pipefishes and tubemouth fishes), none of which are listed as Threatened. Species within these two families generally inhabit nearshore shallow reef environments (Foster and Vincent 2004) and are likely to be distributed widely throughout shallow parts of the NWMR.

The EPBC Act PMST identified nine species of shark and rays as Threatened or Migratory that may occur in the vicinity of the Davros Extension MC3D survey area (Table 3-4).

**Table 3-4: Sharks and Rays Listed Under the EPBC Act as Potentially Occurring in the Davros Extension MC3D Survey Area**

| Scientific Name | Common Name | EPBC Act Status |
|---|---|---|
| *Rhincodon typus* | Whale shark | Vulnerable, Migratory |
| *Carcharias taurus* | Grey nurse shark | Vulnerable |
| *Carcharodon carcharias* | Great white shark | Vulnerable, Migratory |
| *Isurus oxyrinchus* | Shortfin mako | Migratory |
| *Isurus paucus* | Longfin mako | Migratory |

| Scientific Name | Common Name | EPBC Act Status |
|---|---|---|
| *Manta birostris* | Giant manta ray | Migratory |
| *Anoxypristis cuspidata* | Narrow sawfish | Migratory |
| *Pristis clavata* | Dwarf Sawfish | Vulnerable, Migratory |
| *Pristis zijsron* | Green Sawfish | Vulnerable, Migratory |

#### 3.1.3.2.1 Whale Shark

The survey area lies within the whale shark (*Rhincodon typus*) foraging ground BIA that has been identified along the north-west coast of Western Australia (from Exmouth to Cape Talbot) (Figure C) where whale sharks are likely to be present between July and November (DoEE 2017). Outside of the aggregation periods, whale sharks are generally solitary and only low numbers are expected to be encountered in the survey area during July to November.

#### 3.1.3.2.2 Great White Shark

No BIAs have been identified for the great white shark (*Carcharodon carcharias*) in the vicinity of the survey area. No key threats are identified relevant to the proposed activity. Given the survey area is at the northern limit of the known distribution of this species in Western Australia (DSEWPaC 2013a), they are likely to be rare visitors to the survey area.

#### 3.1.3.2.3 Grey Nurse Shark

No BIAs have been identified for grey nurse shark (*Carcharias taurus*) in the vicinity of the survey area. This species may occasionally transit through the Davros Extension MC3D survey area and surrounding waters, however the area is unlikely to contain any critical habitats. The key threat identified relevant to the proposed activity is pollution. Given the survey area is not in the vicinity of any known aggregation sites in Western Australia (DSEWPaC 2013a), it is considered unlikely that grey nurse sharks would occur in the vicinity of the survey area.

#### 3.1.3.2.4 Mako Sharks

The shortfin mako (*Isurus oxyrinchus*) and longfin mako (*Isurus paucus*) may occasionally transit the survey area; however, the area is unlikely to contain any critical habitats for these species.

#### 3.1.3.2.5 Giant Manta Ray

No BIAs for the giant manta ray (*Manta birostris*) have been identified within the vicinity of the survey area. However, it is possible that manta rays may be encountered occasionally in the survey area.

#### 3.1.3.2.6 Narrow Sawfish

No recovery Plan or Conservation Advice exists for narrow swordfish (*Anoxypristis cuspidata*) and BIAs have not been defined.

Narrow sawfish are known to occur within the vicinity of the survey area, however the species is unlikely to be encountered within the survey area based on habitat preference.

#### 3.1.3.2.7 Dwarf Sawfish

The nearest dwarf sawfish (*Pristis clavata*) BIAs are located approximately 310 km east of the survey area and comprise a pupping, nursing and foraging ground located along 80 mile beach, which is restricted to within 25 km from shore but runs for around 250 km.

Dwarf sawfish are known to occur in shallow inshore waters within the ZPI. The survey area is located a considerable distance from any critical habitats identified for green sawfish and the available evidence

suggests that the species is unlikely to occur within the survey area, with the possible exception of mature individuals transiting through the survey area.

#### 3.1.3.2.8 Green Sawfish

The nearest green sawfish (*Pristis zijsron*) BIAs are located approximately 300 km east of the survey area and comprise a pupping, nursing and foraging ground that runs east from Cape Keraudren along 80 mile beach for around 250 km but is restricted to within 25 km from shore.

Green sawfish are known to occur in shallow inshore waters within the ZPI. The survey area is located a considerable distance from any critical habitats identified for green sawfish and the available evidence suggests that the species is unlikely to occur within the survey area, with the possible exception of mature individuals transiting through the survey area.

### 3.1.3.3 Marine Reptiles

The EBPC PMST identified one Threatened sea snake species and five Threatened and Migratory marine turtle species listed under the EPBC Act as potentially occurring in the survey area (Table 3-5).

**Table 3-5: EPBC Act Listed Marine Reptiles Potentially Occurring in the Davros Extension MC3D Survey Area**

| Scientific Name | Common Name | EPBC Act Status |
|---|---|---|
| **Sea Snakes** | | |
| *Aipysurus apraefrontalis* | *Aipysurus apraefrontalis* | *Aipysurus apraefrontalis* |
| **Marine Turtles** | | |
| *Caretta caretta* | Loggerhead turtle | Endangered, Migratory |
| *Chelonia mydas* | Green turtle | Vulnerable, Migratory |
| *Dermochelys coriacea* | Leatherback turtle | Endangered, Migratory |
| *Eretmochelys imbricata* | Hawksbill turtle | Vulnerable, Migratory |
| *Natator depressus* | Flatback turtle | Vulnerable, Migratory |

#### 3.1.3.3.1 Sea Snakes

Short-nosed sea snakes (*Aipysurus apraefrontalis*) are not known to occur at Glomar Shoals and are unlikely to be present in the deeper parts of the survey area.

#### 3.1.3.3.2 Marine Turtles

The five Threatened and Migratory marine turtle species identified as potentially occurring in the survey area are managed in Australian waters under the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017). The recovery plan includes 22 turtle species genetic stocks that nest or forage in Australian waters. Seven of which have a dispersal range that includes the survey area (i.e. the Western Australian loggerhead turtle stock, Western Australian and Scott Browse green turtle stocks, leatherback turtle stock, Pilbara and south-west Kimberley flatback turtle stocks, and the Western Australian hawksbill turtle stock) as adult turtles show strong fidelity to both feeding and breeding grounds, and migrate long distances (up to thousands of kilometres) to return to the region where they hatched. The timing and location of breeding events for the marine turtle stocks with breeding aggregations in the vicinity of the ZPI are shown in Table 3-6 (Commonwealth of Australia 2017).

The recovery plan includes information on “habitat critical to the survival of species” identified by experts in marine turtle biology, and also recognises the foraging, nesting and interesting BIAs identified as part of the Commonwealth Bioregional Planning Process. Both are shown in Figures D-1 and D-2.

Inter-nesting habitat critical to survival is identified within the ZPI for flatback, green and hawksbill turtles based on rookeries at the Dampier Archipelago to the south-east of the survey area and the Montebello Islands to the south-west of the survey area. However, habitat designated as critical for survival only overlaps the survey area for flatback turtles.

No foraging BIAs occur within the ZPI, the nearest are green turtle foraging BIAs located inshore of Barrow Island (approximately 70 km south of the survey area) and in the De Grey River to Bedout Island area (over 200 km east of the survey area).

In summary, the waters of northern Western Australia support important nesting, inter-nesting and foraging areas for green, hawksbill, loggerhead and flatback turtles. Leatherback turtles forage in Western Australian waters but are not known to breed in the region. Turtle nesting periods vary between species (Table 3-6) and both habitat critical to survival and BIAs have been identified for inter-nesting turtles travelling around important nesting sites within Western Australia (Commonwealth of Australia 2017). No nesting beaches occur in the survey area and only the inter-nesting BIA for flatback turtles overlaps the survey area (Figure D-2). Post-nesting marine turtles travel greater distances and individuals may visit the survey area between breeding events.

**Table 3-6: Critical Periods for Marine Turtle Stocks in Waters of the North West Shelf (Source: Commonwealth of Australia 2017)**

| | Stock | Event | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | June | July |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Loggerhead turtle | Western Australia | Mating[1] | | | | | | | | | | | | |
| | | Nesting | | | | | | | | | | | | |
| | | Hatching | | | | | | | | | | | | |
| Green turtle | North West Shelf | Mating | | | | | | | | | | | | |
| | | Nesting | | | | | | | | | | | | |
| | | Hatching | | | | | | | | | | | | |
| Hawksbill turtle | Western Australia | Mating | | | | | | | | | | | | |
| | | Nesting | | | | | | | | | | | | |
| | | Hatching | | | | | | | | | | | | |
| Flatback turtle | Pilbara | Mating | | | | | | | | | | | | |
| | | Nesting | | | | | | | | | | | | |
| | | Hatching | | | | | | | | | | | | |

*Dark grey = peak of activity, light grey = lower activity level confirmed, white = low activity possible, but unconfirmed.
[1]Mating period for Western Australian loggerhead turtle stock is unknown. Period shown is for the loggerhead turtle stock found on the east coast of Australia (i.e. south-west Pacific loggerhead turtles).

### *Loggerhead Turtle*

The inter-nesting habitat critical for survival and inter-nesting BIA for loggerhead turtles (*Caretta caretta*) are shown in Figure D-1 and do not overlap the Davros Extension MC3D survey area. Although it is therefore unlikely that loggerhead turtles will be encountered during the survey, individuals may occasionally transit through the survey area.

### *Green Turtle*

The inter-nesting habitat critical for survival and inter-nesting BIA for green turtles (*Chelonia mydas*) is shown in Figure D-1 and does not overlap the Davros Extension MC3D survey area. Although it is unlikely that inter-nesting green turtles will be encountered during the survey, individuals may occasionally transit through the survey area.

*Leatherback Turtle*

No areas of habitat critical to the survival of the leatherback turtle (*Dermochelys coriacea*) have been identified and no BIAs have been identified within Western Australia. While leatherback turtles may occasionally transit through the Davros Extension MC3D survey area, the absence of important areas for feeding and nesting indicates that it is unlikely leatherback turtles will be present in significant numbers.

*Hawksbill Turtle*

The inter-nesting habitat critical for survival and BIA for the hawksbill turtle (*Eretmochelys imbricata*) are shown in Figure D-1 and does not overlap the Davros Extension MC3D survey area. Although it is therefore unlikely that hawksbill turtles will be encountered during the survey, individuals may occasionally transit through the survey area.

*Flatback Turtle*

The inter-nesting habitat critical for survival and the inter-nesting BIA for flatback turtles (*Natator depressus*) is shown in Figure D-2 and overlaps the southern portion of the Davros Extension MC3D survey area. The 60 km inter-nesting buffer for flatback turtles in the Commonwealth of Australia (2017) Recovery Plan is primarily based on the movements of tagged inter-nesting flatback turtles along the North West Shelf reported by Whittock et al. (2014), which found that flatback turtles may demonstrate inter-nesting displacement distances up to 62 km from nesting beaches. However, these movements were confined to longshore movements in nearshore coastal waters or travel between island rookeries and the adjacent mainland (Whittock et al. 2014). There is no evidence to date to indicate flatback turtles swim out into deep offshore waters during the inter-nesting period.

A recent paper by the same authors (Whittock et al. 2016) has more precisely defined flatback turtle interesting habitat along the North West Shelf. The Whittock et al. 2016 study developed a habitat suitability map to identify areas where inter-nesting flatback turtles may be present along the North West Shelf based data compiled for a suite of environmental variables and satellite tracks of 47 inter-nesting flatback turtles from five different mainland and island rookeries tracked over 1289 tracking days. Whittock et al. (2016) defined suitable inter-nesting habitat as water 0–16 m deep and within 5–10 km of the coastline while unsuitable inter-nesting flatback habitat was defined as water >25 m deep and >27 km from the coastline. The area within the 60 km inter-nesting flatback BIA and habitat critical for survival buffers deemed unsuitable for inter-nesting flatback turtles based on the latest available evidence from Whittock et al. (2016) is demarcated in Figure D-2. The nearest area of habitat suitable for inter-nesting flatback turtles is shown to occur approximately 23 km south-east the survey area and approximately 18 km south of the operational area (Figure D-2).

Inter-nesting flatback turtles occur within the ZPI from October and March are not likely to be present in the survey area. Pre- and post-nesting flatbacks and other marine turtle species may be encountered transiting through the survey area. However, as the survey area is not part of any known migration route the number of individuals transiting through the area is likely to be limited.

#### 3.1.3.4 Seabirds and Migratory Shorebirds

A search of the EPBC PMST did not identify any Threatened or Migratory species in the vicinity of the Davros Extension MC3D operational area. One “listed” species, the eastern osprey (*Pandion cristatus*), was identified from the PMST report as potentially occurring, however, this species is found in littoral and coastal habitats and on offshore islands and is unlikely to be present in the operational area due to the absence of emergent features.

The EPBC Act PMST did not list the wedge-tailed shearwater (*Puffinus pacificus*) as potentially present; however, this species has a foraging BIA that overlaps a portion of the survey area (Figure E). It is likely to be encountered occasionally in the survey area.

Three species of tern have breeding and foraging BIAs around coastal islands of the NWS, however these are all distant to the survey area (Figure E). All of these species are highly mobile and likely to forage widely over the waters surrounding emergent roosting and nesting sites. However, as there are no emergent features within or in the near vicinity of the survey area (the closest being >30 km to the south), it is likely that these seabirds will only be encountered occasionally in the survey area.

A search of the EPBC PMST identified ten Threatened or Migratory seabird species and 29 Threatened or Migratory shorebird species that may potentially occur in the Zone of Potential Influence (ZPI) in the event of an accidental oil spill. The seabird species identified by the EPBC PMST search include the common noddy, fork-tailed swift, two shearwaters, two frigatebirds, three terns and the southern giant petrel. These seabirds are all highly mobile and likely to forage widely over the waters surrounding emergent roosting and nesting sites. However, as the operational area is more than 20 km offshore from the nearest emergent feature it is likely that these seabirds will only be encountered occasionally in the survey area. There are no BIAs (breeding or foraging) that intersect the operational area for any of these species identified in the oil spill ZPI.

### 3.1.4 Marine Protected Areas

#### 3.1.4.1 World Heritage and Ramsar Sites

There are no listed World Heritage Properties or Ramsar Wetlands of International Importance within or in the vicinity of the Davros Extension MC3D survey area. The nearest World Heritage Property to the survey area is the Ningaloo Coast World Heritage Property, which is located approximately 365 km to the south-west of the survey area. The closest Ramsar wetland to the survey area is Eighty Mile Beach, which is located approximately 310 km to the east of the survey area. These marine protected areas are outside the ZPI for the survey.

#### 3.1.4.2 Marine Parks (Commonwealth Marine Reserves)

Between 21 July and 20 September 2017, the Director of National Parks (DNP) commissioned the independent review of the Commonwealth Marine Reserves that were established in November 2012, i.e. those reserves in the South-west, North-west, North, Temperate East and Coral Sea marine regions. As a result of this consultation, a proclamation was formally made to change the name of 58 marine reserves to 'Marine Parks'.

##### 3.1.4.2.1 Montebello Marine Park

The Davros Extension MC3D survey overlaps the Montebello Marine Park, which is zoned as a Multiple Use Zone - IUCN Category VI. The total area of the Montebello Marine Park is 3,413 km$^2$ (Figure A) and the conservation values (DoEE 2017) include: foraging areas adjacent to important breeding areas for migratory seabirds; foraging areas for vulnerable and migratory whale sharks; foraging areas adjacent to important nesting sites for marine turtles; migratory pathway of the protected humpback whale; shallow shelf environments with depths ranging from 15 to 150 m and provides protection for shelf and slope habitats, as well as pinnacle and terrace seafloor features; examples of the 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: ancient coastline (a unique seafloor feature that provides areas of enhanced biological productivity) is represented in this reserve.

##### 3.1.4.2.2 Dampier Marine Park

The Dampier Marine Park is located approximately 27 km south-east of the Davros Extension MC3D survey area but falls within the ZPI. The Dampier Marine Park is zoned as both a Marine National Park IUCN Category II (150 km$^2$ area) and Habitat Protection Zone – IUCN Category IV (1,102 km$^2$) (Figure A). The total area of the Dampier CMR is 1,252 km$^2$ and the conservation values (DoEE 2017) include: foraging areas adjacent to important breeding areas for migratory seabirds; foraging areas adjacent to important nesting sites for marine turtles; migratory pathways of the protected humpback whale; protection for offshore shelf

habitats adjacent to the Dampier Archipelago; high-level protection for the shallow shelf with depths from 15 to 70 m; examples of the communities and sea floor habitats of the Pilbara (nearshore) and Pilbara (offshore) meso-scale bioregions.

#### 3.1.4.2.3 Marine Park Management Plans and Principles

The Montebello and Dampier Marine Parks are both managed under North-west Commonwealth Marine Reserves Network Management Plan 2014-24 (Director of National Parks 2013). The DNP has drafted a new management plan for the North-west Marine Region, the Draft North-west Commonwealth Marine Reserves Network Management Plan (Director of National Parks 2017), which is currently out for public consultation. This draft management plan is likely to be finalised and enter into effect during the lifetime of this EP. However, until the new management plans come into effect, there will be no changes to the transitional management arrangements under the North-west Commonwealth Marine Reserves Network Management Plan 2014-24.

There are no changes proposed to the previously planned zoning for the Montebello Marine Park under the Director of National Parks (2017) Draft North-west Commonwealth Marine Reserves Network Management Plan. However, the Dampier Marine Park is proposed to be re-zoned to include a western 105 $km^2$ km Habitat Protection Zone (IV), central 73 $km^2$ National Park Zone (IUCN II) and eastern 1,074 $km^2$ Multiple Use Zone (IUCN VI). Titleholders are expected to ensure that their activities are also consistent with the Australian IUCN reserve management principles for the IUCN category to which the reserve or reserve zone was assigned (NOPSEMA 2015).

The Montebello and Dampier Marine Parks are considered “Type B” reserves under the NOPSEMA (2015) Guidance Note for Activities within Commonwealth Marine Reserves, and are therefore subject to the following considerations:

- EPs that involve planned or emergency response activities within, or with potential to impact on the Marine Park/CMR should have regard to the Australian IUCN reserve management principles relevant to each zone within the Marine Park/CMR.
- Consideration should be made to the activity impacts and risks in the context of the representative values of the reserve and information contained in relevant marine bioregional plans, conservation advice(s) and other relevant documentation on the DoE website.
- Only emergency response activities inside the Marine Parks/CMRs are approved if carried out in accordance with the s359B approval (for emergency response) issued for the Northwest, Southwest and Temperate East Marine Park/CMRs.
- Titleholders should note the approval requires observing any requirements advised by DNP about minimising potential impacts of emergency response activities on Marine Park/CMR values.
- Ensure that the EP for the activity demonstrates that the environmental impacts and risks of the activity (including emergency response activities) will be reduced to ALARP and to an acceptable level.

These considerations have been taken in to account in the impact and risk assessments for the Davros Extension MC3D activity.

### 3.1.4.3 State Protected Areas

No state protected areas occur in the vicinity of the Davros Extension MC3D survey area (Figure A). The closest is the proposed Dampier Archipelago Marine Park (approximately 22 km to the south at its closest point to survey area), and the Montebello Islands Marine Park (approximately 35 km to the south west at its closest point to the survey area). Approximately 550 hectares within the Montebello Islands Marine Park (1% of the marine park area) is zoned for special purpose areas for pearling (Travaille et al. 2016). These marine protected areas are within the ZPI for the survey.

### 3.1.5 Key Ecological Features

The NWMR bioregional plan (Commonwealth of Australia 2017) identifies 13 key ecological features (KEFs), two of which occur within or immediately adjacent to the survey area, namely Glomar Shoal and the ancient coastline at 125 m depth contour KEFs (Figure A).

Glomar Shoal KEF is a regionally important shoal for its high biological diversity and high localised productivity for both its benthic and pelagic communities. It is a submerged feature situated in a high energy environment with strong sea floor currents, consisting of a high percentage of marine-derived sediments with high carbonate content and gravels of weathered coralline algae and shells. The KEF is important for a number of commercial and recreational fish species. Catch rates at the shoal is high, indicating high productivity region.

The ancient coastline at 125 m depth contour KEF is a unique sea floor feature with ecological properties of regional significance. Parts of the KEF, particularly the rocky escarpment, are thought to provide biologically important habitats in areas otherwise dominated by soft sediments. The topographic complexity of these escarpments may also facilitate vertical mixing of the water column, providing relatively nutrient-rich local environments. The KEF may also facilitate increased availability of nutrients off the Pilbara by interacting with internal waves and enhancing vertical mixing of water layers (which may attract larger marine life such as whale sharks and large pelagic fish).

## 3.2 Socio-economic Environment

### 3.2.1 Commercial Fisheries

Commonwealth and Western Australian commercial fisheries in the vicinity of the Davros Extension MC3D survey area are described in Table 3-7, and shown on Figure F and Figure G, respectively. Information on Commonwealth commercial fisheries were gathered from the AFMA (Australian Fisheries Management Authority) annual reports. Information on the Western Australian commercial fisheries was gathered from the DoF (now DPIRD), WAFIC and current/recent Status Reports of the Fisheries and Aquatic Resources of Western Australia 2013/14, 2014/15 and 2015/2016 (Fletcher and Santoro 2014, 2015; Fletcher et al. 2017).

Recreational Fisheries and Tourism Recreational fishing is concentrated around key population centres, with a seasonal peak in activity during winter months (Fletcher and Santoro 2014, 2015; Fletcher et al. 2017). Those involved in recreational fishing and other recreational activities constitute the largest single use group in the region. Approximately 2,000 recreational vessels are registered in the Pilbara region. A limited number of licensed charter vessels and a large number of recreational vessels fish out of most Western Australian population centres including Onslow, Coral Bay, Tantabiddi, Exmouth, Dampier and Port Hedland. Occasional recreational fishing occurs at Glomar Shoal (located within the survey area); however, due to the distance from land (46 km north of Dampier port) it is sporadic. Encounters with recreational fishers are therefore unlikely.

Recreational boating in the vicinity of the proposed survey may also include cruising yachts sailing along the coast between the mainland and islands. Cruising yachts may occasionally traverse the survey area. Encounters between the survey vessel and nature based tourism activities in the area of the Davros Extension MC3D survey area are considered unlikely as the majority of tourism activities are carried out within the reserve boundaries and along the coast.

**Table 3-7: Commercial Fisheries in the Vicinity of the Davros Extension MC3D Survey Area**

| Fishery | Primary Target Species | Comments |
|---|---|---|
| **Commonwealth Fisheries** | | |
| Southern Bluefin Tuna Fishery (SBTF) | Southern bluefin tuna (*Thunnus maccoyii*) | The southern bluefin tuna fishery encompasses the entire Australian exclusive economic zone, including the Davros Extension MC3D survey area. Fishing effort for southern bluefin tuna is concentrated in temperate Australian waters, with over 95% of the annual catch of the species taken in the Great Australian Bight (Patterson et al. 2016). Interactions with fishing vessels during the survey will not occur. |
| Western Skipjack Fishery (WSF) | Skipjack tuna (*Katsuwonus pelamis*) | Fishing effort in the fishery is confined to temperate waters off southern Australia (DSEWPaC 2012). The target species has historically been used for canning, and with the closure of canneries at Eden and Port Lincoln, effort in the fishery is considered very low (DSEWPaC 2012). Commercial operators were not working in the Skipjack Tuna fishery during 2015–16 (Patterson and Bath 2016). Interactions with fishing vessels during the survey will not occur. |
| Western Tuna and Billfish Fishery (WTBF) | Broadbill swordfish (*Xiphias gladius*)<br>Bigeye tuna (*Thunnus obesus*)<br>Yellowfin tuna (*T. albacares*)<br>Albacore tuna (*T. alalunga*)<br>Swordfish (*Xiphias gladius*)<br>Striped marlin (*Tetrapturus audax*) | The WTBF methods include longline and some minor line (including handline, troll, rod and reel), with the main method in use being longline. The fishing season extends all year and concentrated off south-west Western Australia. The fishery extends to the Australian exclusive economic zone boundary in the Indian Ocean and targets four main pelagic species, which are all highly migratory. The number of vessels operating in the fishery has declined in recent years, with less than five vessels operating in the fishery since 2005 (Williams and Bath 2015). Effort data shows fishing effort is concentrated offshore of the 200 m isobath off southern Western Australia (Figure G), with effort also recorded off the central and Pilbara coasts off Western Australia (Williams and Bath 2015). No significant effort in the vicinity of the Davros Extension MC3D survey area has been documented. Interactions with fishing vessels during the survey are therefore unlikely to occur. |
| North-west Slope Trawl Fishery (NWSTF) | Scampi:<br>Australian scampi (*Metanephrops australiensis*)<br>Boschma scampi (*M. boschmai*)<br>Velvet scampi (*M. velutinus*) | The target species for the fishery are found on the upper continental slope at depths between 250 and 500 m. A small number of operators are active in the fishery and effort in the fishery is low (Woodhams and Bath 2016), with the catch recorded for the period 2015-2016 at 33 tonnes (Woodhams and Bath 2016). There is a small overlap between the survey area (non-operational area) and the boundary of the fishery on the north-western section (Figure G). This represents only a very small proportion of the total area of waters fished. Interactions with fishing vessels during the survey are therefore unlikely to occur. |

| Fishery | Primary Target Species | Comments |
|---|---|---|
| **Western Australian Fisheries** | | |
| Abalone Managed Fishery | Roe's abalone (*Haliotis roei*)<br>Greenlip abalone (*H. laevigata*)<br>Brownlip abalone (*H. conicopora*) | Commercial fishing takes place far to the south of Western Australia, despite the abalone management plan stating that all Western Australia waters are part of the fishery. Fishing methods are dive and wading. Abalone fishery was closed in Area 8 (which is the area overlapping the survey) during the 2014/5 season due to the catastrophic mortality observed following a marine heatwave (Fletcher and Santoro 2015), and still remains closed (Fletcher et al. 2017). Interactions with fishing vessels during the survey will not occur. |
| Mackerel Managed Fishery | Spanish mackerel (*Scomberomorus commerson*)<br>Grey mackerel (*S. semifasciatus*) | The fishery extends from the West Coast Bioregion (Cape Leeuwin on the south-west coast) of Australia to the Western Australian–Northern Territory border, with most of the catch landed in the Pilbara and Kimberley regions (Fletcher and Santoro 2015). The MMF is divided into 3 fishing areas (Figure G). The majority of catch is taken in Area 1, Kimberley. The survey area overlaps with Area 2 of the fishery, with 11 vessels reported as being active in the entire zone during 2014, landing 193.8 tonnes of *Scomberomorus* spp. from the Kimberley Area (Fletcher and Santoro 2015). Given the small number of vessels and the large area over which Area 2 of the fishery extends, encounters between fishing vessels and the survey vessel are considered unlikely. |
| North Coast Prawn Managed Fisheries | Banana prawns (*Penaeus merguiensis*)<br>Western king prawns<br>(*Penaeus latisulcatus*)<br>Brown tiger prawns (*Penaeus esculentus*)<br>Endeavour prawns (*Metapenaeus* spp.) | This fishery includes the Nickol Bay Prawn Managed Fishery (NBPMF) and the Onslow Prawn Managed Fishery (OPMF). The Nickol Bay Prawn Managed Fishery (NBPMF) and Onslow Prawn Managed Fishery (OPMF) areas overlap the whole of the survey area, with the OPMF overlapping a small area in the east of the survey area and the NBPMF overlapping the remaining entirety of the survey area (see Figure H).<br>NBPMF: The total landings of major penaeids for the 2015 season were 87 t, which was comparable with levels caught over the past 7 years. There were 85.2 t banana prawns landed, 1.6 t of brown tiger prawns, and negligible amounts of western king and endeavour prawns (Fletcher and Santoro 2015).<br>OPMF: The total landings of major penaeids were 10.1 t for the 2015 season, comprising 5.6 t of brown tiger prawns, 4.0 t of banana prawns, 0.5 t of endeavour prawns and <0.1 t of western king prawns, (Fletcher and Santoro 2015).<br>The most productive area of the ONPMF is Area 1, which is a small area adjacent to the coast at Ashburton and Onslow. There has been limited fishing in the ONMPF from 2013 to 2015, with most effort recorded by the NBPMF (Fletcher and Santoro 2014, 2015, 2017). Gear used in the fishery consists of otter trawls and are typically restricted to depths less than 60 m. Published information on fishing activity in recent years and the geographic locations where fishing effort is concentrated (e.g. close to the mainland coast for prawns) indicates a very low level of effort in the survey area. In addition these fisheries are closed between October and April/May (Fletcher and et al. 2017). Potential interactions with commercial fishers is unlikely and will be limited to a few individual fishers (<60 m water depth) at the time of the survey. |
| North Coast Shark Fishery | Sandbar shark (*Carcharhinus plumbeus*)<br>Blacktip shark (*C. limbatus*) | The Northern Shark Fishery is not currently active; no activity has been reported in either of these fisheries from 2009 to 2014, with low levels of activity reported prior to these years. Interactions with fishing vessels during the survey will not occur. |

| Fishery | Primary Target Species | Comments |
|---|---|---|
| Pearl Oyster Managed Fishery (POMF) | Indo-Pacific silver-lipped pearl oyster (*Pinctada maxima*) | The WA pearl oyster fishery is the only remaining significant wild-stock fishery for pearl oysters in the world. It is a quota-based, dive fishery, operating in shallow coastal waters along the NWS from Exmouth to the NT border, and is managed under its own Act. The harvest method is drift diving, in which six to eight divers are attached to large outrigger booms on a vessel and towed slowly over the pearl oyster beds, harvesting legal sized oysters by hand, as they are seen. The WA pearling industry comprises three main components: the collection of pearl oysters from the wild, production of hatchery-reared pearl oysters, and grow-out of pearls on pearl farm leases. Quota limits are set for the take of pearl oysters from the wild to ensure the long-term sustainability of the resource (Fletcher and Santoro 2015).<br><br>*P. maxima* is widespread in the Indo-West Pacific. In WA, the species has been recorded as far south as Dirk Hartog Island in Shark Bay WA, (but it is not commercially fished south of North West Cape), to the east for a length of nearly 3,500 km to south of Cape York Cooktown, QLD (Southgate and Lucas 2008). Harvesting of *P. maxima* is focussed between Exmouth Gulf and Cape Leveque, with the main fishing areas off Eighty Mile Beach and a channel (10 to 20 m depth) between the mainland (north of Broome) and the Lacepede Islands (Figure 5-7) (Travaille et al. 2016). Fishing activity primarily occurs in water depths of 10 to 35 m (DoF 2016). Collection of wild *P. maxima* generally occurs for three to four months of the year, between March and July, during the neap phase of the tidal cycle when currents are reduced (Hart et al. 2016b). The number of vessels operating in the fishery has been slowly reducing from 16 in 1997 to six in 2014 (Hart et al. 2016a).<br><br>*P. maxima* are mostly found in shallow waters of the littoral (5 to 10 m) and sub-littoral zone, occasionally reaching the maximal recorded depths of 100 m to 120 m (Ranson 1961 and Shirai 1994, cited in: Southgate and Lucas 2008). However, spawning in the main fishing areas of the Eighty Mile Beach region is concentrated around broodstock distributed between 8 and 15 m depth, with potential smaller contributions from the north-east (towards fishing Zone 3), (Condie et al. 2006) These spawning events lead to recruitment locally and alongshore to the south-west and also feed larvae into neighbouring shallow coastal environments and deeper waters to the west (~20 m depth). Larval dispersion from known broodstock populations mostly travel less than 30 km (Figure 5-7), however some have been modelled as potentially travelling up to 60 km (Condie et al. 2006). High local abundances of broodstock and spat observed occasionally in deeper water (~30 m depth) are supported by intermittent larval transport from inshore populations, however spawning in these deeper waters appears to contribute little to recruitment in inshore populations (Condie et al. 2006).<br><br>The Davros Extension MC3D survey area is located within fishing Zone 1 of the POMF (Figure G and Figure 6-2), with the shallowest section of the survey area closest to shore is 35 m. There are five licences within this zone. No fishing was undertaken in Zone 1 between 2008 and 2013, though catch was taken for the second consecutive year in 2015, with 19,504 wild-caught pearl oyster shell landed, of which 19,341 were culture shells and 163 mother of pearl shells (MOP). However, this comprised only 3% of total catch (Fletcher et al. 2017). Given that the POMF is a dive fishery operating in shallow coastal waters (<35 m water depth) (DoF 2016; Hart et al. 2016b), it is extremely unlikely that there will be any activity in this fishery in the offshore waters of the survey area.<br><br>An assessment of potential interactions with the POMF has been undertaken (see Section 5.2.1.7.2). |

| Fishery | Primary Target Species | Comments |
|---|---|---|
| North Coast Demersal Scalefish Managed Fishery (NCDSMF) | Red emperor (*Lutjanus sebae*)<br>Goldband snapper (*Pristipomoides multidens*)<br>Bluespotted emperor (*Lethrinus punctulatus*) | This fishery includes the Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF), Pilbara Trap Managed Fishery (PTMF) and the Pilbara Line Fishery (PLF). These fisheries collectively use a combination of vessels, effort allocations (time), gear limits, plus spatial zones (including extensive trawl closures) as management measures.<br>The PFTIMF occupies the waters north of latitude 21°35'S and between longitudes 114°9'36"E and 120°E. The fishery is seaward of the 50 m isobath and landward of the 200 m isobath. The fishery consists of two zones, Zone 1 in the south-west of the fishery (which is closed to trawling) and Zone 2 in the north, which consists of six management areas. There were three active vessels in the fishery in 2014 and the total commercial landings for the season was 1,157 tonnes (Fletcher and Santoro 2015). The Davros Extension MC3D survey area overlaps Zone 2 (Area 1, 2 and 6) of the PFTIMF. Area 6 is closed to trawling, so fishing may only be affected in Areas 1 and 2 throughout the survey. The survey area only overlaps Area 1 by 73% and Area 2 by 15%. Therefore, while it is possible that vessels operating in the PFTIMF could operate in the vicinity of the survey area during the proposed activity, it only represents a small portion of the fisheries area.<br>The PTMF lies north of latitude 21°44'S and between longitudes 114°9.6'E and 120°00'E on the landward side of a boundary approximating the 200 m isobath and seaward of a line generally following the 30 m isobath. There were three active vessels in the fishery in 2014 and the total commercial landings for the season was 268 tonnes (Fletcher and Santoro 2015). The Davros Extension MC3D survey area is located entirely within the management regions of the PTMF. However, it represents only 1% of the entire fishery's licence area. Given the small area of the fishery that the survey area represents, interactions with this fishery are unlikely.<br>The PLF licences are permitted to operate anywhere within "Pilbara waters" up to the boundary of the Australian Fishing Zone. The total annual catch of scalefish in 2014 was approximately 40 t (Fletcher and Santoro 2015). The Davros Extension MC3D survey area is located entirely in the PLF management area; therefore encounters with fishing vessels during the survey are possible. |
| Pilbara Developmental Crab Fishery (PDCF) | Blue swimmer crab (*Portunus armatus*) | The PDCF operates in inshore waters from Onslow to Port Hedland, with most activity occurring around Nickol Bay. Fishing methods are using hourglass traps from the inter-tidal zone to at least 50 m in depth. There is very low effort associated with this fishery, e.g. in 2011–2012, two people were employed as skippers and crew and the estimated total catch was 12 t (Fletcher and Santoro 2014). During 2013/14, the catch along the Pilbara coast was 45.9 t (Fletcher and Santoro 2015). Due to fishing occurring in shallow inshore waters east of Onslow, interactions with fishing vessels during the survey will not occur. |
| West Coast Deep Sea Crustacean Managed Fishery (WCDSCF) | Crystal (snow) crabs (*Chaceon albus*)<br>Giant (king) crabs (*Pseudocarcinus gigas*)<br>Champagne (spiny) crabs (*Hypothalassia acerba*) | The WCDSCF is a quota based "pot" fishery that mostly operates in depths of 500–800 m (full range from 150-1200 m, Fletcher and Santoro 2015), with no fishing is permitted in depths <150 m, with the only allowable method for capture being baited pots ("traps") on long-lines, with most traps set on muddy sea beds. The boundaries of this fishery include all the waters lying north of latitude 34°24"S (Cape Leeuwin) and west of the NT border on the seaward side of the 150 m isobath out to the extent of the Australian Fishing Zone. The Davros Extension MC3D survey area is located entirely within Zone 1, however due to the restriction of operations to >150 m water depth and the majority of fishing occurring >500 m water depth, interactions with fishing vessels during the survey is unlikely. |

### 3.2.2 Heritage

#### 3.2.2.1 Indigenous Heritage

There are no known Indigenous cultural heritage values or issues for the waters and seabed within the Davros Extension MC3D survey area. The nearest pending Native Title Determination (Yaburara and Mardudhunera people WC1996/089) is located approximately 25 km to the south of the south-eastern corner of the survey area (Figure A).

#### 3.2.2.2 National Heritage

No listed National Heritage Places have been identified within the Davros Extension MC3D survey area. Similarly, no historic places listed under the EPBC Act were identified within the vicinity of the survey area. The nearest National Heritage Place is the Dampier Archipelago, which includes Rosemary Island, approximately 22 km to the south-east of the survey area.

#### 3.2.2.3 Historic Shipwrecks

Within the NWMR and Western Australian state waters there are 34 known shipwrecks protected under the *Historic Shipwrecks Act 1976* (Commonwealth) and three protected under the *Maritime Archaeology Act 1973* (Western Australia). These shipwrecks are listed on the Australian National Shipwreck Database (DoEE 2017m) and the Western Australian Museum Shipwreck Database. A search of these databases found no historic shipwrecks within the Davros Extension MC3D survey area. The nearest wreck is that of the *Tryal,* which was wrecked in 1622 on Tryal Rocks, approximately 64 km south-west of the survey area, near the Montebello Islands (Figure H).

### 3.2.3 Shipping

There is significant vessel traffic in the NWMR associated with commercial and recreational fishing, tourism, international shipping, and oil and gas operations (Director of National Parks 2013a). There are several major harbours in the region including the ports of Broome, Port Hedland and Dampier.

The Davros Extension MC3D operational and regional area overlaps parts of three shipping fairways that operate generally in a north south direction to the coast. The survey may encounter shipping traffic, both commercial and locally based vessels, throughout the duration of the survey including the following:

- commercial vessels using international shipping fairways (e.g. bulk freighters, tankers, salt carriers from Dampier and Port Hedland)
- domestic support/supply vessels servicing offshore facilities (e.g. North Rankin, Barrow Island, Cape Lambert, Dampier, Cape Preston and the Wheatstone development)
- local / small vessel traffic.

### 3.2.4 Petroleum Exploration and Production

The NWMR has been the target of significant petroleum exploration activity for over 40 years. There have been a large number of both 2D and 3D seismic surveys conducted in the region. A number of production facilities are located within the NWMR including Floating Production Storage Offshore (FPSO) facilities, manned and unmanned monopods, and larger production platforms.

A summary of planned seismic activities and petroleum operators with interests in the survey area and is provided in Table 3-8. CGG undertook an assessment of EP submissions available online on NOPSEMA's EP submission register to determine the baseline petroleum activities occurring within the survey area and regionally. There are also a number of gas pipelines extending from offshore areas to land-based production facilities (Figure 1-1).

**Table 3-8: Petroleum Facilities and Seismic Surveys in the Vicinity of Davros Extension MC3D**

| Petroleum Operator | Relevant Petroleum Instruments | Description of Planned Activity Within Existing EPs |
|---|---|---|
| **Petroleum Facilities** | | |
| Vermillion Oil & Gas | Production Licence: WA-14-L<br>Wandoo A and Wandoo B Platforms Export CALM buoy, infield secondary lines from Wandoo A to Wandoo B, export secondary lines from Wandoo B to CALM buoy | Accepted EP: Wandoo Facility. For ongoing activities associated with the operation of the Wandoo A and Wandoo B facilities. |
| Woodside Energy Ltd | North Rankin Complex (NRC)<br>Production Licence: WA-1-L<br>Pipeline Licence: WA-1-PL | Accepted EP: North Rankin Complex Operations. For ongoing activities associated with the operation of the NRC facilities. From 2017, it is proposed that the NRC will also extract gas and condensate from the Persephone (PSP) gas field. Production from the PSP field will be via a two well subsea tieback into the NRC. |
| | Goodwyn A Platform<br>Production Licences: WA-5-L, WA-6-L, WA-24-L, WA-57-L and WA-58-L | Accepted EP: Goodwyn Alpha (GWA) Operations Environment Plan. Ongoing GWA facility activities for processing dry gas and condensate the Goodwyn area reservoirs and associated subsea developments.<br>Accepted EP: Greater Western Flank Phase 2 Geophysical and Geotechnical Investigations for undertaking two geotechnical surveys and one geophysical survey. Activities commenced in June 2016 and are ongoing as at June 2018. Option to undertake additional surveys as required throughout the life of the project. |
| | Production Licences: WA-9-L, WA-11-L and WA-16-L<br>Pipeline Licence: WA-4-PL<br>Okha FPSO<br>Cossack Wanaea Lambert Hermes Redevelopment Project FPSO OKHA Safety Zone<br>Wanaea-1, Wanaea-2, Wanaea-3, Wanaea-4 and Cossack-4 wellheads<br>Wanaea 8 (well)<br>Wanaea 9 (Well)<br>Lambert 6 (Well)<br>Lambert 7 (Well) | Accepted EP: OKHA Floating Production Storage and Offloading Facility Operations. For ongoing activities associated with the operation of the Okha FPSO and associated infrastructure. The Okha FPSO consists of subsea wells, associated topside processing and subsea infrastructure and a single Gas Export Line (GEL). |
| | Angel Platform<br>Production Licence: WA-3-L<br>Pipeline Licence: WA-14-PL | Accepted EP: Angel Facility Operations. For activities associated with the ongoing operation of the Angel facility (operates as a Not Normally Manned facility). |
| Quadrant Northwest Pty Ltd | Reindeer Wellhead Platform<br>Production Licence: WA-41-L<br>Pipeline Licence: WA-18-PL | Accepted EP: Reindeer Wellhead Platform and Offshore Gas Supply Pipeline Operations. For operational activities for the Reindeer WHP and the offshore gas supply pipeline. The Reindeer WHP operates as a Not Normally Manned facility. Operational activities include: general WHP visits; subsea, pipeline and seafloor visual and imaging surveys; maintenance activities; and vessel operations. |
| Chevron Australia Pty Ltd (CAPL) | Production Licence: WA-39-L | Submitted EP. Jansz-Io Compression Geophysical and Geotechnical Survey. The proposed geophysical and geotechnical surveys will be used as a basis for the engineering design of the compression facility location, mooring locations, and flowline routes. The surveys will also include potential future flowline routes from adjacent backfill fields to the Jansz–Io compression facility |

| Petroleum Operator | Relevant Petroleum Instruments | Description of Planned Activity Within Existing EPs |
|---|---|---|
| | Production Licences:<br>WA-46-L<br>WA-47-L<br>WA-48-L | Submitted EP. Wheatstone Project - Well Intervention and Infill Drilling. EP covers well intervention activities for the producing wells with either a Mobile Offshore Drilling Unit (MODU) or vessel; and infill drilling of <5 wells by 2022. |
| Jadestone Energy (Australia) Pty Ltd | Production Licence: WA-15-L<br>FPSO Dampier Spirit and Stag Central Production Facility (CPF), Stag Water Injection Template and Stag Calm Buoy | Accepted EP: Stag Field Production and Export Facility. For activities associated with the ongoing operation of the Stag Field Production and Export Facility which comprises a Central Production Facility (CPF), fixed platform and a Floating Storage and Offload (FSO) tanker. |
| Santos Ltd | Production Licences: WA-8-L, WA-26-L, WA-27-L, WA-54-L<br>MODEC Venture 11 FPSO | Accepted EP: Mutineer-Exeter Development Field Operations. Covers operational activities for the Mutineer-Exeter Development. Comprises a subsea production system that ties four fields (Mutineer, Exeter, Fletcher and Finucane) into an FPSO moored via a disconnectable turret mooring. |
| **Seismic Surveys** | | |
| PGS Australia | SPA Application B24B67 | Submitted EP: Rollo MC 2D and 3DMS and CSEM surveys, comprising of greater than 841,000 km$^2$. The Rollo EP is designed to cover a period of five years from date of acceptance of the EP by NOPSEMA. The timing of commencement and duration of individual surveys to be acquired within the Rollo Operational Area have not yet been determined. |
| Polarcus Seismic Limited | Not given on NOPSEMA website | Accepted EP: Capreolus Phase II Multi-client Marine Seismic Survey. The Capreolus Phase II 3D MSS will encompass two distinct survey areas (where seismic data acquisition will be targeted) within a larger Operational Area (which encompasses additional areas where vessel manoeuvring and ancillary activities will occur). The Capreolus Phase II 3D MSS was scheduled to commence during or after the second quarter of 2016 and is expected to be completed over a period of approximately two years i.e. by 30th June 2018. Activities have not started as at December 2017. |
| TGS-NOPEC Geophysical Company Pty Ltd | SPA Application B59A26 | Accepted EP: North West Shelf Renaissance South Multi Client Marine Seismic Surveys. The North West Shelf Region (NWSR) South MC MSS operational area comprises more than 300,000 square kilometres within which 2D and 3D marine seismic surveys will be undertaken. Timing of commencement and duration of individual surveys within the NWSR South MC MSS operational area have not yet been determined. |
| TGS-NOPEC Geophysical Company Pty Ltd | Title Application No. 3325C9 | Submitted EP: North West Shelf Renaissance North Multi Client Marine Seismic Surveys. The North West Shelf Region (NWSR) North MC MSS operational area within which 2D and 3D marine seismic surveys will be undertaken is not specified. Restrictions within the EP allow for smaller surveys to be undertaken within this larger operational area and over a two-year period. Timing of commencement and duration of individual surveys within the NWSR North MC MSS operational area have not yet been determined. |

### 3.2.5 Defence

There are no designated defence or military exercise areas (MEA) in the vicinity of the Davros Extension MC3D survey area.

# 4.0 Environmental Impact and Risk Management Methodology

Regulations 13(5) and 13(6) of the OPGGS(E) Regulations require CGG to identify, analyse and evaluate the risks and potential environmental impacts associated with the Davros Extension MC3D MSS.

CGG's impact and risk management methodology is based on the principles, framework and processes defined by the *Australian/New Zealand Standard AS/NZS International Standards Organization (ISO) 31000:2009 Risk Management – Principles and Guidelines*. The environmental impact and risk management process includes the identification of hazards/threats, evaluation of potential impacts and risks associated with the activity, development of control measures to be adopted to reduce the impacts/risks to as low as reasonably practical (ALARP), and acceptance

### 4.1.1 Impact and Risk Assessment

All identified impacts and risks associated with the activity were analysed and evaluated in accordance with the CGG modified risk matrix (Table 4-3). The coloured region signifies the tolerability of the risk criteria. Environmental impact and risks ranked as Low or Medium are considered generally ALARP and acceptable (i.e. acceptable providing that it can be shown that all practicable impact and risk reduction measures have been taken and they will continue to be taken). Impacts and risks ranked as High are undesirable or unacceptable and require additional control measures to be implemented to reduce the residual level of risk to ALARP and Acceptable.

**Table 4-1: Definition of Consequences**

| Category | | Definition | |
|---|---|---|---|
| | | Environment | Socio-economic |
| 0 | Negligible | No or very limited effect on ecosystems, species or habitats.<br>Full recovery expected. | No or very limited effect on commercial and/or recreational users. |
| 1 | Minor | Minor disruption and temporary effect (days) on individuals within a protected species, including impacts on health, critical habitats, or critical behavioural processes. No overall threat to populations.<br>Localised scale (immediate area) and temporary effect on other habitats/communities.<br>No effects on ecosystem function.<br>Full recovery expected in days to weeks. | Minor disruption, localised scale (immediate area) and temporary effect (days) on commercial and/or recreational users. |
| 2 | Moderate | Moderate disruption and short-term effect (weeks) on a proportion of a protected species' population, including impacts on health, critical habitats or critical behavioural processes. No overall threat to populations.<br>Localised scale and short-term effect (weeks) on other habitats/communities.<br>No effects on ecosystem function.<br>Recovery in months to 1 year. | Moderate disruption, localised scale and short-term effect (weeks) on commercial and/or recreational users. |

| Category | | Definition | |
|---|---|---|---|
| 3 | Severe | Moderate disruption and short-term effect (months) on a significant proportion of a protected species' population, including impacts on health, critical habitats or critical behavioural processes. No overall threat to populations.<br>Localised scale and medium term effect (months) on other habitats/communities.<br>No effects on ecosystem function.<br>Recovery >1 to 3 years. | Moderate disruption and short-term effect (months) on commercial and/or recreational users. |
| 4 | Major | Major disruption and medium to long-term effect (years) on a protected species' population, including impacts on health, critical habitats or critical behavioural processes. No overall threat to populations.<br>Injury or death of individuals of a protected species.<br>Medium scale and medium term effect (years) on other habitats/communities.<br>Effects are at an ecosystem function level.<br>Recovery >3 to 10 years. | Major disruption and medium to long-term effect (years) leading to loss of commercial and/or recreational use. |
| 5 | Catastrophic | Extensive disruption and long-term effect (decades) on a protected species' population, including impacts on health, critical habitats or critical behavioural processes. No overall threat to populations.<br>Injury or death of a significant proportion of a protected species population.<br>Large scale and long-term effect (decades) on other habitats/communities.<br>Effects are at an ecosystem function level.<br>Recovery >10 years. | Extensive disruption and long-term effect (decades) leading to loss of commercial and/or recreational use. |

**Table 4-2: Definition of Likelihood**

| Category | | Definition | Experience (History of Occurrence) | Probability |
|---|---|---|---|---|
| A | Rare | Almost impossible | Unheard of in the industry | Event occurs once in 10 years |
| B | Unlikely | Could occur but would not be expected | Has occurred once or twice in the industry | Event occurs once in five years |
| C | Possible | Might occur at some point | Has occurred many times in the industry but not within the company | Event occurs once a year |
| D | Likely | Will probably occur at some point | Has occurred frequently within the company | Event occurs monthly |
| E | Almost Certain | Expected to occur in most circumstances | Has occurred frequently at the Location | Event occurs weekly |

**Table 4-3: CGG Environmental Risk Assessment Matrix**

| Consequence | | Likelihood | | | | |
|---|---|---|---|---|---|---|
| | | A | B | C | D | E |
| | | Rare | Unlikely | Possible | Likely | Almost Certain |
| 0 | Negligible | | | | | |
| 1 | Minor | | | | | |
| 2 | Moderate | | | | | |
| 3 | Severe | | | | | |
| 4 | Major | | | | | |
| 5 | Catastrophic | | | | | |

| Term | Definition |
|---|---|
| Low | No effect, or those that are beneath levels of perception, within normal bounds of variation. Good industry practice (including legislation and standards) have been applied. Acceptable without further reduction measures being required. |
| Medium | Acceptable (tolerable), providing that it can be shown that all practicable control measures have been implemented, if the sacrifices are not grossly disproportionate to the environmental benefit gained, with continual review of these measures and any potential new ones. Deemed to be "as low as reasonably practical" (ALARP) and acceptable. |
| High | Undesirable, CGG management decision required to accept risks and proceed. Additional control measures are required to be considered and implemented, if the cost is not grossly disproportionate to the environmental benefit gained, to prevent or reduce the impact/risk to ALARP and an acceptable residual level. |
| Very High | Unacceptable (intolerable) and may require re-design of project and/or its parameters, additional control measures are required to be implemented (regardless of cost) to prevent or reduce the impact/risk to ALARP and be acceptable. |

### 4.1.2 Demonstration of ALARP and Acceptability

Regulations 10A(b), 10A(c) and 13(5)(c) of the OPGGS(E) Regulations require that where significant effects are identified, details of the control measures that will be used to reduce the impacts and risks of the activity to as low as reasonably practicable (ALARP) and an "acceptable level", must be included in the EP. Risk treatment involves a process of selecting additional control measures for reducing impact and risks that have not been demonstrated to be ALARP during the risk analysis and evaluation processes, and then establishing whether the residual impact/risk can be deemed acceptable.

Additional control measures were assessed to demonstrate whether the impact or risk could be further reduced, or if the impact or risk level is ALARP. Treatments considered by CGG to be reasonably practicable have been implemented, while those considered to be not reasonably practicable have not been implemented, e.g. the cost, time and effort required to implement the measure is grossly disproportionate to the benefit gained.

CGG's QHSE and SD Risk Management Guidance Note (GRP_HSE_GEI_04E) requires that the effectiveness of control measures must be assessed, before they are implemented. Determination of effectiveness is subjective and thereby based on professional judgement, taking into account the following considerations:

- Availability – will the control exist and be available when and where you need it?
- Reliability – will the control work as it was designed and intended?

- Impact – what will be the scale of effect if this control works perfectly?
- Duration – what will be the duration or time that the control will have its effect?

CGG's criteria for acceptance of impacts and/or risks following the demonstration of ALARP are based upon the criteria and associated considerations described in Table 4-4.

**Table 4-4: Criteria for Acceptable Levels of Impact**

| Criteria for Acceptance | Definitions of Acceptability |
|---|---|
| CGG's Internal Context | ■ Alignment with CGG's HSE Management System and Environment Policy<br>■ CGG risk matrix defines 'low risk' as acceptable, 'medium risk' as acceptable providing ALARP has been demonstrated, 'high risk' as undesirable (i.e. requiring ALARP demonstration and decision to accept based on CGG management decision), and 'very high risk' as unacceptable (Table 4-3). |
| Legislative Requirements | ■ Is the impact/risk being managed in accordance with existing Australian or international legislation, conventions and/or standards, such as MARPOL 73/78, AMSA Marine Orders, and Marine Notices, Policy Statements? |
| Industry Good Practice | ■ Is the impact/risk being managed in accordance with industry good practice (refer to guidelines and standards including ISO 31010:2009 Risk Management – Risk Assessment Techniques, Standards Australia / Standards New Zealand Risk Management Guidelines, APPEA Code of Environmental Practice and IAGC guidelines? |
| Social Acceptance | ■ Concerns raised during stakeholder consultation have been assessed for their merits and control measures developed, as appropriate, to manage those concerns |
| Existing Environmental Context | ■ Have the potential impacts/risks to environmental values or sensitivities been assessed at a local, regional (and if applicable global) level in terms of population level and long-term effects? Are the adopted control measures appropriate and adequate in avoiding such effects and thereby reducing the risks to ALARP?<br>■ Is the proposed management of the impact/risk aligned with species specific or protected area management plans/conservation advice<br>■ Is the proposed management of the impact/risk aligned with the identified conservation values for the existing environment, as defined in the North-west Marine Region Bioregional Plan (Director of National Parks 2013a) and associated report cards? |
| Ecologically Sustainable Development | ■ Aligned with the five principles of ESD |
| ALARP | ■ Demonstration that all reasonable and practicable control measures have been adopted to reduce the impact/risk, without the sacrifice being disproportionate to the benefit of reduction |

## 4.2 Environmental Performance Outcomes and Standards

CGG's overall environmental performance outcome for the activity is to avoid or minimise environmental risks, as outlined in the CGG Environment Policy. Environmental performance outcomes, standards and measurement criteria for each aspect of the activity that has the potential to cause adverse environmental impacts or risks are detailed in the assessments presented in Section 5.0. Environmental performance will be measured and reported against these standards and measurement criteria, as part of CGG's commitment to continuous improvement of environmental, health and safety performance.

# 5.0 Environmental Risk and Impact Assessment and Performance Outcomes and Standards

## 5.1 Impact and Risk Assessment Summary

This section of the EP presents the results of the impact and risk assessment for the Davros Extension MC3D MSS using the methods described in Section 4.0. As required by Regulation 13(5) and 13(6) of the OPGGS(E) Regulations, this assessment demonstrates that the risks and impacts associated with the activity will be reduced to ALARP and will be of an acceptable level. A summary of the environmental risks, potential impacts and proposed control measures to reduce risks to ALARP, for the Davros Extension MC3D MSS is presented in Table 5-1.

The Davros Extension MC3D MSS is located in water depths between 35 and 271 m and is more than 22 km from the nearest landfall (i.e. islands within the Dampier Archipelago), with no emergent land or features shallower than this within the survey area. Risks and potential impacts associated with vessel or towed equipment grounding (accidental event) were not assessed as credible risks and have therefore been excluded from the scope of the risk assessment. Risks and potential impacts associated with transit of the survey vessel and support vessel(s) to and from the survey area, are considered outside the activity and therefore outside the scope of this EP and risk assessment.

**Table 5-1: Summary of Impact and Risk Assessment for the Davros Extension MC3D MSS**

| Impacts / Risks | Residual Impact/Risk | | | Acceptability | EP Section Ref |
|---|---|---|---|---|---|
| | Consequence | Likelihood | Impact/Risk | | |
| Underwater noise emissions from operation of the seismic source – plankton (incl. eggs and larvae) | Negligible | Almost Certain | Low | 5.2.1.10.3 | 5.2.1 |
| Underwater noise emissions from vessel operations – invertebrates | Minor | Unlikely | Low | | |
| Underwater noise emissions from vessel operations – Glomar Shoal / Rankin Bank fish | Moderate-Severe | Unlikely | Medium | | |
| Underwater noise emissions from vessel operations – commercial fish and fisheries | Minor – fish<br>Moderate - fishers | Unlikely (both) | Low – fish<br>Medium – fishers | | |
| Underwater noise emissions from vessel operations – hard corals | Minor | Unlikely | Low | | |
| Underwater noise emissions from vessel operations – whale sharks | Minor | Unlikely-Rare | Low | | |
| Underwater noise emissions from vessel operations – marine turtles | Minor | Unlikely | Low | | |
| Underwater noise emissions from vessel operations - cetaceans | Minor | Unlikely | Low | | |
| Underwater noise emissions from vessel operations | Minor | Unlikely | Low | 5.2.2.5.3 | 5.2.2 |
| Interaction with other marine users | Moderate | Unlikely | Medium | 5.2.3.5.3 | 5.2.3 |
| Light emissions | Minor | Unlikely | Low | 5.2.4.5.3 | 5.2.4 |
| Routine discharges | Minor | Rare | Low | 5.2.5.5.2 | 5.2.5 |
| Atmospheric emissions | Negligible | Rare | Low | 5.2.6.5.3 | 5.2.6 |

| Impacts / Risks | Residual Impact/Risk | | | Acceptability | EP |
|---|---|---|---|---|---|
| Vessel collision with marine fauna | Moderate Major | Rare | Medium | 5.3.1.5.3 | 5.3.1 |
| Equipment entanglement with marine fauna | Minor | Rare | Low | | |
| Seabed disturbance due to loss of equipment and/or emergency anchoring | Minor | Rare | Low | 5.3.2.5.3 | 5.3.2 |
| Introduction and establishment of invasive marine species | Moderate | Rare | Low | 5.3.3.5.3 | 5.3.3 |
| Accidental release of hazardous and non-hazardous substances | Minor | Rare | Low | 5.3.4.5.3 | 5.3.4 |
| Accidental oil spill (refuelling and vessel collision) | Severe | Rare | Medium | 5.3.5.4.3 | 5.3.5 |
| Oil spill response | Minor | Unlikely | Low | 5.3.6.5.3 | 5.3.6 |

## 5.2 Routine (Planned) Operations

### 5.2.1 Impact 1 - Underwater Noise Emissions from Operation of the Seismic Source

#### 5.2.1.1 Description of Hazard

The dominant source of underwater noise during the Davros Extension MC3D MSS will be from the operation of the seismic source (airgun array), which is proposed to be in frequent operation for the duration of the survey. There will also be periods when the airguns are not in operation, e.g. during maintenance, refuelling and marine fauna shut-downs, or firing at less than full power, e.g. during 'soft starts'.

The airgun array will comprise two sub-arrays, each with a maximum volume of 4,500 cui, and which can be operated at a lower volume by selectively discharging a subset of the individual guns. Smaller volume airguns are suitable for imaging shallower layers in the rock formations underlying the seabed, but are not suitable for the deeper formations. The target formations in the survey area are generally deep (>4-6 km below seabed), except under Glomar Shoal where there is a shallower target formation (approximately 2-3 km below seabed). Using a smaller array in most parts of the survey area is not acceptable due to loss of data resolution of deeper seabed stratigraphy. The shallow targets of the general area have been surveyed (e.g. legacy MSS in 2014) and the deeper targets are the focus of this survey; inability to accurately resolve the deeper layers would compromise the effectiveness of the survey. Therefore, smaller arrays are only acceptable for the shallow target at Glomar Shoal and in other shallow water depths where a concession needs to be made in response to stakeholder expectations.

Seismic data will not be acquired in water depths of <35 m during the survey. The array discharge volume will be reduced to 1,800 cui in water depths of 35 to 50 m within the survey area, with exclusion areas around the shallower parts of Glomar Shoal and Rankin Bank. CGG will specifically exclude the shallowest reef areas at Glomar Shoal, and has established a 'fish protection area' (FPA) with a conservative buffer (500 m wide) around the most important fish habitat areas on Glomar Shoal. CGG has also established an exclusion area encompassing a 500 m buffer around the most important fish habitats on Rankin Bank (Figure 5-10). The seismic array will not be discharged within these exclusion areas.

The survey vessel will tow the array of airguns, which will be fired at regular intervals; producing pulses of high intensity, low frequency sound. Seismic pulses typically have 98% of the signal power in dominant frequencies less than 200 Hz; predominantly in the 6 to 100 Hz range (McCauley 1994), which is the range most useful for seismic data imaging. The array comprises a series of airguns that are fired in pre-determined order to achieve the desired sound energy and frequency of discharges (shot point interval). The volume of the airgun array is a useful indicator of sound energy (measured in dB); however, the configuration of individual arrays has a significant effect on the actual power output. Sound energy levels for particular airgun arrays must be modelled or measured to determine actual power outputs.

Actual sound levels immediately adjacent the arrays are significantly lower than the theoretical maximum because the cumulative sound pressure levels (energy from all guns firing together) are computed from a far-field sound level on the assumption that the seismic array is a point source, 1 m from all airguns. However, the guns are further than 1 m apart (typically spread over an area of 17 x 17 m) in the array and it is not possible to be 1 m from all compressed air elements in a source array simultaneously. This is important in understanding that modelled gun power levels are inherently conservative and therefore, sound transmission loss modelling, (estimating the propagation of sound through the water), starts with an inflated source level. Comparison of modelled and measured sound levels herein shows this rapidly equalises and there is a high level of agreement between the two levels within the near-field (< 500 m from the source).

Actual near-field and far-field received sound levels are influenced by a number of factors including the overall size (capacity) of the acoustic source, water depths in the area, distance from the source, and geo-acoustic properties of the seabed. Sound tends to propagate further in deeper water partly due to reduced interference from the seabed.

#### 5.2.1.2 Environmental Receptors

Review of the environmental resources described in Section 4, indicates that discharge of the acoustic source in the Davros Extension MC3D survey area has the potential to affect adversely the following environmental receptors, values and sensitivities, to varying degrees:

- plankton (including commercially important fish and pearl oyster larvae/eggs, and spawning corals in areas of shallow reef)
- fish and shellfish
  - Glomar Shoal KEF and Rankin Bank fish assemblages (Section 4.3.1.3), including site-attached species in the consolidated reef areas in the shallowest parts of these areas. The shallowest areas are around 22 to 30 m for Glomar Shoal (<10% of the total area of the Glomar Shoal KEF) and around 19 to 40 m for Rankin Bank. Site-attached fish species are less likely to be able to avoid the sound source at distance and are expected to seek shelter within the reef.
  - migrating whale sharks (broad migratory pathway overlaps survey area)
  - commercially fished species (e.g. goldband snapper)
- migrating humpback whales (main migratory corridor is to the east of the survey area, but there is an overlap in the southern section)
- pygmy blue whales (survey area is within a known distribution area)
- transient cetacean species (e.g. Bryde's, Antarctic minke, sperm and killer whales possible visitors)
- inter-nesting turtles (survey area overlaps the Biologically Important Area and Habitat Critical to the Survival for flatback turtles based on generic inter-nesting buffers around nesting beaches in the region. Local model of flatback turtle inter-nesting habitat indicates no overlap with survey area or operational area).

#### 5.2.1.3 Potential Impacts

These potential environmental impacts to the environmental receptors include:

- physical injury to auditory tissues or other air-filled organs
- hearing loss; either temporary threshold shift (TTS) or permanent threshold shift (PTS)
- direct behavioural effects through disturbance or displacement and consequent disruption of natural behaviours or processes, e.g. migration, feeding, resting, calving
- indirect behavioural effects by impairing/masking the ability to navigate, find food or communicate or by affecting the distribution or abundance of prey species
- indirect effects on the catchability of commercial fish stocks.

The potential for impact on individual animals depends on a number of factors, including the presence of the animal during the survey period, its proximity to the noise source, its ability to avoid the sound field generated by the airgun array, its specific physiological tolerance and the overlap between its hearing range and the seismic frequency range. Most of the sound energy of the seismic airgun pulses is in the low frequency range of 10 to 200 Hz (McCauley 1994; OGP 2011). This overlaps with the hearing frequency range of some marine fauna groups, but is unlikely to be heard by many marine species. The marine species most at risk from the low frequency acoustic emissions from seismic operations within the operational area are cetaceans migrating through the area, particularly baleen whale species that hear and communicate in a similar low frequency range.

In general the risks and potential impacts are well understood with regard to potential mechanisms of mortality and/or physiological injury; however uncertainty lies in the critical thresholds for many taxa and in understanding the spatial and temporal extents of behavioural disturbances and the potential effects on populations. In light of such uncertainty highly precautionary approaches have been taken.

The DPIRD (previously DoF), WAFIC, Pearl Producers Association (PPA) and commercial fishery licence holders from the Pilbara Demersal Scalefish (Pilbara Trawl, Line and Trap fisheries) and Mackerel Managed Fisheries have specifically expressed concern regarding the potential for noise generated by the seismic source to affect the quality and quantity of wild stock and catches and larval recruitment of commercial species (Table 8-1). This assessment therefore focusses on potential impacts to fish species, fish catch rates and larval stages (planktonic organisms). Other receptors (cetaceans, turtles) are also covered, but risks to these groups are well mitigated by spatial and temporal avoidance controls.

#### 5.2.1.4 Underwater Sound Modelling

Seismic airgun modelling packages (e.g. Nucleus) generate a theoretical maximum energy level at 1 m from the source array and simulate sound propagation at increasing distance via spherical spreading from the source. This an accurate representation of the propagation of sound underwater in the near-field where the sound is mostly travelling directly downwards, but does not adequately account for site-specific variation in water depth and seabed type.

CGG engaged Centre for Marine Science and Technology (CMST) to undertake underwater noise propagation modelling for the proposed survey to determine the potential spatial extent of potential underwater noise impacts (Appendix 4). Seismic sound was modelled by the CMST for three different airgun arrays at three depths (25 m, 50 m and 100 m) within the survey area. Source levels for each airgun array were calculated using the CMST airgun array model and a wavenumber integration propagation model. CMST modelling of the seismic source was compared with waveforms provided by CGG (using Nucleus modelling) and the overall agreement of both CMST and CGG models was considered very good (Appendix 4). The source levels for the smallest (2,220 cui) and largest (4,630 cui) modelled airgun arrays were 252.2 dB re 1 µPa peak sound pressure level ($SPL_{peak}$) (or 228.0 dB re 1 $\mu Pa^2$.s sound exposure level (SEL)) and 260 dB re 1 µPa (or 234.6 dB re 1 $\mu Pa^2$.s SEL) respectively.

The modelling predicted received peak SPLs and SELs in the immediate vicinity of the 4,630 cui array, and additionally for two smaller airgun array configurations of 2,220 and 3,430 cui. Modelled received levels were predicted for receptors at the seabed at horizontal ranges of up to 1 km, operating in three different water depths representative of those within the survey area: 25 m (e.g. reef crest at Glomar Shoal), 50 m (e.g. body of Glomar Shoal) and 100 m (i.e. deeper parts of survey area). The modelling included a tow depth of the airgun array of between 5 and 9 m.

Although, CGG has reviewed historical data and found that an array size of 4,500 cui is required to accurately acquire seismic data within the survey area (refer to Section 3.3.2), the two smaller arrays were also modelled to assess the potential for environmental benefits associated with smaller airguns in the ALARP assessment. As stated above, CGG would in reality use an even smaller array of 1,800 cui, and has committed to using this in water depths of <50 m, including around Glomar Shoal. The measured source levels provided by CGG for the 4,500 cui array are 244.4 dB re 1 µPa ($SPL_{peak}$) and 219.4 dB re 1 $\mu Pa^2$.s (SEL); and for the 1,800 cui array are 240 dB re 1 µPa ($SPL_{peak}$) and 215 dB re 1 $\mu Pa^2$.s (SEL) (Table 3-3).

At the time that the modelling was undertaken in 2015, the activity was planned for a smaller survey area largely concentrated over Glomar Shoal, however since that time the survey area has been expanded to the area known as the Davros Extension MC3D MSS (Figure 3-1).

#### 5.2.1.4.1 Conservatism in Model Assumptions

Although there is considerable uncertainty in the relationship between noise levels and impacts on aquatic species, the science underlying noise modelling is well understood (Farcas et al. 2016). The process involves the application of quantitative noise exposure thresholds for particular species (see Section 6.2.1.3.1), to a model of predicted noise levels over a particular area. The accuracy of model predictions depends both on employing an appropriate model and on the quality of the input data (Farcas et al. 2016). Noise propagation models require assumptions regarding the marine environment in which they are based. Uncertainties quite often exist in terms of site-specific knowledge of physical oceanographic conditions and/or seabed type and composition, all of which are influencing factors on the propagation of sound in underwater environments. The level of influence that these physical environmental conditions have on acoustic propagation varies and where site-specific data are not available, a precautionary approach is taken, often basing assumptions on regional conditions. The influence of site-specific physical environmental characteristics of the Davros Extension MC3D survey area e.g. seabed substrate type, sea surface roughness, have been discussed below to demonstrate the conservatism that has been built into CMST's modelled received levels.

CMST assumed a calcarenite seabed in their model based on initial advice provided by CGG as the worst-case scenario. The characteristics of the calcarenite seabed presented in the modelling report are within the generally accepted range of values, however CMST highlighted the variability that can arise in modelling data based on peer reviewed publications on calcarenite. Seabed sediments around Glomar Shoal have been sampled during two dedicated seabed sampling studies in 1967 and 2013 (Falkner et al. 2009; AIMS 2014). These studies concluded that sediments have a high proportion of coarse material (i.e. sand and gravels of weathered coralline algae and shells), and predominantly comprise sand. Sand and gravel layers overlying the calcarenite will absorb some of the acoustic energy, reduce reflection of sound into the water column and reduce the received noise levels just above the seabed.

When the sea surface is smooth, it creates an interference pattern in the underwater sound field known as the Lloyd Mirror or Surface Ghost (Urick 1982; Etter 2013). The underwater noise model has assumed a perfectly flat sea surface that acts as a perfect reflector of wave energy, however typically the sea surface is rarely smooth (i.e. windless and calm). This does not occur in reality as shown in the wind data in the offshore environs of the survey area (Figure 4-1), demonstrating moderate to strong winds with peak wind speeds of up to 10 to 12 m/s for over 10 months of the year. Reflected noise levels will be therefore be lower than those predicted for a perfectly reflective sea surface.

The CMST model assumes a homogeneous water column, without density structures that may impede noise propagation. However, in reality, the water column is subject to turbulence that does impede noise propagation (Roberson and Hartlipp 2014). The continental shelf edge is a complex area with internal turbulence, tidal and current effects in the water column, with affects similar to those reported for tidal currents elsewhere, especially around shallow-water shoals. The resulting impact is invariably a significant increase in propagation losses as the sound passes through different densities and currents of water.

#### 5.2.1.4.2 Nucleus vs CMST Modelling

CGG modelled sound levels using a spherical spreading model (Nucleus) to determine likely sound levels at varying distances from the source, as part of its geophysical assessment and planning process for the survey. CMST compared the sample waveforms and frequency spectra generated by CGG's Nucleus modelling with its own airgun array modelling and found 'excellent' agreement between the two models (CMST 2015; Alec Duncan pers. comm. 2017).

#### 5.2.1.5 Sound Source Verification

The complex behaviour of sound underwater is influenced by numerous variables as described above; modelling the behaviour of sound propagating underwater takes into account all the known variables, using the best available data for each input parameter, and conservatism where there is uncertainty. Even so, it is likely that actual sound levels vary from those modelled, due to small-scale variation and complex reflection, refraction, absorption, interference and reinforcement patterns. It is, therefore, ideal to verify the modelled sound levels using measurements of underwater sound levels from the survey area.

CGG measured received sound levels during the earlier surveys near the Davros Extension MSS area using ocean-bottom nodes (OBN) and streamer hydrophones and compared these data to modelled data. The methods have been peer-reviewed and agreed by Dr Alexander Gavrilova from the Curtin University Centre for Marine Science and Technology (CMST). Streamer hydrophone records at conventional (7 m depth) and BroadSeis (7-50 m depth) were compared against OBN recordings. There was little difference between the two cable depths and only a small (~4 dB) difference between OBN data and streamer data across water depths of 160 - 385 m at 500 – 7,000 m from the source (offsets). The comparison with modelled sound levels is discussed below.

##### 5.2.1.5.1 Ocean-bottom Node Measurements

Ocean-bottom nodes (OBN) measure sound levels reaching the seabed and are a good indicator of sound level which benthic and demersal biota would be exposed to during a survey using a similar source array. OBN were deployed in 159 m water depth and in 385 m water depth; the shallower deployment being relevant here. Figure 5-1 shows the modelled sound levels from CGG's Nucleus model in SPL (red) and SEL (blue) units overlaid on the corresponding OBN measurements. It confirms a high level of concordance between the modelled and measured data out to 500 m from the source array. This means that the modelled data (which has greater resolution and is therefore more useful in determining distances to threshold isopleths) can be confidently used for impact assessment in the near-field.

Impacts to demersal fish, which are typically within the 0 – 200 m range from the source, can be accurately predicted using the modelled data.

Beyond 500 m from the source, the modelled data under-estimates the actual received sound levels and have not been used in the impact assessment. Beyond the near-field it is generally the sensitive biota that inhabit the water column (e.g. cetaceans) that are affected and the hydrophone data has been used in preference to OBN data.

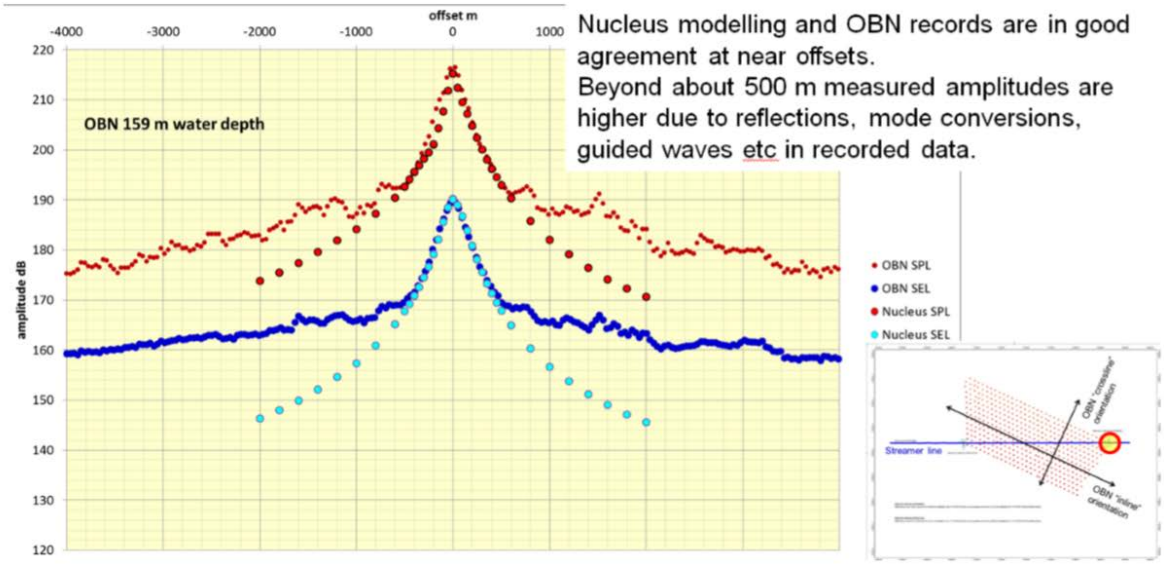



**Figure 5-1: SPLpeak and SEL from OBN Compared to Nucleus Model (159 m Water Depth)**

The OBN data have been compared to historical measurements from CMST's underwater sound loggers, as shown in Figure 5-2. The plots show high concordance between the OBN data (dark blue points) and logger data (magenta curves). The measured data aligns with the higher measurements from the loggers which is consistent with the slightly larger airgun volume; the CMST logger (magenta) data represents 3,000 - 4,000 $in^3$ arrays; whereas the OBN data is for the 4,630 $in^3$ array used in the earlier Davros surveys. This confirms that the CGG measured data is the best predictor of received sound levels for the impact assessment.

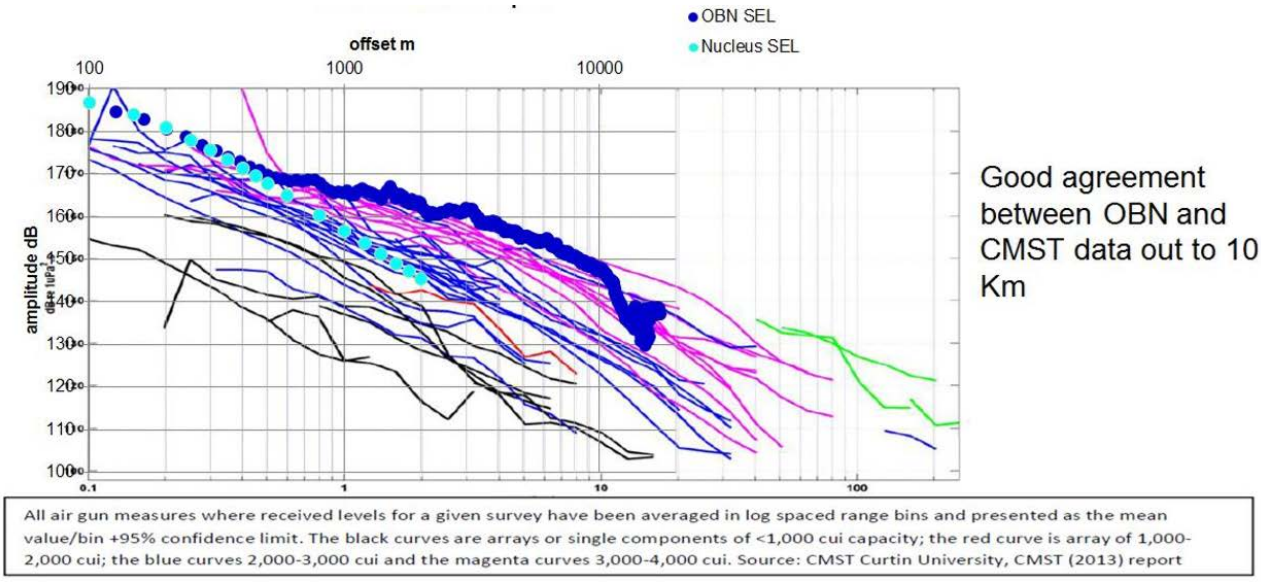



**Figure 5-2: OBN Measurements Compared to CMST Logger Measurements**

#### 5.2.1.5.2 Hydrophone Streamer Measurements

Sound levels were measured using streamer hydrophones during the Davros-1 and Davros-2 seismic surveys which spanned the Davros Extension MSS area of the current EP (Figure 5-3). The coloured lines in Figure 5-3 show the sail-lines and the colours represent water depths. The range of water depths where sound levels were measured encompasses the full range of water depths in the Davros Extension survey area. These results are therefore suitable for verifying water column sound levels across the current survey area.

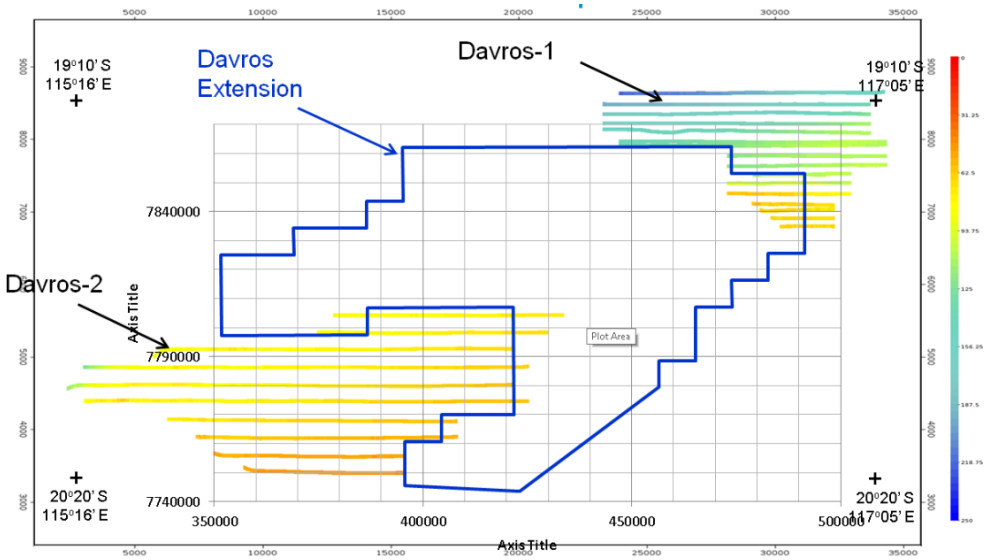



**Figure 5-3: CGG Sound Measurement Areas during Previous Davros Surveys**

SPLpk and SEL sound levels extracted from streamer seismic data agree with Nucleus modelling and ocean bottom recordings. Results are also in line with more sophisticated modelling techniques which take into account seabed conditions and are in agreement with independent CMST measurements.

The hydrophone measurements were separated into water depth bins (50-100 m; 100-150 m; 150-200 m; 200-250 m) to examine the effect of depth on received sound levels. The measured data show that received sound levels are more variable with distance from source and this is more pronounced in shallower waters (Figure 5-4; Figure 5-5). Further, sound levels are higher at distance from the source in waters greater than 100 m deep, and there is less distinction between sound levels in deeper bins. The variation within depth bins is most likely due to variation in water depth and also seabed types. The upper 99% percentile for the relevant depth bin was used in the assess impacts to receptors; thereby accounting for variation due to within-bin depth range and seabed type.

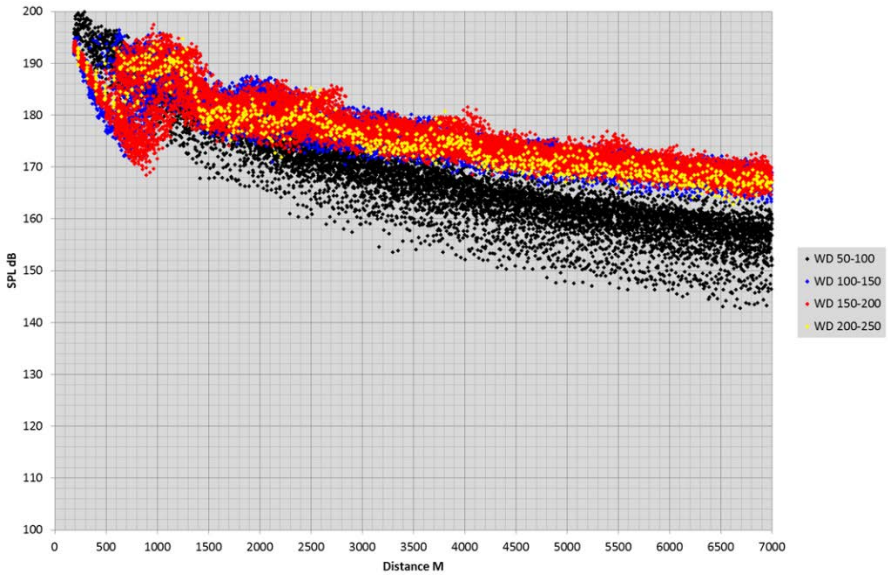



**Figure 5-4: Hydrophone SPLpeak Sound Measurements from Davros Area**

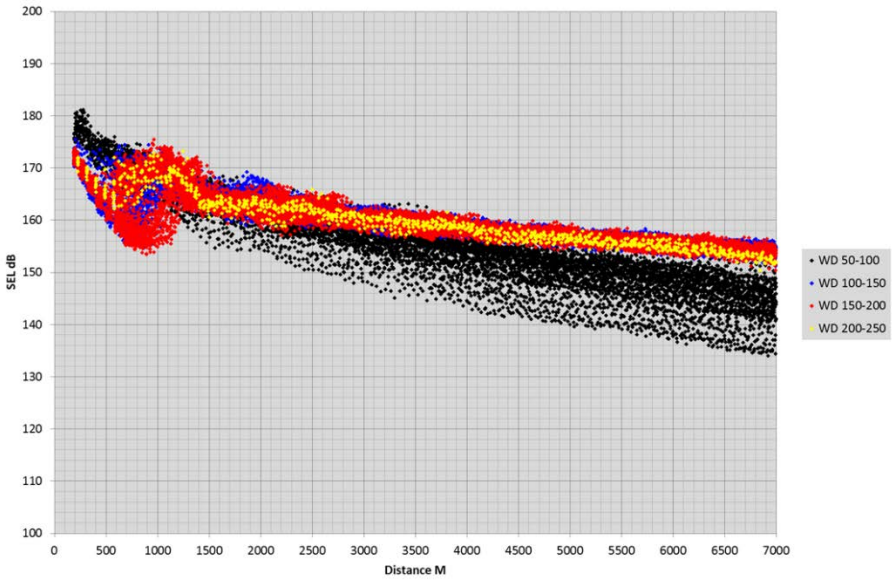



**Figure 5-5: Hydrophone SEL Sound Measurements from Davros Area**

### 5.2.1.6 Marine Fauna Exposure Criteria Adopted

#### 5.2.1.6.1 Plankton, Fish Larvae and Eggs

Guideline thresholds for mortality to eggs and larvae have been proposed based on the sound exposure guidelines by the ANSI-Accredited Standards Committee S3/SC 1, Animal Bioacoustics Working Group (Popper et al. 2014). These guidelines represent the Working Group's efforts to establish broadly applicable guidelines for fish, marine turtles, and eggs and larvae. The criteria that Popper et al. (2014) suggest for mortality in eggs and larvae are based on levels measured in the study by Bolle et al. (2012) that indicated no damage was caused by simulated repeated pile driving signals of 210 dB re 1 $\mu Pa^2$.s $SEL_{cum}$.

#### 5.2.1.6.2 Invertebrates

Invertebrates are less sensitive to noise impacts than are fish species and marine mammals, due to their lack of air-filled internal organs. Sound detection among crustaceans is believed to occur through hair and statocyst detection of the particle motion component of the sound field (Edmonds et al. 2016). There are no peer reviewed and/or recognised sound exposure guidelines/criteria for shellfish species.

Day et al. (2016a) assessed the impact of seismic sound on rock lobsters, scallops and their larvae. The outcomes of the study have been used to develop a comparative sound exposure level for prawns, for the assessment of impacts associated with the received sound levels predicted by the underwater noise modelling. Exposure to the maximum measured SELs of 186 to 190 dB re 1$\mu Pa^2$.s did not result in mortality of any adult lobsters or a reduction in the quantity or quality of larvae; however a range of sub-lethal effects to adults were observed (Day et al. 2016a). For the assessment of potential effects for prawns and their eggs/larvae from the Davros Extension MC3D MSS, an SEL of 186 dB re 1$\mu Pa^2$.s has been adopted as the exposure level for which a range of effects may be experienced ranging from sub-lethal to behavioural or catchability effects. Exposure to air gun signals did not result in any lobster mortality in any of the experiments conducted in the Day et al. (2016a) study; therefore mortality is not expected to occur based on these findings. A summary of the Day et al. (2016a) study and its outcomes is provided in Section 5.2.1.7.2.

#### 5.2.1.6.3 Fish

The thresholds for harm to fish species have been based on the sound exposure guidelines for fish proposed by the ANSI-Accredited Standards Committee S3/SC 1, Animal Bioacoustics Working Group (Popper et al. 2014). The guidelines represent the Working Group's consensus efforts to establish broadly applicable guidelines for fish and sea turtles, with specific criteria relating to mortality and potential mortal injury, recoverable injury and TTS (Table 5-2). The Working Group defines the criteria for injury and TTS as follows:

- mortality and mortal injury – immediate or delayed death
- recoverable injury – injuries, including hair cell damage, minor internal or external hematoma, etc. None of these injuries is likely to result in mortality
- TTS – short or long-term changes in hearing sensitivity that may or may not reduce fitness (defined as any persistent change in hearing of 6 dB or greater).

**Table 5-2: Summary of Fish Injury Exposure Guidelines for Seismic Airguns (Popper et al. 2014)**

| Type of Fish | Mortality and Potential Mortal Injury (dB re1 µPa) | Impairment (dB re1 uPa) | |
|---|---|---|---|
| | | Recoverable Injury | TTS |
| Fish: no swim bladder (particle motion detection) | >213 dB peak | >213 dB peak | >186 dB $SEL_{cum}$ |
| Fish: swim bladder is not involved in hearing (particle motion detection) | >207 dB peak | >207 dB peak | >186 dB $SEL_{cum}$ |
| Fish: swim bladder involved in hearing (primarily pressure detection) | >207 dB peak | >207 dB peak | 186 dB $SEL_{cum}$ |

The guideline levels for each of the criteria above have been derived from a number of sources. The mortality and recoverable injury guidelines are based on predictions derived from effects of impulsive sounds from piling (Halvorsen et al. 2011), since there are no quantified data for seismic airguns. Popper et al. (2014) acknowledge that there are few data regarding the effects of seismic airgun noise on fish mortality and damage to organ systems, and that studies of fish with swim bladders have not shown mortality to date (Popper et al. 2007; Hastings et al. 2008; and McCauley and Kent 2012). In the absence of such data, the guidelines for "mortality and potential mortality" and for "recoverable injury" have been extrapolated from piling studies and are therefore typically conservative and precautionary in nature (Halvorsen et al. 2011; and Popper et al. 2014).

Both cumulative SEL and peak SPL guidelines have been proposed, however the Working Group states that the direct application of cumulative criteria adopted for piling driving to seismic airguns would not be appropriate. This is because the received peak SEL (or "single strike" SEL) changes from shot to shot since the seismic vessel is moving and will be at different distances from the fish. Note that for piling, it is possible to determine the cumulative noise exposure as piling is a stationary noise source. Therefore the Working Group conclude that it is better to use a guideline based on the closest peak level for seismic airguns than one based on a cumulative exposure (Popper et al. 2014).

The tentative thresholds proposed by Popper et al. (2014) are extremely conservative as they use the "recoverable injury" sound level as a "mortality and potential mortality" threshold in the absence of data on mortality levels. The potential mortality level was based on the 'lowest level where injury was found' in a study of fish exposed to piling noise. Halvorsen et al. (2011, 2012) measured the 'response weighted index (RWI)' of Chinook salmon exposed to pile driving. From this study, the authors identified that an RWI of 2 would be an acceptable level of physiological injury for the fish species exposed to pile driving, with a peak SPL level of 207 dB re 1 µPa. It should be noted that the RWI ranking of 2 relates to two 'mild' and 'non-life threatening' injuries.

Casper et al. (2012) further investigated the RWI for several fish species representative of the three fish groups identified by Popper et al. (2014), i.e. Group1: fish without swim bladders (sharks, rays, flatfish (e.g. hogchoker)), Group 2: fish with swim bladders not involved in hearing (salmonids, sturgeons, jewfish, snapper) and Group 3: fish with swim bladders involved in hearing and structurally connected to the inner ear, (herring, perch, bass, rockfish). The study did not identify any mortal or potentially mortal injuries in the four fish species studied exposed to piling noise levels above an SEL of 177 dB re 1 $\mu Pa^2$.s (or 207 dB re 1 µPa SPL peak). This level was concluded by the authors as being the potential onset of physiologically significant injuries (Casper et al. 2012).

In the absence of data specific to quantification of the effects on fish from seismic sources, the guidelines for "mortality and potential mortality" and for "recoverable injury" have been extrapolated from these piling studies and are, therefore, highly conservative and precautionary in nature (Halvorsen et al. 2011, 2012; Casper et al. 2012; Popper et al. 2014). It is, however, important to note that the intent of authors in proposing these guidelines was as "a first step in setting guidelines that may lead to the establishment of exposure standards for fish (and sea turtles)" (Popper et al. 2014).

The actual impacts associated with noise levels at the tentative threshold proposed by Popper et al. (2014) are unknown, but they represent the level at which physiological damage may start to occur. They do not represent a likely mortal impact zone and empirical field data (Section 6.2.1.3.5) indicates mortality will not occur at these levels.

The guideline levels for TTS for fish are based on data from Popper et al. (2005, 2014) for exposure of fish to a seismic airgun array. The fish were exposed to a noise level of 186 dB re 1$\mu Pa^2$.s ($SEL_{cum}$), accumulated over five seismic pulses, and provide the most relevant cumulative exposure guideline specific to a seismic study. In the Popper et al. (2005) study, the experimental design was based on five exposures to the airgun at 40 second intervals so that the fish were exposed to a steady sound level. The authors note that in contrast, a normal seismic survey might present signals as often as every 10 seconds; however several contributing factors are described in the paper that lead the study authors to conclude that, although these

factors do not compensate for the more frequent exposure in an actual seismic survey, their experiments exposed fish with an approximate ‘‘worst case’’ with regard to seismic stimulation (Popper et al. 2005). These factors include that as the survey vessel is moving, a stationary fish subject would be exposed to the maximum level only once in a sequence of exposures. Further, that the majority of exposed fishes during a seismic survey are likely to be at greater distances from the source than those in the Popper et al. (2005) study (i.e. 13 and 17 m) and would therefore receive a lower sound level. The guideline level for TTS proposed by Popper et al. (2014) derived from the results of the experiments conducted by Popper et al. (2005) are based on TTS responses from a hearing specialist fish species (i.e. those with the highest sensitivity to sound). This guideline level can also be considered worst case in this respect for the fish species assessed within this EP.

Popper et al. (2014) did not propose specific behavioural guideline values due to the limited experimental data supporting previously proposed guidelines, and the specific nature of behavioural responses amongst fish species, i.e. one guideline or criteria does not fit all. So although there are no recommended guidelines as such, the assessment of the potential effects on behaviour in this EP is based on a study by McCauley et al. (2000), during which various fish species in large cages were exposed to a seismic airgun. Fish were recorded moving away from the source at noise levels greater than 156 to 161 dB re 1 µPa $SPL_{rms}$. However, they returned to normal behavioural patterns 14 to 30 minutes after airgun operations ceased. McCauley et al. (2000) presented an approximate conversion of the behavioural response trigger to peak pressure levels of 168 to 173 dB re 1 µPa $SPL_{peak}$. The higher threshold of 173 dB re 1 µPa has been used in this assessment for a strong avoidance response.

#### 5.2.1.6.4 Marine Turtles

Popper et al. (2014) proposed a guideline for mortality and potential mortal injury for marine turtles of 207 dB re 1 µPa based upon piling studies. There have been no studies conducted on hearing loss or the effects of exposure to intense sounds on hearing in any turtles, therefore Popper et al. (2014) have extrapolated from fish, based on the rationale that the hearing range for turtles much more approximates to that of fishes than of any marine mammal.

There are no specific guideline values proposed by the Working Group for behaviour due to the limitations described above (Popper et al. 2014). Therefore, the assessment of the potential effects on behaviour for marine turtles in this EP is based on a strong avoidance response of 175 dB re 1 µPa from a study conducted by McCauley et al. (2000).

#### 5.2.1.6.5 Cetaceans

Based on current knowledge of functional hearing in marine mammals, NOAA (2016) identify three distinct, functional groups of cetaceans, based on the frequency range at which their hearing is most sensitive: a) low frequency (LF) cetaceans (7 hertz – 35 kilohertz); b) mid-frequency (MF) cetaceans (150 hertz – 160 kilohertz); c) high frequency (HF) cetaceans (275 hertz to 160 kilohertz). These hearing groups have been slightly revised from those first identified by Southall et al. (2007) and accepted by the global scientific community through the peer review process for the NOAA (2016) paper.

CMST’s underwater noise modelling has predicted peak sound pressure levels (SPLpeak) and maximum sound exposure levels (SEL) for assessing the effects of noise on mid and low-frequency cetaceans. Of the list of cetaceans identified in Section 4.3.2.1 that may potentially be present within or in the vicinity of the survey area, there are no species classified as high-frequency hearing cetaceans; the sperm whale *Physeter macrocephalus* is a mid-frequency hearing group species (NOAA 2016). The peak sound pressure levels from the NOAA (2016) guidelines have been compared with the results of the sound modelling carried out for the Davros Extension MC3D EP to determine the impact distances for permanent and recoverable effects. These peak SPL guidelines are described by NOAA (2016) as being “flat”, i.e. indicating that the peak sound pressure should be ‘flat weighted’ or ‘unweighted’ within the generalised hearing range for marine mammals.

NOAA's (2016) revised acoustic thresholds did not suggest a revised approach to Southall et al.'s (2007) suggested criteria for behavioural disturbance; the latter which is based on a severity scaling system that ranks the behavioural response from zero for "no response" to nine for "outright panic, flight, attack of conspecifics or stranding events" (Southall et al. 2007). Severity scales of five to six are considered to have potential to affect foraging, reproduction, or survival. Specifically, a severity score of five indicates a change in swimming behaviour but not avoidance, and six (likely avoidance) indicates minor to moderate avoidance. For mid-frequency cetaceans a lower behavioural threshold of a score of five (possible avoidance) has been used in the assessment, due to the similarity in the revised TTS/fleeing threshold and provide more conservativism in the estimate of the range of potential effects. Table 5-3 presents a summary of the assessment criteria used in this assessment for cetaceans.

**Table 5-3: Summary of Injury and Behavioural Criteria for Cetaceans**

| Species Group | Threshold Peak Sound Pressure Level (dB re 1 µPa) |
|---|---|
| **Low-Frequency Cetaceans** | |
| PTS-onset/injury | 219 [1] |
| TTS-onset/ Fleeing response | 213 [1] |
| Likely avoidance of area [2] | 152 [3] |
| EPBC Act Policy Statement 2.1 Guideline | 160 [4] |
| **Mid-Frequency Cetaceans** | |
| PTS-onset/injury | 230 [1] |
| TTS onset/ Fleeing response | 224 [1] |
| Likely avoidance of area | 170 [3] |
| Possible avoidance of area [2] | 160 [3] |

Note 1: Using the most recent peer reviewed and globally accepted thresholds for onset of permanent and temporary threshold shifts NOAA (2016)
Note 2: Derived from Southall et al. (2007) severity scaling behavioural response. Likely avoidance indicates actual avoidance of the area; possible avoidance indicates a change in swimming behaviour but not avoidance.
Note 3: Derived from Southall et al. (2007) severity scaling behavioural response and converted to SEL (of the pulse) from root mean square (RMS) (over the duration of the pulse) by subtracting 10 dB for mid-frequency cetaceans and 8 dB for low-frequency cetaceans (based on the longer ranges for low-frequency cetaceans).
Note 4: Based on 160 dB re 1 $\mu Pa^2$.s for 95% of shots at 1 km.

### 5.2.1.7 Predicted Impacts from the Davros Extension MC3D Survey

#### 5.2.1.7.1 Impacts to Plankton

Plankton is a diverse group of organisms defined by their pelagic habitat and inability to swim actively against a current. Some organisms form part of the plankton for only part of their life cycle, e.g. as eggs and larvae. Marine plankton comprise four groups:

- phytoplankton – plant-like photosynthesising organisms, including diatoms, dinoflagellates, blue-green algae and coccolithophores
- zooplankton – small protozoa, crustaceans, jellyfish and various other animals that feed on the phytoplankton and other zooplankton and the eggs and larvae of larger animals such as fish, crustaceans and molluscs
- bacterioplankton – bacteria and archaea, which play an important role in absorbing dissolved nutrients and remineralising organic material
- mycoplankton – fungi and yeasts, which also play an important role in nutrient cycling and remineralisation.

This impact assessment focusses on the phytoplankton and zooplankton components of marine plankton for which there is more information and a stronger link with valued ecosystems components; they are considered to be representative of the planktonic suite.

Planktonic organisms are transported by prevailing wind- and tide-driven currents; becoming very widely dispersed and they cannot take effective evasive behaviour to avoid seismic sources. Some forms of phytoplankton and zooplankton are capable of independent movement and can migrate vertically in the water column, but their horizontal position is largely determined by water movement and currents. Zooplankton typically exhibit diel vertical migration whereby they migrate to the water surface at night and return to deeper waters during the day. Certain species (e.g. the copepod *Neocalanus plumchrus*) will also migrate to different depths at different stages of their life cycle (Kobari and Ikeda 2001). Phytoplankton, particularly diatoms and dinoflagellates, also show diel vertical migration (e.g. Cullen and Horrigan 1981, Hajdu et al. 2007), triggered by environmental conditions such as irradiance in the photosynthetically active radiation range (400 to 700 nm wavelengths) (Gerbersdorf and Schubert 2011).

Spatially, phytoplankton will vary according to nutrient concentrations and light availability. Temporally, phytoplankton populations in subtropical oceans drop off in summer as the buoyant warmer water becomes nutrient depleted. In Western Australia, the Leeuwin Current can have pronounced intra- and inter-annual effects on phytoplankton abundance, probably due to entrainment in the eddies and gyres that spin off the current. Phytoplankton along the WA coast generally bloom in late autumn and winter, coinciding with the strongest flows of the Leeuwin Current (Koslow et al. 2008, Feng et al. 2009). Phytoplankton population growth rates in the euphotic zone are largely controlled by the grazing activities of zooplankton and the availability of nutrients, but light-saturated growth rates in subtropical latitudes correspond to a doubling time of roughly 1 day (Laws 2013).

Zooplankton growth rates are highly variable among species, but McKinnon et al. (2015) recently reported rates for copepods in Australia were comparable to those reported elsewhere in the world and that rates in WA's Kimberley region were around six times higher than in Queensland's Great Barrier Reef region. Spatially, the abundance and diversity of zooplankton varies significantly at all scales, driven by environmental conditions such as water temperature, depth, season, the availability of food resources and predation.

In general, there have been few studies into the effects of marine seismic surveys on plankton. Up until recently, studies on the effects of noise from airguns on plankton have indicated that any effect is likely to be highly localised (<10 m from the source and typically within 0.5 to 5 m) (Table 5-4) (Kostyuchenko 1973; Matishov 1992; Booman et al. 1996; Payne 2009). These studies indicated that impacts would be insignificant compared with the naturally high turnover rates of zooplankton (Kostyuchenko 1973; Swan et al. 1994). Kostyuchenko (1973) reported fish egg mortality out to 0.5 m and only pathological effects (e.g. embryo curling, membrane perturbation and yolk displacement) at 5 m in a small percentage of anchovy eggs exposed to an estimated source level of 230 dB re 1 µPa. Matishov (1992) observed delamination of the retina in cod larvae within 1 m of a seismic source with a level of 250 dB re 1 µPa (peak to peak). Booman et al. (1996) recorded the highest mortality rates of Norwegian fish eggs and larvae within 1.4 m and low or no mortality and infrequent pathology within 5 m of the seismic source. In contrast, Dalen and Knutsen (1987) exposed cod eggs, larvae and fry to a single seismic discharge with a source level of 220 dB re 1 µPa and no effects were observed at either 1 m or 5 m. Furthermore, a study by Bolle et al. (2012) also observed no statistically significant effect on the survival rate of common sole larvae exposed to piling noise at a peak SPL of 210 dB re 1 µPa and cumulative SEL of 206 dB re 1 $\mu Pa^2$.s.

In a recent study, egg-bearing female spiny lobsters (*Jasus edwardsii*) were exposed to noise from three air gun configurations, all of which exceeded sound exposure levels (SEL) of 185 dB re 1 $\mu Pa^2 \cdot s$ (Day et al 2016a). Lobsters were maintained until their eggs hatched and the larvae were then counted for fecundity, assessed for abnormal morphology using measurements of larval length and width, tested for larval competency using an established activity test and measured for energy content. Overall there were no differences in the quantity or quality of hatched larvae, indicating that the condition and development of spiny lobster embryos were not adversely affected by air gun exposure (Day et al. 2016a, 2016b). Although no

apparent morphological abnormalities were observed, exposed larvae from the 45 $in^3$ experiment were found to be significantly longer than control larvae. However, the size of larvae in this study fell well within the range of natural variation, indicating natural variation in larvae is much greater that the differences observed between treatments in this study. Day et al. (2016a, 2016b) concluded no effects on embryos early in development within 1 to 1.5 km of the seismic source.

Most recently, McCauley et al. (2017) reported zooplankton mortality rates more than two orders of magnitude higher than recorded in earlier studies. They found that exposure to a 150 $in^3$ airgun shot significantly decreased zooplankton abundance and that the mortality rate increased from a natural rate of 19% per day to 45% per day (McCauley et al. 2017). Impacts were detected out to edge of the study area, at 1.2 km from the airgun in waters 34 to 36 m deep (McCauley et al. 2017); these water depths are considerably shallower than the majority of seismic surveys in Australia. In view of this recent study, CGG has also assessed the significance of potential impacts to zooplankton (including fish larvae / eggs) out to a distance of 1.2 km.

To further examine the relevance of the results of McCauley et al. (2017) study to a large-scale seismic survey in deeper waters (similar to many seismic surveys conducted on the North West Shelf), researchers from CSIRO modelled the impacts on zooplankton from a 35-day seismic survey in 300 to 800 m deep water in an 80 km x 36 km survey area (Richardson et al. 2017). Within the survey area, the model predicted a 22% reduction in zooplankton biomass, which declined to 14% within 15 km of the survey area (Richardson et al. 2017). They modelled the recovery of the plankton population and found it returned to 95% of the original biomass level within three days after the end of the survey. The rapid recovery was attributed to the fast growth rates of zooplankton and the dispersal and mixing of zooplankton from inside and outside the impacted area (Richardson et al. 2017).

The potential impacts of seismic surveys on plankton will depend on the species in question, the life history stages, the specifications of the airgun array, the distance between the airgun discharge and the plankton, the number of discharges, the water depth and the seabed features. Consequently, predicting impacts is difficult due not only to the diversity of organism in the plankton but to the variation in environmental and physical parameters, even within the timeframe of a seismic survey. As an example of the complexities in predicting impacts, characteristics of the acoustic signal may affect different life stages differently; for 2-day old yolk-sac anchovy larvae, Holliday et al. (1987; cited in Payne 2004) found that energy density was more important than peak pressure for short-term survival rates, whereas for long-term egg survival exposure at a lower peak level and lower cumulative energy appeared to have a greater effect. There is also mixed evidence for impacts as well as no impacts on plankton due to seismic surveys. Even among similar organisms, responses have been shown to vary.

The lack of a consistent response may be partly attributable to methods and laboratory experiments cannot truly replicate the responses of organisms in their natural habitat. Similarly field studies face limitations in applicability to other situations. McCauley et al. (2017) reported significant decreases in abundance and increase mortality rates in zooplankton, but their study area was in very shallow waters compared to the majority of offshore seismic surveys in Australia. Richardson et al. (2017) agreed that McCauley et al. (2017) found evidence of some local-scale impact of seismic activity on zooplankton but also noted that their modelled impacts may have been over-estimated due to diel vertical migration which was not included in their model. Notwithstanding, they predicted recovery of the zooplankton community within three days after the end of the seismic survey.

Based on the research to date, there are not enough data to define zones of impact for planktonic organisms, including the eggs and larvae of fish and crustaceans. Although the recent work by McCauley et al. (2017) and Richardson et al. (2017) suggests that the zone of impact for zooplankton may be two orders of magnitude higher than previously thought, there is still evidence that for certain components of the plankton effects are likely to be limited to the 5 - 10 m range. Further, for many components of the zooplankton and phytoplankton, recovery is expected to be rapid (in the order of days), so the potential for secondary impacts flowing up the food chain are limited and expected to be within the range of natural variability.

Given the trophic status of the plankton, secondary effects of a zooplankton decline could include reduced recruitment to fish stocks due to mortality of planktonic eggs and larvae, and reduced prey availability for fish at various life history stages. These secondary effects are discussed in Section 6.2.1.2.5 with regard to potential impacts on commercially fished finfish in the vicinity of the survey area.

**Table 5-4: Observed Seismic Noise Pathological Effects on Zooplankton**

| Species | Source | Source Level (dB re 1 µPa) | Distance from Source | Exposure Level (dB re 1 µPa SPL) | Observed Effect | Source |
|---|---|---|---|---|---|---|
| Cod (larvae 5 days) | Single airgun | 250 | 1 m | 250 | Delamination of the retina | Matishov (1992) |
| Cod (larvae 2–10 days) | Single airgun | 222 | 1 m | 222 | No injuries detected | Dalen and Knutsen (1986) |
| | | | 10 m | 202 | No injuries detected | |
| Fish eggs (anchovy) | Single airgun | 230 (estimated) | 1 m | 230 | 7.8% of eggs injured relative to control | Kostyvchenko (1973) |
| | | | 10 m | 210 | No injuries detected | |
| Fish eggs (red mullet) | | | 1 m | 230 | No injuries detected | |
| | | | 10 m | 210 | No injuries detected | |
| Dungeness crab (larvae) | Seven airgun array | 244 (estimated) | 1 m | 233.5 | No significant difference in survival rate relative to controls | Pearson et al. (1994) |
| | | | 3 m | 230.9 | | |
| | | | 10 m | 222.5 | | |
| Snow crab (eggs) | Single airgun | 216 | 2 m | 216 | 1.6% mortality; 26% delay in development | Christian et al. 2004 |
| Spiny lobsters (embryos) | Single airgun | 223 (estimated) | Run over the pots | 200 | No differences in the quantity or quality of hatched larvae | Day et al (2016a) |
| | | 224 (estimated) | | 203 | | |
| | | 227 (estimated) | | 205 | | |
| Zooplankton (incl. krill) | Single airgun (150 cui) | 205 (estimated) | 1.2 km | 178 (SPL) (153 dB re 1 µPa$^2$·s SEL) | Decreased abundance and increased mortality rate from 19% to 45% | McCauley et al. (2017) |

#### 5.2.1.7.2 Impacts to Shellfish, Other Invertebrates and Fisheries

Few marine invertebrates have sensory organs that can perceive sound pressure, but many have organs or elaborate arrays of tactile “hairs” that are sensitive to hydro-acoustic disturbances (McCauley 1994). These sensory hairs or organs are collectively known as mechanoreceptors, and crustaceans are particularly well endowed with them. Close to a seismic source, the mechano-sensory system of many benthic crustaceans will perceive the “sound” of airgun pulses, but for most species such stimulation would only occur within the near-field or closer, perhaps within distances of several metres from the source (McCauley 1994).

Until recently, effects on marine invertebrates were expected to be limited in spatial extent (<10 m as reported in a study of the effect of seismic explosions on pearl oysters by Le Provost et al. (1986)), as they are considered less sensitive to noise than hearing-specialist fish species, due to the lack of air-filled organs. La Bella et al. (1996) examined biochemical indicators of stress in bivalves exposed to seismic airgun noise. In this study, they found that hydrocortisone, glucose and lactate levels between test and control animals were significantly different in the venerid clam *Paphia aurea*, showing an evidence of stress caused by acoustic noise. This was measured at an exposure distance of 7.5 m. Following on from this a study by Hirst and Rodhouse (2000) suggested that most invertebrates would only detect seismic shots within about 20 m, and that catch levels of shrimp and lobster in areas surveyed with airguns reported no change during the

surveys (Hirst and Rodhouse 2000). A study conducted in 2002 examined a number of health, behavioural, and reproductive variables before, during, and after, seismic shooting on snow crabs (*Chionoecetes opilio*). Experimental animals were exposed to peak received broadband sound levels of 201 to 237 dB re 1 µPa. The results of the study suggested no obvious effects on crab behaviour, health or catch rates (Christian et al. 2004).

A study conducted by the Tasmanian Aquaculture and Fisheries Institute (TAFI) assessed the immediate impact of seismic surveys on adult commercial scallops (*P. fumatus*) in the Bass Strait in 2010 (Harrington et al. 2010). Participants in the Bass Strait Central Zone Scallop Fishery (BSCZSF) were concerned that the seismic survey may have a negative impact on the commercially important adult scallops within the region. The TAFI study concluded that no short-term (<2 months) impacts on the survival or health of adult commercial scallops were detected after the seismic survey (Harrington et al. 2010). There had been no change in the abundance of live scallops (or related change in dead scallop categories) or macroscopic gonad and meat condition after seismic surveying within either the control, impacted or semi-impacted strata. There was also no observable change in the size frequency distribution of scallops in the impacted and semi-impacted strata following the survey.

In response to the lack of discernible results from the 2010 before and after study and the concerns from fisheries groups that seismic operations negatively affect catch rates, the Gippsland Marine Environmental Monitoring (GMEM) project was developed (Przeslawski et al. 2016). This study aimed at modelling and measuring sound at various depths before and during a seismic survey in 2015 to quantify potential impacts of seismic surveys on scallops and other benthic organisms. Sound exposure was assessed using both field monitoring and desktop modelling. The sound monitoring was undertaken using four calibrated acoustic recording units (ARUs) moored at varying seafloor depths (44 – 70 m) within the study area, including one control >25 km from seismic survey operations. Scallops and other bivalves were assessed using seafloor imagery obtained from AUVs and samples collected from dredging. Data were collected two weeks prior to the start of seismic operations ('before' survey) and two months after the conclusion of seismic operations ('after' survey) in experimental and control zones. The underwater sound model predicted SELs of 170 dB re 1µPa$^2$.s within 250 m of the source and sound levels exceeding 150 dB re 1µPa$^2$.s out to 4 km from the source. However, the highest SEL measured by hydrophones during the survey was 146 dB re 1µPa$^2$.s at 51 m depth when the airguns were operating 1.4 km away. As such, the model was shown to be highly conservative, with actual noise levels falling to under 150 dB re 1µPa$^2$.s much closer to the seismic source than predicted. There was no evidence of increased scallop mortality, or effects on scallop shell size, adductor muscle diameter, gonad size, or gonad stage due to the seismic sound (Przeslawski et al. 2016). The authors concluded that the GMEM study provided no clear evidence of adverse effects on scallops, fish, or commercial catch rates due to the 2015 seismic survey undertaken in the Gippsland Basin. Przeslawski et al. (2016) further concluded that the GMEN study provides a robust and evidence-based assessment of the potential effects of a seismic survey on some fish and scallops, however these results should be interpreted in the context of other studies such as Day et al. (2016a, 2016b), and should not be generalised to include other animals due to the vast range of different physiology and sensory systems.

The Day et al. (2016a) study is the most recent that has recorded negative effects on commercially important shellfish species from seismic sound. The study investigated the effects of seismic sound on southern rock lobsters (*Jasus edwardsii*) and the Australian scallops (*Pecten fumatus*). Source levels for the different airgun configurations were predicted to be 223 to 227 dB re 1 µPa SPL peak to peak ($SPL_{pk-pk}$) and SELs of 200 to 205 dB re 1 µPa$^2$.s. Rock lobster experiments consisted of four sampling times between days 0 and 120 post-exposure, as well as over the longer term of 365 days post-exposure. Each lobster experiment comprised two treatments; a control pass of the airgun where it was deployed but not operated, and an active pass of the airgun (Day et al. 2016a). Following exposure, a total of 302 lobsters, were sampled and assessed for mortality, two behavioural reflex tests, statocyst damage (balance and gravity sensing organ), condition, haemolymph biochemistry, the number of circulating haemocytes and embryonic development (see Section 6.2.1.2.3 for a description of results on lobster larvae). The maximum measured exposures were 209 to 212 dB re 1 µPa $SPL_{pk-pk}$, and 186 to 190 dB re 1 µPa$^2$.s SEL. The maximum cumulative SEL received from multiple shots was between 192 and 199 dB re 1 µPa$^2$.s (Day et al. 2016a). The study found

that exposure to seismic sound levels up to a maximum SEL of 186 dB re 1µPa$^2$.s did not result in mortality of any adult lobsters, even at close proximity. However, sub-lethal effects, relating to impairment of reflexes, damage to the statocysts and reduction in numbers of haemocytes (possibly indicative of decreased immune response function), were observed after exposure (Day et al. 2016a).

Although, the Day et al. (2016a) study did not investigate the ecological impacts of the sub-lethal effects, of note however, is that the lobsters used for the July 2014 standard pressure experiment were collected from a scientific reserve in an area of high ambient levels of anthropogenic noise. These animals were found to have a high level of pre-existing damage to statocysts similar to that induced by the airgun experiments. These lobsters when exposed to the seismic airgun did not exhibit a significant increase in statocyst damage. The study authors suggested that this indicates that lobsters can adapt to statocyst damage, as these control lobsters with damaged statocysts did not display impaired righting reflexes.

Scallop experiments comprised four treatments, a control pass of the airgun deployed but not operated, one pass of the airgun, two passes of the airgun or four passes of the airgun. A total of 560 scallops were sampled at three times between days 0 and 120 post-exposure for mortality, haemolymph (blood analogue) biochemistry, the number of circulating haemocytes (blood cell analogues), righting reflex, recessing behaviour and other condition indices. Seismic sound exposure did not cause mass mortality of scallops during the experiment; however, repeated exposure (i.e. more than one pass of the airgun) where maximum exposure levels were in the range of 181 to 188 dB re 1µPa$^2$.s SEL (191 to 213 dB re 1µPa peak-peak SPL) was considered to possibly increase the risk of mortality (Day et al. 2016a, 2016b). Scallops exposed to repeated seismic sound suffered physiological damage with no signs of recovery over the four-month period; suggesting potentially reduced tolerance to subsequent stressors. In addition, changes in behaviour and reflexes during and following seismic exposure were observed. Day et al. (2016a, 2016b) however cautioned that it was unclear from the study whether the observed physiological (and behavioural) impairments would result in mortality beyond the timeframes considered in their study.

Day et al. (2016a) concluded that the results of their study were broadly applicable to spiny lobster and scallop fisheries throughout the world and crustacean and bivalve fisheries in general. The relevance and implications of their research, (and that of Przeslawski et al. 2016), has therefore been considered in the context of crustacean (prawn) and bivalve (pearl oyster) fisheries in the Davros Extension MC3D survey area.

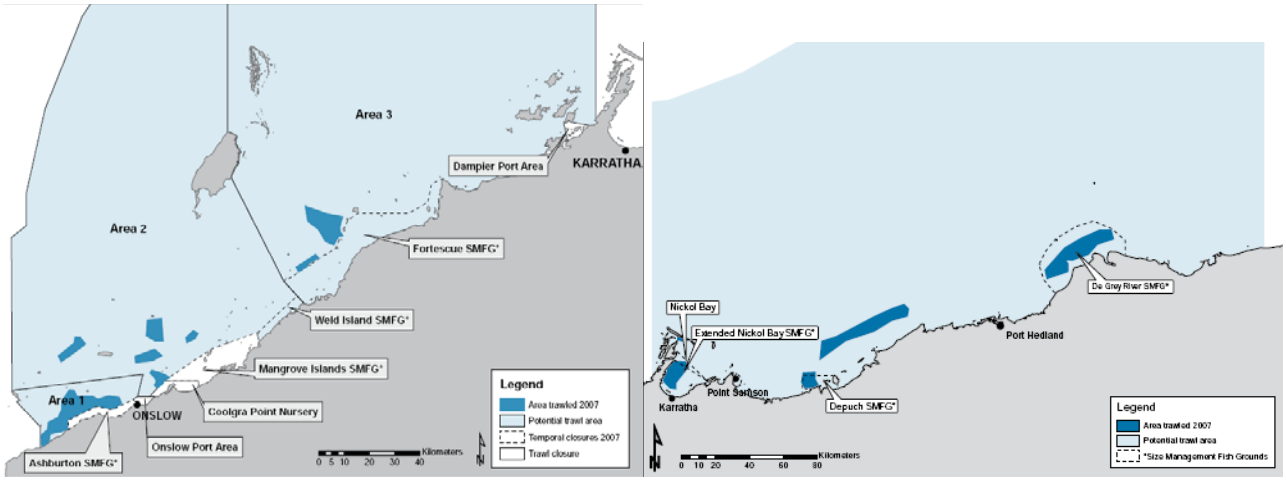
*Impacts to Prawns and Prawn Managed Fisheries*

The underwater noise modelling predicted exposure to 186 dB SEL (maximum SEL in Day et al. 2016) up to 110 to 160 m from the survey area boundary (Table 5-6). The most productive area of the Onslow Prawn Fishery is Area 1, which is a small area adjacent to the coast at Ashburton and Onslow (Figure G). Fishing effort and catch is concentrated close to the coast as gear used in the fishery is typically restricted to depths less than 60 m and indicates a very low level of effort in the survey area. The closest prawn trawl and nursery areas are >10 km from the operational area. Therefore, there is no spatial overlap between the known prawn fishing or nursery areas and the area that will be ensonified at levels above those which have been shown to affect lobsters.

**Table 5-5: Summary of Modelled Impact Ranges for Prawns based on Day et al. (2016a) Noise Exposure Levels**

| Invertebrate Group | Seismic Array Volume | Day et al. (2016a) Exposure Level | Impact Range (m) Based on Water Depths | | |
|---|---|---|---|---|---|
| | | | 25 m | 50 m | 100 m |
| Prawns | 2,220 | 186 dB re 1µPa$^2$.s SEL (sub-lethal effects) | 70 | 75 | 80 |
| | 4,630 | | 110 | 140 | 160 |

Published information taken from the most recent Commonwealth government assessment of the Broome, Kimberley, Onslow and Nickol Bay prawn managed fisheries against the guidelines for ecologically sustainable management of fisheries indicates a very low level of effort in the survey area, with effort concentrated close to the mainland coast (Figure 5-6). CGG concludes that there will be negligible effect on prawns or prawn catches from underwater sound from operation of the seismic source during the survey.




(Source: DoF 2009)

**Figure 5-6: Onslow and Nickol Bay Prawn Fishery Areas Trawled in 2007**

*Impacts to Pearl Oysters and the Pearl Oyster Managed Fishery*

*Pinctada maxima* is mostly found in shallow waters of the littoral (5 to 10 m) and sub-littoral zone, occasionally reaching the maximal recorded depths of 100 m to 120 m (Ranson 1961 and Shirai 1994, cited in: Southgate and Lucas 2008). However, spawning in the main fishing areas of the Eighty Mile Beach region is concentrated around broodstock distributed between 8 and 15 m water depth, with potential smaller contributions from the north-east (towards fishing Zone 3), (Condie et al. 2006) These spawning events lead to recruitment locally and alongshore to the south-west and also feed larvae into neighbouring shallow coastal environments and deeper waters to the west (approximately 20 m depth).

The movements of pearl oyster larvae prior to settlement on the benthos are dictated by physical oceanographic processes such as wave action, prevailing winds and currents (Condie et al. 2006). Oceanographic modelling of larval distribution carried out by Condie et al. (2006) suggests that shallow water '5-12 mile' pearl stock off Eighty Mile Beach acts as the core of the fishery, hence the highest rates of settlement. Oceanographic modelling suggests that broodstock sources for the main fishing grounds off Eighty Mile Beach are in shallow water grounds inshore of the 10 m depth contour and also to the north-east (Condie et al. 2006). Recruitment is greatest in shallow water (10 to 20 m), where density of Mother-of-Pearl (MOP) broodstock is lowest (Hart et al. 2011). The low abundance of MOP in shallow areas is likely caused by high fishing mortality (Hart et al. 2011). Conversely, MOP abundance is greatest at deeper depths, where recruitment is lower.

Natural mortality ranges from 0.18 or 16.5% per year (Eighty Mile Beach, inshore shallow) to 0.1 (10%) at the Compass Rose (Figure 5-7) deep water stocks (Hart and Friedman 2004). This trend was correlated with depth, i.e. highest mortality in shallower waters (10 to 15 m) and lowest in deep (30 to 40 m) in the Eighty Mile Beach stocks (Hart and Friedman 2004; Hart and Joll 2006). Under average growth and mortality and recent levels of total allowable catch, recruitment into the pearl oyster breeding stock exceeds natural mortality, and hence breeding stocks are likely to be increasing in most years (Hart et al. 2017). Coupled with very low natural mortalities results in a large broodstock being built-up over time.

Condie et al. (2006) investigated the population structure of *P. maxima* to determine whether the hypothesis that broodstock in deep waters support inshore stocks. Condie et al. (2006) modelled larval dispersion from known broodstock populations and estimated that net larval drift over the pelagic larval phase was generally <30 km (Figure 5-7), however some have been modelled as potentially travelling up to 60 km (Condie et al. 2006). High local abundances of broodstock and spat observed occasionally in deeper water (approximately 30 m depth) are supported by intermittent larval transport from inshore populations, however spawning in these deeper waters appears to contribute little to recruitment in inshore populations (Condie et al. 2006). Based on the results of the modelling, Condie et al. (2006) suggested that the hypothesis that deeper "unfished" stocks are a broodstock source for the commercially fished inshore stock is not likely to be true. The inshore stocks appear to be self-sustaining, and may even be providing larvae to deeper stocks in irregular recruitment events (Condie et al. 2006).

Harvesting of *P. maxima* is focussed between Exmouth Gulf and Cape Leveque, with most pearl oysters collected off Eighty Mile Beach and in a channel between 10 to 20 m depth between the mainland and the Lacepede Islands off the Kimberley coast (Figure 5-7) (DoF 2016; Hart et al. 2016; Travaille et al. 2016). Collection of wild *P. maxima* generally occurs for three to four months of the year, between March and July, during the neap phase of the tidal cycle when currents are reduced (Hart et al. 2016). The Davros Extension MC3D MSS is located within Zone 1 of the POMF and the shallowest depth of the survey area is 35 m (Figure 5-7). The POMF is primarily based on *P. maxima* from Zone 2, which has supplied 70% of the total harvest in the past 30 years, and close to 100% in recent years (Figure 5-8) (DoF 2016; Hart et al. 2016).

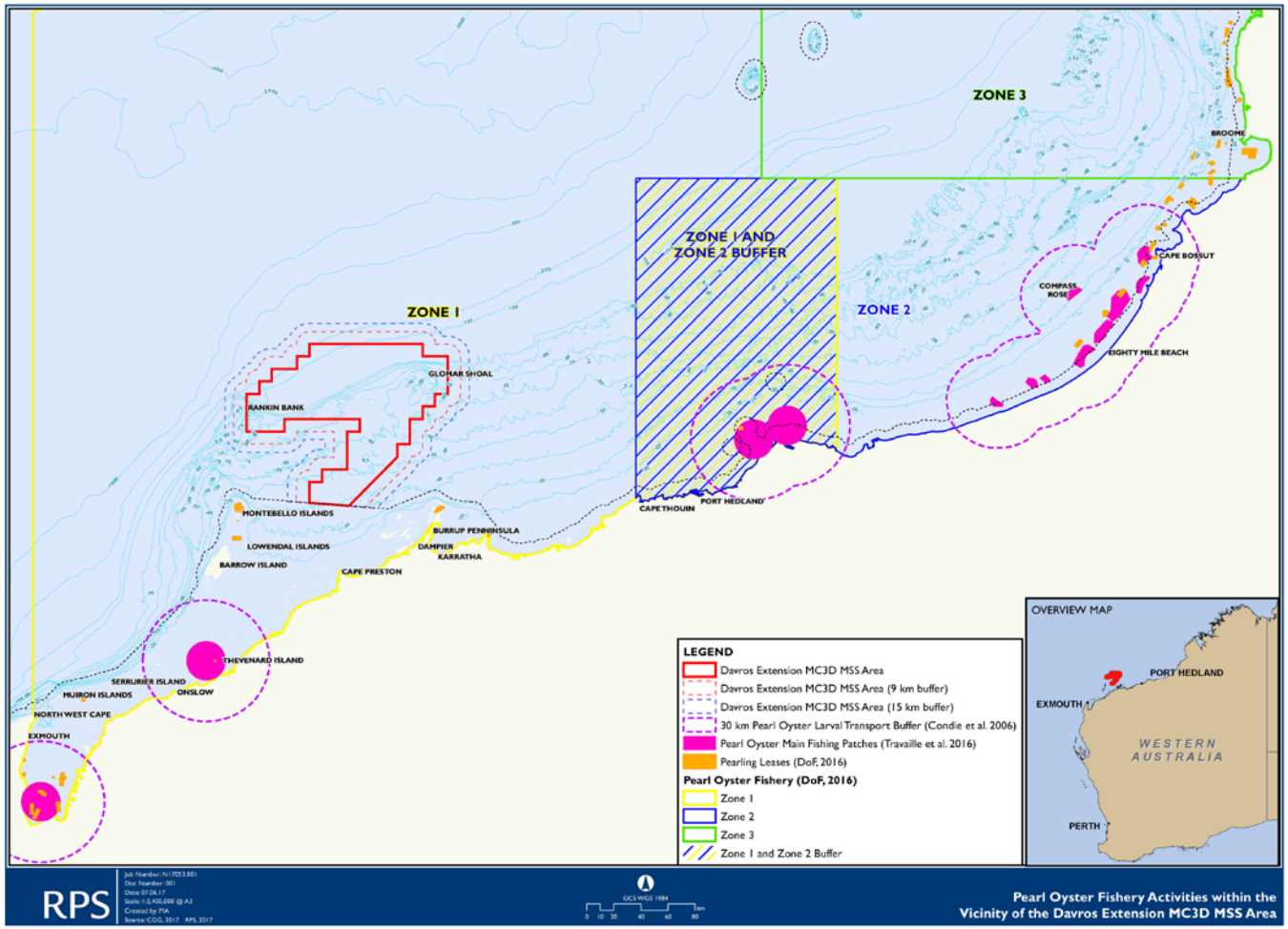



**Figure 5-7: Pearl Oyster Fishery Activities in the vicinity of the Davros Extension MC3D Survey Area**

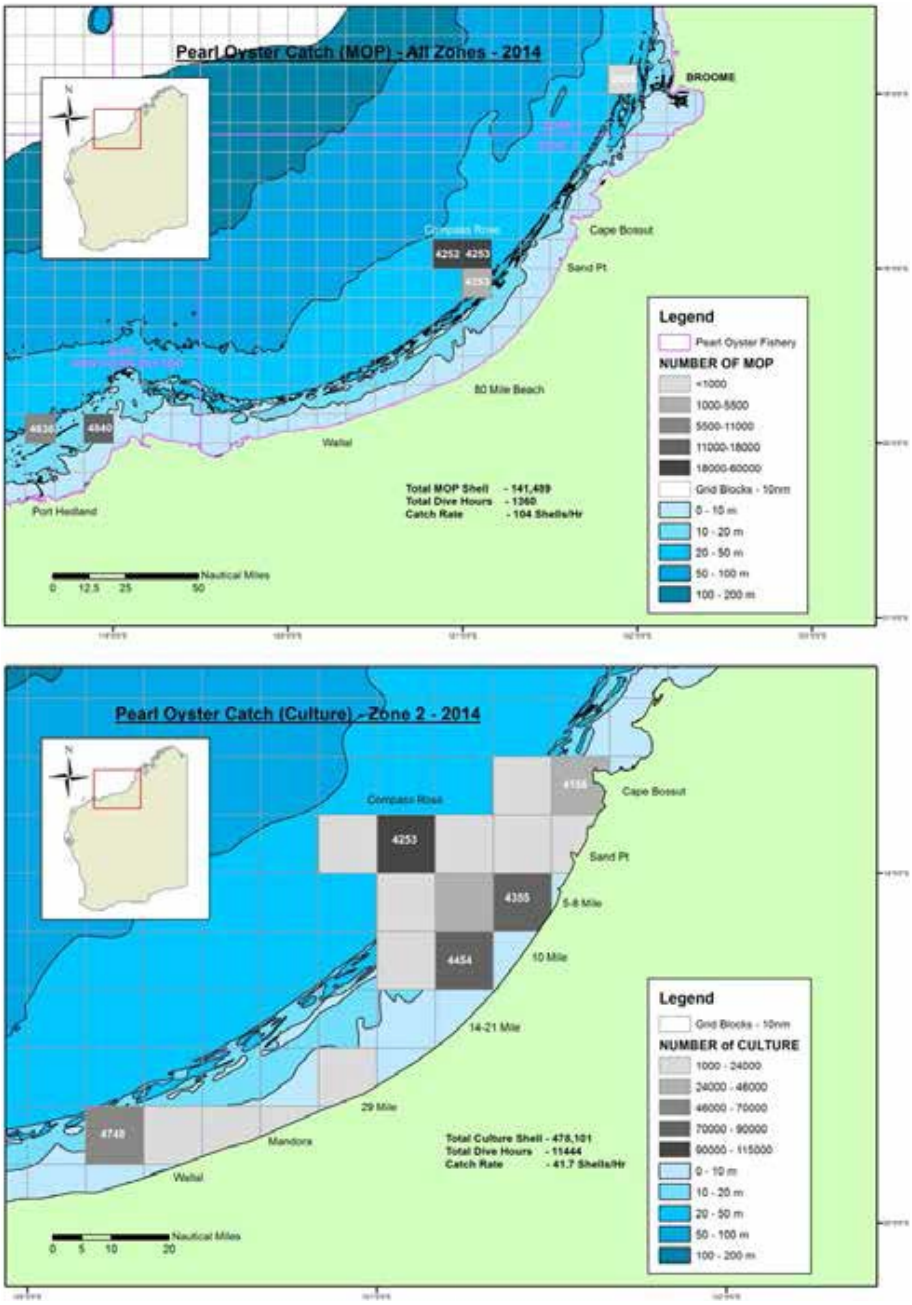



**Figure 5-8: Pearl Oyster Catch in 2014 across All Fishery Management Zones (Top); and Culture Pearl Oysters in Zone 2 (Bottom) (Source: Hart et al. 2016)**

From 1987 to 2009 there was a limited fishing on *P. maxima* breeding stock (or broodstock) (MOP) (Figure 5-9), and since then fishing of broodstock has been tightly controlled (Hart et al. 2016). In 2014, catch was taken in Zones 1, 2 and 3 and the number of wild-caught pearl oyster shell was 627,634 comprising of 486,145 culture shells and 141,489 mother-of-pearl (MOP) shells (i.e. individuals >175 mm in length, termed as broodstock) (Figure 5-9) (Hart et al. 2016). In 2015, the total number of wild-caught pearl oysters from Zones 1, 2, and 3 was 560,005 comprising of 519,743 culture shells and 40,262 MOP shells (Hart et al. 2017). Fishing recommenced in Zone 1 in 2014, and in 2015, the number of wild-caught pearl oyster shell in Zone 1 was 19,504 comprising of 19,341 culture shells and 163 MOP shells (contributing to 3% of the total POMF catch) (Hart et al. 2017).

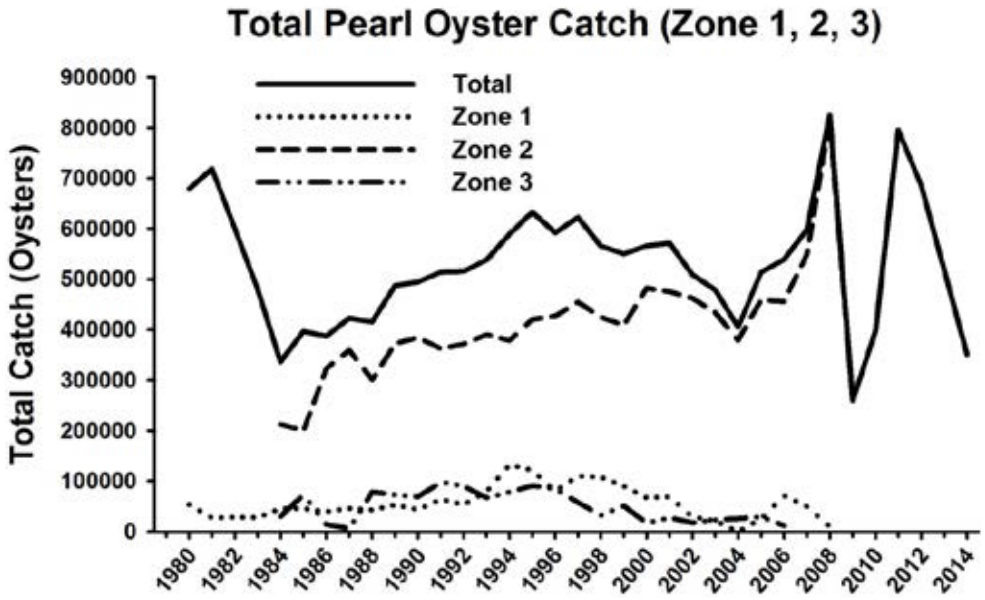



**Figure 5-9: Total POMF Catch of *P. maxima* and Catch by Management Zone (Source: Hart et al. 2016)**

During the most recent stakeholder consultation (via telephone on 5 July) with the Pearl Producers Authority (PPA), CGG were advised that the PPA viewed the Pilbara Coast "north of Barrow Island" including the survey area as not of major concern compared to areas such as the Exmouth Gulf or Eighty Mile Beach (Table 8-1). PPA explained that this was because pearl oyster distribution is relatively patchy, and there are no longer active pearl farm leases near Dampier (Table 8-1). PPA advised CGG that water depths of 18 m to 30 m are considered prime habitat for pearl oyster, though communities may occur in shallow water areas up to 70 m, and stressed the importance of the Zone 1 broodstock and that this was a potential concern for recruitment to the fishery (Table 8-1).

Underwater noise modelling was undertaken for the Davros Extension MC3D MSS based on an airgun array source level of 4,630 cui modelled at three different water depths of 25, 50 and 100 m in the survey area. Using the maximum received SEL, (i.e. 181 dB re 1 $\mu Pa^2$.s), recorded by Day et al. (2016) that resulted in dose-dependent mortality in scallops, the noise modelling results for the Davros Extension MC3D MSS predicted an effect between 98 m (25 m depth) and 260 m (100 m depth). These predicted distances are consistent with the distances measured by Day et al. (2016) (i.e. dose-dependent increased mortality up to 166 to 232 m from the seismic source). However, the potential for longer term effects (i.e. greater than four months) cannot be inferred from studies undertaken to date (Day et al. 2016; Przeslawski et al. 2016). To address some of this uncertainty on longer term effects, CGG has elected to use a smaller airgun array volume of 1,800 cui in the more sensitive shallower depths of 35 to 50 m.

The net larval transport buffer distances around all main fishing areas identified for the POMF in Figure 5-7 are based on the modelled 30 km buffer (Condie et al. 2006), and are located 92 km from the closest main fishery patch around Thevenard Island and 347 km from the closest point to the Eighty Mile Beach fishing area (Figure 5-7). Larvae from the main fishing areas are therefore not predicted to be effected by underwater sound from operation of the seismic source during the survey. Furthermore, even if the distance travelled by pearl oyster larvae is increased to the maximum modelled distance of 60 km (Condie et al. 2006), there will still be negligible effect on the main fishing areas or to broodstock recruitment.

Given the lower importance of Zone 1 to the overall fishery catch levels, the fishery operating in shallow waters (<35 m water depth), and spawning in the deeper waters (>35 m) contributing little to recruitment in commercially important inshore populations (i.e. Eighty Mile Beach); it is extremely unlikely that there will be effects to pearl oysters, or to the catch, or recruitment to the fishery.

**Table 5-6: Summary of Modelled Impact Ranges for Pearl Oysters based on Day et al. (2016a) Noise Exposure Levels**

| Invertebrate Group | Seismic Array Volume (cui) | Day et al. (2016a) Exposure Level | Impact Range (m) based on Water Depths | | |
|---|---|---|---|---|---|
| | | | 25 m | 50 m | 100 m |
| Pearl Oysters | 2,220 | 181 dB re 1µPa$^2$.s SEL (mortality and sub-lethal effects) | 100 | 110 | 140 |
| | 4,630 | | 165 | 205 | 260 |

#### 5.2.1.7.3 Impacts to Fish and Commercial Fisheries

The ANSI-Accredited Standards Committee S3/SC 1, Animal Bioacoustics Working Group (Popper et al. 2014) gathered relevant scientific experts and regulators to define acoustic impact guidelines for fish. Popper et al. (2014) cite studies on seismic sound effects on fish and state that no studies have linked mortality of fish, with or without swim bladders, to seismic noise from airguns or in experimental studies replicating seismic sound fields (Popper et al. 2005; Boeger et al. 2006; Popper et al. 2007; Hastings et al. 2008; Halvorsen et al. 2011, 2012; Casper et al. 2012; McCauley and Kent 2012; Miller and Cripps 2013; and Popper et al. 2015). Empirical evidence comes from a more recent study by Wagner et al. (2015) which exposed gobies to seismic sound at a level greater than the mortality and potential mortality threshold proposed by the Popper et al. (2014). The fish were exposed to six discharges at an average peak SPL of 229 dB re 1 µPa. Fish were monitored for 60 hours post exposure and no mortality or significant physiological damage (hair cell loss or otolith damage) were observed. In another study, individuals of four fish species were exposed to piling noise levels above a peak SPL of 207 dB re 1 µPa, but did not suffer any mortal or potentially mortal injuries (Casper et al. 2012).

Underwater noise levels significantly higher than ambient levels can have a negative impact on fish, ranging from physical injury or mortality, to temporary effects on hearing and behavioural disturbance effects. The hearing system of most fishes is sensitive to sound pressures between 50 and 500 Hz, the lower end of which (<200 Hz) overlaps the predominant frequency range of seismic noise emissions (Ladich 2012; McCauley et al. 2000). Sound is perceived by fish through the ears and the lateral line (the acoustico-lateralis system) which is sensitive to vibration.

The effects of underwater noise on fish within the vicinity of the Davros Extension MC3D MSS will vary depending on the size, age, sex and condition of the receptor among other physiological aspects, and the topography of the benthos, water depth, sound intensity and duration. The effect of noise on a receptor may be either physiological (e.g. injury or mortality) or behavioural. Behavioural changes are expected to be localised and temporary, with displacement of pelagic or migratory fish likely to have insignificant repercussions at a population level (McCauley 1994).

A study on four tropical fish species at Scott Reef using a 2,055 in$^3$ airgun array (considered to be comparable to the 1,800 cui array to be used in <50 m water depth) and caged fish which could not avoid the seismic noise, found no TTS even after exposure to a cumulative SEL of 190 dB re 1µPa$^2$.s (Hastings et al. 2008). The species studied included a hearing specialist, the pinecone soldierfish (*Myripristis murdjan*). The pinecone soldierfish has an air-filled chamber directly adjacent to its ear, which functions much like the eardrum in mammals. This special anatomy makes the pinecone soldierfish particularly sensitive to sound at frequencies over a broader range than the other fishes (Hastings et al. 2008). The other three fish species (blue green damselfish (*Chromis viridis*), sabre squirrelfish (*Sargocentron spiniferum*) and bluestripe seaperch (*Lutjanus kasmira*)) are hearing generalists. Soldierfish, squirrelfish, and damselfish are site-attached reef fish that would not be expected to leave their immediate habitats to avoid high-level sounds. The bluestripe seaperch, a tropical snapper, is a pelagic fish that could be expected to swim away from an approaching seismic survey vessel with an operating airgun array. The species studied are representative of fish species recorded at Glomar Shoal and Rankin Bank by AIMS (2014).

Another study by McCauley et al. (2003) found evidence of damage to sensory hair cells in the ears of snapper exposed to around 212 dB re 1 µPa in a caged trial. However, sensory hair cells are constantly added in fishes (Popper and Hoxter 1984; Lombarte and Popper 1994) and are also replaced when damaged (Lombarte et al. 1993; Smith et al. 2006; Schuck and Smith 2009). Therefore, any impacts to the hair cells of fish that could not avoid the seismic source would likely be temporary.

Field studies of seismic sound impacts on fish behaviour and health have mostly looked at the effects on caged fish (e.g. Boeger et al. 2006; McCauley and Kent 2012). These studies found no mortality and little evidence of physiological damage due to exposure to a lower powered seismic source. A more relevant study was undertaken by Miller and Cripps (2013) to investigate the effects of seismic surveys on open (wild) coral reef fish communities, including site-attached fish species from the family Pomacentridae. Pomacentrid fish are coral obligates and are truly site-attached in the sense that CGG uses it in the EP to represent fish that are less able to escape an approaching airgun. The study found no evidence of direct mortality or indirect mortality due to sub-lethal effects in site-attached pomacentrid fish exposed to a seismic source level of 200 dB re 1 $\mu Pa^2$.s $SEL_{cum}$. The seismic sound had no measurable effect on the diversity and abundance of the shallow reef fish community at Scott Reef. The authors concluded that the effect of the seismic survey was clearly non-lethal and there was no statistical evidence of an impact on either the diversity or abundance of shallow water, coral reef slope, fish communities (Miller and Cripps 2013). Another, related field experiment exposed caged reef fish to the same seismic source in approximately 5 m of water. The caged fish did not suffer any direct mortality, soft tissue damage, or permanent or temporary hearing threshold shifts (Woodside 2007; Hastings and Miksis-Olds 2012).

Trials with captive fish indicate that some species exhibit alarm and avoidance responses to seismic discharges, such as swimming faster, swimming to the bottom of the cage, and tightening of school structure (McCauley et al. 2000). The tightening of school structure behaviour suggests the survey is unlikely to adversely affect the aggregation behaviour of spawning fish. These trials also indicate the following:

- fish generally show little evidence of increased stress from exposure to seismic signals unless restricted from moving away from the source
- fish may become acclimatised or habituated to seismic signals over time and the severity of the startle responses decreases with exposure time
- no significant measured stress increases (blood cortisol concentrations) which could be directly attributed to airgun exposure.

Behavioural observations of captive fish and squid were made before, during and after air gun noise exposure in a study carried out by Fewtrell and McCauley (2012). The results indicated that as air gun noise levels increase, fish respond by moving to the bottom of the water column and swimming faster in more tightly cohesive groups. In addition, behavioural responses such as fish huddling in groups and swimming towards the lower part of the water column in response to air gun noise have been observed in studies by Chapman and Hawkins, (1969), Dalen and Knutsen (1987), Dalen and Raknes (1985) and Slotte et al. (2004).

A range of responses have also been observed when studying the behaviour of wild fish species in the presence of anthropogenic sounds. Some fishes have shown changes in swimming behaviour and orientation, including startle reactions (Pearson et al. 1992; Wardle et al. 2001; Hassel et al. 2004). Sound can also cause changes in schooling patterns and distribution (Pearson et al. 1992). However, researchers have observed that once acoustic disturbances are removed, fish return to normal behaviour within about an hour (Pearson et al. 1992; McCauley et al. 2000; Wardle et al. 2001).

In natural situations, the great majority of fish are expected be able to avoid the approaching noise source before it reaches injurious or potentially lethal levels through horizontal or vertical movements. Evidence that fish can actively avoid the source comes from studies of caged fish actively swimming away from the approaching noise source and temporarily reduced catchability in commercial fisheries. Wardle et al. (2001) conducted a field study, using a video camera to document the behaviour of fish in response to noise levels

equivalent or greater than those in the proposed survey. This study showed that the resident fish on the site did not evade the active source until it was within a few metres. No direct mortality was observed at sound levels of up to 218 dB ($SPL_{peak}$).

*Impacts to Glomar Shoal and Rankin Bank Fish Aggregation Areas and Site Attached Fish*

For the purposes of the underwater noise impact assessment in this EP, the term 'site-attached' is used to describe fish species with strict and localised habitat dependence, for example dascyllids which show a high degree of site fidelity to shelter in coral heads. Under stress, individuals of these species are less likely to flee the area, but will seek refuge within their preferred habitat shelter instead. Due to the absence of coral reef habitat (characterised as >10% coral cover) at Glomar Shoal (Section 4.3.1.3.1), there is a low likelihood of the presence of site-attached fish at this location, which was instead characterised by genera more commonly associated with sandy sea bed habitats, such as threadfin breams (*Nemipterus* spp.) and triggerfish (*Abalistes* sp.) (AIMS 2014). Coral reef habitat does occur at Rankin Bank (13.6% overall coral cover), and fish communities normally associated with reefs or 'hard ground' are known at this location, including surgeonfishes (*Acantharus* and *Naso* spp.), emperors (*Lethrinus* spp.) and coronation trout (*Variola* sp.) (AIMS 2014). Glomar Shoal and Rankin Bank support significant populations of commercially important fish species, including Rankin cod, brown-striped snapper, red emperor, crimson snapper and bream (AIMS 2014).

Fish with swim bladders tend to be more sensitive to impacts from underwater noise. Within this group, fish that are site-attached, for example coral-obligates, would be more susceptible to underwater noise impacts as they are less able to escape the approaching airgun. Of the fish recorded by AIMS (2014), 35 of the 49 families of fish recorded have swim bladders. Within this group, fish that are site-attached, for example coral-obligates, would be more susceptible to underwater noise impacts. The recorded fish species with swim bladders comprised bream, wrasse, trevally, kingfish, emperor, triggerfish, dartfish, fusilier, snapper, toadfish, rock cod, grouper, goatfish, surgeonfish, barracuda, mackerel and angelfish. None of these fish families are truly site-attached to the extent that they could not avoid an approaching airgun. In addition, noise pollution has been identified as "not of concern" for Glomar Shoal KEF (Section 4.3.4) (Commonwealth of Australia 2012c).

CGG recognises that while there is some uncertainty in the actual species and abundances of fish inhabiting the shallow reefal habitats, there is good evidence that the shallowest part of the Glomar Shoal and Rankin Bank are of the highest conservation significance. While the available data indicate that site-attached species with strict habitat dependency and very limited home ranges are uncommon, it is recognised that some of these species may not have been adequately sampled as the AIMS survey was undertaken during spring (September) as a 'snap-shot' survey, with less survey effort (i.e. SBRUVS locations) in the more topographically complex (or more rugose) shallow water habitats (Section 4.3.1.3.2). CGG has therefore taken a precautionary approach to address the uncertainty inherent in the assessment of acoustic impacts to fish populations on Glomar Shoal and Rankin Bank. This is also considered appropriate in view of the KEF status of Glomar Shoal, the paucity of studies on the long-term effects of acoustic disturbance, and the limited data from which fish species richness and abundance in the shallow areas of both areas is derived (AIMS 2014).

The Davros Extension MC3D MSS incorporates an exclusion zone over Glomar Shoal within which there will be no seismic activity. This exclusion zone comprises Fish Protection Areas (FPAs) and a 500 m buffer area around the FPA to ensure seismic sound levels do not have adverse impacts on fish within the FPA. The FPA encompasses the shallow areas which support the richest fish assemblages. This covers the shallow waters of Glomar Shoal (<30 m) on the north-east facing reef slope. The FPA boundary was based on bathymetry and increased to include the AIMS (2014) modelled areas of highest fish species richness and abundance (Figure 5-10 and Figure 5-10). The total area of key fish habitat protected by the FPA (plus the 250m buffer) at Glomar Shoal is 16.7 $km^2$. In addition, CGG have committed to using a smaller airgun array (1,800 cui) in water depths of <50 m, providing a potential additional buffer zone between Glomar Shoal and anticipated maximum exposure levels (from the 4,630 cui airgun array active data acquisition areas).

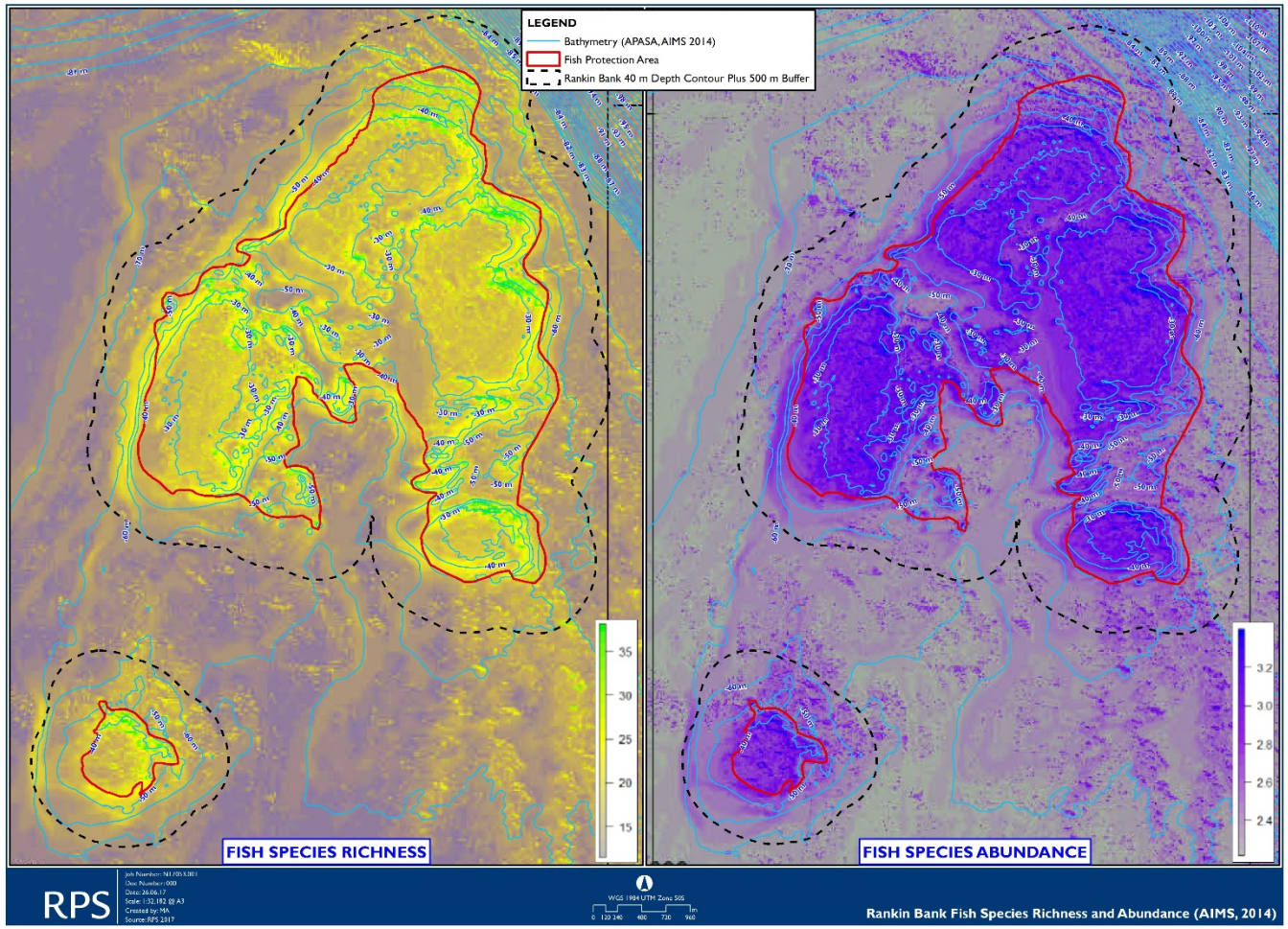



**Figure 5-10:Rankin Bank Seismic Exclusion Zone (FPA plus Buffer) based on AIMS Bathymetry and Modelled Fish Species Richness and Abundance**

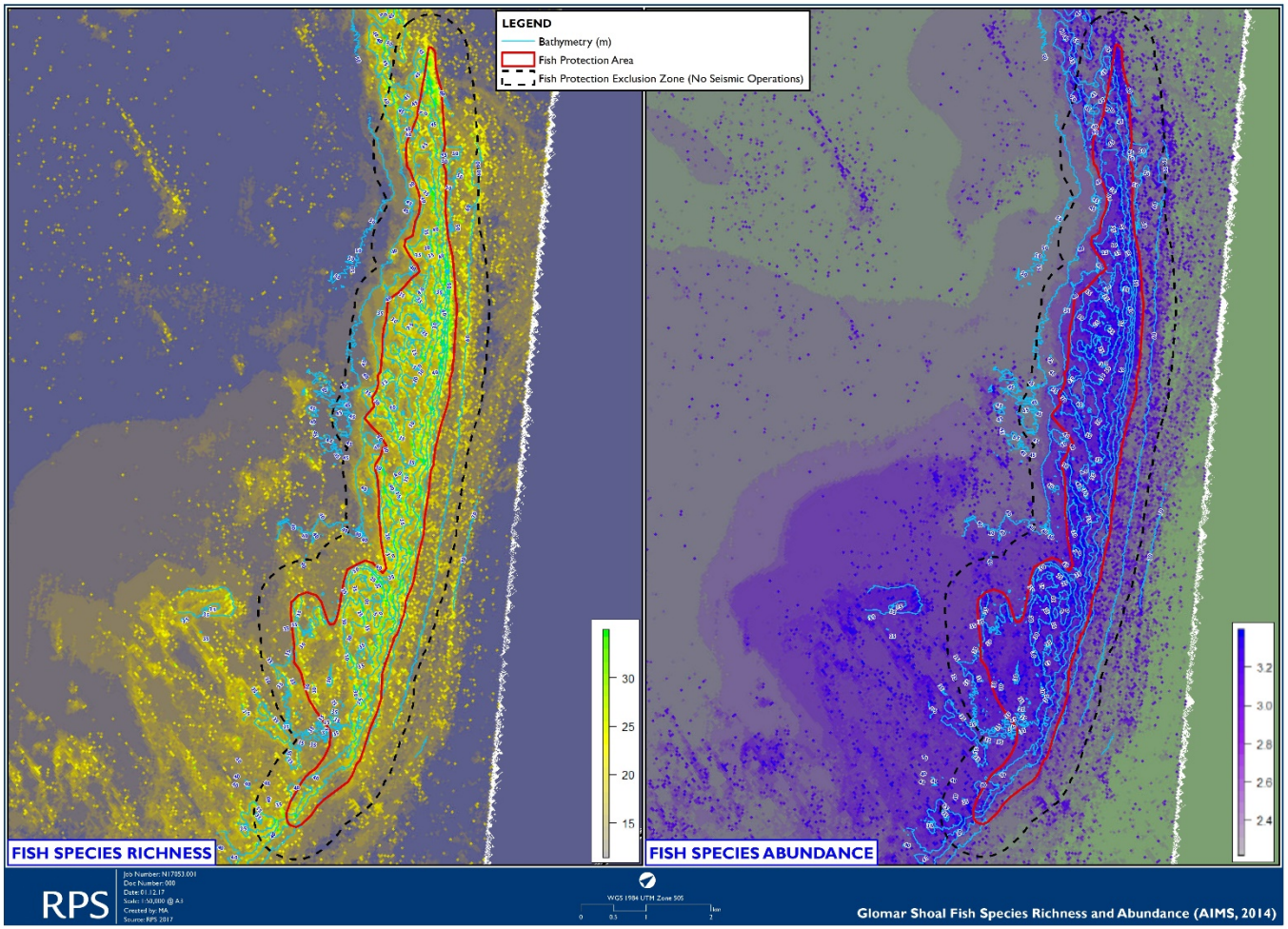



**Figure 5-11:Glomar Shoals Seismic Exclusion Zone (FPA plus Buffer) based on AIMS Bathymetry and Modelled Fish Species Richness and Abundance**

The received levels predicted by the modelling (Table 5-7) represent the worst-case levels for site-attached fish species on the seabed. The guideline level for TTS is based on a cumulative SEL level of 186 dB SELcum for five seismic shots (Section 6.2.1.6.3)), whereas the modelled results are based on a single shot (maximum SEL) level. It is possible to conservatively convert single shot SELs to cumulative SELs using the equation below, which assumes a worst case scenario that the source is stationary:

SELcum = SEL + 10log(N)

(where SEL is the single-shot SEL and N is the number of shots)

This gives a worst-case result in the cross-line direction which will, in any case, be the direction in which the highest levels occur (A. Duncan, CMST, pers comm.).

The water depths along the boundary of the FPAs range from 35 to 60 m based on AIMS (2014) LADS bathymetry data over Glomar Shoal and Rankin Bank, and so the modelled 50 m source location depth is appropriate to use for the assessment over these areas. Despite the conservatism of the thresholds proposed by Popper et al. (2014), the width of the 500 m buffer is based on a worst case scenario with added precaution built in, whereby mortality and/or partial mortality could occur out to distances of 124 m and TTS out to 220 m from the seismic source (i.e. largest airgun array in 50 m water depth, Table 5-7). An additional layer of precaution has been added by CGG around Glomar Shoal in committing to using a smaller airgun array (1,800 cui) in water depths of <50 m, therefore the predicted distance for mortality/partial mortality for the most sensitive fish hearing group (i.e. swim bladder is involved in hearing) will be much lower and only out to a maximum distance of 85 m. This further demonstrates the added precaution CGG has built into the width of the buffer for the FPA.

Figure 5-12 presents four potential locations of the seismic source along indicative sail lines at the closest points to the buffer zone boundary to demonstrate the potential effects on fish within this zone. At each potential location, the sound levels on the seabed are mapped over the bathymetry; the four locations ranging from around 35 m to 60 m water depth. None of the impact zones representing potential temporary physiological effect or potential mortality overlap the FPA or the original 250 m buffer (Figure 5-12). This confirms the efficacy and conservatism of the 500 m buffer to protect fish species from sound levels that could cause permanent (PTS) or temporary (TTS) effects.

**Table 5-7: Summary of Modelled Impact Ranges for Fish for 2,220 and 4,630 cui Airgun Arrays**

| Fish Group | Guidelines | Impact Range (m) based on Water Depths | | |
|---|---|---|---|---|
| | | 2,220 cui | 4,630 cui | |
| | | 50 m | 50 m | 100 m |
| Fish: no swim bladder | Mortality and potential mortal injury (>213 dB peak SPL) | 65 | 84 | 114 |
| | Recoverable injury (>213 dB peak SPL) | 65 | 84 | 114 |
| | TTS (>186 dB SELcum) | 90 | 220 | 300 |
| Fish: swim bladder is NOT involved in hearing | Mortality and potential mortal injury (>207 dB peak SPL) | 85 | 124 | 160 |
| | Recoverable injury (>207 dB peak SPL) | 85 | 124 | 160 |
| | TTS (>186 dB SELcum) | 90 | 220 | 300 |
| Fish: swim bladder IS involved in hearing | Mortality and potential mortal injury (>207 dB peak SPL) | 85 | 124 | 160 |
| | Recoverable injury (>207 dB peak SPL) | 85 | 124 | 160 |
| | TTS (186 dB SELcum) | 90 | 220 | 300 |
| Fish behaviour (all groups) | Strong avoidance (173 dB peak) | N/A | MD | MD |

MD: Measured OBN data used to calculate impact ranges.

Once the vessel has moved outside of this distance, fish are likely to resume normal behaviour and distribution within the area, as observed by McCauley et al. (2000), which showed that fish returned to normal behavioural patterns within 14 to 30 minutes after the cessation of airguns firing. This is supported by a more recent study investigating the effect of repeated exposure of the coral reef fish (*Dascyllus trimaculatus*) to motorboat-noise playback (Nedelec et al. 2016). Fish did not appear to be under chronic stress after two days of exposure, however juveniles were more likely to hide during the period of a motorboat-pass playback than in the period immediately before. In addition fish that had not experienced motorboat-noise playback before also showed an increased ventilation rate in response to noise in the short-term (1 min exposure). However, the study also found evidence for behavioural and physiological attenuation, as after one week of motorboat-noise exposure, hiding responses were no longer observed during motorboat passes in repeat measures of the same fish, and ventilation rate increased less in response to noise exposure (Nedelec et al. 2016). The study also found that noise exposure did not cause chronic stress responses: size, mass, condition and baseline cortisol levels were not significantly different from ambient-noise exposed controls after up to 21 days of repeated noise exposure (Nedelec et al. 2016).

Fish assemblages are more species-rich and abundant in the shallower and more topographically complex (more rugose) areas on top of the shoal/bank. These habitat types are much reduced in the areas outside the seismic exclusion area (Figure 5-10 and Figure 5-10). Fish species richness and abundance are predicted by the AIMS modelling to be much lower in deeper areas and the potential for population level impacts is much reduced in these deeper parts of the shoal. The fish assemblage in the more open habitats of the deeper areas where unconsolidated substrates are more common is expected to include the highly mobile species sought after by fishers; the emperors, breams, ballistids and snappers. These larger species would be expected to move away from the seismic source as the seismic vessel approaches. Once the source of the sound has passed, fish would likely resume their normal behaviour (Wardle et al. 2001; Miller and Cripps 2013; Bruintjes et al. 2016; Nedelec et al. 2016; Radford et al. 2016, Popper et al. 2005).

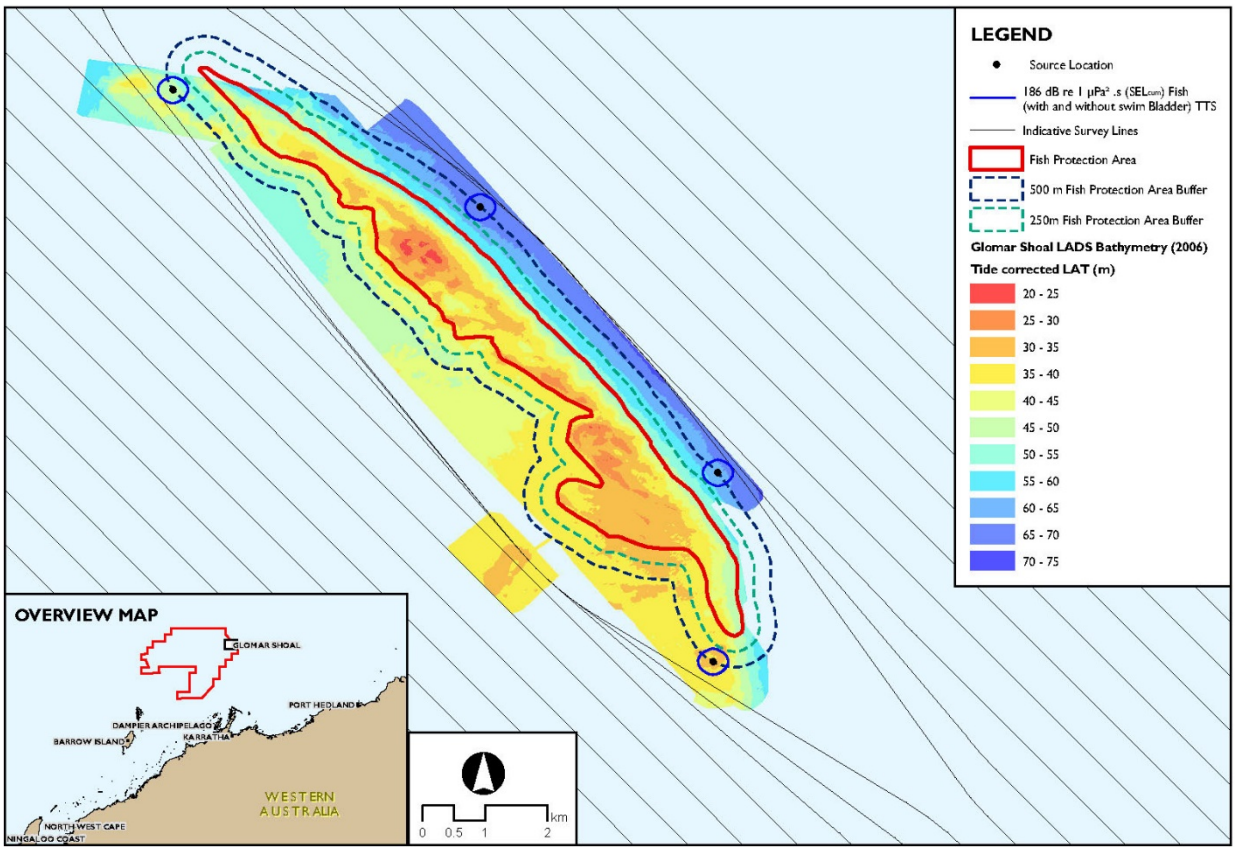



**Figure 5-12:Seabed Noise Contours at Four Nominal Source Locations along Boundary of Glomar Shoal Exclusion Zone (i.e. FPA plus Buffer Area)**

*Impacts to Commercial Finfish Fisheries*

Fish may avoid areas of seismic activity, and fish schools may disperse or change feeding behaviour patterns, resulting in fewer fish being attracted to baited traps or hooks or movement of target species in response to changed distributions of prey species during the survey. This can temporarily reduce the catchability of commercially valuable species or recreationally targeted species.

Underwater noise generated by the seismic airgun is likely to affect the behaviour of fish in shallower parts of the survey area. The affected fish will include commercially exploited species and there is potential for short-term changes in catchability during the survey. Some fishers believe there is a longer term effect on fish catchability or presence in fished areas; however, it is not possible to tease a possible seismic survey effects out from confounding factors such as fishing pressure, climatic changes and variation in natural population dynamics. A series of studies have been undertaken to determine the effects of seismic surveys on fish catches and distribution, primarily in the United States and Europe (e.g. California: Greene 1985, Pearson et al. 1992; Norway: Dalen and Knutsen 1987, Lokkeborg and Soldal 1993; and UK Pickett et al. 1994). While the conclusions from these studies are largely ambiguous, due to the inherently high levels of variability in catch statistics, one study noted that pelagic species appear to disperse, resulting in a decrease in reported catches during the surveys (Dalen and Knutsen 1987).

Engås et al. (1996) and Engås and Løkkeborg (2002) looked at the effects of a seismic exploration on fishing success for haddock (*Melanogrammus aeglefinus*) and Atlantic cod (*Gadus morhua*). They found that, compared to pre-seismic catches, there was a significant decline in the long-line catch rate during and after the seismic study. The catch rate did not return to normal for five days after the end of the seismic study, although evidence of this decline being related solely to the survey is inconclusive. More recently, the same group used sonar to observe the behaviour of blue whiting and Norwegian spring spawning herring during a seismic operation and observed that fish would dive from the seismic source and not return until after the activity had stopped (Slotte et al. 2004).

A study undertaken by the CSIRO and Geoscience Australia (Thomson et al. 2014) examined fisheries catches (10 species of interest) and catch rates for potential effects from 183 seismic surveys undertaken in the Gippsland Basin (Bass Strait). This study found no clear or consistent relationships between seismic surveys and subsequent fisheries catch rates (Thomson et al. 2014).

The stakeholder consultation process identified WA State-managed finfish fisheries actively fishing in the survey area and/or with interests in the region. Of the finfish fishery areas/zones that the Davros Extension MC3D survey area overlaps, concerns have been raised through stakeholder consultation for the Mackerel Managed Fishery and Pilbara Trap, Line and Trawl Fisheries (Table 8-1). Overlap of the survey area with these fisheries is as follows:

- Mackerel Managed Fishery – survey area and operational buffer areas lie completely within the boundary of this fishery (overlaps 2% of Area 2 and 1% of the total fishery area).
- Pilbara Fish Trawl – survey area overlaps Areas 1, 2 and 6 within Zone 2 of the fishery. Area 6 is closed to trawling, so fishing may only be affected in Areas 1 and 2 (overlaps 73% of Area 1 and 15% of Area 2).
- Pilbara Trap – survey area and operational buffer areas lie completely within the boundary of this fishery (overlaps only 8% of the total fishery).
- Pilbara Line – survey area and operational buffer areas lie completely within the boundary of this fishery (overlaps only 2% of the total fishery). The proportion of overlap with 60 to 90 fathom (or 110 to 165 m) water depths within the fishery, where the key species of interest to the PLF i.e. goldband snapper is actively fished, is 10%.

The Mackerel Fishery in the Pilbara region appears to be generally increasing over time (Figure 5-13). Some of this is attributable to the introduction of a daily logbook in 2006 for fishers to provide detailed and reliable data on effort (and catch) in the mackerel fishery (Fletcher et al. 2017).

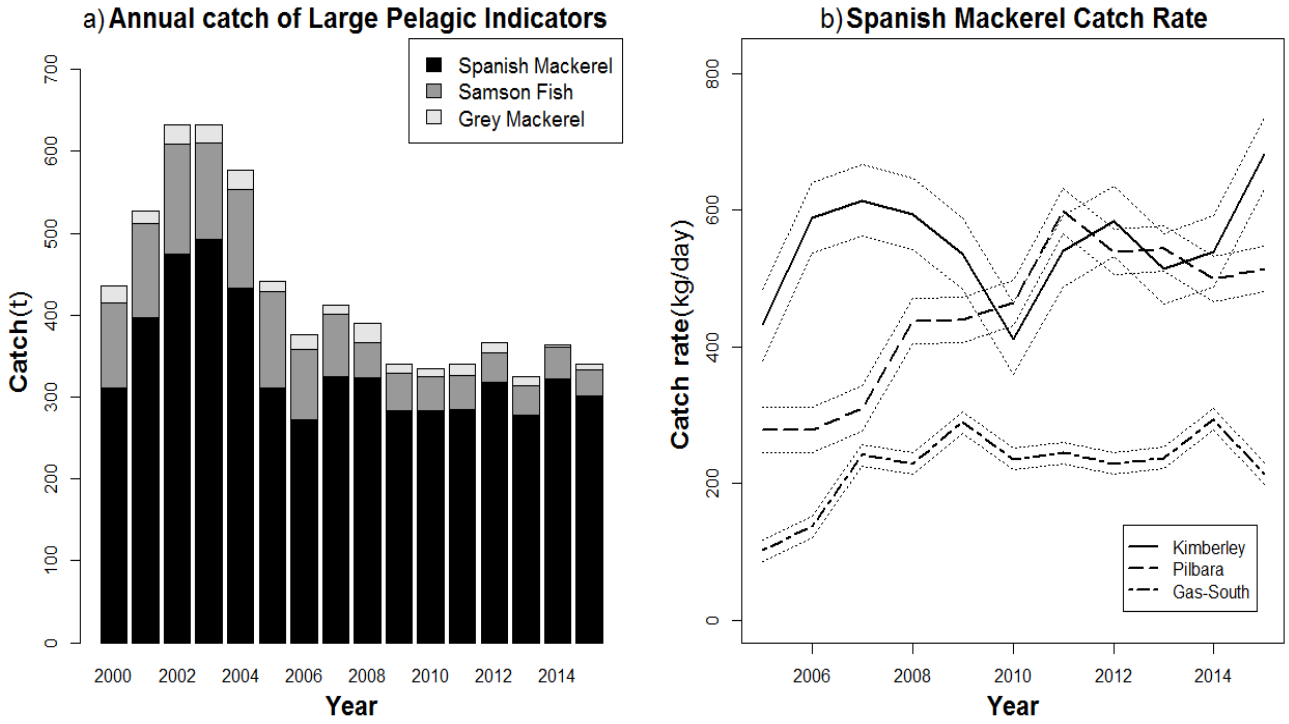



**Figure 5-13:Mackerel Fishery Historic Catch Rates (Left: Total Fishery; Right: Catch by Area) (Fletcher et al. 2017)**

The three demersal indicator species for the North Coast Demersal Managed Fishery, (comprising Pilbara Trap, Trawl and Line Managed Fisheries in the Pilbara region), are red emperor (*Lutjanus sebae*), bluespotted emperor (*Lethrinus punctulatus*) and Rankin cod (*Epinephelus multinotatus*) (Figure 5-14). A 2016 assessment of the three indicator species in the Pilbara for the North Coast Demersal Managed Fishery estimated the spawning biomass of red emperor stock to be currently above the threshold level. The stocks of bluespotted emperor and Rankin cod are well above the target spawning biomass levels (Fletcher et al. 2017). The DPIRD consider the biological stock classified as a sustainable stock (Fletcher et al. 2017).

The Pilbara Trawl Fishery operates at lower exploitation rates and only in restricted parts of the continental shelf (<5% of the North West Shelf) (Fletcher et al. 2017). Annual fishing effort capacity limits the amount of effort available in the fishery to achieve the notional target total allowable catch. Total trawl catches have reduced from an annual average of approximately 2,500 t during the period 1995-2004 to an annual average of 1,159 t since 2008, in response to the effort quota reductions imposed on the trawl fishery since 2008 (Figure 5-15). The total annual catch taken by the Pilbara Line and Trap fisheries have remained relatively consistent over the past 10 years and total catch were within the acceptable catch ranges in 2015 (i.e. 241-537 t for trap and 36-127 t for line) (Fletcher et al. 2017).

As discussed in Section 6.2.1.5, the CMST modelled results show good agreement with the near-field OBN data measured at 159 m water depth, and are appropriate to use to calculate received levels for injury and temporary effects (TTS) out to distances of 500 m. Based on the modelling, CGG has taken a precautionary approach to the impact assessment assuming a fish could be exposed to injurious noise levels within 160 m each side of the sail lines based on the largest airgun array modelled of 4,630 cui in water depths of up to 100 m (Table 5-7). In deeper water (approximately 110 to 170 m) such as over the area identified as important for goldband snapper (Figure 5-20). TTS is predicted to occur out to 300 m in the area important for goldband snapper. The ocean bottom node measured sound levels from the previous Davros surveys in 2015 (Section 6.2.1.5) have been used to determine impact ranges for behavioural disturbance. Based on the measured OBN sound levels, behavioural disturbance could occur out to 4.7 km.

Due to the small areas of overlap compared to the total areas for the fisheries active within the survey and operational areas (ranging from 2 to 8% for Mackerel and Pilbara Trap and Line Fisheries), no effects on catch rates are expected during or after the survey. Interactions with Pilbara Trawl Fishery Areas 1 and 2 are possible; however it has not been possible to determine if any of the survey area is actively fished by licence holders.

Consultation with fisher stakeholders will be ongoing through the survey planning period in order to determine whether conflicts with licence holders could arise (see Section 8.5).

CGG has elected to use a much smaller airgun array (1,800 cui) in water depths of <50 m within the survey area (more than half of the survey area), adding an extra layer of precaution and conservatism to potential effects, and reduces the impact range for potential injury to 85 m (Table 5-7). As discussed above, this is an extremely conservative approach as in reality there would be a range of effects within these impact ranges, including recoverably injury (Popper et al. 2014). Commercially exploited fish comprise an array of highly mobile species that can avoid the approaching airgun well before the noise reaches injurious levels.

Effects will be temporary as the seismic vessel traverses each survey line, and fish are expected to move away as the airgun array approaches. Localised effects on the catchability of commercially important finfish species within the survey area (pelagic or demersal) will be limited to a small radius on the seabed around the location of the airgun.

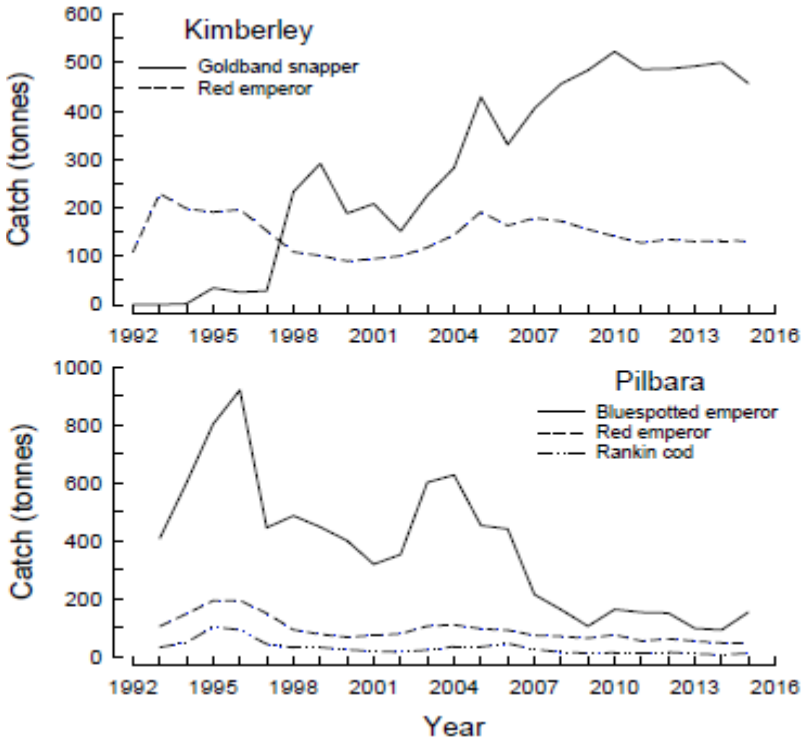



**Figure 5-14:North Coast Demersal Fishery Historic Catch Rates for Indicator Species from 1993 to 2015 (Fletcher et al. 2017)**

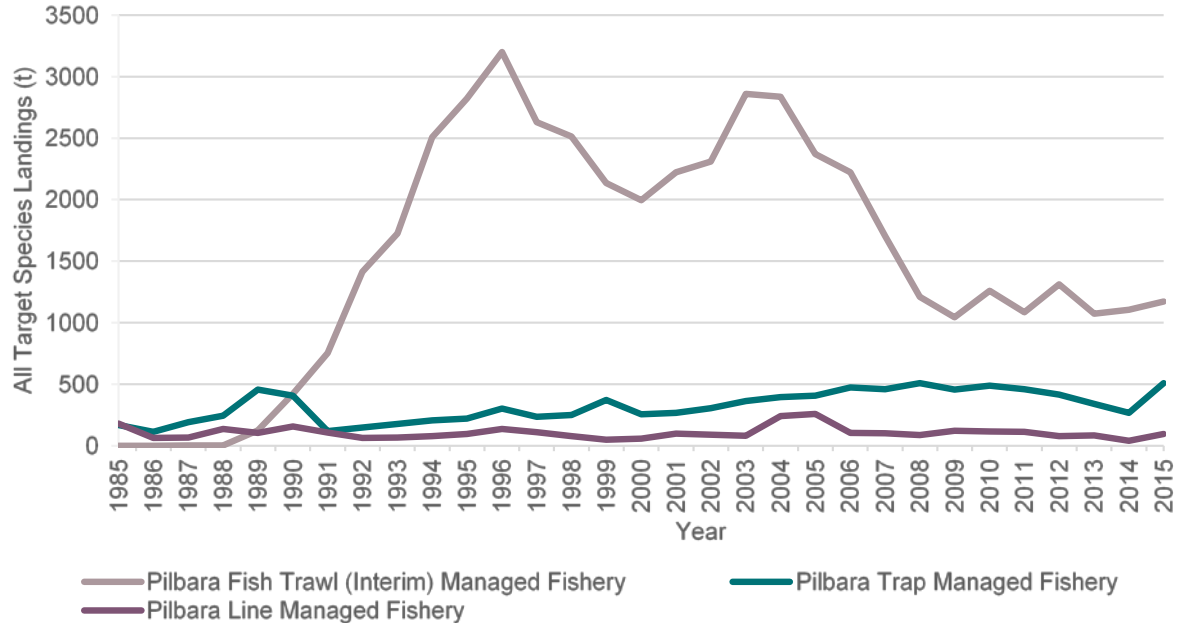



**Figure 5-15: Pilbara Trawl, Trap and Line Fishery Historic Catch Rates (Using Data from Fletcher et al. 2017)**

*Indirect Effects to Fish Populations*

As discussed in Section 6.2.1.2.3, there is potential for indirect effects on fisheries as a result of negative impacts on fish eggs / larvae following exposure to seismic survey activities. The Pilbara region hosts fish assemblages characterised by high diversity, with low productivity but economically important fisheries (Molony et al. 2011; McLean et al. 2016). In nearshore waters (to 21 m depth), 343 species of fish were recorded across a range of habitat types (McLean et al. 2016); total diversity of all fish in the region would be considerably higher if deeper waters were included. Around Barrow Island, which lies within the Pilbara Offshore Marine Bioregion, 380 species of fish have been reported (Chevron 2012, 2014).

A number of commercially-important species of broadcast spawners (i.e. species that release vast numbers of eggs into the water column, or in some cases are substratum egg scatterers) occur in the area, with several species forming spawning aggregations (e.g. red emperor *Lutjanus sebae*, Rankin cod *Epinephelus multinotatus*, bluespotted emperor *Lethrinus punctulatus*, saddletail snapper *Lutjanus malabaricus*, crimson snapper *Lutjanus erythropterus*, brownstripe snapper *Lutjanus vitta* and pink snapper *Pagrus auratus*). Several broadcast spawning species form spawning aggregations at reef edges, or on the seaward edges of oceanic islands or the continental shelf (e.g. Spanish mackerel *Scomberomorus commerson*, goldband snapper *Pristipomoides multidens* and bluespotted emperor *Lethrinus punctulatus*). Aggregations may occur at specific times (e.g. full or new moon for the bluespotted emperor) or throughout the year. Section 4.3.1.4 identifies several valued commercially fished species that may spawn in the area in which the survey is planned.

Quantification of the flow-on effect of egg and larval mortality due to seismic surveys is not possible given the current lack of hard data, but can be inferred from what is known of fish biology and of other anthropogenic impacts on fish. For example, the population age structure of pink snapper in Shark Bay is clearly truncated and has been attributed to a historic period of high fishing pressure (Jackson 2007). In Australia, planktonic larval pink snapper occur in the open ocean over the continental shelf before entering bays and estuaries as juveniles of about 1 cm in length (Australian Museum 2016). As such, pink snapper eggs and larvae would be susceptible to impacts due to seismic surveys prior to their movement into bays and estuaries. Combined with the low growth rates of pink snapper (Jackson 2007), it is likely that any event that significantly affects recruitment into the population will persist for two to three decades – the expected lifespan of pink snapper.

Like the pink snapper, goldband snapper and red emperor have low productive capacities as a consequence of slow growth, late maturity and extended longevity (Newman and Dunk 2002, 2003, Newman et al. 2010). Again, these characteristics make these species vulnerable to exploitation and other threats and negative effects are likely to persist for several decades. Goldband snapper, however, appear to be multiple spawners (i.e. spawn multiple times in a season) (Newman 2006), which would reduce the potential for negative impacts due to seismic surveys because spawning events are spread over a greater period of time. Similarly, the serial spawning of the Spanish mackerel reduces the likelihood of increased egg mortality due to seismic surveys; females can produce a batch of eggs every 1 to 3 days during the spawning season (Mackie et al. 2010). Within Australian waters, species such as goldband snapper and the red emperor are considered as comprising distinct site-specific stocks from a fisheries perspective, but recruit from a common regional (i.e. north-west Australia, tropical northern Australia) or national gene pool (Johnson et al., 1993; Newman et al. 2000; van Herwerden et al. 2009).

Rankin cod are another long-lived target fish species in north-west WA. Rankin cod probably spawn during restricted periods (between August and October) and tend to form aggregations during spawning (How 2013). Their eggs and larvae are probably pelagic (Kailola et al. 1993; cited in Froese and Pauly 2017). The relatively narrow spawning period and the tendency to form spawning aggregations means that impacts on egg and larval mortality rates of Rankin cod can be avoided if the timing and location of seismic surveys are planned to avoid these events (i.e. the Davros Extension MC3D MSS will avoid the months of August and September). The pelagic nature of the eggs and larvae imposes a greater risk, however, as water movement could transport them to within the range of potential impacts from seismic surveys. The same is true of the pelagic eggs and larvae of Spanish mackerel, which generally drift southwards with the Leeuwin Current, but since spawning probably occurs at many sites over a protracted spawning season (Mackie et al. 2010) the likelihood of impacts from seismic surveys on Spanish mackerel recruitment is low.

The commercially targeted blacktip shark is viviparous, giving birth to live young that remain in the nursery grounds for up to one year (DoE 2011). Blacktip sharks feed on crustaceans, cephalopods and fish (DoE 2011), all of which have planktonic life history stages. If seismic survey activity causes a reduction in the recruitment success of these prey items within nursery grounds, blacktip and sandbar shark populations could be affected. Heupel and Simpendorfer (2002) state that starvation and predation are the major threats to blacktip sharks.

CGG recognises that locations such as Glomar Shoal and Rankin Bank have the potential to be fish spawning areas, though the actual importance of these locations for spawning of commercially-important and site-attached species is not known. All fish species (particularly those that are site-attached or are at early life history stages that are restricted in their ability to travel) are at risk of starvation if their prey items are negatively impacted by seismic surveys. With adequate water movement to facilitate dispersal and mixing, Richardson et al. (2017) predict that zooplankton biomass in well-mixed offshore waters would recover within three days following the completion of a seismic survey. This assessment was based on modelling of a 35-day seismic survey of around 2,900 $km^2$ area (80 km by 36 km) in 300 to 800 m water depth in the Carnarvon Basin (north-west Australia) during summer, using 3,000 to 3,200 cui airgun arrays. This scenario is for a shorter duration and smaller area than the proposed Davros extension MC3D MSS, so these differences must be taken into consideration when applying the conclusions of Richardson et al. (2017). Recognising these differences, the values presented in the following paragraphs are considered indicative but of the right order of magnitude.

For species that feed directly on planktonic organisms, effects may be felt immediately and for around three days until the plankton populations have recovered following cessation of survey operations (Richardson et al. 2017). Proximity to the source (i.e. airgun array) will also be variable due to diel migration of plankton (including fish larvae) between surface and deep waters. Richardson et al. (2017) identified a maximum decline of 22% in zooplankton communities within the survey area; the Davros 3D MSS proposes to use an airgun array in the areas closest to the shallow reefs where spawning may occur, and therefore 22% loss has been considered conservative.

Richardson et al. (2017) showed that zooplankton communities can begin to recover during the survey period during periods of good oceanic circulation, or "bottom out" at a maximum impact level (presumably where growth rates and/or zooplankton entering the survey area roughly approximate mortality rates) after 23 - 30 days of commencement of survey operations, and therefore a continuous decline is zooplankton throughout the survey period is not anticipated and parts of the survey are would progressively recover during the survey. It is unlikely there would be localised patches of reduced food availability for plankton feeders over the period of the survey and during the recovery period. Therefore long-term, population-level indirect impacts are not anticipated.

For species that feed on larger organisms that have planktonic stages, effects may be displaced in time as there will be a lag between mortality of the planktonic stages and the subsequent reduced recruitment to the later stages. The potential mortality of larval fish that rely on zooplankton for food is difficult to predict but is not expected to affect a significant proportion of larvae based on the assumption that not all zooplankton are killed by exposure to airguns (around 22% to 35%, depending on ocean circulation; Richardson et al. 2017), only a very small proportion of the plankton would be exposed at any one time, and that zooplankton populations are likely to begin to recover rapidly following completion of a seismic survey due to fast growth rates, combined with dispersal and mixing of zooplankton from both within and without the zone of potential impact. No population level effects are expected in commercially caught finfish species, or to their catch rates as an indirect result of impacts on eggs/larvae.

*Long-term Impacts and Recovery of Fish Populations*

Potential recovery for non-reef associated fish from anthropogenic noise exposures has been studied more recently in European seabass and European eel (Bruintjes et al. 2016; Radford et al. 2016). Naive European seabass fish (i.e. those that had not experienced anthropogenic playback before) showed elevated ventilation rates, indicating heightened stress, in response to impulsive additional noise (playbacks of recordings of pile-driving and seismic surveys), but not to a more continuous additional noise source (playbacks of recordings of ship passes) (Radford et al. 2016). However, the authors of this study observed that fish exposed to playbacks of pile-driving or seismic noise for 12 weeks no longer responded with an elevated ventilation rate to the same noise type, and that fish exposed long-term to playback of pile-driving noise also no longer responded to short-term playback of seismic noise. The lessened response after repeated exposure, likely driven by increased tolerance or a change in hearing threshold, helps explain why fish that experienced 12 weeks of impulsive noise showed no differences in stress, growth or mortality compared to those reared with exposure to ambient-noise playback.

Recovery in non-reef fish is also supported by a recent study investigating the potential for recovery of European eel and European seabass under both laboratory (tank) and open water (Bristol Harbour) conditions, which showed that anthropogenic noise-induced effects quickly dissipated and both fish species showed rapid recovered of startle responses and startle latency within 2 minutes after noise cessation (Bruintjes et al. 2016). Seabass also showed complete recovery of ventilation rate when exposed to peak SPLs of 200.1, 200.7 and 201.5 dB re 1 µPa; whereas eels showed rapid albeit incomplete recovery compared with ambient conditions.

There are few studies of the long-term impact and recovery of pelagic and/or demersal fish populations following seismic surveys; however there have been many papers investigating the resilience of reef fish assemblages and ecosystems (including fish populations) to other forms of disturbance, such as over-fishing, nuclear shock, coral bleaching, cyclones, oil spill and crown-of-thorns predation. These studies support the view that reef fish communities are resilient to perturbation and recover rapidly from disturbance if the source of perturbation is removed and the habitat is intact. Even in the case of extensive fish mortality, assemblages recover through recruitment from surrounding areas when the habitat has recovered.

Planes et al. (2005) investigated the resilience and recovery of tropical reef fish assemblages following a large underwater pressure wave associated with a nuclear testing program in French Polynesia. The sudden change in pressure as the shock wave from the underground test passed through the area around the blast site had a serious effect on fish, especially those with swim bladders; causing widespread and almost

complete mortality over a 2 km radius of the blast site. The habitats and other fauna were largely unaffected, but all of the fish within an area of approximately 12.5 $km^2$ around each blast site were killed. Post-impact monitoring showed the fish assemblages recovered rapidly through immigration and recruitment and within 1 to 5 years the assemblage structure had been restored. The authors conclude that reef fish assemblages are resilient to large-scale mortality events, as long as the structural and biotic integrity of their habitat is maintained and neighbouring sites are able to supply recruits.

A study conducted by GBRMPA on the Barrier Reef (GBRMPA 2009; 2014) assessed the resilience of coral trout to disturbance by commercial and recreational fishing. Data from before and after management measures to protect coral trout were implemented show a two-fold increase in their biomass in zones closed to fishing within two years of implementation, indicating that recovery occurs reasonably quickly even for a higher order predatory fish with a longer generational time. The report concludes a "Good" resilience to recovery of this group of fishes, and ultimately predicts that populations will be restored within a reasonable timeframe. A long-term monitoring study undertaken by Sano (2000) investigated the response of disturbed adult fish assemblages and coral reef recovery after a crown-of-thorns (*Acanthaster planci*) outbreak. Following an initial period of decline, fish species richness and density increased steadily across the disturbed areas of the reef as the coral habitats recovered, until the fish assemblage properties did not differ significantly from neighbouring reef areas (90% similarity). The authors concluded that the structure of the disturbed fish assemblage had returned to its pre-perturbation state (Sano 2000).

Under an extremely conservative, worst-case scenario where fish populations within the noise impact zones were to suffer partial mortality, truly site-attached fish populations could be adversely affected over a limited period of time (i.e. less than one year; genetic studies have shown that as broadcast spawners, these populations are not considered to be self-recruiting at local population scales) due to their extremely limited capacity for avoidance. While the most likely scenario is some temporary physiological impacts and no mortality (Miller and Cripps 2013; Casper et al. 2012), the recovery of fish assemblages is considered likely as has been evidences in recent published studies (Miller and Cripps 2013; Bruintjes et al. 2016; Nedelec et al. 2016; Radford et al. 2016). No population level effects are predicted for commercially-important fish species within the vicinity of the survey as a result of the activity, and no long-term effects to Glomar Shoal fish assemblages are expected. No impact is expected on the conservation and biodiversity values of the Glomar Shoal KEF. No long-term impacts to fish assemblages at Rankin Bank are expected as it lies outside of the survey area.

#### 5.2.1.7.4 Impacts to Hard Corals

CGG recognises the need to consider coral spawning periods at Rankin Bank. Rankin Bank is a small and localised coral reef due to the presence of >10% coral cover (AIMS 2014). Hard coral cover however is relatively low for a coral reef (<14%), but is higher than Glomar Shoal and similar to other isolated shoals on the NWS. Rankin Bank hard coral communities are also of greater diversity than Glomar Shoal (AIMS 2014).

Previous surveys of Rankin Bank have indicated that coral communities are likely to be dominated by the genera *Porites*, *Favia*, *Goniastrea*, *Platygyra*, *Turbinaria*, *Acropora*, *Montipora* and *Fungia* (AIMS 2014). Spawning of corals is most likely to take place in autumn (March to May), and is triggered by lunar cycles (usually related to neap tides approximately one week after the full moon). Approximately one third of acroporids have been inferred to spawn in spring (October to December). Of the non-acroporid corals, only *Favites flexuosa*, and potentially *Favites pentagona* and *Montipora undata* are thought to spawn in spring/early summer (Gilmour et al. 2016). Massive corals, such as *Porites* spp., *Pavona decussata* and *Turbinaria mesenterina*, are gonochoric, and display different reproduction patterns to most corals participating in the spring and/or autumn spawning events. *Porites* (e.g. *P. lobata*) spawns in December; *Pavona decussata* spawns in March/April (potentially exhibiting split spawning between seasons); and *Turbinaria mesentarina* is thought to spawn between November and April (Gilmour et al. 2016).

Coral spawning is an important component of maintaining the biodiversity of the benthic communities. Tropical coral reef habitats in WA (such as Ningaloo Reef) have been identified with average hard coral cover ranging between 19.5% and 41% (Speed et al. 2013). Rankin Bank being an isolated reef with likely

episodic spawning, coral cover is low and is unlikely to be regionally significant in terms of being a source of recruits for down current reefs. No negative effects are predicted on hard coral community recruitment and coral cover.

#### 5.2.1.7.5 Impacts to Whale Sharks

Sharks are sensitive to low frequency sounds between 40 to 800 Hz; sensed solely through the particle-motion component of an acoustic field (no sound pressure). However, sharks do not appear to be attracted by continuous signals or higher frequency sounds which presumably they cannot hear (Popper and Løkkeborg 2008). Hearing studies show that elasmobranchs may detect particle motion associated with sound from 50 Hz to 500 Hz (Normandeau Associates 2012). As elasmobranchs (sharks and rays) do not possess swim bladders, and hence internal organs that have a disparity of acoustic impedance between water and gas filled chambers, these fish are not susceptible to physiological trauma associated with high underwater noise levels (McCauley 1994; Normandeau Associates 2012).

The survey area lies within the foraging ground BIA that has been identified along the north-west coast of Western Australia (from Exmouth to Cape Talbot) (Figure C) where whale sharks are likely to be present between July and November (DoEE 2017). However, whale sharks are generally solitary and expected to be present in low numbers (Section 4.3.2.2.1). CGG will not be carrying out the survey during the majority of this period, i.e. July to September, and will apply adaptive management procedures in the survey area (refer to Section 5.2.1.10.1). Behavioural effects (strong behavioural avoidance) may occur at distances of 4.7 km from the seismic source (Table 5-7); however the survey will avoid the peak of potential presence for whale sharks in the area; if encountered animals are expected to avoid the noise as the airgun array approaches. No effects are predicted at a population level for whale sharks.

#### 5.2.1.7.6 Impacts to Marine Turtles

Marine turtles appear to use acoustic cues in perception of their local and distant environment on their long (sometimes thousands of kilometres) migrations between nesting and foraging sites (Swan et al. 1994). Marine turtles can detect sounds below 1600 Hz (Dow Piniak 2012). Studies using auditory brainstem responses of juvenile green and olive ridley turtles have shown that juvenile turtles have a 100 to 800 Hz bandwidth, with best sensitivity between 600 and 700 Hz, while adults have a bandwidth of 100 to 500 Hz, with the greatest sensitivity between 200 and 400 Hz (Bartol and Ketten 2006). Studies have also found that for loggerhead turtles best sensitivity is between 100-400Hz (Martin 2012). As discussed previously, the sound from seismic operations is primarily low frequency (between 2 to 200 Hz); therefore, there is a degree of overlap of the frequencies generated by the seismic survey and the audible frequency range of marine turtles (Ridgway et al. 1969).

Most studies looking at the effect of seismic noise on marine turtles have focused on behavioural changes and responses as physiological damages are more difficult to observe in living animals. Studies carried out by Lenhardt (1994) showed that marine turtles increased their movements after seismic noise emissions and did not return to the depth at which they usually rested. Observational studies have also attempted to monitor turtle avoidance of sound during an active seismic survey (Weir 2007; De Ruiter and Doukara 2010). Weir (2007) observed 240 animals during a 10 month seismic survey off the coast of Angola, during which fewer turtles were observed near the seismic source during noise emissions compared to periods when the seismic noise was not being emitted. De Ruiter and Doukara (2010) also observed turtles during active seismic operations and recorded startle responses (rapid dive) to the seismic emissions; 51% of turtles dived at or before their closest point of approach to a seismic source. However, these authors could not distinguish the stimulus source of the startle response, as they did not perform a control without the seismic stimulus (De Ruiter and Doukara 2010).

McCauley et al. (2000) conducted controlled experiments on a caged loggerhead turtle and a caged green turtle and observed two responses:

- exposure to noises from seismic sources louder than 166 dB re 1 µPa SPL (RMS) increased their swimming activity
- exposure to noises louder than 175 dB re 1 µPa SPL (RMS) resulted in erratic swimming behaviour, possibly indicating the turtles were in an agitated state.

The study by McCauley et al. (2000) estimated that a typical seismic source operating in 100 to 120 m water depth could affect the behaviour of marine turtles at a distance of about 2 km and that they would probably avoid the source at around 1 km.

The results of the noise modelling have been used to determine impact ranges for marine turtles for mortality and potential mortal injury and for a strong behavioural avoidance response. Mortality and potential mortal injury may occur within a small radius of within 88 m of the seismic source in water depths up to 50 m using the smaller airgun array (1,800 cui) to 160 m in >50 m water depths (

Table 5-8); however it is unlikely that turtles will remain close enough to the source to suffer physiological trauma. Strong avoidance behaviour is predicted up to 3.5 km from the source in 50-100 m water depth and up to 5.6 km in the deepest depth (200 to 250 m) for the largest array (4,6350 cui) based on received sound levels measured by streamer data during the Davros surveys carried out in 2015 (Figure 5-4). Such behavioural changes are expected to only last for the duration of a survey pass with normal behaviour anticipated to resume when the vessel has moved this distance or more away along the seismic sail line.

**Table 5-8: Summary of Modelled Impact Ranges for Marine Turtles**

| Guideline – Popper et al. (2014) | Impact Range (m) Based on Water Depths | | |
|---|---|---|---|
| | 2,220 cui | 4,630 cui | |
| | 50 m | 50 m | 100 m |
| Mortality and potential mortal injury (>207 dB peak SPL) | 88 | 125 | 160 |
| Behaviour: strong avoidance (>175 dB SPL) | MD | MD | MD |

MD: Measured OBN and streamer data used to calculate impact ranges.

The Davros Extension MC3D survey area overlaps the buffer zone of the BIA identified for inter-nesting flatback turtles, as well as habitat identified as critical to survival of this species in the area (Figure E). However, as discussed in Section 4.3.2.3.2, inter-nesting Pilbara island flatbacks migrate towards the mainland coasts, with the longest inter-nesting movement of the inshore turtles is alongshore (rather than out to sea) (Whittock et al. 2014). Whittock et al. (2016) further defined suitable inter-nesting habitat for flatback turtles as water depths of 0–16 m and within 5–10 km of the coastline, while unsuitable inter-nesting flatback habitat was defined as water >25 m deep and >27 km from the coastline and has been mapped on Figure D-2.

Based on the habitat identified as critical for survival for inter-nesting flatback turtles, the nearest area of habitat suitable is approximately 23 km south-east of the survey area and approximately 18 km south of the operational area (Figure D-2). These distances are greater than predicted behavioural disturbance distances for marine turtles; therefore inter-nesting turtles are unlikely to be disturbed during the survey. It is possible that inter-nesting flatback turtles could still be encountered in the operational area; however, these will likely be limited to individuals transiting through the survey area. It is likely that a large proportion of the turtles nesting on the Montebello Islands will move away from the survey area towards the mainland coast during inter-nesting. The greater the inter-nesting range, the greater the dispersion of turtles at sea and therefore the lower the density of encounter and the lower the likelihood of disturbance of natural behaviours. Any disturbance will be limited to avoidance response followed by rapid resumption of normal activity. In addition, there are no nesting areas or known foraging habitats within or in the vicinity of the survey area (Figures D-1 and D-2) and so no effects on turtle breeding success or to populations are predicted.

The Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017) considers threats to turtle stocks on an individual basis. Acute noise interference is identified as a threat with a "moderate risk" rating for all marine turtle species stocks with a limit of dispersal that includes the proposed survey area (Section 3.1.3.3.2) other than leatherback turtles, which are considered "low risk". Although, the Commonwealth of Australia (2017) recovery plan does not specify actions to address threats treated as "moderate" or "low risk", the assessment within this EP aligns with the precautionary approach for minimising acute noise interference recommended by the recovery plan. Previously, there was a much larger overlap of the Davros Extension survey area with flatback inter-nesting BIA buffer and habitat critical survival, however this was reduced during the ALARP assessment to provide an additional layer of protection for inter-nesting turtles (refer to Section 6.2.1.9.1). The recovery plan also identifies that soft starts may afford protection for marine turtles. EPBC Act Policy Statement 2.1 will be implemented for the survey, which will include soft-starts and a larger low-power zone (2 km) (Table 5-13).

#### 5.2.1.7.7 Impacts to Cetaceans

Marine mammals use sound for foraging, orientation, communication, navigation, echolocation of prey and predator avoidance (Richardson et al. 1995) and therefore are sensitive to underwater noise. High levels of anthropogenic underwater sound can potentially have negative impacts; ranging from changes in their acoustic communication, displacing them from an area, and in more severe cases causing physical injury or mortality (Richardson et al. 1995).

Theoretically, the high peak pressure sound levels very close to a seismic source have the potential to cause death, or severe injury leading to death of cetaceans. Some of these effects may be considered barometric pressure effects due to the shock experienced by the animal, rather than acoustic effects per se. However, limited information is available regarding the sound levels at which hearing damage or physical injury occurs in cetaceans and it is extremely unlikely they will be close enough to the active airgun for such effects.

High levels of noise exposure can also cause an instantaneous auditory injury resulting in a permanent threshold shift (PTS) that persists once sound exposure has ceased. PTS may also result from prolonged exposure at lower levels. Hearing loss may be considered permanent if hearing does not return to normal after several weeks. Lower noise levels or shorter exposures to noise have the potential to cause a temporary threshold shift (TTS) where animals would experience temporary auditory injury, and from which they would recover fully, particularly as they move away from the source.

The relationship between these two thresholds is complex since PTS can either be induced by a single high level noise exposure or by chronic (longer term) noise exposure at lower levels (Southall et al. 2007). The threshold for auditory injury is therefore taken as the levels at which PTS starts to occur, based on the overall noise dose received over time, and is termed the PTS-onset criteria. Given that PTS cannot be ethically or legally induced in animals to determine the threshold, Southall et al. (2007) proposed that noise exposure criteria for PTS-onset should be extrapolated from the onset of TTS based on the assumed relationships between the relative levels of noise likely to cause TTS and PTS. This provides a very conservative estimate of the noise levels likely to induce permanent auditory injury, however, not all animals exposed to this level will experience PTS.

The level at which TTS-onset occurs is also precautionary as it assumes that the hearing of all animals within a group (with hearing sensitivity to the same range of frequencies) will be affected in the same way. For example, Gedamke et al. (2011) identified a TTS in hearing for one beluga whale at 186 dB re 1 $\mu Pa^2$.s and no TTS was observed in one bottlenose dolphin at approximately 188 dB re 1 $\mu Pa^2$.s. The ecological effect of TTS depends on the magnitude of the TTS, its duration (depending on the exposure duration), the recovery time after the exposure stopped, the frequency at which hearing is affected and whether this frequency is important, for example, for echolocation (Kastelein et al. 2013). The most likely response of marine mammals to noise levels that could induce TTS is to flee from the area (Southall et al. 2007). Subsequently, the onset of TTS is referred to as the "fleeing response" threshold in the underwater noise modelling assessment within this EP. As an animal flees an area, its exposure to the noise level decreases and therefore the likelihood of TTS (and PTS) is reduced.

In considering behavioural responses in cetaceans, Southall et al. (2007) discussed a range of likely behavioural reactions that may occur. These include orientation or attraction to a noise source, increased alertness, modification of characteristics of their own sounds, cessation of feeding or social interaction, alteration of movement/diving behaviour, temporary or permanent habitat abandonment and in severe cases, panic, flight stampede or stranding. Behavioural effects may result in animals being displaced from preferred foraging grounds to potentially less optimal areas, experiencing increased competition or greater energy costs associated with finding food. The effect may be a reduction in the individual's long-term fitness and survival.

For example, behavioural responses to low frequency acoustic sound in baleen whales range from tolerance at low–moderate acoustic levels (McCauley et al. 2000) to graduated behavioural responses including shifts in respiratory and diving patterns (McCauley 1994) at higher levels. It has been observed that the behaviour of cetaceans to differing sound levels depends on their activity at the time of exposure and is variable between and within species (Richardson et al. 1995). Cetaceans tend to be less responsive to sound when migrating or feeding than when suckling, resting or socialising. Behavioural responses to low frequency sounds like seismic airgun discharges include:

- minor to moderate behavioural responses have been observed in migrating (McCauley et al. 1998) and in socialising (McCauley et al. 2000) humpbacks at received SPL of between 140 and 180 dB re 1 µPa
- a startle response when a resting or slow moving whale rapidly moves away from the sound source or changes surface – dive – respiration behaviour
- avoidance by a course or speed change to maintain a minimum buffer distance to the sound source (observed in grey and bowhead whales at 150 to 180 dB re 1 µPa sound level contour (Richardson et al. 1995)
- swimming directly to the source up to a stand-off point
- changes to vocalisation patterns.

The key marine mammal species within the Davros Extension MC3D survey area that may be affected by underwater noise from seismic operations have been classed into the functional hearing groups as follows:

- low-frequency cetaceans (baleen whales): limited to migrating individuals for humpback whales, and potential presence of pygmy blue, Bryde's and Antarctic minke whales
- mid-frequency cetaceans: limited to transiting individuals for dolphins, sperm and killer whales.

The results of the noise modelling for the 2,220 cui and 4,630 cui arrays have been used to determine impact ranges for out to 500 m for low and mid-frequency cetaceans (Table 5-9). At distances greater than 500 m, the modelling under-estimates the actual received sound levels and OBN and streamer data measured during the Davros surveys in 2015 have been used to determine impact ranges (Section 5.2.1.5). The impact ranges for low-frequency indicate that injury/PTS-onset would only occur in animals at close range to the seismic source 110 m in survey areas 35 to 50 m depth, based on using the smaller array in these depths (i.e. 1,800 cui), to 200 m in deeper waters of the survey area (100 m depth). However, it is considered highly unlikely that a cetacean would be exposed to these levels due to the implementation of a shut-down buffer zone of 500 m as required under EPBC Policy Statement 2.1. It is therefore unlikely that an animal will be within this range of the seismic vessel at the commencement of the survey as soft-start procedures would encourage the animal to move away.

Impact ranges for TTS-onset/fleeing are predicted to occur within 150 m in survey areas 35 to 50 m depth, based on using the smaller array in these depths (i.e. 1,800 cui) (Table 5-9), out to 200 m in deeper waters of the survey area (200 – 250 m) using the largest array volume of 4,500 cui based on measured streamer data (Figure 6-4)). Again it is highly unlikely that a cetacean would be exposed to TTS levels using the larger gun in >200 m water depths due to the shut-down buffer zone of 500 m. It is also unlikely that low-frequency cetaceans such as humpback and pygmy blue whales would be exposed to TTS levels that could cause the animal to flee as CGG has taken a precautionary approach in applying a larger low-power zone of 2 km around the seismic vessel, in accordance with EPBC Policy Statement 2.1.

**Table 5-9: Summary of Modelled Impact Ranges for Low and Mid-Frequency Cetaceans**

| Marine Mammal Group | Thresholds | Impact Range (m) Based on Water Depths | | |
|---|---|---|---|---|
| | | 2,220 cui | 4,630 cui | |
| | | 50 m | 50 m | 100 m |
| Low-frequency Cetaceans | Injury (PTS-onset) (219 dB re 1 µPa (SPLpeak)1) | 110 | 180 | 200 |
| | TTS-onset / Fleeing (213 dB re 1 µPa (SPLpeak)1) | 150 | MD | MD |
| | Likely Avoidance (152 dB re 1 µPa2.s (SEL)1) | MD | MD | MD |
| | EPBC Act Policy Statement 2.1 Threshold (160) | MD | MD | MD |
| Mid-frequency Cetaceans | Injury (PTS-onset) (230 dB re 1 µPa (SPLpeak)1) | 95 | 140 | 160 |
| | TTS-onset / Fleeing (224 dB re 1 µPa (SPLpeak)1) | 130 | 500 | MD |
| | Likely Avoidance (170 dB re 1 µPa2.s (SEL)1) | 130 | 500 | MD |
| | Possible Avoidance (160 dB re 1 µPa2.s (SEL)1) | MD | MD | MD |

Note 1: NOAA (2016) PTS-onset and TTS-onset/fleeing thresholds;
Note 2: Derived from Southall et al. (2007) severity scaling behavioural response and converted to SEL (of the pulse) (i.e. single shot SEL) from RMS (over the duration of the pulse) by subtracting 10 dB for mid-frequency cetaceans and 8 dB for low-frequency cetaceans (based on the longer ranges for low-frequency cetaceans).
MD: Measured OBN and streamer data used to calculate impact ranges.

Behavioural disturbance distances for low-frequency cetaceans are predicted to be greater than the 7 km horizontal range measured by the streamers in the previous Davros surveys in 2015 (Figure 5-5). The OBN data and the towed streamer data are very close in value at intermediate distances from the source (1000-2000 m), however then the streamer data exhibits a greater degree of variation – possibly due to wave noise – at further distances. This gives rise to higher received SELs in the OBN data (at the seabed) which are approximately 3 dB higher than the streamer data at longer distances, likely due to a combination of longer travel time (pass through the water column) and array effects for the streamer data. Therefore, as the streamers measured received sound levels out to 7 km, it is appropriate to consider the measured OBN sound levels, which indicate that behavioural disturbance in water depths of 159 m are possible up to 12 km from the seismic vessel (Figure 6-17). The majority of the survey area lies in water depths of <200 m, with only a very small area (58 $km^2$, or <0.1% of the total survey area in the north-west deeper than 200 m (see Figure 5-20). Therefore it is expected that behavioural (likely) avoidance by low-frequency cetaceans would be limited to within 12 km of the seismic vessel.

Seismic operators and MFOs on seismic vessels regularly see dolphins and other small-toothed whales in the vicinity of seismic surveys. In general, dolphins avoid operating seismic vessels (Stone and Tasker 2006), and in most cases, the avoidance radii for dolphins are small (1 km or less), with some individuals showing no apparent avoidance (Holst et al. 2006; Moulton and Miller 2005; Stone 2003; Stone and Tasker 2006; Weir 2008). In terms of behavioural response, levels at which likely avoidance in mid-frequency cetaceans could occur are predicted up to 1.5 km from the source or possible avoidance at 4.7 km, based on are measured streamer received levels from the previous Davros surveys in 2015 (Figure 5-5).

Underwater noise impacts resulting in behavioural effects in low and mid-frequency cetaceans are predicted to be localised, short-term and recoverable. No impacts at a population level are predicted.

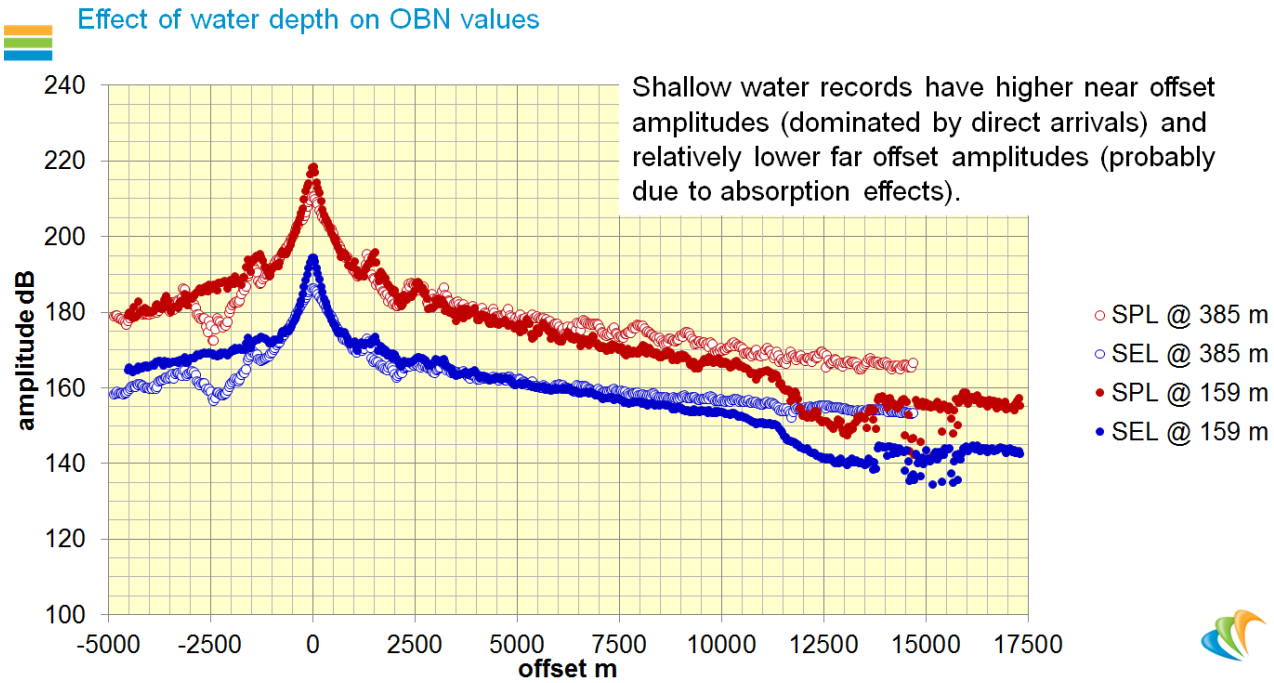



**Figure 5-16: Ocean Bottom Node Measured Sound Levels for the Davros (2015) surveys**

The survey area overlaps with the humpback whales' migration BIA therefore, there may be humpback whales that pass within the southern boundary of the survey area from July to September during the peak of their northern and southern migrations (Section 4.3.2.1.1). CGG recognises there is significant overlap with the humpback whale migration route and will schedule the survey to avoid the peak migration period for the humpback whales during the months of July to September. During the months of June and October, small numbers of humpback whales may traverse the operational area whilst on migration. CGG will adopt adaptive management procedures within the southern part of the survey area defined as the humpback whale adaptive management zone when operating during from October to June. The boundary for this adaptive management zone is based on the humpback whale migratory BIA that overlaps the survey area (Figure 5-20), and the humpback whale sightings from the previous Davros surveys in 2015 (Figure 5-16).

From industry experience, it is rare for more than three power-downs/shut-downs to occur within 24 hours. Rather, one or two power-downs/shut-downs may be implemented within 24 hours, which is usually followed by gap periods of no observations. However, in the event of three or more whale sightings within the power-down/shut-down zone occur within the preceding 24 hours (including times when the acoustic source is shut-down and/or powered down), the following adaptive management procedures will be implemented:

- Relocation - survey vessel will relocate to another survey line >12 km from northern boundary of the humpback whale adaptive management zone and will not return within 24 hours; or
- If cannot relocate - pre-start up visual observation will be increased to 45 minutes and the low power zone will be increased to 3 km horizontal radius from the acoustic source.

Adaptive management will also be applicable within other areas of the survey area, i.e. outside the specified humpback whale adaptive management zone. The seismic vessel would be required to relocate to another survey line >12 km from its existing location (as long as it is outside of the humpback whale adaptive management zone). If the vessel cannot relocate the pre-start up visual observation and low power zone will be increased as described above.

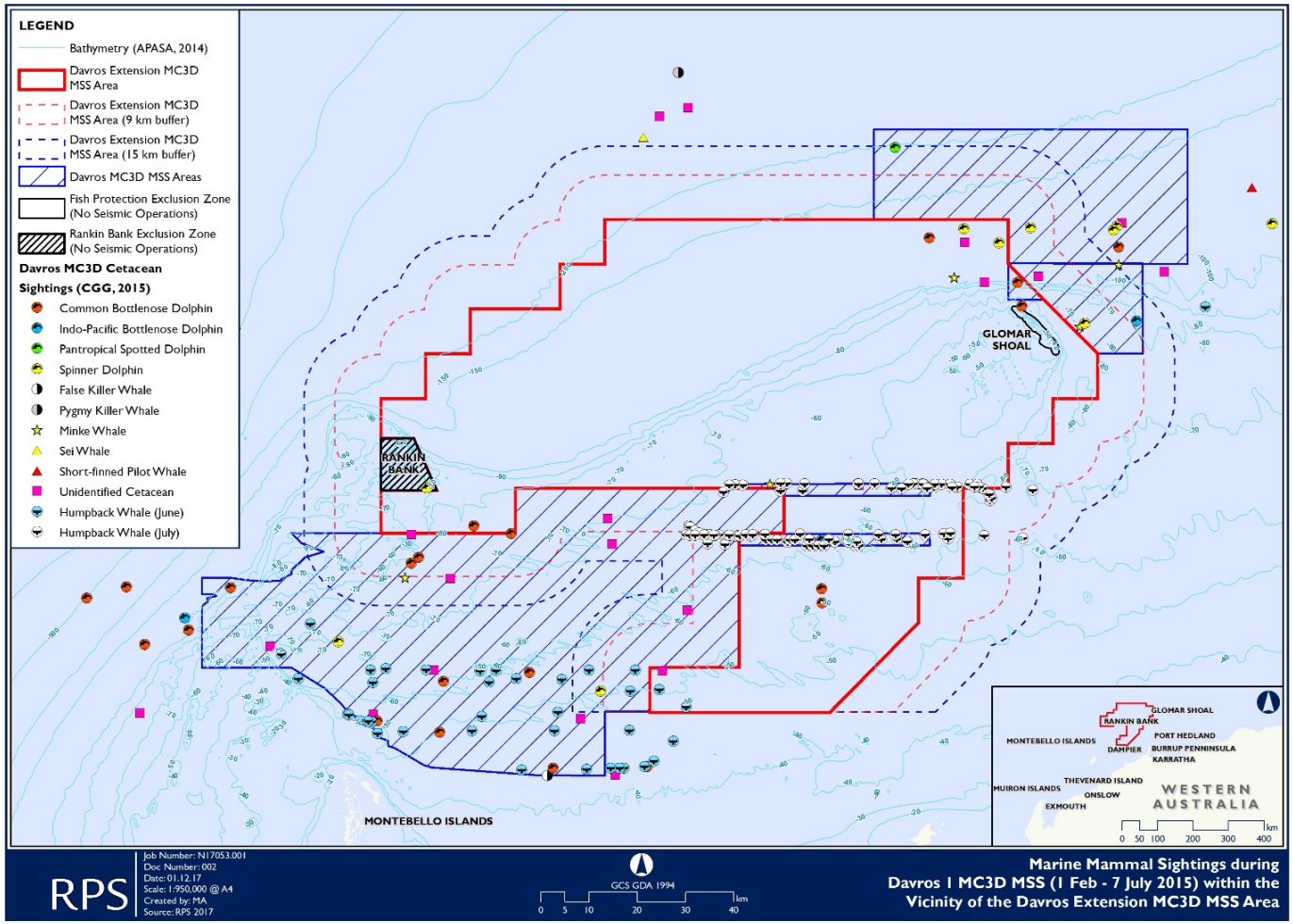



**Figure 5-17: Marine Mammal Sightings during Seismic Operations for the Davros (Phase I) MC3D MSS Period from the Beginning of February to Early July 2015**

The key threats identified by the Conservation Advice of relevance to the activity assessed within this EP include noise interference, habitat degradation, entanglement and vessel disturbance and strike (DotE 2015) (DotE 2015c). A number of Conservation Management Actions have been identified in the Conservation Advice, of which those relevant to the Davros Extension MC3D MSS are shown in Table 5-31 with a description of how the EP aligns with each action.

**Table 5-10: Humpback Whale Conservation Management Actions (DotE 2015c) and Alignment with the Davros Extension MC3D MSS EP.**

| Conservation Management Action | Alignment with EP |
|---|---|
| **Assessing and addressing anthropogenic noise, shipping, industrial and seismic surveys** | |
| All seismic surveys must be undertaken consistently with the EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales (DEWHA 2008). Should a survey be undertaken in or near a calving, resting, foraging area, or a confined migratory pathway then Part B. Additional Management Procedures must also be applied | Part A management measures will be implemented for the survey. Additional Part B management measures will also be implemented including provision of a dedicated marine fauna observer (MFO), increased precaution zone for the low-power zone of 2 km, and adaptive management procedures for three or more whale or whale shark instigated power-down or shut-down situations during the preceding 24-hours (Table 5-13).<br>To address uncertainty in the actual distribution of whales, CGG has taken a precautionary approach and avoid scheduling the survey during peak migration months (i.e. July to September), and will implement adaptive management procedures described in Table 5-14. CGG will additionally employ a smaller airgun array volume in water depths of 35 to 50 m within the survey area (refer to ALARP assessment in Table 5-14). |
| For actions involving acoustic impacts on humpback whale calving, resting, feeding areas or confined migratory pathways site specific acoustic modelling should be undertaken (including cumulative noise impacts) | The survey area overlaps the migratory pathway for humpback whales (northern and southern migrations). As discussed above CGG will avoid scheduling the survey during peak migration months (i.e. July to September), and will implement adaptive management procedures described in Table 5-14).<br>Modelling has been undertaken by CMST for assessment of potential impacts ranging from mortality/physical injury, PTS and TTS which has been used in the evaluation of impacts in Section 5.2.1.2. CGG will employ a smaller airgun array volume in water depths of 35 to 50 m within the survey area, therefore smaller impact ranges. Adaptive management distances for relocation of the vessel to >12 km from the northern boundary of the humpback whale adaptive management zone have been based on measured data from previous Davros surveys (2015). CGG will use monitoring data collected during the survey to verify the sound propagation levels predicted by the modelling, and if necessary refine distances(refer to ALARP assessment in Table 6-13).<br>In the event that another vessel is acquiring seismic data, the survey vessel shall not acquire data simultaneously within 50 km of another seismic vessel in order to avoid cumulative impacts to cetaceans. |
| Should acoustic impacts on humpback calving, resting, foraging areas, or confined migratory pathways be identified a noise management plan should be developed. This can include:<br>■ the use of shutdown and caution zones.<br>■ pre and post activity observations.<br>■ the use of marine mammal observers and / or Passive Acoustic Monitoring (PAMS).<br>■ Implementation of adaptive management procedures. | CGG has taken a precautionary approach and avoid scheduling the survey during peak migration months (i.e. July to September), and will implement adaptive management procedures described in Table 5-14).<br>CGG will additionally employ a smaller airgun array volume in water depths of 35 to 50 m within the survey area (refer to ALARP assessment in Table 6-13).<br>Additional control measures will also be implemented including:<br>■ provision of a dedicated marine fauna observer (MFO) and increased precaution zone for the low-power zone of 2 km (Table 5-13).<br>■ adaptive management distances for relocation of the vessel to >12 km from the northern boundary of the humpback whale adaptive management zone have been based on measured data from previous Davros surveys (2015). |

The Davros Extension MC3D survey area is within an area of "known occurrence" for pygmy blue whales (based on direct observations, satellite tagged whales or based on acoustic detections); however there are no known or possible foraging areas in, or close to, the survey area (Commonwealth of Australia 2015) (Figure B). Furthermore, the survey area water depths are shallower (up to approximately 230 m) than the depths in which the pygmy blue whales generally pass along the shelf edge; they typically travel at between 500 and 1,000 m water depth, as is evidenced by the BIA for migration in Figure B (Commonwealth of Australia 2015). However, there is the potential for encounters with migrating individual pygmy blue whales within or in the vicinity of the survey area.

Threats identified under the Conservation Management Plan for the Blue Whale of relevance to the activity assessed under this EP are noise interference and vessel disturbance (Commonwealth of Australia 2015). Management actions under the plan aim to address these threats in accordance with the plan's interim objective of demonstrably minimising anthropogenic threats. The management actions relevant to the Davros Extension MC3D MSS are shown in Table 5-32 with a description of how the EP aligns with each action. Given the spatial separation between the survey area and pygmy blue whales' migration BIA (Figure B), it is very unlikely that migrating whales will be encountered in significant numbers during the activity; however it is possible that individuals may still be encountered during the survey, potentially during the southern migration from September to December.

**Table 5-11: Pygmy Blue Whale Management Actions (Commonwealth of Australia 2015) and Alignment with the Davros Extension MC3D MSS EP.**

| Management Action | Alignment with EP |
|---|---|
| **Assessing and Addressing Anthropogenic Noise (Very High Priority)** | |
| Assessing the effect of anthropogenic noise on blue whale behaviour | Modelling has been undertaken by CMST for assessment of potential impacts ranging from mortality/physical injury, PTS and TTS which has been used in the evaluation of impacts in Section 5.2.1.2.<br>Control measures adopted for humpback whales will also benefit pygmy blue whales, i.e. no seismic operations from July to September and adaptive management procedures described in Table 5-14.<br>CGG will employ a smaller airgun array volume in water depths of 35 to 50 m within the survey area, therefore smaller impact ranges. Adaptive management distances for relocation of the vessel to >12 km from the northern boundary of the humpback whale adaptive management zone have been based on measured data from previous Davros surveys (2015).In the event that another vessel is acquiring seismic data, the survey vessel shall not acquire data simultaneously within 50 km of another seismic vessel in order to avoid cumulative impacts to cetaceans. |
| Anthropogenic noise in biologically important areas (BIAs) will be managed such that any blue whale continues to utilise the area without injury, and is not displaced from a foraging area | While the survey area is outside the pygmy blue whale migratory BIA it is within the area the whales "are known to occur" (Figure B). As discussed above there will be no seismic operations from July to September. CGG will implement adaptive management procedures described in Table 5-14.<br>Additional Part B management measures will also be implemented including provision of a dedicated marine fauna observer (MFO) and increased precaution zone for the low-power zone of 2 km (Table 5-13). |
| EPBC Policy Statement 2.1 – Interaction between offshore seismic exploration and whales is applied to all seismic surveys. | EPBC Policy Statement 2.1 Part A management measures will be implemented for the survey. Additional Part B management measures will also be implemented including provision of a dedicated marine fauna observer (MFO) and increased precaution zone for the low-power zone of 2 km (Table 5-13). |

There are currently no specific Conservation and Management Actions for the Fin whale or Sei whale Conservation Advices (DoTE 2015a; DoTE 2015b). However, the control measures that have been described for both humpback and pygmy blue whales will afford protection to other baleen whales in the event that they may be encountered in the survey area.

#### 5.2.1.7.8 Cumulative Impacts

Potential cumulative impacts associated with the Davros Extension survey may occur if:

- the Davros Extension survey is undertaken at the same time as another seismic survey within the area, there is an overlap in the areas ensonified by each survey and there are noise sensitive receptors in the overlap zone (concurrent surveys)
- the Davros Extension survey is undertaken within an area where previous seismic surveys have occurred, the affected marine biota are still in the same area and have not fully recovered (sequential surveys).

Cumulative impacts have been assessed in terms of the key receptors within the Davros Extension survey area, namely:

- Ancient coastline KEF
- Glomar Shoal KEF
- Marine Turtle BIA – however no habitats critical to the survival (HCTS) of marine turtles were identified
- Humpback whale BIA (migratory)
- Pygmy blue whale BIA (occurrence)
- Commercial fish species – target species for the Pilbara Trap, Trawl and Line fisheries
  - Pilbara Line Fishery – Key Fishing Area

It should be noted that this section does not assess cumulative impacts from future seismic surveys within the area that may occur after the Davros Extension EP validity, as this is the responsibility of that titleholder as part of their cumulative impact assessment.

***Concurrent surveys***

All currently submitted and approved EPs for seismic surveys have been investigated on the NOPSEMA website and those with potential spatial and temporal overlap with the Davros survey have been assessed for cumulative noise impacts.

As outlined in the Section 4.4.4 (Table 4-10), three other seismic contractors are planning seismic surveys concurrently with the Davros Extension MC3D MSS EP duration. As the scheduling for Davros Extension MC3D is not yet finalised, it is not yet possible to determine which other seismic surveys will be in progress during the Davros Extension MC3D. Furthermore, the known strategic seismic surveys proposed by TGS and PGS are planned over multiple year durations (2 and 5 years respectively), over large-scale areas and multiple surveys within the operational area, therefore it is unknown whether the Davros Extension MC3D MSS would overlap temporally or spatially with these surveys. Polarcus' Capreolus Phase II 3D MSS was scheduled to commence during or after the second quarter of 2016 and was expected to be completed within 2 years, i.e. by 30 June 2018; however, the activity had not commenced at the time of revising this EP (December 2017).

The chances of two seismic companies targeting the same open acreage at the same time is extremely unlikely, block titleholders will allocate work to one seismic company only. If a 4D survey is undertaken after a 3D survey, it would generally be years between surveys, at which point cumulative impacts would be negligible. Acquisition over open acreage would only ever occur if it was adjacent to an existing titleholder who had commissioned a survey.

A review of the submitted and approved EPs for seismic surveys identified the following:

**Table 5-12: Receptors Potentially Impacted by Cumulative Sound Exposure during Concurrent Seismic Surveys.**

| Receptors | TGS NWSR North MC MSS (>200 m water depths only) | PGS Rollo MC MS and CSEM EP (> 39 m water depths only) | Polarcus Capreolus Phase II 3D MSS (>67 m water depths only) |
|---|---|---|---|
| Ancient coastline KEF | No | Possible repeated exposure, but no long-term impacts | Possible repeated exposure, but no long-term impacts |
| Glomar Shoal KEF | No | No | No |
| Marine Turtle BIA & HCTS | No | No | No |
| Humpback whale BIA (migratory) | No | Possible repeated exposure, but no long-term impacts | No |
| Pygmy blue whale BIA (occurrence) | No | Possible repeated exposure, but no long-term impacts | Possible repeated exposure, but no long-term impacts |
| Commercial fish species – target species for the Pilbara Trap, Trawl and Line fisheries | Possible repeated exposure, but no long-term impacts | Possible repeated exposure, but no long-term impacts | Possible repeated exposure, but no long-term impacts |

The Bureau of Ocean Energy Management (BOEM 2014) recommended maintaining a 40 km geographic separation distance between active seismic vessels to minimise cumulative impacts to marine life. CGG will implement a conservative 50 km separation distance between its vessel and any vessel involved in other simultaneous surveys. At 25 km from each survey vessel (the point with the greatest cumulative sound level from the two arrays), the sound levels would be approximately 3 dB higher than for each individual source; derived from the cumulative sound calculation of SELcum = 10Log(Number of pulses) (CMST pers. com.). The plot of seismic sound levels at distance for a range of different array sizes (Figure 5-2) indicates that the maximum sound level at a point midway between two active seismic sources (25 km from each) of 3,000-4,000 $in^3$ would be 143 dB SEL. This is well below the level which may elicit avoidance behaviour in cetaceans which are the only marine fauna possible affected over such large distances.

For site-attached or sessile species located on Glomar Shoal, Rankin Bank or the Ancient Coastline KEF, commercially important demersal fish or fish transiting through the survey area, including commercial fish species of the Pilbara Line Fishery, the conservative 50 km buffer between seismic vessels will keep sound levels below the level at which physiological impacts could occur. No cumulative impacts are predicted from concurrent surveys.

Following acceptance of this EP and as part of the pre-survey planning and notification process, the NOPSEMA website will be monitored for newly accepted EPs for marine seismic surveys which could contribute to cumulative noise in the survey area. If a survey is permitted within 50 km of the Davros Extension MC3D survey area, and scheduling for both surveys may overlap, the relevant titleholder will be contacted and arrangements made to ensure that the potential cumulative impacts will be reduced to ALARP. As a minimum, CGG will not acquire seismic data within 50 km of another actively acquiring seismic vessel.

Given the very low probability of two seismic surveys occurring simultaneously and the controls that will be implemented to establish and maintain communications prior to and during the survey to ensure such simultaneous activities would maintain an adequate separation distance (50 km), there is very little risk of cumulative impacts to marine receptors.

***Sequential surveys***

Cumulative impacts can occur when the timing between activities is less than the recovery rate of any potential impacts to receptors. The US National Marine Fisheries Service (NMFS) applies a “resetting” of $SEL_{cum}$ after 12 hours of non-exposure (Stadler and Woodbury 2009). Whereby, if there is a 12-hour period

between the end of one pile driving operation and the start of the next, the $SEL_{cum}$ for a fish during the pile driving operation is reset to zero for the next set of exposures. Applying a pile-driving management measure to a seismic survey is highly conservative, given the much lower number of sound pulses associated with seismic surveys and the ability of most fish and other receptors to move away from the source.

Depending on the size of the survey area, and with the racetrack formation utilised by CGG for the survey, it is anticipated that it will be at least 12 to 24 hours before an adjacent area (distance away based on the size of the array spread) is acquired, ensuring negligible cumulative impacts resulting from consecutive sail-lines during the Davros Extension survey.

Where long-lived and resident receptors have been impacted and are still present in the impact area during a subsequent survey, multiple exposures may be possible. The Davros areas was surveyed previously in 2016 and while the area surveyed does not broadly overlap the planned survey area for the Davros Extension survey, there will be some overlap along the margins of the two areas. Individual fish recovery times (Stadler and Woodbury 2009) indicate that it is highly unlikely that individual fish in an area where a seismic survey was acquired 1-2 years ago would not have recovered over this time. Populations would be more resilient due to immigration and recruitment of unaffected individuals.

Commercial fishing stakeholders (Pilbara Trap, Trawl and Line) have expressed concern that seismic surveys could affect fish catchability over extended periods. However, it is not currently possible to separate changes in catchability from natural or fishing-induced population changes and behavioural changes due to climate, weather, life-history stage, prey abundance etc; and the balance of evidence suggests that long-term behavioural impacts are highly unlikely. Recent work has shown that fish can recover from the startle response of acoustic disturbance within minutes (Bruintjes et al 2016) and that repeated exposure can lead to habituation and reduced response within weeks (Nedelec et al 2016).

Figure 5-18 shows seismic surveys conducted in the Davros area over the 3 - 10 years prior to the proposed Davros Extension survey. It is also important to note that no seismic surveys have been conducted over Glomar Shoal, and the closest survey to the shoal was conducted in water depths >70 m. Therefore, no cumulative impacts from historical seismic surveys are predicted for the proposed Davros Extension survey.

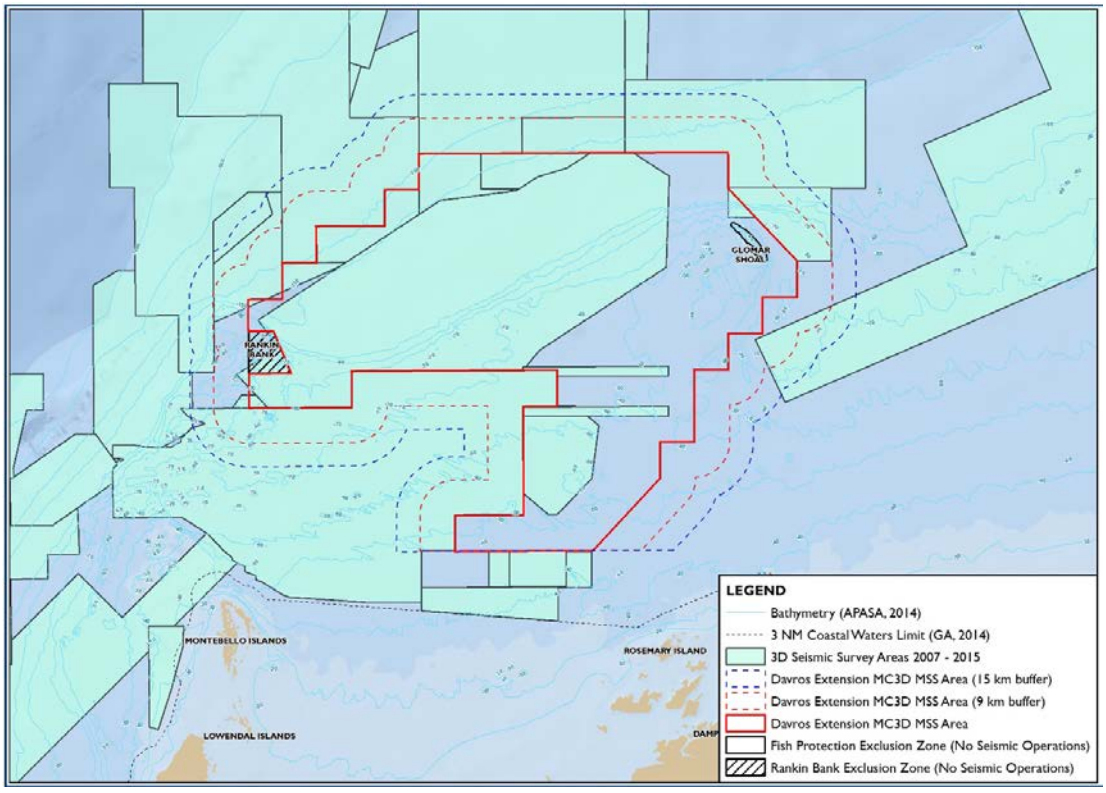



**Figure 5-18: Historical Surveys in the vicinity of the Davros Extension Survey Area**

### 5.2.1.8 Inherent Impact Assessment

#### 5.2.1.8.1 Plankton (incl Eggs/Larvae)

Underwater noise emissions from seismic operations could cause localised scale, short-term effects over the duration of the survey (150 days) on plankton (and fish/coral spawn) within the survey area, and at a worst case extending 1.2 km from the survey boundary (based on the impact range reported by McCauley et al. (2017)). Secondary impacts could include reduced prey availability and reduced recruitment to fish stocks due to mortality of planktonic eggs and larvae but would be within the range of natural variability. There will be no threat to fish populations as a result of secondary impacts because the variation in local plankton assemblages at any location will be short-term and fall within the large level of natural variability in prey availability and egg survival. This is a Minor consequence, given that recovery of plankton is expected to be rapid (in the order of days to weeks) following the cessation of the survey, and only a proportion of the plankton within the survey area would be exposed at any one time. The very small proportion of the regional and local planktonic assemblages affected is not expected to have population or ecosystem level impacts and any individual area would recover in days to weeks through rapid growth rates combined with dispersal and mixing of plankton (from inside and outside the zone of potential impact). The likelihood of this impact is Almost Certain because there will be some exposure of plankton to sound from the seismic source. The inherent impact is Medium.

#### 5.2.1.8.2 Invertebrates and Fisheries

Underwater noise emissions from seismic operations could cause a localised (directly below the airgun and out to between 98 to 260 m from the seismic sources) risk of dose-dependent mortality to invertebrates (prawns and pearl oysters) in the event of >1 airgun pass, with no immediate mortality, and no threat to populations. The potential impact on the health or behaviour of benthic invertebrates, without threat to populations or fisheries, is a Minor consequence.

Impacts to invertebrate fisheries are not expected given that the survey area does not contain habitat critical for the survival of prawns and pearl oysters (i.e. nursery, spawning, recruitment), animals would not be exposed to more than two airgun passes (as the survey line distance is 500 m), dose-dependent mortality could occur but would not be expected. There is very low level prawn fishing effort in the survey area and with no impact on catchability are predicted. Catchability of pearl oysters is unlikely to be affected as fishing activities are restricted to <35 m and recruitment to the fishery is not known to occur at distances of >60 km from the closest key fishing areas at Eighty Mile Beach. The likelihood of these impacts is Unlikely given the low importance of the survey area for commercially and ecologically important invertebrates. The inherent impact is Low.

#### 5.2.1.8.3 Glomar Shoal and Rankin Bank Fish Species

Underwater noise emissions from seismic operations could cause localised medium term (months) effects on site-attached fish species associated with Glomar Shoal and Rankin Bank, conservatively including mortality, potential mortality and recoverable injury up to 160 m from the source, and temporary behavioural effects up to 300 m; but with no effects on population status or ecosystem function. Noise may also have short-term effects on commercial fishers displaced from the area, or experiencing short-term reduced catchability. This is a Moderate to Severe consequence.

Given that CGG will use the smaller airgun array (1,800 cui) in water depths <50 m (including the areas of highest species richness and abundance on both Glomar Shoal and Rankin Bank (AIMS, 2014)), and that the great majority of fish species are not site-attached and would be expected to swim away from the moving source, temporary effects could be expected, however mortality, potential mortality and recoverable injury would not be expected. The likelihood of temporary effects is Possible. The inherent impact is High.

#### 5.2.1.8.4 Fish and Commercial Fisheries

Underwater noise emissions from seismic operations could cause localised medium term (days) effects on commercially fished species outside of Rankin Bank and Glomar Shoals area, including mortality/potential mortality or recoverable injury up to 160 m from the source, and temporary effects up to 300 m. Mortality has never been reported and is only included in the threshold criteria as an extremely conservative measure. Recovery from behavioural effects or TTS would be expected in days to weeks. No population level effects are expected in commercially caught finfish species, and no lasting effects on their catchability and consequently to their catch rates. This is a Minor consequence.

Stakeholder consultation has identified an area important for commercial fishing of goldband snapper, therefore it is possible that indirect effects on catchability could occur and temporarily affect the fisher. This would be a Moderate disruption, being localised and short-term effect (weeks) on commercial users.

Given that commercially exploited fish comprise an array of highly mobile species that can avoid the approaching airgun well before the noise reaches injurious levels and that mortality is unlikely, with a range of the effects including recoverable injury potentially occurring, mortality could occur but would not be expected. The likelihood of adverse impacts on mobile fish species in open waters is Unlikely. The inherent impact for both impacts is Low. The likelihood of the Moderate disruption impact on the commercial fishing for goldband snapper is Possible. The inherent impact for both impacts is Medium.

#### 5.2.1.8.5 Hard Corals

Underwater noise emissions from seismic operations could cause localised scale, temporary effects (days) on coral spawn if it were to occur within the survey area, with no threat to hard coral cover over Rankin Bank and Glomar Shoal due to the buffering effect of up-current sources of coral recruits and the negligible impact on mature colonies which would continue to grow and spawn in subsequent years. Given that Glomar Shoal has very low coral cover (<0.1%) it is very unlikely to rely on mass spawning events to support recruitment.

Should the survey vessel encounter a floating slick of coral spawn, acoustic emissions could kill coral larvae in the immediate area. The Rankin Bank is not a protected area, but is a recognised biodiversity value of the region. No impacts on ecosystem function or coral reef populations are expected. This is a Minor consequence.

Coral mass spawning occurs over a short period (~ 3 days) in autumn and, in some areas and some species, in spring also. The likelihood of this impact is Possible. The inherent impact is Medium.

#### 5.2.1.8.6 Whale Sharks

Underwater noise emissions from seismic operations could cause minor disruption and temporary effect (days) on whale sharks, including impacts on critical behavioural processes (foraging), but with no threat at a population level. This is a Minor consequence.

Given that the survey is scheduled outside the peak of potential presence for whale sharks in the area, and the survey area is not a known area for aggregation (the closest aggregation area is at Ningaloo Reef), this will limit the presence of animals during the survey. If encountered animals are expected to avoid the noise as the airgun array approaches and would not be expected to be exposed to injurious noise levels. The likelihood of this impact is Unlikely. The inherent impact is Minor.

#### 5.2.1.8.7 Turtles

Underwater noise emissions from seismic operations could cause moderate disruption and short term (days) behavioural disturbance/avoidance to individual protected species (turtles), including impacts on critical behavioural processes (inter-nesting migration), but with no threat at a population level or to the regional stocks (turtles). Disturbance would be limited to a few days when the survey vessel was completing adjacent sail-lines in areas closest to the island nest sites. This is a Minor consequence.

Given that it is likely that a large proportion of turtles nesting on the Montebello Islands (and the Dampier Archipelago) will move away from the survey area towards the mainland coast and islands (i.e. not offshore towards the survey area) during inter-nesting, and that the survey area does not include any islands or emergent land (so no nesting areas or known foraging habitats within or in the vicinity of the survey area), this will limit the exposure of turtles to seismic noise. Any disturbance will be limited to avoidance response followed by rapid resumption of normal activity. The likelihood of this impact is Possible. The inherent impact is Medium.

#### 5.2.1.8.8 Cetaceans

Underwater noise emissions from seismic operations could cause moderate disruption and medium term (months) behavioural disturbance/avoidance to individual protected species (cetaceans), including impacts on critical behavioural processes (migration), but with no threat at a population level. Behavioural effects in low and mid-frequency cetaceans are predicted to be localised, short-term and recoverable This is a Moderate consequence.

Given that the survey does not contain habitats critical to the survival of any listed cetacean species, i.e. breeding, nursery, aggregation or migration areas, and that if encountered, migrating animals are expected to avoid the noise as the airgun array approaches, it is Unlikely the migrating cetaceans would be exposed to injurious sound levels. The inherent impact is Medium.

### 5.2.1.9 Control Measures

Table 5-13 presents the impact assessment summary for underwater noise associated with operation of the seismic source and the control measures to be implemented.

EPBC Act Policy Statement 2.1, for managing interactions between seismic surveys and cetaceans, requires demonstration through modelling or empirical measurements that received sound exposure levels for each shot will not likely exceed an SEL of 160 dB re 1 $\mu Pa^2$.s for 95% of shots at 1 km range (DEWHA 2008). Modelling results predict that the EPBC Act Policy Statement 2.1 threshold of 160 dB re 1 $\mu Pa^2$.s is reached within 1 km for the 4,630 cui modelled array within 50 m water depth, and is close to this distance for a source in 100 m depth (Table 5-9). However, employing the smaller array (1,800 cui) in water depths of 35 to 50 m will mean that the Policy Statement 2.1 requirements are met and a smaller low-power precaution zone could be used. Consequently, CGG has applied the more conservative precautionary zones defined within EPBC Act Policy Statement 2.1 (Table 5-13).

**Table 5-13: Control Measures for Underwater Noise from Seismic Operations**

| Control Measures | |
|---|---|
| Good Practice/ EIA | Seismic airgun array designed to direct sound energy downwards and reduce horizontal spreading; this will reduce horizontal sound propagation and reduce impacts to marine fauna in the water column. Note: this also reduces potential for propagation into State waters. |
| | The minimum depth within the survey area that seismic data will be acquired is 35 m. |
| | A smaller airgun array volume of 1,800 cui will be used in water depths within the survey area from 35 to 50 m. |
| | No seismic activity within the exclusion areas (including conservative 500 m buffer) set over Glomar Shoal and Rankin Bank (Figure 5-10). Sail lines will be orientated in a NW-SE direction to avoid the shallow parts of Glomar Shoal while maximising data coverage. |
| | In the event that another vessel is acquiring seismic data in the region, the survey vessel shall not acquire data simultaneously within 50 km of the other seismic vessel in order to avoid cumulative impacts to marine fauna. |
| | EPBC Policy Statement 2.1 Part A Standard Management Measures will be implemented for whales and whale sharks. |
| | Pre-start-up visual observation: visual observations for whales and whale sharks undertaken in the 3 km “observation zone” by MFOs for 30 minutes prior to commencement of soft start procedures. |
| | Soft start procedures: may only commence if no whales or whale sharks have been sighted within the low power or shutdown zone during the pre-start-up visual observations. Soft start procedures will be used each time the acoustic source is initiated; gradually increasing power over a 30-minute period. |
| | If a whale or whale shark is sighted within the 3 km observation zone during the soft start, an additional trained crew member will be brought onto the bridge to monitor the animals. |
| | If the whale or whale shark enters the “low power zone” (<2 km) the source will be powered down to the lowest setting; and if it enters the “shut-down zone” (<500 m) the acoustic source will be shut down completely. |
| | Following a shut-down, soft start procedures will only commence after the whale or whale shark has moved outside the low power zone, or when 30 minutes have elapsed since the last sighting. |
| | If the array is shut down for any reasons during the survey (including as a result of whale entering the shutdown zone or entering a ‘no acquisition zone’), either visual observations for whales will continue until the soft start procedure commences; or pre-start visual observations will apply prior to re-commencement. This is to ensure observations are either continuous or at least occurring for 30 minutes prior to the commencement of the soft start procedure. |
| | Shut-down or power down the acoustic source to the lowest setting when not collecting data, or undertaking soft start procedures (e.g. during line turns or when moving to another part of the Operational Area). |
| | Soft start procedures can only resume after the whale has moved outside the low power zone, or when 30 minutes have elapsed since the last sighting |

| Control Measures | |
|---|---|
| | At night or at other times of low-visibility, start-up of the acoustic source will occur:<br>■ providing that there have not been three or more whale or whale shark instigated power-down or shut-down situations during the preceding 24 hour period<br>■ if operations were not underway during the preceding 24 hours, the vessel has been in the vicinity (approximately 10 km) of the proposed start-up position for at least two hours (under good visibility conditions) within the preceding 24 hour period, and no whales or whale sharks have been sighted. |
| | Whale sighting will be reported in accordance with Compliance and Sighting Reports requirements. |
| | Relevant vessel crew members are inducted in their responsibilities regarding vessel / marine fauna interactions. |
| | EPBC Policy Statement 2.1 Part B Additional Management Measures will be implemented for whales and whale sharks. |
| | The Davros Extension MC3D MSS will be undertaken outside peak humpback whale migration periods and will avoid the months of July through to September. |
| | The precaution zones for the survey are based on a precautionary approach and will be as follows:<br>■ Observation zone: 3+ km horizontal radius from the acoustic source<br>■ Low power zone: 2 km horizontal radius from the acoustic source<br>■ Shut-down zone: 500 m horizontal radius from the acoustic source. |
| | At least one dedicated MFO will observe whales and whale sharks from an elevated platform on the seismic survey vessel during all seismic survey activities conducted in daylight hours. |
| | If at any time during the survey there have been three or more whale or whale shark instigated power-down or shut-down situations during the preceding 24-hour period the first response of the seismic vessel will be to move >12 km away from the current area and continue data acquisition in another area. Seismic vessel operations will implement EPBC Policy Statement 2.1 Part A Standard Management Measures for pre-start visual observations and soft start procedures in the new area. |
| | The seismic survey vessel will not discharge airguns in shallow waters <35 m water depth or within the exclusion areas. |

#### 5.2.1.10 Demonstration of ALARP and Risk Acceptability

##### 5.2.1.10.1 Summary of ALARP Demonstration

CGG is committed to ensuring continual risk reduction and considered the additional measures in Table 6-12. Where the cost of implementation is disproportionate to the benefit gained, control measures have not been adopted.

As part of the ALARP assessment for this aspect of the activity, CGG established both spatial and seasonal exclusion zones for sensitive receptors. The Glomar Shoal fish protection area and 500 m buffer around the FPA includes >90% of the areas of highest fish density and species richness surveyed by AIMS (2014), and is also the largest area that could be excised from the survey area without significantly reducing the value of the dataset and therefore the commerciality of the survey. There will be no seismic operations at all (i.e. including soft-starts) within the fish protection area and 500 m buffer. CGG considers the environmental benefit to be gained by protecting the FPA from potentially injurious noise levels, and thereby protecting the values of the KEF, to outweigh the cost.

CGG would like to acquire the Davros Extension with the same source size as the existing Davros data, namely 4500 $in^3$. The Davros data has allowed much deeper imaging in the Carnarvon Basin due to a combination of large source size, deeper cable tow depth, longer cable and extended recording time. A comparison with the legacy MSS acquired in 2014 with a 3,147 $in^3$ array shows that the larger source does generate a much better image at deeper depths in the basin (Figure 5-19). However, CGG has agreed to use a smaller array of 1,800 $in^3$ in water depths <50 m to in recognition of sensitive receptors in or in close vicinity to the survey area, particularly Glomar Shoal. In this area there is a relatively geological shallow target at approximately 2-3 km below seabed which CGG is confident can be surveyed effectively with 1,800 $in^3$ array. Hence it is worthwhile acquiring data using the smaller array in this area.

CGG does not believe that the smaller array would provide much uplift in imaging quality over Rankin Bank, therefore this area has excised from the originally planned survey (Figure 5-20). The area over Rankin Bank identified as being of highest species richness and abundance (i.e. down to the 40 m depth contour and including a 500 m buffer) is wholly located within the Rankin Bank Exclusion Zone (Figure 5-20). There will be no seismic operations at all (i.e. including soft-starts) within this exclusion zone.

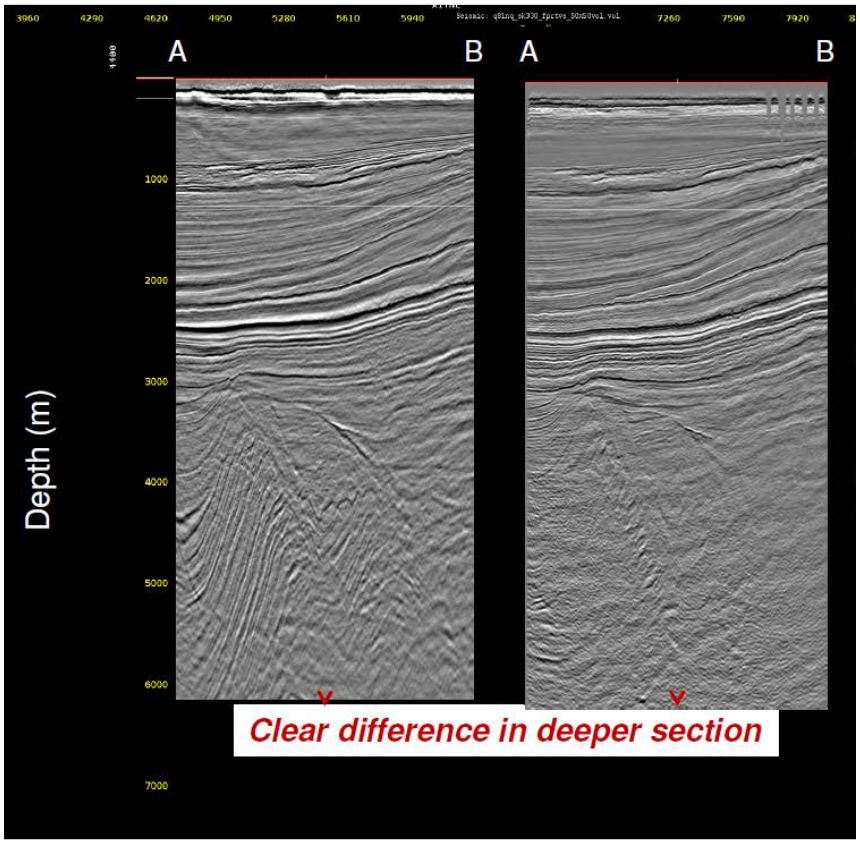



**Figure 5-19: Image Showing Difference in Seismic Data Capture Quality Between Smaller (3,147 cui) and Larger (4,650 cui) Airgun Arrays Between Davros (2015) and a Legacy Survey (2014)**

CGG has responded to concerns raised during stakeholder consultation with commercial fishers following a face-to-face meeting with Fat Marine (Pilbara Line Managed Fishery (PLMF) licence holder) and WAFIC. CGG was advised by Fat Marine that the area for fishing operations for the key species of interest to the PLMF (goldband snapper) is within the 60 to 90 fathom (or 110 to 165 m) depth range (Table 8-1). Fat Marine have two licences under the PLMF operating for 10 months of the year under these licences, and are currently inactive during January and February. CGG recognises the concerns raised by fishers and would seek to minimise the potential for interaction with the fishery and disruption of their operations, particularly for the fishery's key species of concern, goldband snapper. However, the survey cannot commence prior to the beginning of March 2018 and it is now not possible to acquire data in Jan-Feb 2018. In the event that the Fat Marine changes the months that they are inactive, CGG will monitor this through the ongoing consultation process (Section 8.5) and will to determine whether the timing of acquiring data within the key depth range for goldband snapper can be modified accordingly. CGG will manage this through ongoing stakeholder consultation with Fat Marine as described in Section 8.5.

CGG has taken a further precautionary approach to the impact assessment for humpback whales in addition to no seismic activity during the peak migration months of July and September, and will implement additional controls in the area defined as the humpback whale adaptive management zone (Figure 5-20). Adaptive management procedures include: in the event that three or more whale sightings within the power-down/shut-down zone occur within the preceding 24 hours (including times when the acoustic source is shut-down and/or powered down), the survey vessel will relocate >12 km from the northern edge of the humpback whale adaptive management zone, if the survey vessel cannot relocate, pre-start up visual observation will be increased to 45 minutes and the low power zone will be increased to 3 km horizontal radius from the

acoustic source. Further, the vessel will relocate to a distance >12 km after a single shutdown, if greater than 20 whales in observation zone during the pre-start observation, but not close enough to prevent soft-start commencing (i.e. in observation zone, but outside low power zone).Previously the survey area overlapped a small area of the BIAs for inter-nesting buffers for green, hawksbill and loggerhead turtles around the Dampier Archipelago, as well as habitat defined as critical to survival of these species in the area (Figure D-1). The southern extent of both the survey and operational areas has been reduced during the ALARP assessment by 11,174 $km^2$ to ensure that the proposed activities would not displace inter-nesting green, hawksbill and loggerhead turtles in the Dampier Archipelago. CGG recognises the inherent uncertainty in modelling underwater sound levels and the potential for under-estimating impact distances for sensitive fauna. With new approaches to analysing seismic streamer returns and using dedicated seabed loggers, the actual received sound levels can be assessed, and if necessary the predicted sound impact distances can be revised and mitigation controls appropriately modified to maintain impacts at ALARP and an Acceptable level. CGG has already undertaken extensive real-time monitoring of sound levels during the previous seismic surveys in the same area as the Davros Extension MC3D MSS, using the 4,500 cui array. The monitoring data has been used within this EP to verify the sound propagation levels predicted by the modelling (Section 5.2.1.5). This information has been used to compare measured levels with modelled levels and corrections made to the where modelled levels previously under-estimated potential received sound levels. Controls in the EP have been appropriately revised to maintain impacts from underwater sound at ALARP and Acceptable levels. Further real-time monitoring and adaptive management in response to measured sound level is considered unnecessary given the highly transferrable nature of the existing data (same area, same range of depths and bottom types). While there is a minor benefit to be gained in verifying sound levels in the Davros Extension area, the complexities of implementing this process are considered likely to increase significant costs during the survey. The complexities are mainly due to the need for appropriately skilled and experienced personnel at all time of day and night; it requires an analyst who can progressively analyse the streamer return data, assess impact distances, relate these to sensitivities of the area, assess adequacy of existing controls, revise controls and assess Reg 17 triggers. The minor benefit is outweighed by the cost of having one or more dedicated analysts available at all times.

CGG considers the adopted controls to be appropriate in reducing the environmental risks and impacts associated with underwater noise from operation of the seismic source (airgun array) to ALARP. No other control measures have been identified that may practicably or feasibly be adopted to further reduce the risks and impacts without grossly disproportionate costs compared to the benefit of risk reduction.

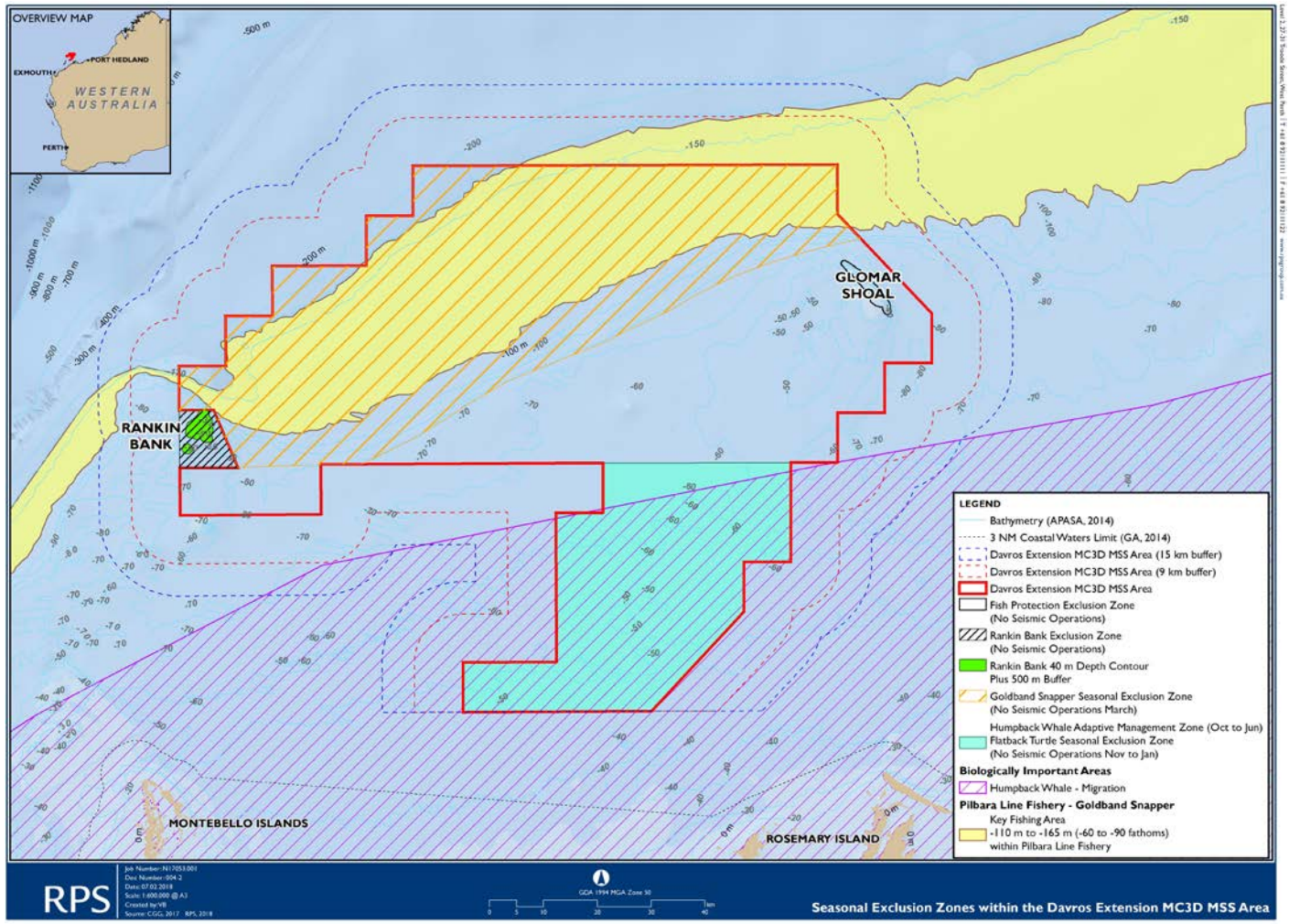



**Figure 5-20: Seasonal Seismic Precautionary Areas for the Davros Extension MC3D MSS**

**Table 5-14: Demonstration of ALARP for Underwater Noise from Seismic Operations**

| Additional Control Measures | Practicability/ Effectiveness? | Cost Benefit Analysis | Impact Reduction (L/C/RR ↓)? | Control Adopted |
|---|---|---|---|---|
| Precautionary Approach | | | | |
| An Adaptive Management Zone will be implemented for humpback whales during the shoulder months for whale migration (i.e. June and October) (Figure 5-20). | P: Yes<br>E: Very effective (++) | CGG recognises the importance of the BIA for humpback whales and that there is the potential for significant numbers of animals to be present immediately prior to and after the known peak periods for the northern and southern migrations. Excluding seismic operations during the 'shoulder' months either side of the peak migrations will provide additional protection for these 'early' or 'late' migrating animals,<br>Seismic data can be acquired within the northernmost area of the operational area during January to May. This will reduce the potential for interactions with the humpback whale migratory pathway and will engender limited cost/time loss for CGG. Benefit outweighs cost. | Yes | Yes |
| In the event of three or more whale or whale shark sightings within the power-down/shut-down zone occur within the preceding 24 hours (including times when the acoustic source is shut-down and/or powered down), the following adaptive management procedures will be implemented:<br>■ Relocation – seismic vessel will relocate to another survey line >12 km from northern boundary of the humpback whale adaptive management zone and will not return within 24 hours; or<br>■ If the vessel cannot relocate - pre-start up visual observation will be increased to 45 minutes and the low power zone will be increased to 3 km horizontal radius from the acoustic source. | | CGG recognises that humpback whales may be present within the survey area within the 'shoulder' months of migration (June and October). Implementing the additional mitigation procedure of moving >12 km from the northern boundary of the adaptive management zone will ensure the seismic vessel has moved to a location where received levels from the array are reduce to below levels that may cause likely avoidance. This will provide additional protection in the event that low densities of migrating humpback whales are encountered moving through the survey area. Benefit outweighs cost. | Yes | Yes |

| Additional Control Measures | Practicability/ Effectiveness? | Cost Benefit Analysis | Impact Reduction (L/C/RR ↓)? | Control Adopted |
|---|---|---|---|---|
| Relocate vessel >12 km after a shutdown, if greater than 20 whales or whale sharks in observation zone during the pre-start observation, but not close enough to prevent soft start commencing (i.e. outside low power zone). | P: Yes<br>E: Effective (+) | A large number of whales in the observation zone could indicate that the vessel is heading into a migrating pod. Vessel can relocate prior to shutdowns being triggered to avoid disturbance to the whales. Minor additional cost implication as shutdowns and relocation likely anyway.<br>Potential environmental benefit to be gained outweighs costs associated with implementation. | Yes | Yes |
| Reduction in size of the southern extent of the survey area to protect inter-nesting turtles. | P: Yes<br>E: Very Effective (++) | Previously the survey area overlapped a small area of the BIAs for inter-nesting buffers for green, hawksbill and loggerhead turtles around the Dampier Archipelago, as well as habitat defined as critical to survival of these species in the area (Figure D-1). The southern extent of both the survey and operational areas has been reduced during the ALARP assessment by 11,174 $km^2$ to ensure that the proposed activities would not displace inter-nesting green, hawksbill and loggerhead turtles in the Dampier Archipelago. This is not a critical area for the survey and can be excluded without compromising survey objectives<br>Benefit outweighs cost. | Yes | Yes |
| Seismic data will be acquired within the survey area only using the small (1,800 $in^3$) airgun array. | P: No<br>E: Fairly effective (0) | CGG would like to acquire the Davros Extension with the same source size as the existing Davros data, namely 4,500 $in^3$. The Davros data has allowed much deeper imaging in the Carnarvon Basin due to a combination of large source size, deeper cable tow depth, longer cable and extended recording time. A comparison with the legacy MSS acquired in 2014 with a 3,147 $in^3$ array shows that the larger source does generate a much better image at deeper depths in the basin. Our preference would be to use the same large array for the entire survey.<br>However, CGG have agreed to use a smaller array of 1,800 $in^3$ in water depths <50 m to reduce any environmental impact particularly in the region of Glomar Shoal. In this area there is a relatively shallow target at approximately 2-3 km which CGG is confident can be surveyed with 1,800 $in^3$ array. Hence it is worthwhile acquiring data using the smaller array in this area.<br>CGG does not believe that the smaller array would provide much uplift in imaging quality over Rankin Bank, therefore this area has excised from the originally planned survey (Figure 5-20).<br>If CGG were limited to a smaller array size over most of the survey area, the survey would not go ahead it could not be guaranteed that the necessary | Yes | No |

| Additional Control Measures | Practicability/ Effectiveness? | Cost Benefit Analysis | Impact Reduction (L/C/RR ↓)? | Control Adopted |
|---|---|---|---|---|
| | | imaging quality could be achieved.<br>The southern part of the survey area is also in shallow water and we have agreed to use an 1,800 $in^3$ array as ALARP. This area has limited seismic coverage and maximum depths required to be imaged are generally less than those further north.<br>Control not practicable and would preclude the survey taking place. | | |
| Establish wider (500 m) buffer around Glomar Shoal | | CGG recognises there is uncertainty in the modelled sound levels and in the distribution of fish as predicted by AIMS (2014). The larger buffer (500 m) incorporated into the exclusion area provides an adequate level of conservatism to offset the uncertainty in the impact prediction. Benefit outweighs cost. | Yes | Yes |
| Increasing the Glomar Shoal FPA to encompass the 40 m depth contour. | P: No<br>E: Effective (+) | Partial dependency plots (Figure 5. 8) and partial interaction plots (Figure 5. 9) showed that the major influences on species richness were depth and the presence (% cover) of hard coral<br>Partial dependency plots (Figure 5. 10) and partial interaction plots (Figure 5. 11) showed that fish abundance was highest in the 20m-30 m depth range and declined quickly from 30 to 60m depth<br>Excluding all areas <40 m would compromise ability to image shallow water target under Glomar Shoal; however, waters >40 m are included in northern buffer zone around the FPA already, so little additional benefit.<br>Control not practicable, cost outweighs benefit. | Yes | No |
| In the event that the MFO observes a dense coral spawning slick during the predicted mass spawning times, the seismic vessel will relocate >2 km from the slick | P: Yes<br>E: Fairly effective (0) | Although Rankin Bank is an isolated reef with low coral cover and unlikely to be regionally significant in terms of being a source of recruits for down-current reefs, coral spawning is an important component of maintaining the biodiversity of the benthic communities. As it is likely that coral spawning at Rankin Bank is highly episodic, it is not practical to establish a temporal (i.e. time-based) exclusion, however as coral spawn surface slicks can be observed at the sea surface and are of short duration (e.g. 3 days on Ningaloo Reef), it would be practical to move the vessel up-current in the event that a slick is observed. McCauley et al (2017) reported possible plankton impacts to 1.2 km, so it would be conservative to move 2 km from the observed slick. | Yes | Yes |

| Additional Control Measures | Practicability/ Effectiveness? | Cost Benefit Analysis | Impact Reduction (L/C/RR ↓)? | Control Adopted |
|---|---|---|---|---|
| In-field real-time monitoring and adaptive management during the survey | P: No<br>E: Fairly effective (0) | Further real-time monitoring and adaptive management in response to measured sound level is considered unnecessary given the highly transferrable nature of the existing data (same area, same range of depths and bottom types). While there is a minor benefit to be gained in verifying sound levels in the Davros Extension area, the complexities of implementing this process are considered likely to increase significant costs during the survey. The complexities are mainly due to the need for appropriately skilled and experienced personnel at all time of day and night; it requires an analyst who can progressively analyse the streamer return data, assess impact distances, relate these to sensitivities of the area, assess adequacy of existing controls, revise controls and assess Reg 17 triggers. The minor benefit is outweighed by the cost of having one or more dedicated analysts available at all times. | Yes (minor) | No |
| CGG will only acquire seismic data within the key fishing depth range of 60 to 90 fathoms (110 to 165 m) for goldband snapper identified by Fat Marine (Pilbara Line Managed Fishery) during the months of January and February, when the fishery is inactive. | P: Yes<br>E: Very effective (++) | CGG recognise the concerns raised by fishers, particularly the Pilbara Line Managed Fishery through stakeholder consultation with Fat Marine, and would seek to minimise the potential for interaction with the fishery and disruption of their operations, particularly for the fishery's key species of concern, goldband snapper. However, the survey cannot commence prior to the beginning of March 2018 now and it is not possible to acquire data in Jan-Feb 2018. | Yes | No |
| CGG will continue to consult with Fat Marine (and other fishers) to understand the fishers' activities and to seek opportunities to minimise disruption of fishing activity during this consultation process. CGG will notify fishers eight weeks prior to the start of the survey of the survey details including, timing, location, duration. | P: Yes<br>E: Effective (+) | Fishery stakeholders vary their months and locations of fishing according to market forces and personal situations. Ongoing consultation will enable CGG to plan day-to-day activities around key fisheries drivers, and to inform the fishers when an unavoidable relocation is required. Benefit outweighs cost. | Yes | Yes |
| As part of the ongoing consultation process, CGG will notify all other relevant persons four weeks prior to the start of the survey of the survey details including, timing, location, duration. | P: Yes<br>E: Very effective (++) | Early notification of activities will allow other marine users to plan activities around the survey and avoid negative interactions. Benefit outweighs cost. | Yes | Yes |

| Additional Control Measures | Practicability/ Effectiveness? | Cost Benefit Analysis | Impact Reduction (L/C/RR ↓)? | Control Adopted |
|---|---|---|---|---|
| Commercial fishers, Recfishwest and relevant recreational fishing groups/ organisations and will be issued a 7 to 10 day forecast prior to activities commencing. | P: Yes<br>E: Very effective (++) | Early notification of activities will allow fishers to plan activities around the survey and avoid negative interactions. Benefit outweighs cost. | Yes | Yes |
| Commercial and recreational fishers are kept informed of daily survey activities through CGG's 24-hour look-ahead communication. | P: Yes<br>E: Very effective (++) | There is a potential benefit to fishers of being able to plan around the maximum time they may be displaced and no real cost to CGG. Benefit outweighs cost. | Yes | Yes |
| Provision of bathymetric data to Fat Marine commercial fishery. | P: Yes<br>E: Very effective (++) | Fat Marine identified during a face-to-face meeting with CGG that the Davros Extension MC3D survey area is a relatively new area for their fishing operations and would like to receive bathymetric data collected during the survey. CGG will consult with Fat Marine to determine the format required for supply of bathymetric data. | Yes | Yes |
| Spotter aircraft to observe the survey area and provide vessel with locations of any observed cetaceans or whale sharks | P: No<br>E: Effective (+) | This is not considered a significant benefit given the survey area is outside the whale BIAs and outside the whale shark aggregation BIA. There is also a limited availability of suitable aircraft, limited aircraft endurance and considerable additional safety risk and cost in using manned aircraft. Costs outweigh benefits. | No | No |
| No seismic during spawning periods for key fisheries species | P: N (no periods of the year where spawning does not occur)<br>E: Fairly effective (0) | Spawning occurs all year round for various species. It is not possible to determine species spawning and periods within the survey area due to lack of spawning data. Limited benefit (if any). Avoidance of the peak humpback whale migration period will however avoid Rankin cod spawning periods. | Not possible to determine due to lack of data | No |
| Seismic acquisition will only occur outside key fishing seasons. | P: No<br>E: Ineffective (-) | Fishing occurs all year round in the region and no indication of peak fishing times from stakeholders. Costs outweigh benefits. | Yes | No |
| No seismic activity within the 100 m depth contour | P: No – loss of >90% of survey area<br>E: Unknown. Suggested benefit to pearl oyster larvae contrary to scientific evidence. | CGG investigated the proposed implementation of an exclusion zone proposed by the PPA for waters shallower than the 100 m isobath, and have deemed it an unworkable option as it would cut out more than 90% of the survey area. In addition, the ERA (Section 5.2.1.2) has identified that potential effects to planktonic organisms from increased noise from the seismic source are small (<10 m). Sacrifice outweighs benefits. | No – due to distance from pearl oyster fishery along coast (80 Mile Beach region) and other study conclusions of lethal impact range <10 m from source | No |

| Additional Control Measures | Practicability/ Effectiveness? | Cost Benefit Analysis | Impact Reduction (L/C/RR ↓)? | Control Adopted |
|---|---|---|---|---|
| No night-time operations | P: No<br>E: Ineffective (-) | Limiting seismic activities to daylight hours would significantly extend the time required to acquire data for individual activities. No significant risks associated with night-time operations due to underwater noise that are different from daytime operations identified. Costs disproportionately higher than benefits. | Minimal environmental benefit from avoiding night-time operations. | No |
| Do nothing – no MSS | P: No<br>E: Very effective (++) | Titleholders are required by NOPTA to acquire seismic data within specified time frames. Data required under Glomar Shoal to tie in to surrounding datasets. Minimal benefit given the predicted low impact on other users. Costs disproportionately higher than benefits. | Yes | No |
| Alternative acquisition options – ocean bottom cables or undershooting reefs. | P: No<br>E: Ineffective (-) | The cost could be up to twice that of the proposed seismic survey due to the additional time (longer survey) and vessels (two vessels required) which would make the survey non-commercial. In addition, there is also additional risk of environmental impacts to benthic communities associated with laying equipment on the seabed (physical damage, entanglement).<br>Further, due to the exclusion of the FPA and 250m buffer over the most sensitive areas of Glomar Shoal and Rankin Bank, undershooting would lead to minimal benefit.<br>Costs increases due to additional vessel charter and risk of environmental impacts to benthic habitat is grossly disproportionate to the minimal environmental benefit. | No | No |
| Alternative acquisition options – Two Vessels Shooting | P: No<br>E: Ineffective (-) | CGG considered undershooting the shallow reef using two vessels; one towing the source and the other, on the other side of the shoal, towing the receivers. This would require contracting and mobilising a second seismic vessel (without streamer) to acquire seismic data under the shallower areas of Glomar Shoal.<br>The cost of having two vessels even for only part of the survey would be approximately double the cost of the 3D seismic survey proposed under this EP. Additional post-processing costs would increase.<br>Given the establishment of the FPA and 250 m buffer around Glomar Shoal and Rankin Bank, there would be minimal environmental benefit from this approach.<br>This control measure has therefore not been adopted due to the cost being grossly disproportionate to any environmental benefits. | No | No |

| Additional Control Measures | Practicability/ Effectiveness? | Cost Benefit Analysis | Impact Reduction (L/C/RR ↓)? | Control Adopted |
|---|---|---|---|---|
| Increasing sail line spacing over Glomar Shoal and Rankin Bank | P: No<br>E: Fairly effective (0) | Sail line spacing over the shallower parts of Glomar Shoal and Rankin Bank has been reconsidered, but is counter to the objective of acquiring a high quality dataset.<br>Although wider line spacing may actually reduce acquisition costs due to shorter vessel time, this control would prevent CGG from achieving the geophysical data acquisition objectives for the survey. The loss in data coverage and consequent subsurface resolution would make this project uneconomical to acquire due to CGG's view that clients would not licence the data.<br>In addition, environmental benefits would be minimal given CGG has adopted the broader exclusion area over the shallow reef. Therefore, the cost in terms of loss of commerciality of the survey due to this control measure would be grossly disproportionate to the potential environmental benefit and this control is not adopted. | Limited reduction | No |
| Seismic operations will not be undertaken during March within the area identified as 'Goldband Snapper Seasonal Exclusion Area' in Figure 5-20 | P: Yes<br>E: Very effective (++) | CGG has further considered the potential for seismic noise to impact goldband snapper spawning in the region in the ALARP assessment<br>■ Goldband snapper (*Pristipomoides multidens*) inhabit hard bottom areas and adults are concentrated in depths from 80 to 150 m (Newman and Dunk 2003).<br>■ Stakeholder consultation with the Pilbara Line Fishery has previously identified that key fishing depths for goldband snapper lie between 110 and 165 m (60-90 fathoms).<br>■ The fishers target spawning age (adult) fish and therefore the spawning area is believed to be within the fished depth zone<br>■ The peak spawning time for goldband snapper months in north-western Australia is March (Newman et al. 2001, 2016a).<br>The level of impact on goldband snapper has been further reduced by implementing tighter controls around timing of acquisition in the snapper's main spawning area. Further temporal restrictions on survey timing in the acquisition area (in addition to turtle exclusion areas in response below) would seriously compromise the ability of CGG to acquire the survey in a cost effective manner. | (L/C/RR ↓)?<br>Yes | Yes |

#### 5.2.1.10.2 Residual Impact

*Plankton (incl Eggs/Larvae)*

With the implementation of the control measures described in Table 5-13 and additional controls adopted from the ALARP assessment in Table 5-14, including excising sensitive areas from the survey area (Glomar Shoal and Rankin Bank), avoiding areas of coral spawn and reducing received sound levels in water depths <50 m by using the smaller airgun array, the consequence of the survey on plankton assemblages is reduced to Negligible. Only a small proportion of the plankton within the survey area would be exposed at any one time and avoiding shallow areas reduces the effect to very limited with no lasting impacts on ecosystems, species or habitats and full recovery expected. The likelihood of mortality of plankton during the survey remains Almost Certain, however with the consequences reduced to Negligible, the residual impact is **Low**.

*Invertebrates and Fisheries*

The consequence of a localised risk of dose-dependent health impact or mortality of invertebrates (prawns and pearl oysters) if present within the survey area remains Minor. With the implementation of the control measures described in Table 5-13 and additional controls adopted from the ALARP assessment in Table 5-14, including CGG using the smaller airgun array (1,800 cui) in water depths <50 m (reducing potential impact areas on the seabed), and verification of received sound levels using measured data collected during previous surveys in the same area as the Davros Extension survey area, the impacts will be reduced.

In addition excising the southernmost extent of the survey area previously closest to the mainland and areas where fishing effort is concentrated will reduce the likelihood of exposure and therefore indirect effects on invertebrate health or catchability. The likelihood of remains Unlikely. The residual impact is therefore **Low**.

*Glomar Shoal and Rankin Bank Fish Species*

The consequence of mortality, potential mortality or recoverable injury of fish species associated with Rankin Bank and Glomar Shoals remains Moderate-Severe.

The control measures described in Table 5-13 and additional controls adopted from the ALARP assessment in Table 5-14, including excising the most important habitat areas (highest fish species richness and abundance) of Rankin Bank and Glomar Shoal from the survey, reduces the likelihood that fish in these areas will be exposed to potentially injurious sound levels during the survey. CGG has used measured sound levels during previous surveys in the same area as the Davros Extension survey area to demonstrate that none of the impact zones representing potential temporary physiological effect or mortality/potential mortality/recoverable injury will extend into the Glomar Shoal Fish Protection Area or the exclusion area at Rankin Bank. This confirms the efficacy of the 500 m buffer around the FPA to protect fish species from sound levels that could cause permanent (PTS) or temporary (TTS) effects. The likelihood of these impacts during the survey is reduced to Unlikely. The residual impact is therefore **Medium**.

*Fish and Commercial Fisheries*

The consequence of potential mortality or recoverable injury of commercially fished species and indirect effects on fisheries remains Minor for the fish and Moderate for the fisher.

With the implementation of the control measures described in Table 5-13 and additional controls adopted from the ALARP assessment in Table 5-14, exposure to potentially injurious noise levels during the survey has would be limited to within 160 m of the source, with temporary behavioural effects within 300 m. CGG has used measured sound levels during previous surveys in the same area as the Davros Extension survey area to demonstrate with confidence the spatial extent of such effects. Commercially exploited fish comprise an array of highly mobile species that can avoid the approaching airgun well before the noise reaches injurious levels. It is unlikely that there will be reduced catchability due to mortality/injury of fish stocks and no indirect effects to fisheries. The likelihood of these impacts during the survey remains Unlikely. The residual impact for general fish populations remains **Low**.

Working with the fishers to avoid or minimise disruption of planned fishing activities will reduce the likelihood of conflict between the survey vessel and the fishers to the point where it is not expected to occur. The likelihood of significant disruption is reduced to Unlikely. This remains a **Medium** level of impact.

*Hard Corals*

The consequence of mortality of coral spawn within a mass spawning slick encountered by the survey vessel remains Minor.

With the implementation of the control measures described in Table 5-13 and additional controls adopted from the ALARP assessment in Table 5-14, including in the event that the MFO observes a dense coral spawning slick during the predicted mass spawning times, the seismic vessel will relocate >2 km from the slick, the likelihood that coral spawn would be exposed to seismic noise is reduced. The likelihood of this impact during the survey is reduced to Unlikely-Rare. The residual impact is therefore **Low**.

*Whale Sharks*

The consequence of disturbance to foraging whale sharks in the survey area remains Minor.

With the implementation of the control measures described in Table 5-13 and additional controls adopted from the ALARP assessment in Table 5-14, including no survey operations during July to September (majority of the period for presence of whale sharks in the area), excising the southernmost extent of the survey area, the exposure of whale sharks to seismic noise is reduced. Adaptive management measures such as moving the vessel in the event of >3 shut-downs and relocation of the vessel if large numbers of animals are observed further reduce the likelihood of exposure. The likelihood of this impact during the survey remains Unlikely. The residual impact is therefore **Low**.

*Turtles*

The consequence of disturbance to or displacement of inter-nesting turtles remains Minor. Excising the southernmost extent of the survey area will reduce the impacts to all inter-nesting turtles by avoiding overlap with all but the flatback turtle inter-nesting area. Survey within the flatback inter-nesting area has potential to cause minor disruption (days) to individuals.

With the implementation of the control measures described in Table 5-13 and additional controls adopted from the ALARP assessment in Table 5-14, including excising the southernmost extent of the survey area, using a smaller (1,800 cui) array in water depths <50 m (i.e. southern most extent of the survey area) and implementation of soft-starts in accordance with EPBC Policy Statement 2.1. The survey area does not contain nesting areas or known foraging habitats, and studies have determined that there is no suitable habitat for inter-nesting flatback turtles. The likelihood that inter-nesting turtles will be present in the survey area and be exposed to sound levels that could lead to injury or disturbance/displacement during the survey is therefore reduced. The likelihood of this impact during the survey is reduced to Unlikely. The residual impact is therefore **Low**.

*Cetaceans*

The consequence of behavioural disturbance/displacement of cetaceans, including impacts on critical behavioural processes (migration) is reduced to Minor. Excising the southernmost extent of the survey area, scheduling the survey outside the peak migration period for humpback whales (July to September) will reduce the potential sound impact on migrating whales to a Minor behavioural disruption (days) to individuals. The potential impacts from the smaller source are reduced also. The consequence is reduced to Minor.

With the implementation of the control measures described in Table 5-13 and additional controls adopted from the ALARP assessment in Table 5-14, including CGG using a smaller airgun array in water depths <50 m (which includes the southern part of the humpback whale BIA overlapped by the survey area, this will limit the presence of animals during the survey and limit the exposure to noise from seismic operations. Adaptive

management measures described in Table 5-14 and implementation of EPBC Policy Statement 2.1 add an additional layer of protection to any humpback whales potentially occurring either side of the peak migration, as well as to individual animals that may pass through other parts of the survey area. Exposure of cetaceans to levels that could lead to injury or disturbance/displacement during the survey is therefore reduced. The likelihood of this impact during the survey is reduced to Unlikely. The residual impact is therefore **Low**.

#### 5.2.1.10.3 Acceptability

The residual impacts of underwater noise from seismic operations on marine receptor groups comply with CGG's internal context (low to medium risks with additional controls adopted), will be managed in accordance with relevant legislative requirements and complies with industry good practice and the principles of ESD. All concerns raised by stakeholders have been assessed and control measures adopted where appropriate.

*Plankton (incl eggs/larvae)*

Only a proportion of the plankton within the survey area would be exposed to injurious noise levels at any one time. Secondary reduced prey availability and reduced recruitment to fish stocks due to mortality of planktonic eggs and larvae are both considered unlikely. There will be no ecosystem or population level effects. The ALARP assessment demonstrates that the adopted controls (Table 5-13 and Table 5-14) are appropriate to reduce the impact to ALARP without the further impact reduction being required.

Given the nature and scale of the activity, CGG consider that the potential impacts are of an acceptable level as the predicted impacts are within and below the defined acceptable levels of impact in accordance with the criteria defined in Table 4-4.

*Invertebrates and Fisheries*

With the implementation of the adopted control measures mortality of invertebrates (prawns and pearl oysters) is unlikely. The survey area does not contain habitat critical for the survival of prawns and pearl oysters (i.e. nursery, spawning, recruitment). Pearl oyster spawning in the deeper waters similar to the survey area (>35 m) contributes little to recruitment in commercially important inshore populations (i.e. Eighty Mile Beach). There is very low level or no fishing effort for key species in the survey area. The ALARP assessment demonstrates that the adopted controls (Table 5-13 and Table 5-14) are appropriate to reduce the impact to ALARP without the further impact reduction being required.

Given the nature and scale of the activity, CGG consider that the potential impacts are of an acceptable level as the predicted impacts are within and below the defined acceptable levels of impact in accordance with the criteria defined in Table 4-4.

*Glomar Shoal and Rankin Bank Fish Species*

There are no alternatives to seismic surveys to accurately image hydrocarbon reserves beneath the seabed which do not entail a grossly disproportionate sacrifice in terms of time (duration of survey), cost and additional environmental risks (e.g. to benthic/fish communities with alternative acquisition options), and the survey is essential for CGG to undertake work and comply with permit requirements for data acquisition within specified time frames. CGG has selected the smallest practicable seismic array size that can be used in order to meet the survey objectives, and has committed to using a smaller array size of 1,800 cui in water depths of <50 m within the survey area.

The most sensitive areas (highest fish species richness and abundance) of Rankin Bank and Glomar Shoal have been excluded from the survey, including 500 m buffers around these areas to protect fish species from sound levels that could cause permanent or temporary effects. CGG has used measured sound levels during previous surveys in the same area as the Davros Extension survey area to demonstrate that none of the impact zones representing potential temporary physiological effect or mortality/potential mortality or recoverable injury will not extend into the Glomar Shoal Fish Protection Area or Rankin Bank Exclusion

Zone. There are no predicted long-term effects at a population level, and no adverse effects on the environmental values of the Glomar Shoal KEF. The ALARP assessment demonstrates that the adopted controls (Table 5-13 and Table 5-14) are appropriate to reduce the impact to ALARP without the further impact reduction being required.

Given the nature and scale of the activity, CGG consider that the potential impacts are of an acceptable level as the predicted impacts are within and below the defined acceptable levels of impact in accordance with the criteria defined in Table 4-4.

*Fish and Commercial Fisheries*

CGG has used measured sound levels during previous surveys in the same area as the Davros Extension survey area to demonstrate with confidence the spatial extent of exposure to potentially injurious noise levels during the survey has would be limited to within 160 m of the source, with temporary effects within 300 m. Commercially exploited fish comprise an array of highly mobile species that can avoid the approaching airgun well before the noise reaches injurious levels. No impacts to fish populations or reductions in catchability are predicted based on site-specific measured sound levels from CGG's previous seismic surveys. The ALARP assessment demonstrates that the adopted controls (Table 5-13 and Table 5-14) are appropriate to reduce the impact to ALARP without the further impact reduction being required.

Given the nature and scale of the activity, CGG consider that the potential impacts are of an acceptable level as the predicted impacts are within and below the defined acceptable levels of impact in accordance with the criteria defined in Table 4-4.

*Hard Corals*

Rankin Bank is the only area in the survey area identified as a coral reef (low coral cover <14%), and has been excluded from the survey area, with no seismic operations in this zone. Glomar Shoal has low coral cover (<0.1%), in locations with the highest fish species richness and abundance within the FPA. However, in the event of coral spawning observed within the survey area, the seismic vessel will relocate >2 km. The ALARP assessment demonstrates that the adopted controls (Table 5-13 and Table 5-14) are appropriate to reduce the impact to ALARP without the further impact reduction being required.

Given the nature and scale of the activity, CGG consider that the potential impacts are of an acceptable level as the predicted impacts are within and below the defined acceptable levels of impact in accordance with the criteria defined in Table 4-4.

*Whale Sharks*

Much of the expected time of year that whale sharks may be present in the expansive foraging BIA that passes through the survey area is now excluded from the survey timing (i.e. July to September). Adaptive management measures such as moving the vessel in the event of >3 shut-downs and relocation of the vessel if large numbers of animals are observed further reduce the likelihood of exposure. Further, whale sharks are generally known to leave their aggregation at Ningaloo Reef in June, and therefore peak numbers of migrating/foraging whales would be expected July to September outside of the Davros Extension survey timing. However, if present whale sharks are unlikely to be encountered in the survey area in large numbers, being solitary animals. The ALARP assessment demonstrates that the adopted controls (Table 5-13 and Table 5-14) are appropriate to reduce the impact to ALARP without the further impact reduction being required.

Given the nature and scale of the activity, CGG consider that the potential impacts are of an acceptable level as the predicted impacts are within and below the defined acceptable levels of impact in accordance with the criteria defined in Table 4-4.

*Turtles*

The only turtle species that could potential occur in the survey area based on the BIA and critical habitat data is the flatback turtle. However, based on the published data on habitats identified as critical for survival for inter-nesting flatback turtles, the nearest area of habitat suitable is approximately 18 km south of the operational area, which is greater than predicted behavioural disturbance distance for marine turtles based on CGG's measured noise levels during the previous Davros seismic survey. There will be no behavioural disturbance or displacement to inter-nesting turtles, with no effects at a population level or on regional stocks. The ALARP assessment demonstrates that the adopted controls (Table 5-13 and Table 5-14) are appropriate to reduce the impact to ALARP without the further impact reduction being required.

Given the nature and scale of the activity, CGG consider that the potential impacts are of an acceptable level as the predicted impacts are within and below the defined acceptable levels of impact in accordance with the criteria defined in Table 4-4.

*Cetaceans*

The impact assessment has determined that, with the implementation of the adopted control measures, underwater noise from operation of the seismic source (airgun array) will not result in a potential impact greater than localised behavioural avoidance of individual whales (transient species and migrating humpback whales). The transitory nature of noise source will largely limit impacts to avoidance and temporary behavioural effects on cetaceans. Behavioural disturbance effects are expected to cease once the vessel has moved further along the sail line. In addition, there are no predicted long-term effects at an individual or population level. The ALARP assessment demonstrates that the adopted controls (Table 5-13 and Table 5-14) are appropriate to reduce the impact to ALARP without the further impact reduction being required. Conservation Management Actions identified in the Management Plans and Conservation Advice for protected species (humpback and pygmy blue whales) to minimise vessel collisions are aligned with the control measures adopted in this EP for the survey (Table 5-10 and Table 5-11).

Given the nature and scale of the activity, CGG consider that the potential impacts are of an acceptable level as the predicted impacts are within and below the defined acceptable levels of impact in accordance with the criteria defined in Table 4-4.

#### 5.2.1.11 Environmental Performance Outcomes, Standards and Measurement Criteria

The environmental performance outcomes, standards and measurement criteria appropriate to measure performance of the adopted control measures for underwater noise from operation of the seismic source are presented below in Table 5-15. Environmental performance standards and relevant measurement criteria have been developed for each control measure identified in Table 6-11 and each additional control adopted from the ALARP assessment in Table 6-12.

**Table 5-15: Environmental Performance Outcomes, Standards and Measurement Criteria for Underwater Noise from Seismic Operations**

| Environmental Performance Outcome | Environmental Performance Standard | Measurement Criteria |
|---|---|---|
| No mortality or permanent injury to protected species (cetaceans, turtles, whale sharks) due to noise associated with the operation of the seismic source<br>No disturbance to migrating (humpback whales) or transient cetaceans beyond 12 km of the seismic source<br>No disturbance or displacement of inter-nesting turtles beyond 3.5 km of the seismic source<br>No disturbance to foraging/migrating whale sharks beyond 4.7 km of the seismic | Seismic airgun array designed to direct sound energy downwards and reduce horizontal spreading; this will reduce horizontal sound propagation and reduce impacts to marine fauna in the water column. | Modelling of the airgun signature and array configuration pre-survey show directivity of seismic source in the vertical. |
| | The minimum depth within the survey area that seismic data will be acquired is 35 m. | Vessel log and MFO report confirms minimum water depth of 35 m for seismic data acquisition. |
| | The seismic survey vessel will not enter into shallow waters <35 m water depth, unless in the event of an emergency. | Vessel log confirms vessel did not enter <35 m (unless in event of an emergency). |
| | | Incident report confirms emergency requirement to enter <35 m water depth. |
| | A smaller airgun array volume of 1,800 cui will be used in water depths within the survey area from 35 to 50 m. | Vessel log and MFO report confirms 1,800 cui used in water depths within the survey area from 35 to 50 m. |
| | No seismic activity within the Fish Protection Area (and 500 m buffers) set over Glomar Shoal (Figure 5-10). Sail lines will be orientated in a NW-SE direction to avoid the shallow parts of Glomar Shoal while maximising data coverage. | MFO report confirms that seismic data acquisition DID NOT occur within the FPA or its 500 m buffer zone over Glomar Shoal. |
| | | MFO report confirms sail lines closest to Glomar Shoal are orientated in a NW-SE direction. |
| | In the event that another vessel is acquiring seismic data in the region, the survey vessel shall not acquire data simultaneously within 50 km of the other seismic vessel in order to avoid cumulative impacts to marine fauna. | Communication records show that any geophysical contractors operating other seismic survey vessels have been consulted two weeks prior to the survey start and agreed to 50 km separation distance.<br>Records confirm no incidents when vessels less than 50 km apart and actively acquiring data. |
| | Pre-planning search of NOPSEMA approvals data to identify potential for overlap with other seismic surveys | All other submitted EPs for seismic surveys in the region will be reviewed to ascertain potential overlap. |
| | CGG will continue to consult with Fat Marine (and other fishers) to understand the fishers' activities and to seek opportunities to minimise disruption of fishing activity during this consultation process. CGG will notify fishers eight weeks prior to the start of the survey of the survey details including, timing, location, duration. | Stakeholder consultation records show ongoing communication between CGG and Fat Marine.<br>Records demonstrate notification of survey details to all fishers eight weeks prior to the start of the survey. |

| Environmental Performance Outcome | Environmental Performance Standard | Measurement Criteria |
|---|---|---|
| source<br>No permanent or temporary effects to fish or possible spawning fish within the Glomar Shoal FPA and within the 40 m depth contour of Rankin Bank<br>Implementation of EPBC Policy Statement 2.1 for whales and whale sharks. | In the event that the Fat Marine changes the months that they are inactive, CGG will consult with them to modify the timing of maximising data acquisition within this area accordingly. | Stakeholder consultation records show communication between CGG and Fat Marine to confirm months when the fishery is not actively operating. |
| | As part of the ongoing consultation process, CGG will notify all other (i.e. non-fishers) relevant persons four weeks prior to the start of the survey of the survey details including, timing, location, duration. | Records demonstrate notification of survey details to all other relevant persons (i.e. non-fishers) four weeks prior to the start of the survey. |
| | Commercial fishers, Recfishwest and relevant recreational fishing groups/ organisations and will be issued a 7 to 10 day forecast prior to activities commencing adjacent to Glomar Shoal and Rankin Bank. | Copies of forecast notifications to relevant fishing bodies 7 to 10 days prior to activities adjacent to Glomar Shoal and Rankin Bank. |
| | Commercial and recreational fishers are kept informed of daily survey activities through CGG's 24-hour look-ahead communication. | Sighting records of 24-hour look-ahead communications with commercial and recreational fishers. |
| | Provision of bathymetric data to Fat Marine commercial fishery. | Consultation records confirm format and supply of survey area bathymetric data to Fat Marine. |
| | The seismic source (airguns) will not be operational within the area identified as the Goldband Snapper Seasonal Exclusion Area (Figure 5-20) during March. | Vessel log or MFO report confirm seismic acquisition did not occur within the Goldband Snapper Seasonal Exclusion Area during March.<br>The Vessel Master and Marine Fauna Observer will be provided with GPS coordinates and a map showing the boundary of the Goldband Snapper Seasonal Exclusion Area |
| | EPBC Policy Statement 2.1 Part A Standard Management Measures will be implemented for whales and whale sharks. | MFO report confirms EPBC Policy Statement 2.1 is available onboard the seismic vessel and Parts A and specified Part B management measures have been implemented throughout seismic data acquisition. |
| | <u>EPBC Policy Statement 2.1 Part A:</u><br>Pre-start-up visual observation: visual observations for whales and whale sharks undertaken in the 3 km "observation zone" by MFOs for 30 minutes prior to commencement of soft start procedures. | MFO report verifies implementation of procedure. |
| | <u>EPBC Policy Statement 2.1 Part A:</u><br>Soft start procedures: may only commence if no whales or whale sharks have been sighted within the low power or shutdown zone during the pre-start-up visual observations. Soft start procedures will be used each time the acoustic source is | MFO report confirms that soft start procedures:<br>■ only commenced if no whales or whale sharks were sighted within the low power or shutdown zone during the pre-start up visual observations (30 mins). |

| Environmental Performance Outcome | Environmental Performance Standard | Measurement Criteria |
|---|---|---|
| | initiated; gradually increasing power over a 30-minute period. | ■ used each time the acoustic source is initiated gradually increasing power over a 30-minute period. |
| | EPBC Policy Statement 2.1 Part A:<br>If a whale or whale shark is sighted within the 3 km observation zone during the soft start, an additional trained crew member will be brought onto the bridge to monitor the animals. | MFO report confirms that, in the event of a whale (or whale shark) being sighted within the observation zone, an additional crew member assisted with monitoring the animal from the bridge. |
| | EPBC Policy Statement 2.1 Part A:<br>If the whale or whale shark enters the “low power zone” (<2 km) the source will be powered down to the lowest setting; and if it enters the “shut-down zone” (<500 m) the acoustic source will be shut down completely. | MFO report confirms that, in the event of a whale (or whale shark) being sighted within the “low-power zone” the seismic energy source was powered down (or shut down entirely) if the whale or whale shark was observed within the ‘shut-down zone. |
| | EPBC Policy Statement 2.1 Part A:<br>Following a shut-down, soft start procedures will only commence after the whale or whale shark has moved outside the low power zone, or when 30 minutes have elapsed since the last sighting. | MFO report confirms that soft start procedures have not resumed until the whale or whale shark has moved outside the low power zone, or when 30 minutes have elapsed since the last sighting. |
| | EPBC Policy Statement 2.1 Part A:<br>If the array is shut down for any reasons during the survey (including as a result of whale entering the shutdown zone or entering a ‘no acquisition zone’), either visual observations for whales will continue until the soft start procedure commences; or pre-start visual observations will apply prior to re-commencement. This is to ensure observations are either continuous or at least occurring for 30 minutes prior to the commencement of the soft start procedure. | MFO report verifies implementation of procedure. |
| | EPBC Policy Statement 2.1 Part A:<br>Shut-down or power down the acoustic source to the lowest setting when not collecting data, or undertaking soft start procedures (e.g. during line turns in the operational area). | MFO report confirms power down when not collecting data or undertaking soft start procedures. |
| | EPBC Policy Statement 2.1 Part A:<br>Soft start procedures can only resume after the whale has moved outside the low power zone, or when 30 minutes have elapsed since the last sighting | MFO report confirms that requirements for start-up have been met during periods of low visibility (i.e. unsuitable for visual observations). |
| | EPBC Policy Statement 2.1 Part A:<br>At night or at other times of low-visibility, start-up of the acoustic source will occur: | MFO report verifies implementation of procedure. |

| Environmental Performance Outcome | Environmental Performance Standard | Measurement Criteria |
|---|---|---|
| | providing that there have not been three or more whale or whale shark instigated power-down or shut-down situations during the preceding 24 hour period<br>if operations were not underway during the preceding 24 hours, the vessel has been in the vicinity (approximately 10 km) of the proposed start-up position for at least two hours (under good visibility conditions) within the preceding 24 hour period, and no whales or whale sharks have been sighted. | |
| | EPBC Policy Statement 2.1 Part A:<br>Whale sighting will be reported in accordance with Compliance and Sighting Reports requirements. | Compliance and cetacean sighting reports will be completed and provided to NOPSEMA / DoEE within 3 months of completion of the survey |
| | EPBC Policy Statement 2.1 Part B Additional Management Measures – specified additional measures will be implemented for whales and whale sharks. | MFO report confirms specified Part B management measures have been implemented throughout seismic data acquisition. |
| | EPBC Policy Statement 2.1 Part B:<br>The Davros Extension MC3D MSS will be undertaken outside peak humpback whale migration periods and will avoid the months of July through to September. | MFO report confirms no seismic activity from start of July and end of September. |
| | EPBC Policy Statement 2.1 Part B:<br>The precaution zones for the survey are based on a precautionary approach and will be as follows:<br>Observation zone: 3+ km horizontal radius from the acoustic source<br>Low power zone: 2 km horizontal radius from the acoustic source<br>Shut-down zone: 500 m horizontal radius from the acoustic source. | MFO report confirms application of these precaution zones. |
| | EPBC Policy Statement 2.1 Part B:<br>At least one dedicated MFO will observe whales and whale sharks from an elevated platform on the seismic survey vessel during all seismic survey activities conducted in daylight hours. | CV for MFO demonstrates competency |
| | | MFO report demonstrates watch maintained during daylight acquisition. |
| | | Vessel induction includes training an additional crew member in whale and whale shark observing. |
| | EPBC Policy Statement 2.1 Part B:<br>Relevant vessel crew members are inducted in their responsibilities regarding vessel / marine fauna interactions. | Records show that induction for the seismic and support vessels crew includes responsibilities regarding marine fauna interactions |

| Environmental Performance Outcome | Environmental Performance Standard | Measurement Criteria |
|---|---|---|
| | EPBC Policy Statement 2.1 Part B:<br>If at any time during the survey there have been three or more whale or whale shark instigated power-down or shut-down situations during the preceding 24-hour period the first response of the seismic vessel will be to move away from the current area and continue data acquisition in another area. Seismic vessel operations will implement EPBC Policy Statement 2.1 Part A Standard Management Measures for pre-start visual observations and soft start procedures in the new area. | MFO report verifies implementation of procedure and vessel log confirms new location of vessel. |
| | EPBC Policy Statement 2.1 Part B - Adaptive Management:<br>In the event of three or more whale or whale shark sightings within the power-down/shut-down zone occur within the preceding 24 hours (including times when the acoustic source is shut-down and/or powered down), the following adaptive management procedures will be implemented:<br>■ Relocation – seismic vessel will relocate to another survey line >12 km from northern boundary of the humpback whale adaptive management zone and will not return within 24 hours; or<br>■ If the vessel cannot relocate - pre-start up visual observation will be increased to 45 minutes and the low power zone will be increased to 3 km horizontal radius from the acoustic source. | MFO report verifies implementation of procedures |
| | EPBC Policy Statement 2.1 Part B - Adaptive Management:<br>Relocate vessel >12 km after a shutdown, if greater than 20 whales or whale sharks in observation zone during the pre-start observation, but not close enough to prevent soft start commencing (i.e. outside low power zone). | MFO report verifies implementation of procedures |
| | EPBC Policy Statement 2.1 Part B - Adaptive Management:<br>Reduction in size of the southern extent of the survey area to protect inter-nesting turtles. | Survey area extent is as described within this EP. |
| | EPBC Policy Statement 2.1 Part B - Adaptive Management:<br>Establish wider (500 m) buffer around Glomar Shoal | Vessel log and MFO report confirms no seismic operations within the 500 m buffer of Glomar Shoal fish protection area. |
| | EPBC Policy Statement 2.1 Part B - Adaptive Management:<br>In the event that the MFO observes a dense coral spawning slick during the predicted mass spawning times, the seismic vessel will relocate >2 km from the slick | MFO report verifies implementation of procedure in the event of a coral spawn slick being observed. |

| Environmental Performance Outcome | Environmental Performance Standard | Measurement Criteria |
|---|---|---|
| | EPBC Policy Statement 2.1 Part B - Adaptive Management:<br>The survey will not be undertaken during the months of July to September. | Records demonstrate that the seismic survey was not undertaken between the months of July-September. |

### 5.2.2 Impact 2 - Underwater Noise Emissions from Vessel Operations

#### 5.2.2.1 Description of Hazard

The survey vessel and the support vessel(s) will generate low levels of machinery noise, especially when using propulsion thrusters. This noise will be at a much lower level than the noise emitted from the active airgun array. Seismic data acquisition will occur on a continuous basis (24 hours a day) throughout the survey (maximum duration of 150 days), with limited periods of time when the seismic source is not operational. While the seismic source is operational, the underwater noise generated by vessels will be a negligible addition to the cumulative noise levels. The assessment of underwater vessel noise below is therefore limited to the periods when underwater noise levels from vessel operations are dominant, which only will be during infrequent periods when the airgun array is not operational (e.g. travelling between lines, during maintenance / repairs). The area is already subject to intermittent vessel noise due to its proximity to shipping routes.

The potential impacts to marine fauna from increased underwater noise associated with normal vessel operations are reasonably well understood and thought to be limited to behavioural disturbance, rather than direct physiological injury. Vessel operations in the region are widely acceptable to the community and potential for adverse impacts from vessel noise considered low. The greatest source of noise during the activity will be from operation of the airgun array, therefore the risk assessment for the effects of increased noise from vessel operations on marine fauna is also put into the context in terms of the limited periods during which this could be the dominant noise source.

Noise effects are strongly related to the proximity of the receptor to the noise source (affecting received noise levels); therefore, the shallowest areas of the Davros Extension MC3D MSS survey area will be most likely to be affected. Site-attached fish on the shallower Glomar Shoal area are considered the receptors at greatest risk from vessel noise.

No specific stakeholder concerns have been raised regarding noise emissions from vessel operations..

#### 5.2.2.2 Description of Potential Impacts to Environmental Values

The known and potential environmental impacts from underwater noise from vessel operations (especially use of the propulsion thrusters) include:

- direct behavioural effects through disturbance or displacement of marine megafauna, with potential for disruption of natural behaviours or processes, e.g. migration, resting, calving
- indirect behavioural effects by temporarily reducing the ability of marine fauna to navigate, find food or communicate, or by affecting the distribution or abundance of their prey species.

Noise emissions from the seismic and support vessel(s) will be influenced by the activity being conducted by the vessels, for example, the vessel generates less noise when idle and more when holding position using bow thrusters or accelerating. Source levels from typical seismic vessels are approximately 165 to 180 dB re 1 µPa (root mean squared (rams) for vessels <100 m long and 180 to 190 dB re 1 µPa (rms) for vessels >100 m long (Richardson et al. 1995; Kipple and Gabriel 2003; and Heitmeyer et al. 2004). Marine fauna at distance from the vessel will be exposed to much lower noise levels due to decay of the sound energy as it travels through the water.

Underwater noise emissions from vessel operations are generally within or below the range of natural noise levels experienced by marine fauna, and therefore not expected to cause any physiological damage to fauna (McCauley 1998, 2003; McCauley and Jenner 2001; and Richardson et al. 1995). The primary auditory effect of vessel noise on marine fauna is the potential masking of biologically significant sounds (Southall et al. 2007). Potential behavioural effects on marine fauna due to underwater noise from vessels also include changes in vocalisation characteristics and disturbance to foraging, navigation and reproductive activities.

The majority of acoustic energy radiated from large commercial vessels is below 1 kHz, and so the greatest potential for masking exists for marine fauna that produce and receive sounds within this frequency band; primarily baleen whales, pinnipeds, fish, and possibly some toothed whales (Southall et al. 2007). Acoustic masking at higher frequencies (1 to 25 kHz) may affect toothed whales (beaked whales, sperm whales, dolphins and porpoises) in close proximity to the vessel.

There has been relatively little behavioural observation of cetaceans exposed to continuous, low-level underwater noise, such as from vessels. An experimental study involving acoustic tagging and controlled exposure experiments with North Atlantic right whales (*Eubalaena glacialis*), showed no effect of vessel noise on the whales. Five of the six individual whales responded strongly (interrupted dive pattern and swam rapidly to the surface) to the presence of an artificial alarm stimulus (series of constant frequency and frequency modulated tones and sweeps), but ignored playbacks of vessel noise (Nowacek et al. 2004). Small cetaceans are commonly observed swimming near vessels; this attraction indicates that the noise is not having a detrimental effect on the animals.

The frequency range of vessel noise overlaps the hearing ranges of many fish species (Amoser et al. 2003). Hearing impairment (i.e. temporary threshold shift (TTS)) has been recorded for fish exposed to continuous noise from small boats and ferries for two hours (Vasconcelos et al. 2007). However, recovery was observed on cessation of vessel noise.

#### 5.2.2.3 Inherent Impact Assessment

As discussed in Section 3.1.3, few interactions with protected species are expected. If encountered, mobile fauna such as whales, sharks, turtles and the majority of Glomar Shoal and Rankin Bank fish species are expected to be able to avoid actively the survey vessel(s). As such, no long-term impacts to protected species or fish are expected. Given there are no high-energy noise sources associated with the routine operation of the vessel(s), the potential for physiological effects on fauna is low. When the airguns are not operational, there may be localised behavioural disturbance of fauna in the immediate vicinity of the vessel during operations. This would be limited to a temporary change in behaviour due to avoidance of the area. There may be localised behavioural disturbance of fish in shallower areas, but no injury or lasting impact. This is a Negligible consequence.

The likelihood of this impact is Likely. The inherent impact is **Low**.

#### 5.2.2.4 Control Measures

Table 5-16 presents the control measures that CGG will implement during the Davros Extension MC3D MSS to manage any potential impacts associated with underwater noise from vessel operations.

**Table 5-16: Control Measures for Underwater Noise from Vessel Operations**

| Control Measures | |
|---|---|
| Good Practice | All internal combustion engines on board the vessel will be well maintained in accordance with the manufacturer's specifications and hence noise emissions will typical of vessels in the region. |
| | Interaction between survey vessel and cetaceans (whales and dolphins) within the operational area will be consistent with EPBC Regulations 2000 – Part 8 Division 8.1 (Regulation 8.04) – Interacting with cetaceans:<br>■ seismic survey vessels and support vessels will not travel at speed greater than 6 knots within 300 m of a cetacean (caution zone) and will minimise noise<br>■ survey vessel will not approach closer than 50 m for a dolphin and/or 100 m for a whale (with the exception of bow riding animals). |
| | One trained MFO will be stationed on an elevated platform and observing during all seismic survey activities conducted in daylight hours during data acquisition. |

### 5.2.2.5 Demonstration of ALARP and Risk Acceptability

#### 5.2.2.5.1 Summary of ALARP Demonstration

CGG is committed to ensuring continual impact reduction and considered the additional measure in Table 5-17; however this measure has not been adopted as the cost of implementation is disproportionate to the benefit gained. On the basis of the decision methods used in the impact based decision making framework for the activity, CGG considers the adopted controls in Table 5-16 to be appropriate in reducing the environmental impacts associated with underwater noise from vessel operations to ALARP. There are no other control measures that may practicably or feasibly be adopted to reduce the impacts further without disproportionate costs compared to the benefit of impact reduction.

**Table 5-17: Demonstration of ALARP and Additional Controls for Underwater Noise from Vessel Operations**

| Additional Control Measures | Practicability / Effectiveness? | Cost Benefit Analysis | Impact Reduction (L/C/RR ↓)? | Control Adopted |
|---|---|---|---|---|
| **Precautionary Approach** | | | | |
| Do nothing – no MSS | P: No<br>E: Very effective (++) | Titleholders are required by NOPTA to acquire seismic data within specified time frames. Minimal benefit given the predicted low impact on other users. Costs disproportionately higher than benefits. | Yes | No |

#### 5.2.2.5.2 Residual Impact

The consequence of direct behavioural disturbance and/or indirect effects (e.g. disruption of navigation, foraging and prey species) to marine fauna from underwater vessel noise associated with the survey remains Minor.

With the implementation of the control measures described in Table 5-16, the likelihood of underwater vessel noise to adversely affect marine fauna receptors or their prey species during the activity is Unlikely. The residual impact is therefore **Low**.

#### 5.2.2.5.3 Acceptability

The residual impact of underwater noise from vessels during the survey complies with CGG's internal context (low risk), will be managed in accordance with relevant legislative requirements and complies with industry good practice and the principles of ESD. Any concerns raised by stakeholders have been assessed and control measures adopted where appropriate.

Complete elimination of the impact is not possible as there is no practical alternative to the use of vessels which allow CGG to undertake the activity. The impact assessment has determined that, with the implementation of the adopted control measures, underwater noise from vessel operations will not result in a potential impact greater than a localised area of avoidance and short-term effect on marine fauna species. Behavioural disturbance effects are expected to return to cease once the vessel is removed from the area.

The ALARP assessment demonstrates that the adopted controls (Table 5-16 and Table 5-17) are appropriate to reduce impact to ALARP without the further impact reduction being required. Given the nature and scale of the activity, CGG consider that the potential impacts are of an acceptable level as the predicted impacts are within and below the defined acceptable levels of impact in accordance with the criteria defined in Table 4-4.

### 5.2.2.6 Environmental Performance Outcomes and Standards

The environmental performance outcomes, standards and measurement criteria appropriate to measure performance of the control measures are also presented in Table 5-18. Environmental performance standards and relevant measurement criteria have been developed for each control measure identified in Table 5-16 and each additional control adopted from the ALARP assessment in Table 5-17.

**Table 5-18: Environmental Performance Outcomes, Standards and Measurement Criteria for Underwater Noise from Vessel Operations**

| Environmental Performance Outcomes | Environmental Performance Standards | Measurement Criteria |
|---|---|---|
| Minimise impacts of underwater noise generated from the routine vessel movements on threatened and migratory cetacean species listed under the EPBC Act, whale sharks and site-attached fish. | All internal combustion engines on board the vessel will be well maintained in accordance with the manufacturer's specifications. | Records and training matrix demonstrate that a qualified marine engineer is on board throughout survey |
| | Interaction between survey vessel and cetaceans (whales and dolphins) within the operational area will be consistent with EPBC Regulations 2000 – Part 8 Division 8.1 (Regulation 8.04) – Interacting with cetaceans:<br>■ survey vessel will not travel at greater than 6 knots within 300 m of a cetacean (caution zone)<br>■ survey vessel will not approach closer than 50 m for a dolphin and/or 100 m for a whale (with the exception of animals bow riding). | MFO report demonstrates no breaches of EPBC Regulations 2000 (Part 8). |
| | | Compliance and cetacean sighting reports will be completed and provided to NOPSEMA / DoEE within 3 months of completion of the survey. |
| | One trained MFO will be stationed on an elevated platform and observing during all seismic survey activities conducted in daylight hours during data acquisition. | CVs of MFOs to demonstrate competency |
| | | MFO report demonstrates watch maintained during daylight acquisition. |

### 5.2.3 Impact 3 - Interaction with Other Marine Users

#### 5.2.3.1 Description of Hazard

The seismic vessel will acquire data over a two month period and will operate 24 hours a day for the duration of this period. There will also be one or more support vessels to manage interactions with other vessels and fishing activity interactions, and to assist with streamer recovery if required.

Other marine users such as commercial and recreational fishing vessels, commercial shipping and oil and gas titleholders may be temporarily displaced by the presence of the survey vessel and the streamers extending 8.1 km behind the vessel present a navigational hazard to other users. Underwater noise from the seismic vessel may also affect the catchability of fish if they are avoiding the noise.

The potential impacts to other marine users during seismic surveys are well understood. Seismic exploration surveys have been conducted along the Western Australian coast for decades and there established and agreed practices to manage the more common risks. The application of recognised good practice is considered appropriate to manage the risks. However, the assessment recognises the site-specific nature of the risks to the Davros Extension MC3D survey area and the challenges in predicting the use of the area by the individual stakeholders identified during the consultation process (refer to Table 8-2). To augment decision making further, a precautionary approach is applied where uncertainty continues to exist.

Stakeholders from the fisheries sector (specifically the DoF (now DPIRD), WAFIC, Pilbara Trawl and Line Managed Fisheries, Pearl Producers Association (PPA) and Recfishwest representing recreational fishers and charter boat operators) were concerned about loss of access to fishing grounds for the duration of the activity (Table 8-2). Pilbara Trawl and Line Managed Fisheries and PPA also expressed concern regarding the potential for underwater noise from seismic operations to affect the quality and quantity of fish stock/catch and wild broodstock for pearl oysters.

#### 5.2.3.2 Description of Potential Impacts to Environmental Values

The known and potential environmental impacts from interaction with other marine users include:

- temporary and intermittent displacement of other marine users from the survey area
- risk of fishing gear, particularly fish traps and long lines, snagging on the seismic streamers.

Indirect effects of underwater noise disturbance from seismic operations on target fish and shellfish populations (including fish larvae) have been addressed in Sections 5.2.1.7.2 and 5.2.1.7.3.

#### 5.2.3.2.1 Potential Impacts to Commercial and Recreational Fishing

As described in Section 3.2.1, the principal commercial fisheries in the vicinity of the survey area focus on tropical finfish, particularly the high-value emperors, snappers and cods that are taken by the northern demersal trap fisheries (DoF 2012). The NWMR has a number of small, limited-entry trawl fisheries for prawns, and significant fisheries for Spanish mackerel, barramundi/threadfin salmon and shark, and a fishery for blue swimmer crabs. A number of recreational fishing activities, including offshore demersal line fishing and near-shore beach seining and gillnetting also occur in the region (DoF 2012).

Occasionally private recreational fishing boats and charter boat fishing boats visit Glomar Shoal and Rankin Bank; however given the distance from land, effort is low and recreational fishers are only sporadically present in the survey area. Interaction with this user group is therefore unlikely.

Proposed control measures to mitigate these risks and to address stakeholder concerns, include marine notices, ongoing consultation including advising relevant fishers of the seismic vessel schedule to assist fisheries license holders in planning their activities, maintaining a communications protocol to manage interactions with fishing vessels and assessment of the impacts of the underwater discharge of seismic pulses over the activity area and likely effects on target fish catchability (refer to Section 5.2.1.7.3 for this assessment).

The key commercial fisheries that may interact with the activity are described in Table 3-7. The licensed extent of these fisheries includes the survey area; however, the majority of the fisheries cover very large areas and fishing effort is limited in, or in some cases absent from, the survey area. Published information on fishing activity in recent years and the geographic locations where fishing effort is concentrated (e.g. close to the mainland coast for prawns) indicates a very low level of effort in the survey area. Potential interactions will be managed through clear communications prior to and during the survey, including 7 to 10 day notification prior to the survey and 24 hour look ahead communications for daily activities.

Commercial fisheries potentially affected include those that utilise fishing methods that could result in a risk of gear snagging and/or becoming entangled in the seismic streamers. The other fisheries will not have any interaction with the Davros Extension MC3D MSS due to one of the following:

- no overlap (spatially or temporally) with the fishery's boundary
- no fishing effort within the area that the Davros Extension MC3D survey area encompasses.

*North Coast Demersal Scalefish Managed Fishery*

This fishery includes the Pilbara Trawl Managed Fishery (PTMF), Pilbara Trap Managed Fishery (PTMF) and the Pilbara Line Managed Fishery (PLMF). The PFTIMF operates across six areas, of which the Davros Extension MC3D survey area overlaps Area 1 by 73% and Area 2 by 15%. The survey area also overlaps Area 6, however that has been closed to fishing since 1998 (Fletcher and Santoro 2014). The PTMF boundary is large and encompasses the Davros Extension MC3D survey area (Figure H); however the survey area only overlaps 8% of the entire fishery's licence area. Fishers of the PLF can operate anywhere within Pilbara waters and includes the Davros Extension MC3D survey area (which comprises 2% of the total fishery area and 10% of the area within the fishery with water depths between 60 and 90 fathoms, where the key species of interest to the PLF i.e. goldband snapper is actively fished). The areas of the PFTIMF, PTMF and PLMF that the Davros Extension MC3D survey overlaps are small in comparison with total areas of these fisheries, and so any risks of fishing gear snagging with the seismic streamers are considered unlikely; however it is possible that interactions with these three fisheries could occur. Interactions with fishing vessels during the survey, though unlikely to occur, will be managed to reduce impacts on activities.

*Mackerel Managed Fishery*

The MMF is divided into three fishing areas, of which Area 2 is relevant to the Davros Extension MC3D MSS (Figure G). The survey area and operational buffer areas lie completely within the boundary of this fishery (overlaps 2% of Area 2 and 1% of the total fishery area). Although, the majority of catch and effort (number of fishing days) is concentrated within the Kimberley Area (Area 1), it is possible that fishing vessels may operate in or around the Davros Extension MC3D survey area, and interactions with fishing gear are possible. This would be limited to fishers trolling across seismic streamers and snagging gear. Interactions with fishing vessels during the survey, though unlikely to occur, will be managed to reduce impacts on activities.

*Western Tuna and Billfish Fishery*

The WTBF methods include longline and some minor line (including handline, troll, rod and reel), with the main method in use being longline. The fishing season extends all year, however fishing effort is low (<5 vessels operating since 2005), and concentrated off south-west Western Australia (Patterson and Stephan 2014). Fishing effort is low and concentrated away from the Davros Extension MC3D survey area, therefore snagging the seismic streamers on longlines or tended gear used this fishery is unlikely.

*North-west Slope Trawl Fishery*

Through the consultation process, the Northern Fishing Companies Association (NFCA) informed CGG that NWSTF fishers operate in the general area of the Davros Extension MC3D survey area, however fishers are only permitted to fish in water depths >200 m. There is a small overlap between the survey area (non-operational area) and the boundary of the fishery on the north-western section (Figure G), which represents a very small proportion of the total area of waters fished. Interactions with fishing vessels during the survey, though unlikely to occur, will be managed to reduce impacts on activities.

*Pearl Oyster Managed Fishery*

Harvesting of *P. maxima* is focussed between Exmouth Gulf and Cape Leveque, with the main fishing areas off Eighty Mile Beach and a channel (10 to 20 m depth) between the mainland (north of Broome) and the Lacepede Islands. The POMF is a dive based fishery restricted to water depths of 10 to 35 m (DoF 2016). Consultation with the PPA indicates that the Davros Extension MC3D survey area was not a major concern compared to areas such as the Exmouth Gulf or Eighty Mile Beach, largely due to pearl oyster distribution being relatively patchy, and absence of active leases near Dampier (Table 8-2).

Larval dispersion from known broodstock populations mostly travel less than 30 km (Figure 4 11), however some have been modelled as potentially travelling up to 60 km (Condie et al. 2006). High local abundances of broodstock and spat observed occasionally in deeper water (approximately 30 m depth) are supported by intermittent larval transport from inshore populations, however spawning in these deeper waters appears to contribute little to recruitment in inshore populations. PPA's concerns regarding the effect of underwater seismic noise on wild broodstock that may occur in the shallower areas of the survey area are assessed in Section 5.2.1.7.2.

*Nickol Bay and Onslow Prawn Managed Fishery*

The Nickol Bay and Onslow Prawn Managed Fishery areas overlap the whole of the survey area, with the OPMF overlapping a small area in the east of the survey area, including Glomar Shoal; and the NBPMF overlapping the remaining entirety of the survey area (see Figure H). The most productive area of the ONPMF is Area 1, which is a small area adjacent to the coast at Ashburton and Onslow (Figure H). Gear used in the fishery consists of otter trawls and are typically restricted to depths less than 60 m. Fishing effort and catch is concentrated close to the coast and indicates a very low level of effort in the survey area. Potential interactions with commercial fishers will be limited to a few individual fishers who fish the Glomar Shoal, Rankin Bank and surrounding areas, at the time of the survey, and will be managed to reduce impacts on activities.

#### 5.2.3.2.2 Potential Impacts to Commercial Shipping and Oil and Gas Activities

Within the North-west Marine Region, there is significant commercial shipping activity, the majority of which is associated with the mining and oil and gas industry. One major commercial shipping lane directly overlaps the survey area, and another lies approximately 20 km to the east. Interactions with vessels outside these areas are also possible, but less likely.

Petroleum infrastructure present in the survey area includes North Rankin Complex, Goodwin A, Angel, Reindeer wellhead platform, Stag, and Wandoo. Supply vessels supporting the platforms may pass through the survey area; therefore interactions with these vessels are possible. CGG will communicate with operators with facilities/vessels operating in the area prior to and throughout the survey and implement appropriate controls to ensure the seismic survey will not affect activities at any operational facility.

A Concurrent Operations (CONOPS) Plan will be required in the event of moving the seismic vessel (or any part of its streamer), the support boat or chase vessel within the Cautionary Zone of another facility/vessel. The Cautionary Zone is defined by a 2.5 nautical mile (NM) (5 km) radius around a vessel, facility or major sub-sea installation). CGG developed a CONOPS Plan in conjunction with Woodside facility operators for the Angel Platform (WA-003-L) for the Davros Phase I MSS carried out in 2015. The plan described procedures to minimise impacts on activities at the Woodside facility and to ensure activities in the vicinity of the platform are conducted without risk to personnel or facilities.

A CONOPS Plan will be developed for the Davros Extension MC3D MSS and agreed with the relevant operator(s) in the event that the seismic survey vessel is required to enter the Cautionary Zone of another facility/vessel. As part of the CONOPS Plan, CGG will establish a communications guideline outlining all key contacts and contact details for all known concurrent operations. In areas where diving operations are taking place, specific dive procedures will be defined in the CONOPS Plan, including an extension of the Cautionary Zone to 10 km, and the requirement for a joint risk assessment in advance of any CONOPS.

The presence of the survey vessel and towed array in the survey area has the potential to present a navigational hazard to other vessels; however, ongoing consultation and notification of the survey timing/location, and survey vessel position during the survey will be implemented to manage the risk (Section 8.0).

### 5.2.3.3 Inherent Impact Assessment

The presence of the survey vessel and streamers may result in a moderate disruption and displacement over the short-term (weeks) at a localised scale of commercial and/or recreational users, including presenting a temporary navigation hazard, potential loss of access to small areas of much larger fishing grounds for a few commercial fishers, damage to deployed fishing gear (e.g. traps, longlines) and course changes for freighters. This is a Moderate consequence.

The effect will result in a small, temporary change in routing for some vessels if operating or transiting through areas of the survey where the survey vessel is in operation (i.e. not complete re-routing for the entire survey duration of two months). The likelihood of this impact is Possible. The inherent impact is Medium.

### 5.2.3.4 Control Measures

Table 5-19 presents the control measures that CGG will implement during the Davros Extension MC3D MSS to manage any potential impacts associated with interaction with other marine users.

**Table 5-19: Control Measures for Interaction with Other Marine Users**

| Control Measures | |
|---|---|
| Good Practice | Survey vessel to maintain appropriate lighting, navigation and communication at all times to inform other users of the position and intentions of the survey vessel, in compliance with the *Navigation Act 2012* and Chapter 5 of the International Convention on the Safety of Life at Sea (SOLAS Convention). |
| | Adherence to Marine Orders Part 30: Prevention of Collisions (Issue 8) and Part 21: Safety of navigation and emergency procedures (Issue 8) specifically, use of standard maritime safety procedures (including radio contact, display of day shapes, navigational beacons, lights, streamers and reflective tail buoys). |
| | Continuous (24 hour) survey operations with multiple trained crew (STCW95/Elements of Shipboard Safety), and monitoring of vessel position (radar) at all times during seismic acquisition. |
| | The Australian Hydrographic Service (AHS) advised of the survey details (survey location, timing) at four weeks prior to mobilisation and following demobilisation for issue of Notice to Mariners. |
| | CGG will continue to consult with Fat Marine (and other fishers) to understand the fishers' activities and to seek opportunities to minimise disruption of fishing activity during this consultation process. CGG will notify fishers eight weeks prior to the start of the survey of the survey details including, timing, location, duration. |
| | In the event that the Fat Marine changes the months that they are inactive, CGG will consult with them to modify the timing of maximising data acquisition within this area accordingly. |
| | CGG will undertake a review every six months following approval of the EP and two months prior to commencement of activities to ensure that any new stakeholders are identified and consulted. |
| | Survey vessel will notify AMSA's Joint Rescue Coordination Centre (JRCC) 24 to 48 hours before operations commence via email address (rccaus@amsa.gov.au) or phone (1800 641 792 or +61 2 6230 6811) for promulgation of radio-navigation warnings. AMSA JRCC will be advised of the survey vessel's details (including vessel name, call-sign and Maritime Mobile Service Identity (MMSI)), satellite communications details (including INMARSAT-C and satellite telephone), area of operation and requested clearance from other vessels. |
| | AMSA JRCC will be notified at the end of the survey when operations have been completed (via email address (rccaus@amsa.gov.au) or phone: 1800 641 792 or +61 2 6230 6811). |
| | Survey vessel will be equipped with Automatic Radar Plotting Aid (ARPA) for detection of vessels, speed and heading. Vessel location information automatically updated to AMSA JRCC. |
| | As part of the ongoing consultation process, CGG will notify all other (i.e. non-fishers) relevant persons four weeks prior to the start of the survey of the survey details including, timing, location, duration. |
| | Support vessel(s) to manage vessel interactions and maintain communications with commercial shipping in the survey area. |
| | Tail buoys clearly marked to identify streamer ends to other users. |
| | In-water equipment lost will be recovered, if retrievable. |
| | AMSA and AHS to be advised of the loss of large items of buoyant waste or lost equipment (potential navigational hazards). |
| | Access agreements will be agreed with oil and gas titleholders. |
| | Survey vessel shall not acquire data simultaneously within 50 km of another seismic vessel in the event that another vessel is acquiring data. |
| | CGG will provide Chevron with 7 day and 24 hour notification of first approach to Wheatstone Platform as the vessel will show up as a converging track on the platform radar causing an alarm in the CCR. |

### 5.2.3.5 Demonstration of ALARP and Risk Acceptability

#### 5.2.3.5.1 Summary of ALARP Demonstration

CGG is committed to ensuring continual risk reduction and to identifying additional control measures that may be applied if they do not engender disproportionate sacrifice (e.g. cost of implementation). Additional controls have been considered and adopted where they can further reduce risks to ALARP (Table 5-20). Where the cost of implementing the additional control measures is disproportionate to the benefit gained, they have not been adopted. There are no other controls measures that may practicably or feasibly be adopted to reduce the risks and impacts further without disproportionate costs compared to the benefit of the potential risk reduction.

**Table 5-20: Demonstration of ALARP and Additional Controls for Interaction with Other Marine Users**

| Additional Control Measures | Practicability / Effectiveness? | Cost Benefit Analysis | Risk Reduction (L/C/RR ↓)? | Control Adopted |
|---|---|---|---|---|
| **Good Practice** | | | | |
| Seismic acquisition will only occur during daylight hours. | P: No<br>E: Ineffective (-) | There are substantial additional costs in limiting acquisition to daylight hours. Interactions with fishing and shipping vessels would still potentially occur, therefore costs outweigh benefits. | Yes | No |
| Seismic acquisition will only occur outside key fishing seasons. | P: No<br>E: Ineffective (-) | Fishing occurs all year round in some region of the operational area. Costs outweigh benefits | Yes | No |
| Prohibition of recreational fishing from the seismic and support vessels. | P: Yes<br>E: Very effective (++) | This is a standard prohibition and will be implemented at no cost and provides some perceived environmental benefit in reducing impacts of survey on local fishers. | Yes | Yes |
| Commercial and recreational fishers will be kept informed of daily survey activities through CGG's 24-hour look ahead communication. | P: Yes<br>E: Very effective (++) | It is likely that fishers would be displaced from any area over the shoal for much less than 3 weeks (several adjacent sail-lines will typically be completed within a day), however allowing a maximum displacement of 3 weeks will allow fish behaviour to normalise and for the seismic vessel to be well out of the area. There is a potential benefit to fishers of being able to plan around the maximum time they may be displaced and no real cost to CGG. | Yes | Yes |
| Payment of compensation to the rightful owner for any fishing equipment that has been damaged beyond repair by the survey and cannot be re-used. | P: Yes<br>E: Very effective (++) | Benefit to fishers' livelihoods and industry reputation outweighs the cost of compensation. | Yes. | Yes |
| Payment of compensation to fishermen for loss of catch. | P: No<br>E: Unknown, relationship between seismic acquisition and loss of catch not founded on scientific data | Difficulties exist in proving cause/effect relationship between seismic acquisition and any real/perceived loss of catch. This would amount to significantly increased costs, and set a precedent for the seismic industry. Costs outweigh benefits as impacts to fish stocks and catchability over the fishing season are considered negligible. | Not possible to determine due to lack of data | No |

| Additional Control Measures | Practicability / Effectiveness? | Cost Benefit Analysis | Risk Reduction (L/C/RR ↓)? | Control Adopted |
|---|---|---|---|---|
| **EIA** | | | | |
| Commercial fishers, Recfishwest and relevant recreational fishing groups/ organisations will be issued a 7 to 10 day forecast prior to activities commencing adjacent to Glomar Shoal and Rankin Bank | P: Yes<br>E: Very effective (++) | Early notification of activities will allow other marine users (fishers) to plan activities around the survey and avoid negative interactions. Benefit outweighs cost. | Yes | Yes |
| Notification of activity details to all relevant non-fisher stakeholders four weeks prior to the survey commencing | P: Yes<br>E: Very effective (++) | Early notification of activities will allow stakeholders (without commercial fishing interests in the survey area) to plan activities around the survey and avoid negative interactions. Benefit outweighs cost. | Yes | Yes |
| Fishers (including Fat Marine, RNR and Old Brown Dog Fisheries) will be notified of the activity details eight weeks prior to the survey commencing. | P: Yes<br>E: Very effective (++) | Ongoing consultation will allow fishers to plan activities around the survey, early notification of activities is critical, particularly given that responses from fishers have taken longer than the expected four weeks during previous rounds of consultation in preparation of the EP. Benefit outweighs cost. | Yes | Yes |
| The seismic vessel will adhere to specific CONOPS procedures when operating within the Cautionary Zone of platforms (5 km, or 10 km during diving operations) or of any other facility/vessel. | P: Yes<br>E: Very effective (++) | Benefit of lower likelihood of interactions, greater preparedness, minimising operational interruptions outweighs cost. | Yes | Yes |
| During CONOPS, communications will be maintained with the other facilities/vessels. | P: Yes<br>E: Very effective (++) | Benefit outweighs cost. | Yes | Yes |
| **Precautionary Approach** | | | | |
| Do nothing – no MSS | P: No<br>E: Very effective (++) | Titleholders are required by NOPTA to acquire seismic data within specified time frames. Minimal benefit given the predicted low impact on other users. Costs disproportionately higher than benefits. | Yes | No |
| Avoid shipping routes | P: No<br>E: Ineffective | Shipping occurs throughout the survey area and avoiding the eastern section would seriously compromise the survey objectives. Vessel interactions are manageable through the support vessel and the cost (loss of survey data) outweighs the benefits. | Yes | No |

#### 5.2.3.5.2 Residual Impact

The consequence of temporary disturbance and/or displacement of other marine users and risk of damage to fishing gear remains Moderate.

With the implementation of the control measures described in Table 5-19 and additional controls adopted from the ALARP assessment in Table 5-20, the disturbance and/or displacement of other marine users (particularly fishers and oil and gas activities) from the survey area is reduced. CGG will manage any potential interactions with fishers through the ongoing stakeholder consultation (Section 8.5) to minimise disruption and to provide early notification of the details of the survey (e.g. timing, location, exclusions), and will develop/agree CONOPS plans to manage any simultaneous operations with oil and gas activities. The likelihood of this impact during the activity reduces to Unlikely. The residual impact is therefore **Medium**.

#### 5.2.3.5.3 Acceptability

The residual impact of interference with other marine users complies with CGG's internal context (medium risk with additional controls adopted), will be managed in accordance with relevant legislative requirements and complies with industry good practice and the principles of ESD.

There is no practical alternative to the use of vessels and streamers to undertake the planned activity and achieve the survey objectives, therefore the associated risks (e.g. loss of access, snagging fishing gear on streamers), cannot be totally eliminated. All concerns raised by stakeholders have been assessed and control measures adopted where appropriate. CGG will manage potential interactions with fishers through the ongoing stakeholder consultation process described in Section 8.5, including an eight week notification period for fisheries licence holders and by ensuring that commercial and recreational fishers are kept informed of daily survey activities (including location of vessels and the streamers) through CGG's 24-hour look-ahead communication. The risk and impact assessment has determined that, with the implementation of the adopted control measures, interference with other marine users will not result in a potential impact greater than a localised area of avoidance and short-term loss of access to small areas of the survey area as the survey vessel moves between survey lines. The ALARP assessment demonstrates that the adopted controls (Table 5-19 and Table 5-20) are appropriate to reduce the impact to ALARP without the further impact reduction being required. Given the nature and scale of the activity, CGG consider that the potential impacts are of an acceptable level as the predicted impacts are within and below the defined acceptable levels of impact in accordance with the criteria defined in Table 4-4.

### 5.2.3.6 Environmental Performance Outcomes and Standards

The environmental performance outcomes, standards and measurement criteria appropriate to measure performance of the adopted control measures for interaction with other marine users are presented below in Table 5-21. Environmental performance standards and relevant measurement criteria have been developed for each control measure identified in Table 5-19 and each additional control adopted from the ALARP assessment in Table 5-20.

**Table 5-21: Environmental Performance Outcomes, Standards and Measurement Criteria for Interaction with Other Marine Users**

| Environmental Performance Outcome | Environmental Performance Standard | Measurement Criteria |
|---|---|---|
| No significant interruption or disturbance to another user of the marine environment | Vessel to maintain appropriate lighting, navigation and communication at all times to inform other users of the position and intentions of the survey vessel, in compliance with the *Navigation Act 2012*, COLREGS (International Regulations for Preventing Collisions at Sea 1972), Chapter IV (Radiocommunications) and Chapter V (Safety of Navigation) of SOLAS (International Convention on the Safety of Life at Sea 1974). | Evidence that vessels comply with COLREGS and relevant chapters of SOLAS. Any records of failure to comply are documented. |
| | Vessel navigational lighting and communication system managed in accordance with AMSA Marine Orders Part 30: Prevention of collisions, Part 21: Safety and emergency arrangements and Part 27 (Safety of navigation and radio equipment). | Evidence that vessels have navigational lights and communication system that comply with relevant marine orders. |
| | Continuous (24 hour) survey operations with multiple trained crew (STCW95/Elements of Shipboard Safety), and monitoring of vessel position (radar) and depth at all times during seismic acquisition. | Records confirm bridge was manned continuously during survey operations, and that vessel crew have appropriate qualifications. |
| | The Australian Hydrographic Service (AHS) advised of the survey details (survey location, timing) four weeks prior to mobilisation and following demobilisation for issue of Notice to Mariners. | Records of notification of survey details sent to the AHS four weeks prior to survey mobilisation and within two weeks of survey demobilisation. |
| | AMSA's RCC will be advised of the survey vessel's details (including vessel name, call-sign and Maritime Mobile Service Identity (MMSI)), satellite communications details (including INMARSAT-C and satellite telephone), area of operation and requested clearance from other vessels. This information will be notified to AMSA RCC 24 to 48 hours before operations commence via email address (rccaus@amsa.gov.au) or phone (1800 641 792 or +61 2 6230 6811) | Records demonstrate that AMSA RCC have been notified of the survey vessel details and movements 24 to 48 hours prior to the start of the survey. |
| | AMSA RCC will be notified at the end of the survey when operations have been completed (via email address (rccaus@amsa.gov.au) or phone: 1800 641 792 or +61 2 6230 6811). | Records demonstrate that AMSA RCC have been notified of the end of survey operations. |
| | Survey vessel will be equipped with Automatic Radar Plotting Aid (ARPA) for detection of vessels, speed and heading. | Inspection records confirm ARPA on survey vessel. |
| | Support vessel(s) to manage vessel interactions and maintain communications with commercial shipping in the survey area. | Records demonstrate that a dedicated support vessel is employed for the duration of the activity. |
| | Tail buoys clearly marked to identify streamer ends to other users. | Records show all tail buoys marked to identify streamer ends. |

| Environmental Performance Outcome | Environmental Performance Standard | Measurement Criteria |
|---|---|---|
| | In-water equipment lost will be recovered, if retrievable where safe and practicable to do so. | Incident reports made for lost equipment show that recovery where possible. |
| | | Detailed records of equipment lost overboard will be maintained and reported to NOPSEMA as recordable environmental incidents and also reported via the PEPR) |
| | AMSA and AHS to be advised of the loss of large items of buoyant waste and lost equipment (potential navigational hazards). | Response from AMSA and AHS confirms receipt of notification in event of lost object incident. |
| | Access agreements will be agreed with oil and gas titleholders. | Records of access agreements for data acquisition in permit areas within the survey area. |
| | Commercial fishers, Recfishwest and relevant recreational fishing groups/ organisations and will be issued a 7 to 10 day forecast prior to activities commencing adjacent to Glomar Shoal and Rankin Bank. | Copies of forecast notifications to relevant fishing bodies 7 to 10 days prior to activities adjacent to Glomar Shoal and Rankin Bank. |
| | Commercial and recreational fishers are kept informed of daily survey activities through CGG's 24-hour look-ahead communication. | Sighting records of 24-hour look-ahead communications with commercial and recreational fishers. |
| | No recreational fishing from the seismic and support vessels. | Seismic and support daily vessel records demonstrate no fishing has occurred that day. |
| | Payment of compensation to the rightful owner for any fishing equipment that has been damaged beyond repair by the survey and cannot be re-used. | Incident close-out report demonstrates that the rightful owner was appropriately compensated. |
| | CGG will continue to consult with Fat Marine (and other fishers) to understand the fishers' activities and to seek opportunities to minimise disruption of fishing activity during this consultation process. CGG will notify fishers eight weeks prior to the start of the survey of the survey details including, timing, location, duration. | Stakeholder consultation records show ongoing communication between CGG and Fat Marine.<br><br>Records demonstrate notification of survey details to all fishers eight weeks prior to the start of the survey. |
| | In the event that the Fat Marine changes the months that they are inactive, CGG will consult with them to modify the timing of maximising data acquisition within this area accordingly. | Stakeholder consultation records show communication between CGG and Fat Marine to confirm months when the fishery is not actively operating. |
| | CGG will undertake a review every six months following approval of the EP and two months prior to commencement of activities to ensure that any new stakeholders are identified and consulted. | Records demonstrate CGG has undertaken a review of new stakeholders every six months following approval of the EP and two months prior to commencement of activities. |
| | As part of the ongoing consultation process, CGG will notify all other (i.e. non-fishers) relevant persons four weeks prior to the start of the survey of the survey details including, timing, location, duration. | Records demonstrate notification of survey details to all other relevant persons (i.e. non-fishers) four weeks prior to the start of the survey. |

| Environmental Performance Outcome | Environmental Performance Standard | Measurement Criteria |
|---|---|---|
| | The seismic vessel will adhere to specific CONOPS procedures when operating within the Cautionary Zone around another facility/vessel. Note that the standard Cautionary Zone is 5 km, however during diving operations this is increased to 10 km. | Records demonstrate implementation of CGG CONOPS Plan in the event of CONOPS within another facility/vessel's Cautionary Zone. |
| | During CONOPS, communications will be maintained with other facilities/vessels. | Records demonstrate communications during CONOPS are undertaken in accordance with the communications guidelines with the CONOPS Plan. |
| | Survey vessel shall not acquire data simultaneously within 50 km of another seismic vessel in the event that another vessel is acquiring data. | Communication records show that any geophysical contractors operating other seismic survey vessels have been consulted two weeks prior to the survey start and agreement of 50 km separation distance. |
| | CGG will provide Chevron with 7 day and 24 hour notification of first approach to Wheatstone Platform as the vessel will show up as a converging track on the platform radar causing an alarm in the CCR. | Records demonstrate Chevron provided with a 7 day and 24 hour notification as part of CONOPS. |

### 5.2.4 Impact 4 - Light Emissions

#### 5.2.4.1 Description of Hazard

The *Navigation Act 2012* requires vessels to be well lit for safe navigation. Vessels are required to show lights when operating at night to indicate their position and seismic vessels must indicate their limited ability to manoeuvre. Artificial lighting on board the vessel will include a range of light sources, such as internal lighting, deck lighting and navigational lights. Lighting is required for safe navigation and safe work practices at night; however it has the potential to create light pollution with resultant effects on photo-sensitive fauna.

Potential adverse impacts on marine receptors from artificial lighting during seismic surveys are well understood and there are guidelines for mitigating impacts (WA EPA 2010). Light is considered a significant impact in areas adjacent to sensitive habitats (e.g. turtle and seabird nesting sites). Given the distance of the survey area from emergent land and the associated nearshore waters where these taxa breed, light is not considered a significant issue. In general the application of recognised good practice is considered appropriate to manage the risk.

No specific stakeholder concerns have been raised regarding light emissions.

#### 5.2.4.2 Description of Potential Impacts to Environmental Values

Known and potential environmental impacts resulting from light emissions include:

- disorientation, attraction or repulsion of sensitive marine fauna (particularly turtle hatchlings and juvenile seabirds)
- disruption to natural behavioural patterns and cycles, e.g. enabling nocturnal foraging.

Light emissions have the potential to affect the behaviours of marine fauna, notably marine turtles. Behavioural responses to light can affect breeding success in turtles and seabirds, largely through reduced juvenile survival. They may also affect foraging by seabirds, fish and dolphins; potentially conferring competitive advantage to some species and reducing reproductive success or survival in others.

Artificial light on, or near, nesting beaches poses a threat to marine turtles because it can disrupt critical behaviours such as adult emergence and nesting, hatchling orientation, sea-finding and dispersal behaviour, which may reduce the overall reproductive output of a stock (Commonwealth of Australia 2017). As hatchlings orient towards the lowest light horizon rather than being directly attracted to bright lights, lights of any wavelength can affect behaviour. However, experimental studies have shown increased sensitivity to light in the green/blue end of the colour spectrum and typically white lights on vessels emit a significant component of these wavelengths.

Artificial light can disrupt marine turtles wherever it is stronger than natural light sources (Commonwealth of Australia 2017). For a vessel at sea, light is most likely to affect turtles and seabird at breeding sites through direct light shining on nesting beaches or nearshore dispersal areas (Commonwealth of Australia 2017). Lighting on the seismic vessel will create pools of light on the sea surface around it which if in close proximity to a besting beach, could attract turtle hatchlings in the water. Hatchlings would then probably suffer higher risk of predation (Thums et al., 2016). This has been observed on stationary vessels (Fitzpatrick pers. comm.), but is much less likely for a moving light source given the slow swimming speed of turtle hatchlings.

Diffuse light glow from large industrial centres has the potential to cause disorientation of turtle hatchlings up to 15 km from the light source (Kamrowski 2014). However, the closest turtle nesting beaches in the vicinity of the operational area are on Rosemary Island, approximately 22 km away in the Dampier Archipelago. Direct light spill and glow from the vessel will be comparatively limited and given the considerable distance offshore from turtle nesting beaches, the potential for artificial lighting to impact upon nesting and hatchling turtles is negligible.

There is no evidence to suggest that interesting turtles are impacted by light from offshore vessels and nothing in their biology would indicate that this is a plausible threat. However, the southern extent of the

survey area (including 15 km buffer) was reduced (11,174 km$^2$) during planning and development of the EP to ensure that the proposed activities would not displace marine turtle species from a small portion of the 20 km buffer zones for inter-nesting habitats critical to survival and inter-nesting BIAs for green, hawksbill and loggerhead turtles around the Dampier Archipelago that were previously included in the survey area (Figure D-1). The only identified habitat critical to survival or BIA that remains within part of the survey area is defined for inter-nesting flatback turtles (Figure D-2). However, there is no evidence that interesting flatback turtles swim out into deep offshore waters during interesting and recent research by Whitlock et al. (2016) (described in Section 3.1.3.3.2) demonstrates that habitat suitable for habitat suitable for inter-nesting flatback turtles does not occur in the survey area. Therefore, it is similarly unlikely that inter-nesting flatback turtles will be present in the survey area. There are no nesting areas or known foraging habitats of any marine turtles within or in the vicinity of the survey area (Figures D-1 and D-2) and so no effects on turtle breeding success or to populations are predicted.

The Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017) considers threats to turtle stocks on an individual basis. Light pollution is identified as a threat with a “high risk” rating for three of the seven marine turtle species stocks with a limit of dispersal that includes the proposed survey area (Section 3.1.3.3.2), including the North West Shelf green, Pilbara flatback and Western Australian hawksbill turtle stocks. Light pollution is considered to be of “moderate risk” for the other marine turtle species stocks (the Western Australian loggerhead, Scott Browse green, south-west Kimberley flatback turtle stocks) that may potentially occur in the survey area, with the exception of leatherback turtles, which are considered to be at “low risk” to light pollution (Commonwealth of Australia 2017). The recovery plan includes actions to address threats with “high” or “very high risk” ratings. The alignment of the EP with relevant actions identified in the recovery plan to minimise light pollution are shown in Table 5-22.

The impact to birds is related primarily to potential collision with lit infrastructure. Bright lighting can disorient birds, thereby increasing the likelihood of seabird injury or mortality through collision with infrastructure, or from starvation due to disrupted foraging at sea (Wiese et al. 2001). Nesting birds may be disorientated where lighting is adjacent to rookeries. Habitat for seabirds and shorebirds is well represented throughout the region; however, no nesting or resting areas for birds occur in the vicinity of the survey area. Given the short duration of the activity and distance offshore from breeding and resting sites, light disturbance to birds is likely to be restricted to behavioural changes by a small number of birds in the immediate vicinity of the vessel.

Other marine life may also be attracted to the light spill from the vessel. Although this effect is expected to be greater in a stationary vessel, worms, squid, plankton and fish can aggregate directly under downward facing lights on the water. This in turn can attract predatory fauna such as seabirds, cetaceans and fish. There is minor potential for changes in inter-specific dynamics as some species are more able to exploit the longer foraging periods and to prey on phototropic prey species. However, the constant movement of the vessel will reduce this potential significantly.

There is no evidence to suggest that artificial light sources adversely affect the migratory, feeding or breeding behaviours of cetaceans (DSEWPaC 2012a). Cetaceans predominantly use acoustic senses to monitor their environment rather than visual sources (WDCS 2004), so light is not considered to be a significant factor in cetacean behaviour or survival.

The survey will be conducted in water depths from 35 m to 271 m and approximately 22 km away from emergent land that may be important for marine turtle or seabird nesting, foraging. The activity will result in a temporary moving light source in offshore waters. A moving light source in the sea does not engender the same level of risk of light-induced behavioural impacts to turtle hatchlings or juvenile seabirds as a well-lit onshore facility, or onshore lighting. Such impacts will be localised to the area in which the vessel is visible during the activity and will be limited in duration.

**Table 5-22: Recovery plan for marine turtles in Australian waters (Commonwealth of Australia 2017) and Alignment with the Davros Extension MC3D MSS EP.**

| Recovery Plan Action | Alignment with EP |
|---|---|
| **Minimise light pollution** | |
| Artificial light within or adjacent to habitat critical to the survival of marine turtles will be managed such that marine turtles are not displaced from these habitats. | Control measures will be implemented to manage light emissions (Section 6.2.4.4).<br>The potential for artificial lighting to impact upon nesting and hatchling turtles is negligible given that the vessel will remain at least 22 km offshore from the nearest nesting beach throughout the survey. There is no evidence to suggest that interesting turtles are impacted by light from offshore vessels but the southern extent of the survey area has been reduced to ensure that the vessel would not operate within areas identified as habitat critical to survival for inter-nesting green and hawksbill turtles that were previously included in the survey area. Part of the survey area overlaps with an area defined as habitat critical to the survival of inter-nesting flatbacks. However, there is no evidence that interesting flatback turtles swim out into deep offshore waters during interesting and recent research by Whitlock et al. (2016) (described in Section 4.3.2.3.2) demonstrates that habitat suitable for habitat suitable for inter-nesting flatback turtles does not occur in the survey area. Therefore, artificial light from the vessel will not displace marine turtles from critical habitats and marine turtle stock recovery will not impeded. |

### 5.2.4.3 Inherent Impact Assessment

Light emissions to sea could cause minor disruption and temporary effect (days) on individual protected turtles and seabirds, including impacts on critical behavioural processes (juvenile dispersion), with no threat at a population level or to the regional stocks. This is a Minor consequence.

Given the considerable distance offshore from turtle and seabird nesting sites and associated nearshore waters, the disruption of critical juvenile dispersion processes could occur but would not be expected. Direct light impacts at nesting sites would not occur due to the distance from shore; however, there is a low probability that individual turtles and seabirds will be attracted by the moving light source at sea for a short period. The highly dispersed distribution of the turtles and seabirds would limit their potential exposure. The likelihood of this impact is Unlikely. The inherent impact is Low.

### 5.2.4.4 Control Measures

Table 5-23 presents the control measures that CGG will implement during the Davros Extension MC3D MSS to manage any potential impacts associated with light emissions.

**Table 5-23: Control Measures for Light Emissions**

| Control Measures | |
|---|---|
| Good Practice | Non-essential lighting will be switched off at night when not in use |
| | Where possible, external lighting will be directed onto the deck, minimising light spill to the environment |

### 5.2.4.5 Demonstration of ALARP and Risk Acceptability

#### 5.2.4.5.1 Summary of ALARP Demonstration

CGG is committed to ensuring continual risk reduction and considered the additional measure in Table 5-24; however, this measure has not been adopted as the cost of implementation is disproportionate to the benefit gained. On the basis of the decision methods used in the impact based decision making framework for the activity, CGG considers the adopted controls in Table 5-23 to be appropriate in reducing the environmental impacts associated with light emissions from vessel operations to ALARP. There are no other control measures that may practicably be adopted to reduce the impacts further without disproportionate costs compared to the benefit of impact reduction.

**Table 5-24: Demonstration of ALARP and Risk Acceptability for Light Emissions**

| Additional Control Measures | Practicability / Effectiveness? | Cost Benefit Analysis | Risk Reduction (L/C/RR ↓)? | Control Adopted |
|---|---|---|---|---|
| EIA | | | | |
| No night-time operations. | P: No.<br>E: Effective (+) | Limiting seismic activities to daylight hours would significantly extend the time required to acquire data for individual activities. Activities will take place >20 km from land which will reduce likelihood of disorientation/attraction of hatchlings/juvenile turtles/seabirds. Negligible environmental benefit in 12 hour operations, but significant increase in vessel charter costs. Costs (additional vessel costs) disproportionately higher than benefits. | Limited benefit due to low likelihood of night-time encounters with sensitive receptors in survey area | No |

#### 5.2.4.5.2 Residual Impact

The consequence of the behavioural disturbance to dispersing protected turtles with consequent heightened risk of predation and collisions with seabirds remains Minor.

With the implementation of the control measures described in Table 5-23, the amount of light reaching the sea surface around the vessel is reduced. This means an individual animal would have to be very close to the survey vessel to be exposed to light emissions at a level causing behavioural change. The likelihood of greatly dispersed individuals encountering this smaller light pool is lower, but it could occur. The likelihood of this impact during the activity remains Unlikely.

The residual impact is therefore **Low**.

#### 5.2.4.5.3 Acceptability

The residual impact of light emissions complies with CGG's internal context (low risk), will be managed in accordance with relevant legislative requirements and complies with industry good practice and the principles of ESD.

Any concerns raised by stakeholders have been assessed and control measures adopted where appropriate. There is no safe or practical alternative to the use of artificial lighting during the activity; therefore the associated impacts cannot be totally eliminated. The impact assessment has determined that, with the implementation of the adopted control measures, light emissions will not result in a potential impact greater than a localised area of behavioural change in the immediate vicinity of the survey vessel at night. No stakeholder concerns have been raised to date with regard to lighting. The ALARP assessment demonstrates that the adopted controls are (Table 5-23 and Table 5-24) appropriate to reduce the impact to ALARP without the further impact reduction being required. Recovery Plan Actions identified for marine turtles to minimise impacts from light pollution are aligned with the control measures adopted in this EP for the survey (Table 5-22).Given the nature and scale of the activity, CGG consider that the potential impacts are of an acceptable level as the predicted impacts are within and below the defined acceptable levels of impact in accordance with the criteria defined in Table 4-4.

### 5.2.4.6 Environmental Performance Outcomes, Standards and Measurement Criteria

The environmental performance outcomes, standards and measurement criteria appropriate to measure performance of the adopted control measures for artificial light spill are presented below in Table 5-25. Environmental performance standards and relevant measurement criteria have been developed for each control measure identified in Table 5-23 and each additional control adopted from the ALARP assessment in Table 5-24.

**Table 5-25: Environmental Performance Outcomes, Standards and Measurement Criteria for light Emissions**

| Environmental Performance Outcome | Environmental Performance Standard | Measurement Criteria |
|---|---|---|
| Minimise potential for adverse impacts on light sensitive marine fauna | Non-essential lighting will be switched off when not in use | Inspection during survey confirms non-essential lighting is switched off at night<br>Induction material demonstrates that vessel crew has been inducted in light spill reduction protocols, especially switching off non-essential lights. |
| | External lighting will be directed onto the deck, reducing light spill to the environment where practicable for safe operations | Record of inspection during the activity to confirm orientation of all external work lights in use has been checked and adjusted where practicable. |

### 5.2.5 Impact 5 - Routine Discharges

#### 5.2.5.1 Description of Hazard

Seismic survey vessels routinely discharge non-toxic substances into the sea, such as putrescible wastes (food scraps), grey water (water from showers, laundries and dishwashing), sewage, deck drainage, bilge water, brine and cooling water.

Deck drainage, which is derived from sea spray, rainwater and deck wash-down water, may contain minor quantities of oil, grease and detergents that have been washed off the decks.

Discharge of bilge waters with ≤15 ppm oil-in-water (OIW) content. Bilge water includes deck drainage that has been captured in a closed-loop system (e.g. bunded areas are directed to the bilge water tank for removal of oil prior to discharge).

The contract has yet to be awarded for the vessels for this activity; however, a typical seismic vessel of the size required carries approximately 70 persons on board (POB). Support vessels would carry approximately 15 POB. The volume of discharges during the survey are expected to be approximately 170 L/day/person (United States Environmental Protection Agency 2011), yielding a total daily grey water volume of approximately 14,450 L for the crew of the seismic vessel and one support vessel.

The discharge of contaminated or nutrient-enriched wastewater has the potential to affect the water quality and plankton communities in the local area.

Seawater is used as a heat exchange medium for cooling machinery engines and other equipment. Seawater is drawn up from the ocean, where it is de-oxygenated and sterilised by electrolysis (release of chlorine from the salt solution) and then circulated as coolant for various equipment through the heat exchangers (in the process absorbing heat from the machinery), and is then discharged to the ocean.

Brine (hyper-saline water) is created through the vessel's desalination process that creates freshwater for drinking, showers, cooking etc. This is achieved through reverse osmosis (RO) or distillation; both processes resulting in the discharge of seawater with a slightly elevated salinity (approximately 10% higher than seawater). The freshwater produced is then stored in tanks on board.

The potential impacts of routine discharges to marine waters during seismic surveys are well understood with legislative requirements and industry agreed practices to manage risks. The application of recognised good practice is considered appropriate to manage the impact; particularly due to the distance of the survey area from sensitive receptors and the well-mixed offshore marine waters of the survey area. Small volumes of wastewaters discharged into open ocean conditions will be rapidly diluted and dispersed.

No specific stakeholder concerns have been raised concerning impacts of routine discharges from vessel operations.

#### 5.2.5.2 Description of Potential Impacts to Environmental Values

The known and potential environmental impacts from routine operational discharges are:

- temporary localised decline in water quality in the immediate vicinity of the discharge
- localised increase in biological oxygen demand (BOD)
- localised increase in turbidity of surrounding waters
- temporary toxicity to marine flora and fauna (bilge water discharges)
- temporary and localised increase in sea surface water temperature
- temporary and localised increase in sea surface salinity.

##### 5.2.5.2.1 Potential Impacts to Water Quality

Discharges of sewage, grey water, bilge water and putrescible wastes to the marine environment may cause some temporary localised nutrient enrichment of the surface waters around the discharge point; however the discharge point will be moving with the vessel. There is potential for phytoplankton uptake of the extra nutrients and localised, temporary increases in primary productivity. However, given the oligotrophic (nutrient poor) receiving waters, the temporary nature of the discharges in any one location, the small volumes and the rapid dilution and dispersion, no measurable increases in nutrient concentrations, oxygen demand, turbidity or plankton are expected.

During normal operating conditions, the concentrations of any oil and grease residues in deck drainage and bilge water will be very low and with the rapid dilution and assimilative capacity of the offshore marine environment, the potential for toxicity from hydrocarbon residues is considered low.

Once in the water column, cooling water will remain in the surface layer, where turbulent mixing and heat transfer with surrounding waters will occur rapidly. This will cause very localised and temporary increases in water temperature.

The potential impacts of increased seawater temperatures due to cooling water discharge will be limited to the immediate vicinity of the discharge. Impacts on marine organisms will be negligible given the buffering and dispersive capacities of the receiving seawater.

Given that the temperature of the discharges is likely be only marginally higher than that of the receiving waters, and that the vessels are constantly in motion, the impacts of cooling are considered negligible and will be temporary and localised.

Brine water (salinity of approximately 40 ppt) is denser than seawater (approximately 35 ppt). As such, discharged brine water will sink through the water column which will aid rapid mixing with receiving waters and dispersion by ocean surface currents. The brine discharge may lead to an approximate 10% increase in seawater salinity in the immediate vicinity of the discharge point. This is within the range of surface salinities in the NWMR, where seasonal cyclonic rainfall and riverine discharge have a major influence on sea surface salinity. The potential for adverse biological impact is considered negligible.

##### 5.2.5.2.2 Potential Impacts to Protected Areas and Other Marine Habitats and Communities

Glomar Shoal and Rankin Bank are submerged features with a high biological diversity and high localised productivity (Section 3.1.5). Grey water, sewage, bilge water and putrescible waste discharges will be rapidly diluted and dispersed and the concentrations of any potential contaminant or nutrient will reach background levels very quickly. No effects on individuals or communities are expected for pelagic or benthic receptors. Any reduction in water quality would be extremely localised and temporary and is unlikely to have any measurable impact on species diversity or abundance within these areas. Fisheries and fish resources would not be affected.

#### 5.2.5.3 Inherent Impact Assessment

The offshore disposal of sewage, grey water and putrescible wastes may cause a small, localised (immediate area), temporary increase in the nutrient content in the water column in the immediate vicinity of the discharge. Discharges of brine and cooling water also have the potential to reduce water temperature and salinity in the immediate vicinity of the vessel. However, due to the small volumes discharged and well-mixed open ocean environment in the Davros Extension MC3D survey area, any changes to ambient water quality (including salinity and temperature), nutrient levels or dissolved oxygen in the receiving waters are expected to be negligible. This is a Minor consequence.

Given the considerable distance offshore, the small volumes, the moving discharge point and well-mixed waters of the survey area, the likelihood of this impact is Unlikely. The inherent impact is Low.

#### 5.2.5.4 Control Measures

Table 5-26 presents the control measures that CGG will implement during the Davros Extension MC3D MSS to manage any potential impacts associated with routine discharges.

**Table 5-26: Control Measures for Routine Discharges**

| Control Measures | |
|---|---|
| Good Practice | Compliance with MARPOL 73/78 Annex IV (sewage) and Annex V (garbage), (as applied in Australia under Commonwealth *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*)); and AMSA Marine Orders – Part 96: Marine Pollution Prevention – Sewage, as required by vessel class:<br>Vessel will have a Garbage Management Plan (GMP) and Garbage Record Book<br>Treated sewage discharged >3 NM from land or untreated sewage discharge >12 NM from land and at a speed of greater than 4 knots<br>All food waste is macerated to ≤25 mm in size prior to overboard discharge, any discharge must be at a speed of greater than 4 knots<br>Operational on-board sewage treatment plant approved by the International Maritime Organization (IMO)<br>Operational on-board organic waste macerator compliant with MARPOL Annex V<br>International Sewage Pollution Prevention (ISPP) Certificate |
| | Segregation facilities on all vessels including integral waste oil tank for oils and sludge and tanks for storage bilge water. |
| | All waste holding tanks are to be fully operational prior to survey commencement |
| | Vessel survey crew will be inducted in waste management and made familiar with the vessel GMP. |
| | Compliance with MARPOL 73/78 Annex I (as applied in Australia under Commonwealth *Protection of the Sea (Prevention of Pollution from Ships) Act 1983)*); and AMSA Marine Order - Part 91 Marine Pollution Prevention – Oil):<br>■ oil content of any discharged water to be <15 ppm<br>■ bilge water contaminated with hydrocarbons must be contained and disposed of onshore, except if the oil content of the effluent without dilution does not exceed 15 ppm or an IMO approved oil/water separator (as required by vessel class) is used to treat the bilge water<br>■ seismic vessel has an International Oil Pollution Prevention (IOPP) certificate. |
| | The vessel must not be stationary when undertaking discharge and oil in water (OIW) separator shut off value must be maintained and operational. |
| | Deck drain scupper plugs available. |
| | Minor oil/lubricant spills will be mopped up immediately with absorbent materials that will be stored on board and disposed of onshore as hazardous waste in accordance with the vessel SOPEP. |

### 5.2.5.5 Demonstration of ALARP and Risk Acceptability

#### 5.2.5.5.1 Summary of ALARP Demonstration

Additional controls have been considered and adopted where they can further reduce risks to ALARP (Table 5-27). Where the cost of implementing the additional control measures is disproportionate to the benefit gained, they have not been adopted. CGG has applied a precautionary approach in managing discharges over shallow water sensitive habitats on Glomar Shoal and Rankin Bank, through adopting an additional control measure that prohibits routine discharges within the 40 m depth contour of Glomar Shoal and Rankin Bank.

The Davros MC3D operational area overlaps the boundaries of the Montebello Marine Park, and is located 36 km from the boundary of the Dampier Marine Park (Figure A). Transitional management arrangements under the EPBC Act have been in place for the majority of Marine Parks until very recently. These transitional arrangements previously only allowed commercial vessel transit through Marine Park as "being continuous passage of a vessel through an area by the shortest direct route without any other activity being carried on" (Director of National Parks 2013b). These transitional arrangements would therefore preclude any activity including routine discharges within the boundaries of these Marine Park. The publication of the Draft North-west Commonwealth Marine Reserves Network Management Plan on 21 July 2017, which covers both the Montebello and Dampier Marine Park, now specifically allows activities including disposal of waste from vessels in accordance with MARPOL requirements within all zones except Sanctuary Zones (Director of National Parks 2017). Despite the absence of any shallow water benthic habitats, in the Montebello Marine Park multiple use zone, CGG will apply a precautionary approach in managing routine discharges during the Davros Extension MC3D survey, by precluding routine discharges within the Marine Park boundary. There are no predicted impacts to the Dampier Marine Park as it is located >30 km away from the operational and survey areas, and no activities will be carried out within the marine park boundaries.

CGG considers the adopted controls to be appropriate in reducing the environmental impacts associated with routine discharges to the marine environment to ALARP. There are no other controls measures that may practicably or feasibly be adopted to reduce the risks and impacts further without disproportionate costs compared to the benefit of the potential risk reduction.

**Table 5-27: Demonstration of ALARP for Routine Discharges**

| Additional Control Measures | Practicability/ Effectiveness? | Cost Benefit Analysis | Risk Reduction (L/C/RR ↓)? | Control Adopted |
|---|---|---|---|---|
| **EIA** | | | | |
| Retain all waste streams on board to avoid discharging at sea | P: No<br>E: Effective (+) | Considerable additional storage to be provided on board, discounted due to disproportionate costs in retrofitting vessels, compared to small environmental benefit. | Yes | No |
| **Precautionary Approach** | | | | |
| No discharge within 40 m depth contour of Glomar Shoal and Rankin Bank | P: Yes<br>E: Fairly effective (0) | Due to the well-mixed environment, routine discharges will dissipate quickly, however there may be some perceived environmental benefit to discharging away from the shallowest areas of Glomar Shoal and Rankin Bank, where the greatest diversity is (benthic and fish – refer to Section 3.1.2). Though not raised by stakeholders, this may assist in assuring them of environmental best practice. | Yes | Yes |
| No discharge within the Montebello and Dampier Marine Parks | P: Yes<br>E: Effective (+) | Minor cost involved in not routinely discharging within these Marine Parks to meet transitional management requirements; benefits outweigh costs. | Yes | Yes |

#### 5.2.5.5.2 Residual Impact

The consequence of temporary and localised reductions in water quality and/or toxicity to marine fauna in the vicinity of routine discharges remains Minor.

With the implementation of the control measures described in Table 5-26 and additional controls adopted from the ALARP assessment in Table 5-27, there will be no routine discharges in protected areas or in the vicinity of shallower water areas of the survey (Glomar Shoal and Rankin Bank). Any routine discharges would be carried out to promote rapid dilution (i.e. in offshore waters and moving vessel). The likelihood of adverse effects to marine water quality and/or marine fauna from routine discharges during the activity is reduced to Rare. The residual impact is therefore **Low**.

#### 5.2.5.5.3 Acceptability

The residual impact of routine discharges complies with CGG's internal context (low risk), will be managed in accordance with relevant legislative requirements and complies with industry good practice and the principles of ESD.

Any concerns raised by stakeholders have been assessed and control measures adopted where appropriate. The impact assessment has determined that, with the implementation of the adopted control measures, routine operational discharges will not result in a measurable impact to the well-mixed marine waters of the Davros Extension MC3D survey area. In addition, a precautionary approach has been applied in regard to precluding routine discharges over the shallow areas on Glomar Shoal and Rankin Bank, and within the Montebello and Dampier Marine Parks.

The ALARP assessment demonstrates that the adopted controls (Table 5-26 and Table 5-27) are appropriate to reduce the impact to ALARP without the further impact reduction being required. Given the nature and scale of the activity, CGG consider that the potential impacts are of an acceptable level as the predicted impacts are within and below the defined acceptable levels of impact in accordance with the criteria defined in Table 4-4.

### 5.2.5.6 Environmental Performance Outcomes, Standards and Measurement Criteria

The environmental performance outcomes, standards and measurement criteria appropriate to measure performance of the adopted control measures for routine operational discharges are presented below in Table 5-28. Environmental performance standards and relevant measurement criteria have been developed for each control measure identified in Table 5-26 and each additional control adopted from the ALARP assessment in Table 5-27.

**Table 5-28: Environmental Performance Outcomes, Standards and Measurement Criteria for Routine Discharges**

| Environmental Performance Outcome | Environmental Performance Standard | Measurement Criteria |
|---|---|---|
| Meet legislated discharge requirements for permissible discharges. | Compliance with MARPOL 73/78 Annex IV (sewage) and Annex V (garbage), (as applied in Australia under Commonwealth *Protection of the Sea (Prevention of Pollution from Ships) Act 1983)*); and AMSA Marine Orders – Part 96: Marine Pollution Prevention – Sewage, as required by vessel class:<br>■ survey vessel will have a Garbage Management Plan (GMP) and Garbage Record Book<br>■ operational on-board sewage treatment plant (STP) approved by the International Maritime Organization (IMO)<br>■ All sewage discharges are treated via an approved sewage treatment plant prior to overboard discharge<br>■ operational organic waste macerator compliant with MARPOL Annex V is installed on the survey vessel and used while on location. All food waste is macerated to ≤ 25 mm in size prior to overboard discharge to ensure rapid breakdown upon discharge.<br>■ ISPP Certificate<br>■ segregation facilities on all vessels including integral waste oil tank for oils and sludge and tanks for storage bilge water | Records demonstrate the survey vessel has a GMP compliant with MARPOL. |
| | | Records of any non-compliance with MARPOL are documented; and corrective actions identified and undertaken. |
| | | Maintenance records demonstrate regular maintenance undertaken of on-board STP / macerator |
| | | Records demonstrate the survey vessel holds a valid ISPP certificate, as required by vessel class. |
| | All waste holding tanks are to be fully operational prior to survey commencement | Records demonstrate that the survey waste holding tanks are fully operational prior to survey. |
| | Survey vessel crew will be inducted in waste management and made familiar with the vessel GMP. | Vessel induction confirms that survey crew are inducted in waste management procedures and GMP. |
| | Untreated sewage is only discharged when the vessel is greater than 12 NM from shore and at a speed of >4 knots | Records show that untreated sewage discharged >12 NM from land, and at a speed of >4 knots. |
| | Treated sewage is only discharged when the vessel is greater than 3 NM from shore and at a speed of >4 knots | Records show that treated sewage discharged >3 NM from land, and at a speed of >4 knots. |
| | All food waste is macerated to ≤25 mm in size prior to overboard discharge >3 NM from nearest land, and any discharge must be at a speed of >4 knots. | Records show that all food scraps are macerated to a particle size of ≤25 mm, discharged >3 NM from nearest land and at a speed of >4 knots. |
| | Compliance with MARPOL 73/78 Annex I (as applied in Australia under Commonwealth *Protection of the Sea (Prevention of Pollution from Ships) Act 1983)*); and AMSA Marine Order – Part 91 Marine Pollution Prevention – Oil):<br>■ oil content of any discharged water to be <15 ppm<br>■ bilge water contaminated with hydrocarbons must be contained and disposed of | Oil Record Book confirms volume and concentration of discharge. |
| | | Records demonstrate the survey vessel holds a valid IOPP certificate, as required by vessel class. |
| | | Calibration records verify that the OWS is set to 15 ppm. |

| Environmental Performance Outcome | Environmental Performance Standard | Measurement Criteria |
|---|---|---|
| | onshore, except if the oil content of the effluent without dilution does not exceed 15 ppm or an IMO approved oil/water separator (as required by vessel class) is used to treat the bilge water<br>■ the OWS is maintained in accordance with the planned maintenance system (PMS) to ensure it does not discharge water containing >15 ppm oil<br>■ survey vessel has an IOPP certificate. | PMS records verify that the OWS is being maintained to schedule.<br>Vessel engineers / chief engineer to confirm that OIW is in good working order during vessel audit during the survey (inspection within the last 12 months). |
| | The vessel must not be stationary when undertaking discharge and oil in water (OIW) separator shut-off valve must be maintained and operational. | Records show vessel was moving (not stationary) when undertaking discharge and OIW separator shut-off valve was maintained and operational. |
| | Scupper plugs or equivalent drainage control measures are readily available to the deck crew so that deck drains can be blocked in the event of a hydrocarbon or chemical spill on deck to prevent or minimise discharge to the sea. | Site inspection verifies that scupper plugs (or equivalent) are available on the main deck. |
| | Spill response kits are available in relevant locations around each vessel, are fully stocked and used in the event of a spill to deck to prevent or minimise discharge overboard. | Site inspection verifies that spill response kits are available in relevant locations in accordance with vessel plans. |
| | Minor oil/lubricant spills will be mopped up immediately with absorbent materials that will be disposed of onshore as hazardous waste in accordance with the vessel SOPEP. | Records show that:<br>■ response measures for minor oil/lubricant spills were carried out in accordance with the SOPEP.<br>■ contaminated clean-up wastes stored on board in covered bins prior to onshore disposal at a licensed waste management facility.<br>Records show spills and leaks are recorded and investigated; and corrective actions identified and undertaken. |
| | Equipment served by the cooling water system (e.g. main engines), sewage treatment plant and macerator are maintained in accordance with the PMS to ensure that equipment is operating efficiently. | PMS records confirm that this equipment is maintained to schedule. |
| No routine discharges within 40 m depth contour of Glomar Shoal and Rankin Bank. | No routine discharges within 40 m depth contour of Glomar Shoal and Rankin Bank. | Records show no discharges within 40 m depth contour of Glomar Shoal and Rankin Bank. |
| No routine discharges within Commonwealth Marine Reserves. | No routine discharges within the boundaries of Montebello or Dampier CMRs. | Records show no discharges within the boundaries of Montebello or Dampier CMRs. |

### 5.2.6 Impact 6 - Atmospheric Emissions

#### 5.2.6.1 Description of Hazard

Atmospheric emissions of greenhouse gases and other pollutants will be produced through:

- Combustion of marine diesel from the seismic and support vessel engines and fixed and mobile deck equipment during the survey; and
- Solid non-hazardous waste combustion within an incinerator, if logistics don't allow for the timely removal of waste from the vessel.

The main emissions that present an environmental impact are:

- nitrous oxides ($NO_X$)
- sulfurous oxides ($SO_X$)
- particulate matter <10 µm
- non-methane volatile organic compounds (VOCs)
- benzene, toluene, ethylbenzene and xylenes (BTEX)
- greenhouse gases (predominantly carbon dioxide).

The potential impacts of atmospheric emissions from vessels are well understood with legislative requirements and industry agreed good practices to manage impacts. The application of recognised good practice is considered appropriate to manage the impact; particularly due to the distance of the survey area offshore.

No specific stakeholder concerns have been raised regarding impacts of atmospheric emissions from vessels.

#### 5.2.6.2 Description of Potential Impacts to Environmental Values

The known and potential environmental impacts from atmospheric emissions are:

- localised and temporary decrease in air quality due to emission of gaseous and particulate matter from diesel combustion
- contribution to the global greenhouse gas (GHG) effect.

#### 5.2.6.3 Inherent Impact Assessment

Atmospheric emissions will be localised within the immediate vicinity of the vessel within the survey area. Once in the atmosphere, the emissions will be rapidly dispersed and diluted and no measurable increase in air pollutant or GHG concentrations will occur. There will be no or very limited effect on ecosystems, species or habitats. This is a Negligible consequence.

Given the short duration of the survey, and constant movement of the vessel, emissions from the combustion of fuel on board the vessels will not affect sensitive receptors in the vicinity of the survey area (including the health or amenity of the nearest human settlements). The likelihood of this impact is Rare. The inherent impact is therefore Low.

#### 5.2.6.4 Control Measures

Table 5-29 presents the control measures that CGG will implement during the Davros Extension MC3D MSS to manage any potential impacts associated with atmospheric emissions.

**Table 5-29: Control Measures for Atmospheric Emissions**

| Control Measures | |
|---|---|
| Good Practice | Compliance with MARPOL 73/78 Annex VI as applied in Australia under Commonwealth *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* and *Marine Order – Part 97 (Part IIID Marine Pollution Prevention – Air Pollution)*, where applicable to vessel class including:<br>■ Vessels will hold a valid International Air Pollution Prevention (IAPP) Certificate.<br>■ The sulfur content of any fuel oil used on board ships shall not exceed 3.5% by mass. |
| | Survey vessel only uses MGO grade fuel. |
| | Sail line planning to increase efficiency and reduce vessel time will also reduce fuel consumption and hence lower emissions. |
| | All engines to be well maintained in accordance with manufacturers specifications |

### 5.2.6.5 Demonstration of ALARP and Risk Acceptability

#### 5.2.6.5.1 Summary of ALARP Demonstration

CGG considers the adopted controls in Table 5-29 to be appropriate in reducing the environmental impacts associated with atmospheric emissions from vessel operations to ALARP. There are no other control measures that may practicably or feasibly be adopted to reduce the impacts further without disproportionate costs compared to the benefit of impact reduction.

#### 5.2.6.5.2 Residual Impact

The consequence of a reduction in air quality due to gaseous emissions from the seismic and support vessel and/or a contribution to the GHG effect remains Negligible.

With the implementation of the control measures described in Table 5-29, atmospheric emissions generated by the survey/support vessels remains unchanged; however emissions will be localised to the survey area and be rapidly dispersed and diluted in the atmosphere by the moving vessels. The likelihood of this impact during the activity remains Rare. The residual impact is therefore **Low**.

#### 5.2.6.5.3 Risk Acceptability

The residual impact of atmospheric emissions complies with CGG's internal context (low risk), will be managed in accordance with relevant legislative requirements and complies with industry good practice and the principles of ESD.

Any concerns raised by stakeholders have been assessed and control measures adopted where appropriate. The impact assessment has determined that, with the implementation of the adopted control measures, atmospheric emissions will result in localised and temporary effects in the vicinity of the vessel.

The ALARP assessment demonstrates that the adopted controls (Table 5-29) are appropriate to reduce the impact to ALARP without the further impact reduction being required. Given the nature and scale of the activity, CGG consider that the potential impacts are of an acceptable level as the predicted impacts are within and below the defined acceptable levels of impact in accordance with the criteria defined in Table 4-4.

### 5.2.6.6 Environmental Performance Outcomes, Standards and Measurement Criteria

The environmental performance outcomes, standards and measurement criteria appropriate to measure performance of the adopted control measures for atmospheric emissions are presented below in Table 5-30. Environmental performance standards and relevant measurement criteria have been developed for each control measure identified in Table 5-29.

**Table 5-30: Environmental Performance Outcomes, Standards and Measurement Criteria for Atmospheric Emissions**

| Environmental Performance Outcome | Environmental Performance Standard | Measurement Criteria |
|---|---|---|
| Combustion systems comply with MARPOL VI (Prevention of Air Pollution from Ships) requirements. | Compliance with MARPOL 73/78 Annex VI as applied in Australia under Commonwealth *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* and Marine Order – Part 97 (Part IIID Marine Pollution Prevention – Air Pollution), where applicable to vessel class including:<br>■ survey vessel will hold a valid International Air Pollution Prevention (IAPP) Certificate.<br>■ only fuel that contains less than 3.5% m/m sulfur will be bunkered.<br>■ survey vessel only uses MGO grade fuel. | Records demonstrate the vessel(s) hold a valid IAPP certificate, where applicable to vessel class |
| | | Inspection of bunkering records to confirm that the survey vessel is using fuel with <3.5% sulfur by mass |
| | | MSDS and vessel bunker receipts confirm the use of low-sulfur fuel and MGO or lighter grade fuel for main engines. |
| | Fuel usage will be monitored and abnormally high consumption investigated in order to minimise excessive air pollution. | Fuel use is reported in the Daily Report.<br>Non-conformance records show abnormalities are being investigated. |
| | All combustion equipment will be maintained in accordance with the PMS to ensure they are operating to design specifications. | PMS records confirm that combustion equipment is maintained to schedule. |
| | A MARPOL approved incinerator is used to incinerate solid waste (food waste, paper, cardboard, rags, plastics) if logistics don't allow for the timely removal of waste from the vessel. | IAPP certificate verifies the incinerator meets MARPOL requirements. |
| | Oil and other noxious liquids and solids will not be incinerated. | The Oil Record Book and Garbage Record Book verify that waste oil and other noxious substances are retained on board for transfer to shore. |

## 5.3 Non-routine (Unplanned) Events

### 5.3.1 Risk 1 - Vessel Collision / Equipment Entanglement with Marine Fauna

#### 5.3.1.1 Description of Hazard

During the activity, the survey and support vessels working within the survey area may present a potential physical hazard (risk of collision) to marine fauna such as whales, dolphins, whale sharks and turtles that may be swimming across the sail-lines at the sea surface. Additionally, there is a potential risk of turtles becoming trapped in the tail buoys that are attached to the end of each seismic streamer. Not all tail buoy designs present a risk of entrapment, but given the tail buoy design is unknown at this stage, we assume it is a credible risk for this activity.

While seismic vessels may attain speeds of 10 to 12 knots during transit to the survey area, they will maintain a cruising speed of 4 to 5 knots during data acquisition. Vessel speed has been identified as a contributing factor in the occurrence and severity of vessel collisions with various marine vertebrates (Laist and Shaw 2006, Hazel et al. 2007); large whale species in particular (Laist et al. 2001, Jensen and Silber 2003, Pace & Silber 2005, Vanderlaan and Taggart 2007). Damage and risk of injury is greatly increased at higher speeds, and is a higher risk for vessels travelling at 14 knots or faster because the fauna have less time to take evasive action (Laist et al. 2001). An actively acquiring seismic vessel will acoustically announce its approach from distance and fauna are more likely to be aware and able to evade the slow-moving vessel.

The risks from vessel collision / equipment entanglement with marine fauna are relatively well understood, with regard to the potential for injury and/or mortality from high speed collisions. In general the application of recognised good practice is considered appropriate to manage the risks. In addition this assessment considers the risk to the location specific environmental values and sensitivities (e.g. likely encounters with large, slow moving marine fauna). To augment decision making further, a precautionary approach is applied where uncertainty continues to exist.

No specific stakeholder concerns have been raised regarding vessel collisions with marine fauna.

#### 5.3.1.2 Description of Potential Impacts to Environmental Values

The known and potential environmental impacts to marine fauna from the movement of vessels and deployment of equipment associated within the survey area include:

- vessel collision with marine fauna such as cetaceans, whale sharks and turtles
- equipment entanglement with marine fauna such as cetaceans, whale sharks, turtles
- disturbance leading to behavioural changes or displacement of fauna.

The potential impacts associated with vessel/equipment interactions with marine fauna can range from minimal (e.g. behavioural changes) to severe (i.e. serious injury or mortality). Vessel collisions are a cause of mortality of marine fauna, notably turtles (Lutcavage et al. 1997; Hazel & Gyuris 2006; Hazel et al. 2007) and large cetaceans (Knowlton & Kraus 2001; Laist et al. 2001; Jensen & Silber 2003). Fauna at highest risk of collision are those that spend a high percentage of time in surface waters, are slow moving and/or large. The fauna that may occur in the vicinity of the operational area include whales, whale sharks and marine turtles. These fauna are mobile and would be expected to actively avoid the survey vessel.

Seismic streamers and vanes are fitted with pressure-activated, self-inflating buoys that are designed to bring the equipment to the surface if lost accidentally during a survey. As the equipment sinks it passes a certain water depth at which point the buoys inflate and bring the equipment back to the surface where it can be retrieved by the seismic or support vessels. Recovery of streamers would be undertaken where safe and practicable to do so, which would remove the remote risk of faunal entanglement.

Given the susceptibility of cetaceans, whale sharks and turtles to vessel strike, only potential impacts on these have been considered. Other marine fauna, such as birds, fish and sea snakes, are more likely to avoid vessels and are therefore not considered at risk.

##### 5.3.1.2.1 Potential Risks to Protected Species

*Potential Risks to Cetaceans*

Vulnerability of cetaceans to vessel collision will vary according to behaviour (e.g. surfacing habits, direction of travel in relation to shipping routes); morphology; the function of preferred habitat (e.g. breeding, feeding) in areas of vessel activity; and aspects of shipping such as vessel type, speed, density and location. Slow moving species that occur frequently at the surface in areas that overlap with shipping activity are the most vulnerable (Clapham et al. 1999).

Humpback whales are more susceptible to vessel collision due to their extended surface times (Laist et al. 2001). Calves may also be more vulnerable because they spend longer at the surface (Laist et al. 2001). The global International Whaling Commission (IWC) vessel strike database identifies 14 strikes recorded in Australian waters from January 2008 to August 2010, although it is likely that not all cetacean strikes are reported to the relevant authority, hence the figure may be higher in reality. Only a minority of the recorded incidents occurred in Western Australia in spite of the large annual migration of humpback whales in coastal waters. The survey area overlaps with the humpback whale migratory BIA and northbound whales may pass through the area as evident from mapped migratory routes (Figure B). On the basis of current information, collision with vessels has been identified as being of “potential concern” for humpback whales (Commonwealth of Australia 2012a). Conservation Management Actions identified in the Conservation Advice for humpback whales (DotE 2015c) to minimise vessel collisions have been addressed in Table 5-31 with a description of how the EP aligns with each action.

**Table 5-31: Humpback Whale Conservation Management Actions (DotE 2015c) and Alignment with the Davros Extension MC3D MSS EP**

| Conservation Management Action | Alignment with EP |
|---|---|
| **Minimising Vessel Collisions** | |
| Maximise the likelihood that all vessel strike incidents are reported in the National Ship Strike Database. All cetaceans are protected in Commonwealth waters and, the EPBC Act requires that all collisions with whales in Commonwealth waters are reported. Vessel collisions can be submitted to the National Ship Strike Database at https://data.marinemammals.gov.au/report/shipstrike | An additional control has been accepted to ensure consistency with this provision of the plan.<br>All vessel strike incidents will be reported in the National Ship Strike Database (refer to ALARP assessment in Table 5-34). |
| Ensure the risk of vessel strike on humpback whales is considered when assessing actions that increase vessel traffic in areas where humpback whales occur and, if required appropriate mitigation measures are implemented to reduce the risk of vessel strike | The survey area is within the area defined as 'species core range' and migratory BIA for humpback whales (Figure B). CGG recognises that the distribution of whales may extend beyond their BIA and has taken a precautionary approach to the assessment as described in Table 6-9). CGG will avoid scheduling the survey during peak migration months (i.e. July to September), and will acquire data within the exclusion zone defined for the humpback whale migration shoulder period outside the months of June and October (Figure 6-13).<br>CGG will additionally employ a smaller airgun array volume in water depths of 35 to 50 m within the survey area (refer to ALARP assessment in Table 6-12).<br>In addition, at least one MFO will be present onboard the seismic vessel during data acquisition observing whales and whale sharks out to a distance of 3 km of the seismic/supply vessels. The risk of vessel collision during the survey is therefore low. |
| Enhance education programs to inform vessel operators of best practice behaviours and regulations for interacting with humpback whales | Seismic and support vessels crews will be inducted in their responsibilities as required regarding marine fauna interactions. |

Pygmy blue, Bryde's and Antarctic minke whales, as well as other toothed whales (sperm whales, killer whales) and dolphins) may be encountered in the vicinity of the survey area, although they are unlikely to be in significant numbers as the area is not known to be used for feeding, breeding or resting by any of these species. The survey area is outside the BIA (migration corridor) for migrating pygmy blue whales (Figure B); however it is within an area of "known occurrence" (Commonwealth of Australia 2015), although there are no known or possible foraging areas in, or close to, the survey area. There is the potential for encounters with individual pygmy blue whales transiting through or in the vicinity of the survey area. Management actions identified in the Conservation Management Plan for the Blue Whale to minimise vessel collisions (Commonwealth of Australia 2015) have been addressed in Table 5-32 with a description of how the EP aligns with each action.

**Table 5-32: Pygmy Blue Whale Management Actions (Commonwealth of Australia 2015) and Alignment with the Davros Extension MC3D MSS EP**

| Management Action | Alignment with EP |
|---|---|
| **Minimising Vessel Collisions (High Priority)** | |
| Ensure all vessel strike incidents are reported in the National Ship Strike Database | All vessel strike incidents will be reported in the National Ship Strike Database (Table 5-34). |

| Management Action | Alignment with EP |
|---|---|
| Ensure the risk of vessel strikes on blue whales is considered when assessing actions that increase vessel traffic in areas where blue whales occur, and if required, appropriate mitigation measures are implemented | While the survey area is outside the pygmy blue whale migratory BIA it is within the area the whales "are known to occur" (Figure B). Adaptive control measures adopted for humpback whales will also benefit pygmy blue whales (refer to Table 5-14).<br>CGG will additionally employ a smaller airgun array volume in water depths of 35 to 50 m within the survey area (refer to ALARP assessment in Table 6-12).<br>In addition, at least one MFO will be present onboard the seismic vessel during data acquisition observing whales and whale sharks out to a distance of 3 km of the seismic/supply vessels. The risk of vessel collision during the survey is therefore low. |

The likelihood of vessel/cetacean collision being lethal is influenced by vessel speed: the greater the speed at impact, the greater the risk of mortality (Laist et al. 2001; Jensen and Silber 2003). Vanderlaan and Taggart (2007) found that the chance of lethal injury to a large whale because of a vessel strike increases from less than 10% at 4.5 knots, to about 20% at 8.6 knots and 80% at 15 knots. During seismic data acquisition, the survey vessel will be moving at a speed of approximately 4 to 5 knots, so the risk of lethal injury is lower than for most of the freighters transiting the area. Vessel-whale collisions at this speed are uncommon and, based on reported data contained in the US National Ocean and Atmospheric Administration database (Jensen and Silber 2003) there are only two known instances of collisions when the vessel was travelling at less than 6 knots, both of these were from whale watching vessels that were deliberately placed amongst whales.

*Potential Risks to Whale Sharks*

Whale sharks spend a significant amount of their time close to the surface of the water (DEH 2005a; Norman 1999) and are therefore vulnerable to vessel strike (DotE 2015d). There is evidence of whale sharks being hit by vessels (DEH 2005a; Norman 1999).

The survey area lies within the foraging ground BIA that has been identified along the north-west coast of Western Australia where whale sharks are likely to be present between July and November (DotE 2015d). The survey area is well outside the whale shark aggregation area near Ningaloo Reef. Outside of the aggregation periods, whale sharks are generally solitary and only low numbers are expected to be encountered in the survey area at the time the survey is operational in October and November. Due to the survey avoiding the peak humpback whale migration period from July to September; and also committing to adaptive management procedures within the survey area (see Table 5-14), the potential for interactions with whale sharks will be much reduced. In addition, given the slow speed of seismic vessel during the survey, the risk of vessel strike is considered low. In the unlikely event of vessel strike within an individual animal, it is unlikely to cause lethal injury and there would be no overall effect on the population. The slow-moving seismic survey poses a lower risk of impact than the existing shipping activity in the region.

The threats identified by the Conservation Advice of relevance to the activity assessed within this EP are boat strike from large vessels and habitat disruption from mineral exploration, production and transportation (DotE 2015d). The Conservation Management Action identified in the Conservation Advice for whale sharks (DotE 2015d) to minimise these threats is addressed in Table 5-33 with a description of how the EP aligns with the action.

**Table 5-33: Whale Shark Conservation Management Actions (DotE 2015d) and Alignment with the Davros Extension MC3D MSS EP**

| Conservation Management Action | Alignment with EP |
|---|---|
| **Boat strike from large vessels and habitat disruption from mineral exploration, production and transportation** | |
| Minimise offshore developments and transit time of large vessels in areas close to marine features likely to correlate with whale shark aggregations (Ningaloo Reef, Christmas Island and the Coral Sea) and along the northward migration route that follows the northern Western Australian coastline along the 200 m isobath. | While the survey area is outside the whale shark aggregation area near Ningaloo Reef it intersects with the whale shark foraging ground BIA along the northward migration route around the 200 m isobath that whale sharks tend to follow along the northern Western Australian coastline (Figure C). Adaptive management measures adopted for humpback whales will also benefit whale sharks because departures from Ningaloo peak around the end of July (DotE 2015d), so individuals migrating away from the aggregation site through the survey area are most likely to be present during this period during which the survey will not be operational.<br>In addition, at least one MFO will be present onboard the seismic vessel during data acquisition observing whales and whale sharks out to a distance of 3 km of the seismic/supply vessels. The risk of vessel collision during the survey is therefore low. |

*Potential Risks to Marine Turtles*

Boat strikes are a known cause of death and injury in marine turtles. Turtles are most vulnerable to boat strike when they are in shallow waters, basking at the surface or coming to the surface to breathe. In the NWMR, there are few quantitative data on mortality of turtles from boat strike, but in the East Marine Region, boat strikes account for a large number of turtle deaths largely due to collisions with fishing vessels and fast moving tourist vessels (Commonwealth of Australia, 2012b).

Marine turtles on the sea surface or in shallow coastal waters have been observed to avoid approaching vessels by typically moving away from the vessels track (Hazel et al. 2007). Hazel et al. (2007) suggests this observed avoidance behaviour is based primarily on visual cues (although these authors acknowledge that vessel noise is within range of turtle hearing) and the success of this behaviour in avoiding a vessel strike is largely dependent on the speed of the approaching vessel (rather than vessel type) and the prevailing water clarity. While the potential for vessel strikes at various speeds has not been quantified, the success of avoidance behaviour is a factor of the response time available (i.e. visual observation distance/vessel speed). Hazel et al. (2007) suggests that higher vessel speed is more likely to cause impacts particularly in shallow waters where turtles are abundant.

Turtle entrapment with some designs of streamer tail buoys can also lead to mortality (Ketos Ecology 2007, 2009). This has been an issue particularly for marine seismic surveys off the west coast of Africa. In recent years, geophysical acquisition companies and seismic contractors have been fitting “turtle guards” – modifications to the tail buoys that minimise the potential for turtle entrapment. The tail buoys are designed to skim along the surface with just a single chain extending beneath the surface. Not all tail-buoy designs engender risk of entrapment. The survey vessel to be used for surveys within the Davros Extension MC3D survey area shall either be fitted with tail buoys that do not have gaps for entrapment or fitted with turtle guards to prevent entrapment.

Increased commercial and recreational boat traffic results in increased turtle/vessel interactions and disruption to important benthic feeding and inter-nesting behaviours (Commonwealth of Australia 2017). During planning and development of the EP, the southern extent of the survey area (including 15 km buffer) was reduced by 11,174 $km^2$ to ensure that the proposed activities would not displace marine turtle species from a small portion of the 20 km buffer zones for inter-nesting habitats critical to survival and inter-nesting BIAs for green, hawksbill and loggerhead turtles around the Dampier Archipelago that were previous included in the survey area (Figure D). The only identified habitat critical to survival or BIA that remains within part of the survey area is defined for inter-nesting flatback turtles (Figure E). However, there is no

evidence that interesting flatback turtles swim out into deep offshore waters during interesting and recent research by Whitlock et al. (2016) (described in Section 3.1.3.3.2) demonstrates that habitat suitable for habitat suitable for inter-nesting flatback turtles does not occur in the survey area. It is therefore unlikely that inter-nesting flatback turtles will be encountered in the survey area. The inherent likelihood of turtle collisions in the survey area is low overall.

Although the outcome can be fatal for individual turtles, boat strike (as a standalone threat) has not been shown to cause stock level declines (Commonwealth of Australia 2017). In considering the cumulative impacts of threats on small or vulnerable stocks, it is likely to be a contributor to stock level decline (Commonwealth of Australia 2017). The Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017) considers threats to turtle stocks on an individual basis. Vessel disturbance is identified as being of “moderate risk” for all seven marine turtle species stocks with a limit of dispersal that includes the proposed survey area (Section 3.1.3.3.2). The Commonwealth of Australia (2017) recovery plan does not specify actions to address threats treated as “moderate risk”, however, the recovery plan does make reference to the Draft National Strategy for Mitigating Vessel Strike of Marine Mega-fauna (Commonwealth of Australia 2016). The EP has referred to this strategy document in undertaking this risk assessment, and in developing appropriate control measures, such as reducing the size of the survey area to reduce the likelihood of encounters with inter-nesting turtles, and in adaptive management procedures for cetaceans (Table 5-35).

#### 5.3.1.3 Inherent Risk Assessment

Collisions between the survey vessel and sensitive marine fauna may potentially occur during the survey, resulting in injury or death of impacted fauna. Fauna at highest risk of collision are those that spend considerable time in surface waters, are slow-moving and large. Such fauna that may occur in the vicinity of the operational area include whales, whale sharks and marine turtles. These fauna are mobile and would be expected to actively avoid the survey vessel, especially during data acquisition. Few encounters with large marine fauna are expected and the survey vessel will acquire data at a vessel speed of (<5 knots). However, in the event of a collision it is possible that injury or death of an individual of a protected species could occur (e.g. cetaceans, marine turtles); but with no threat at a population level or to the regional stocks (turtles). No effects at an ecosystem function level are predicted. This is a Major consequence.

Equipment entanglement leading to injury of marine fauna, and behavioural disturbance / displacement of marine fauna could cause minor disruption and temporary effects (days) on individual protected cetaceans, whale sharks or turtles, however no effects on critical behavioural processes (e.g. inter-nesting, migration) are expected, and no threats at a population level or to regional turtle stocks. This is a Minor consequence.

Given the survey area is not considered a habitat that is critical to the survival of any listed species and the survey area has been reduced in size in the southern extent to further reduce the likelihood of encounters with inter-nesting turtles and humpback whales, the likelihood of these impacts is Possible. The inherent risk is High.

#### 5.3.1.4 Control Measures

Table 5-34 presents the control measures that CGG will implement during the Davros Extension MC3D MSS to manage any potential impacts associated with vessel collision / equipment entanglement with marine fauna.

**Table 5-34: Control Measures for Vessel Collision / Equipment Entanglement with Marine Fauna**

| Control Measures | |
|---|---|
| Good Practice | The interaction of support vessels and the seismic vessel (when not towing equipment) with cetaceans during the survey will be managed consistently with the Part 8 of the EPBC Regulations (2000):<br>survey vessel will not travel at greater than 6 knots within 300 m of a cetacean (caution zone)<br>survey vessel will not approach closer than 50 m for a dolphin and/or 100 m for a whale (with the exception of animals bow riding). |
| | Soft start procedures will be conducted prior to acquisition commencing. This will encourage noise sensitive marine fauna to move away from the vessel, reducing the likelihood of collision or entanglement. |
| | MFO to maintain watch for marine fauna during the day when the seismic source is active, with observed fauna to be avoided if possible. |
| | Use of streamer tail buoys fitted with appropriate turtle guards. |
| | Buoys and automatic recovery devices attached to streamer to facilitate recovery in the event of loss. |
| | Support vessel available to assist with recovery of lost streamers. |
| | Slow speed of vessel during seismic acquisition (4 to 5 knots) will reduce collision risk |
| | Application of CGG's Contingency Procedure for Marine Animal Event - Standard Operating Procedure (MAR HSE PRC 014E). |
| | All vessel crew are inducted in their responsibilities as required regarding marine fauna interactions. |
| | All entangled marine fauna recovered to the vessel will be returned to the sea as quickly as practicable. |
| | All vessel strike incidents are reported in the National Ship Strike Database at https://data.marinemammals.gov.au/report/ship strike. |

### 5.3.1.5 Demonstration of ALARP and Risk Acceptability

#### 5.3.1.5.1 Summary of ALARP Demonstration

CGG is committed to ensuring continual risk reduction and identifying if additional control measures may be applied that are not disproportionate to the sacrifice (e.g. cost) of implementation. The additional control measures that have been considered are listed in Table 5-35. Where the cost of implementing the additional control measures is disproportionate to the benefit gained, they have not been adopted. CGG has applied a precautionary approach in managing potential encounters with humpback whales by committing to carrying out the seismic survey outside the peak period for whale migration (i.e. outside of the months of July to September).

CGG has taken a further precautionary approach to the impact assessment for humpback whales in addition to no seismic activity during the peak migration months of July and September, and will implement additional controls in the area defined as the humpback whale adaptive management zone (Figure 5-20). Adaptive management procedures will include in the event that three or more whale sightings within the power-down/shut-down zone occur within the preceding 24 hours (including times when the acoustic source is shut-down and/or powered down), the survey vessel will relocate >12 km from the northern edge of the humpback whale adaptive management zone, if the survey vessel cannot relocate, pre-start up visual observation will be increased to 45 minutes and the low power zone will be increased to 3 km horizontal radius from the acoustic source. Further, the vessel will relocate to a distance >12 km after a single shutdown, if greater than 20 whales in observation zone during the pre-start observation, but not close enough to prevent soft-start commencing (i.e. in observation zone, but outside low power zone).

Previously the survey area overlapped a small area of the BIAs for inter-nesting buffers for green, hawksbill and loggerhead turtles around the Dampier Archipelago, as well as habitat defined as critical to survival of these species in the area (Figure D). The southern extent of both the survey and operational areas has been reduced during the ALARP assessment by 11,174 $km^2$ to ensure that the proposed activities would not displace inter-nesting green, hawksbill and loggerhead turtles in the Dampier Archipelago.

CGG considers the adopted controls to be appropriate in reducing the environmental impacts associated with vessel collision / equipment entanglement with marine fauna to ALARP. There are no other controls measures that may practicably or feasibly be adopted to reduce the risks and impacts further without disproportionate costs compared to the benefit of the potential risk reduction.

**Table 5-35: Demonstration of ALARP for Vessel Collision / Equipment Entanglement with Marine Fauna**

| Additional Control Measures | Practicability / Effectiveness? | Cost Benefit Analysis | Risk Reduction (L/C/RR ↓)? | Control Adopted |
|---|---|---|---|---|
| **ERA / Precautionary Approach** | | | | |
| The seismic survey will not operate during the months of July to September. | P: Yes<br>E: Very Effective (++) | Limiting the Davros Extension MC3D survey operations to the months of October to June will avoid the peak period (July to September) for migrating humpback whales, and much of the whale shark migration period. | Yes | Yes |
| An Adaptive Management Zone will be implemented for humpback whales (Figure 5-20). | P: Yes<br>E: Very effective (++) | CGG recognises the importance of the BIA for humpback whales and that there is the potential for significant numbers of animals to be present immediately prior to and after the known peak periods for the northern and southern migrations. Introducing adaptive management for this zone whereby in the event of 3 shut-downs the seismic vessel will move >12 km (i.e. behavioural disturbance impact range) to the north of the boundary of the zone, will provide additional protection for these 'early' or 'late' migrating animals, and will engender limited cost/time loss for CGG. This will also offer benefits to avoiding whale sharks. Benefit outweighs cost. | Yes | Yes |
| Relocate vessel >12 km after a shutdown, if greater than 20 whales in observation zone during the pre-start observation, but not close enough to prevent soft start commencing (i.e. outside low power zone). | P: Yes<br>E: Effective (+) | A large number of whales in the observation zone could indicate that the vessel is heading into a migrating pod. Vessel can relocate prior to shutdowns being triggered to avoid disturbance to the whales. Minor cost implication as shutdowns and relocation likely anyway.<br>Potential environmental benefit to be gained outweighs costs associated with implementation. | Yes | Yes |
| In the event of three or more whale or whale shark sightings within the power-down/shut-down zone occur within the preceding 24 hours (including times when the acoustic source is shut-down and/or powered down), the following adaptive management procedures will be implemented:<br>■ Relocation – seismic vessel will relocate to another survey line >12 km from northern boundary of the humpback whale adaptive management zone and will not return | | CGG recognises that humpback whales may be present within the survey area within the 'shoulder' months of migration (June and October). Implementing the additional mitigation procedure of moving >12 km from the northern boundary of the adaptive management zone will ensure the seismic vessel has moved to a location where received levels from the array are reduce to below levels that may cause likely avoidance. This will provide additional protection in the event that low densities of migrating humpback whales are encountered moving through the survey area. Benefit outweighs cost. | Yes | Yes |

| Additional Control Measures | Practicability / Effectiveness? | Cost Benefit Analysis | Risk Reduction (L/C/RR ↓)? | Control Adopted |
|---|---|---|---|---|
| within 24 hours; or<br>■ If the vessel cannot relocate - pre-start up visual observation will be increased to 45 minutes and the low power zone will be increased to 3 km horizontal radius from the acoustic source. | | | | |
| Reduction in size of the southern extent of the survey area to protect inter-nesting turtles. | P: Yes<br>E: Very Effective (++) | Previously the survey area overlapped a small area of the BIAs for inter-nesting buffers for green, hawksbill and loggerhead turtles around the Dampier Archipelago, as well as habitat defined as critical to survival of these species in the area (Figure D). The southern extent of both the survey and operational areas has been reduced during the ALARP assessment by 11,174 $km^2$ to ensure that the proposed activities would not displace inter-nesting green, hawksbill and loggerhead turtles in the Dampier Archipelago | Yes | Yes |
| Reduce number of vessels in the field by not using support vessels | P: No – support vessels are a safety requirement<br>E: Effective (+) | Reducing vessels used increases safety risk and reduces ability to manage stakeholder interactions; these potential risks are higher than the benefits gained by implementing this control measure. | No | No |
| Remove streamers from water when not in use | P: No – operationally this would be very difficult, and would take considerable time.<br>E: Not effective (-) (minimal reduction in likelihood of equipment loss) | It would increase health and safety risks and would prolong the overall individual activity time. Minimal reduction in risk of equipment loss/entanglement. Costs disproportionately higher than benefits. | No | No |
| No night-time operations | P: No<br>E: Ineffective (-) | Limiting seismic activities to daylight hours only would significantly extend the time required to acquire data for individual activities. This would at least double the survey time and, therefore, increase the likelihood of interactions with diurnal fauna, the overall duration of seismic impacts, and interaction with commercial fisheries. Costs disproportionately higher than benefits. | Minimal environmental benefit from avoiding night-time operations. | No |

#### 5.3.1.5.2 Residual Risk

The consequence of vessel collision with marine fauna (cetaceans, whale sharks, turtles) and the resultant injury or death of an individual remains Major.

The consequence of injury of marine fauna due to equipment entanglement and/or behavioural disturbance leading to displacement of marine fauna is reduced to Minor.

With the implementation of the control measures described in Table 5-26 and additional controls adopted from the ALARP assessment in Table 5-27, the potential for vessel collision and/or equipment entanglement with marine fauna during the activity is reduced. The likelihood of these impacts during the survey is therefore reduced to Rare. The residual risk is therefore **Medium**.

#### 5.3.1.5.3 Acceptability

The residual impact of vessel collision / equipment entanglement with marine fauna complies with CGG's internal context (medium risk with additional controls adopted), will be managed in accordance with relevant legislative requirements and complies with industry good practice and the principles of ESD.

Any concerns raised by stakeholders have been assessed and control measures adopted where appropriate. The impact assessment has determined that, with the implementation of the adopted control measures, routine operational discharges will not result in a measurable impact to the well-mixed marine waters of the Davros Extension MC3D survey area. In addition, a precautionary approach has been applied in regard to precluding routine discharges over the shallow areas on Glomar Shoal and Rankin Bank, and within the Montebello and Dampier Marine Parks.

Complete elimination of the risk is not possible as there is no practical alternative to the use of vessels which allow CGG to undertake the activity. The risk assessment has determined that, with the implementation of the adopted control measures, vessel collision and/or equipment entanglement with marine fauna will not result in a potential risk greater than minor and temporary disruption to a small proportion (individuals) of large marine fauna populations, and no risk on their critical activities. Behavioural disturbance effects are expected to cease once the survey vessel has left the immediate area. The ALARP assessment demonstrates that the adopted controls (Table 5-34 and Table 5-35) are appropriate to reduce the impact to ALARP without the further impact reduction being required. Conservation Management Actions identified in the Management Plans and Conservation Advice for protected species (humpback and pygmy blue whales, whale sharks) to minimise vessel collisions are aligned with the control measures adopted in this EP for the survey (Table 5-31, Table 5-32, Table 5-33).

Given the nature and scale of the activity, CGG consider that the potential impacts are of an acceptable level as the predicted impacts are within and below the defined acceptable levels of impact in accordance with the criteria defined in Table 4-4.

### 5.3.1.6 Environmental Performance Outcomes, Standards and Measurement Criteria

The environmental performance outcomes, standards and measurement criteria appropriate to measure performance of the adopted control measures for vessel collision / equipment entanglement with marine fauna are presented below in Table 5-36. Environmental performance standards and relevant measurement criteria have been developed for each control measure identified in Table 5-34 and each additional control adopted from the ALARP assessment in Table 5-35.

**Table 5-36: Environmental Performance Outcomes, Standards and Measurement Criteria for Vessel Collision / Equipment Entanglement with Marine Fauna**

| Environmental Performance Outcome | Environmental Performance Standard | Measurement Criteria |
|---|---|---|
| No injury or death of marine fauna due to a vessel strike or entanglement with seismic streamers | When streamer not deployed: the interaction of seismic and support vessels with cetaceans during the survey will be managed consistently with the Part 8 of the EPBC Regulations (2000):<br>■ seismic survey and support vessels will not travel at greater than 6 knots within 300 m of a cetacean (caution zone)<br>■ seismic survey and support vessels will not approach closer than 50 m for a dolphin and/or 100 m for a whale (with the exception of animals bow riding). | MFOs reports document appropriate responses to whale and dolphin interactions. |
| | | No records of breaches of Part 8 of the EPBC Regulations (2000) documented. |
| | | Crew induction includes requirements for implementing the guidelines |
| | When streamer deployed, the seismic vessel will comply with EPBC Policy Statement 2.1 (Part A) to reduce the potential for marine fauna interactions, including the implementation of soft starts to encourage all large noise sensitive marine fauna (i.e. cetaceans, whale sharks, turtles) to move areaway from the vessel. | MFO records confirm compliance with EPBC Policy Statement 2.1 (Part A), including implementation of soft starts prior to acquisition commencing. |
| | Use of streamer tail buoys fitted with appropriate turtle guards. | Inspection of tail and head buoys during survey and prior to use records presence of turtle guard. |
| | Buoys and automatic recovery devices attached to streamer to facilitate recovery in the event of loss. | Pre-start inspection shows evidence that buoys and automatic recovery devices are attached to streamer |
| | Support vessel available to assist with recovery of lost streamers. | Incident report for lost equipment documents assistance provided by support vessel to retrieve lost streamers. |
| | One trained MFO will be stationed on an elevated platform and observing during all seismic survey activities conducted in daylight hours during data acquisition. | CV for MFO demonstrates competency.<br>Compliance and cetacean sightings and interactions reports will be completed and provided to NOPSEMA / DoEE within 3 months of completion of the survey. |
| | Seismic survey vessel will not travel at greater than 4-5 knots during seismic acquisition. | Vessel log confirms vessel speed did not exceed 5 knots during acquisition. |
| | Seismic and support vessels crews are inducted in their responsibilities as required regarding marine fauna interactions. | Records show that the seismic and support vessel crew inductions includes responsibilities regarding marine fauna interactions |
| | All vessel strike incidents are reported in the National Ship Strike Database at https://data.marinemammals.gov.au/report/ship strike | MFO report confirms that all vessel strike incidents are reported in the National Ship Strike Database. |
| | All known or suspected threatened fauna injuries or death will be reported to the DoEE within 2 hours of the incident. | Incident report verifies contact was made or attempted to DoEE within 2 hours of the incident. |
| | All entangled marine fauna recovered to the seismic or support vessels will be returned to the sea as quickly as practicable. | MFO report confirms that any marine life recovered with wet equipment was recorded and then quickly returned to the ocean. |
| | The seismic survey will not operate during the months from beginning of July to end of September. | MFO report and vessel log confirms no survey activities conducted between the beginning of July and the end of September. |

| Environmental Performance Outcome | Environmental Performance Standard | Measurement Criteria |
|---|---|---|
| | Adaptive Management:<br>In the event of three or more whale or whale shark sightings within the power-down/shut-down zone occur within the preceding 24 hours (including times when the acoustic source is shut-down and/or powered down), the following adaptive management procedures will be implemented:<br>■ Relocation – seismic vessel will relocate to another survey line >12 km from northern boundary of the humpback whale adaptive management zone and will not return within 24 hours; or<br>■ If the vessel cannot relocate - pre-start up visual observation will be increased to 45 minutes and the low power zone will be increased to 3 km horizontal radius from the acoustic source. | MFO report verifies implementation of procedures |
| | Adaptive Management:<br>Relocate vessel >12 km after a shutdown, if greater than 20 whales in observation zone during the pre-start observation, but not close enough to prevent soft start commencing (i.e. outside low power zone). | MFO report verifies implementation of procedures |
| | Adaptive Management:<br>Reduction in size of the southern extent of the survey area to protect inter-nesting turtles. | Survey area extent is as described within this EP. |

### 5.3.2 Risk 2 - Seabed Disturbance due to Loss of Equipment and/or Emergency Anchoring

#### 5.3.2.1 Description of Hazard

Under normal operations, no anchoring will be undertaken by the seismic and support vessels within the survey area. Unplanned anchoring could occur in the event of an emergency, in order to maintain the safety of the vessel and crew. Anchoring may result in localised disturbance to the benthic environment in contact with the anchor and anchor chain. The extent of disturbance will depend on the nature of the seabed and the area disturbed.

During normal operations, the survey vessel will tow eight to 12 seismic streamers with a maximum length of 8,100 m, at approximately 8 to 9 km/h. Should a seismic streamer become detached from the survey vessel or drag on the seabed it has the potential to cause minor physical damage to benthic habitats. In addition, non-hazardous and hazardous solid wastes (i.e. dropped objects) may be released by accidentally dropping objects overboard (e.g. tools, streamer depth controllers) due to human error, equipment failure or adverse weather.

Vessel grounding is a very uncommon occurrence in the offshore oil and gas industry in Australia and in general the risk of grounding is very small. In general the application of recognised good practice is considered appropriate to manage the risks, and CGG has developed standard operating procedures for both safe navigation and close approach to shallow water areas. Anchoring or streamer dragging may impact marine archaeological resources; however, there are no known historical wrecks in the vicinity of the survey area, and streamers are to be maintained at least 10 m above the seabed to minimise risk of dragging - therefore this is not considered a credible risk.

The risks relating to seabed disturbance from equipment loss / emergency anchoring are relatively well understood. In addition, site-specific survey data for sediment characteristics and benthic habitats over the Glomar Shoal and Rankin Bank areas provide a good baseline against which to assess potential risks from accidental events. In general the application of recognised good practice is considered appropriate to manage the risks. However, the assessment has also specifically considered the site-specific nature and scale of the risk on sensitive receptors such as Glomar Shoal KEF and Rankin Bank.

No specific stakeholder concerns have been raised regarding seabed disturbance from equipment loss / emergency anchoring.

#### 5.3.2.2 Description of Potential Impacts to Environmental Values

The known and potential impacts and risks from the disturbance to benthic habitat from loss of equipment, dropped objects or anchoring are localised disturbance to/loss of benthic habitats and associated biota.

Dragging of streamers along the seabed may occur in the event that a streamer becomes damaged and sinks to the sea floor while the vessel is in motion. Dragging of the streamer may result in localised physical disturbance of substrates, benthic habitats and communities, however, given that the minimum water depth across the Davros Extension MC3D survey area is 19 m over Rankin Bank and 22 m over Glomar Shoal, and the absence of any emergent features, the risk of medium to long-term effects are unlikely.

CGG's standard operating procedures 'Safe Navigation Area (MAR_SEO_PRC_004E)' and 'Close Approach of a Natural Obstacle (MAR_SEO_PRC_010E)', specifically address the risk of streamers being towed over shallow water environments, with a minimum clearance requirement of 10 m between the sea floor and the deepest point on the streamer, lead-ins or airgun source. Furthermore, seismic streamers are fitted with pressure-activated, self-inflating buoys that are designed to bring the equipment to the surface if lost accidentally. As the equipment sinks, it passes a certain water depth at which point the buoys inflate and bring the equipment back to the surface. Once at the surface the survey or support vessel will recover the streamer.

#### 5.3.2.3 Inherent Risk Assessment

Section 3.1 describes the marine habitats and communities in the survey area, particularly over Glomar Shoal KEF and Rankin Bank. None of the benthic habitats in the area are particularly susceptible to physical disturbance. In the event of loss of a seismic streamer / unplanned anchoring, potential environmental effects will be limited to physical disturbance of substrates, benthic habitats and communities in a localised area (i.e. immediate footprint of the disturbance), with only short-term effects on communities in the disturbance footprint and no effects on ecosystem function This is a Minor consequence.

Given In the event of loss of equipment or emergency anchoring, the likelihood of this impact is Unlikely. The inherent risk is Low.

#### 5.3.2.4 Control Measures

Table 5-37 presents the control measures that CGG during the Davros Extension MC3D MSS to manage any potential impacts associated with disturbance to benthic habitat from loss of equipment, dropped objects or anchoring.

**Table 5-37: Control Measures for Seabed Disturbance**

| Control Measures | |
|---|---|
| Good Practice | The survey vessel will adhere to the requirements of CGG's standard operating procedures Safe Navigation Area (MAR_SEO_PRC_004E) and Close Approach of a Natural Obstacle (MAR_SEO_PRC_010E). |
| | Operational procedures will be in place on board the seismic vessel for deployment and retrieval of towed equipment on board, to reduce potential for steamer loss |

| Control Measures | |
|---|---|
| | Streamers equipped with streamer recovery devices (SRDs) and buoys designed to bring the equipment to the surface if lost accidentally and facilitate recovery. |
| | Any lost equipment will be recovered where safe and practicable to do so. |
| | Vessel to be operated by suitably qualified and experienced crew |
| | Encounters with marine archaeological resources / wrecks are recorded and reported to the WA Maritime Museum in accordance with the *Historic Shipwrecks Act 1976*. |

### 5.3.2.5 Demonstration of ALARP and Risk Acceptability

#### 5.3.2.5.1 Summary of ALARP Demonstration

CGG is committed to ensuring continual risk reduction and identifying if additional control measures may be applied that are not disproportionate to the sacrifice (e.g. cost) of implementation (Table 5-38). An additional control of limiting emergency anchoring to areas deeper than 40 m on Glomar Shoal and Rankin Bank, where possible, has been considered and adopted as this will further reduce the risks to ALARP. CGG considers the adopted controls to be appropriate in reducing the environmental risks associated with seabed disturbance due to loss of equipment, dropped objects and/or emergency anchoring to ALARP. There are no other controls measures that may practicably or feasibly be adopted to reduce the risks and impacts further without disproportionate costs compared to the benefit of the potential risk reduction.

**Table 5-38: Demonstration of ALARP for Seabed Disturbance**

| Additional Control Measures | Practicability / Effectiveness? | Cost Benefit Analysis | Risk Reduction (L/C/RR ↓)? | Control Adopted |
|---|---|---|---|---|
| **ERA** | | | | |
| In the event of emergency anchoring all measures will be taken to avoid Glomar Shoal and Rankin Bank shallow areas of <40 m water depth, without compromising vessel or personnel safety | P: Yes<br>E: Very effective (++) | Costs associated with this control are outweighed by the benefits | Yes | Yes |

#### 5.3.2.5.2 Residual Risk

The consequence of localised disturbance to and/or loss of benthic habitats and associated biota during the survey remains Minor.

With the implementation of the control measures described in Table 5-26 and additional controls adopted from the ALARP assessment in Table 5-27, the potential for streamers to drag on the seabed and/or anchoring over sensitive benthic habitats (Glomar Shoal, Rankin Bank) and causing disturbance to benthic habitat is reduced. The likelihood of this impact during the survey is reduced to Rare. The residual risk is therefore **Low**.

#### 5.3.2.5.3 Acceptability

The residual impact of seabed disturbance due to loss of equipment and/or emergency anchoring complies with CGG's internal context (low risk), will be managed in accordance with relevant legislative requirements and complies with industry good practice and the principles of ESD.

Any concerns raised by stakeholders have been assessed and control measures adopted where appropriate. Complete elimination of the risk is not possible as there is no practical alternative to the use of vessels which allow CGG to undertake the activity. The risk assessment has determined that, with the implementation of the adopted control measures, disturbance to benthic habitat from loss of equipment, dropped objects or anchoring will not result in a potential impact greater than minor and temporary disruption to a small area within the direct footprint of the disturbance. Due to the absence of areas of sensitive habitats susceptible to long-term effects, recovery of any areas disturbed on Glomar Shoal or on Rankin Bank is expected with no medium to long-term effects on diversity. The ALARP assessment demonstrates that the adopted controls (Table 5-37 and Table 5-38) are appropriate to reduce the impact to ALARP without the further impact reduction being required.

Given the nature and scale of the activity, CGG consider that the potential impacts are of an acceptable level as the predicted impacts are within and below the defined acceptable levels of impact in accordance with the criteria defined in Table 4-4.

#### 5.3.2.6 Environmental Performance Outcomes, Standards and Measurement Criteria

The environmental performance outcomes, standards and measurement criteria appropriate to measure performance of the adopted control measures for seabed disturbance due to loss of equipment and/or emergency anchoring are presented below in Table 5-39. Environmental performance standards and relevant measurement criteria have been developed for each control measure identified in Table 5-37 and additional control adopted from the ALARP assessment in Table 5-38.

**Table 5-39: Environmental Performance Outcomes, Standards and Measurement Criteria for Seabed Disturbance**

| Environmental Performance Outcome | Environmental Performance Standard | Measurement Criteria |
|---|---|---|
| No loss or disturbance to benthic habitats due loss of equipment or emergency anchoring | The survey vessel will adhere to the requirements of CGG's standard operating procedures Safe Navigation Area (MAR_SEO_PRC_004E) and Close Approach of a Natural Obstacle (MAR_SEO_PRC_010E) when passing over the shallow waters of Glomar Shoal and Rankin Bank. | Vessel log demonstrates application of CGG's Safe Navigation Area and Close Approach of a Natural Obstacle over the shallow waters of Glomar Shoal and Rankin Bank. |
| | Operational procedures will be in place on board the seismic vessel for deployment and retrieval of towed equipment on board | Vessel inspections show evidence of implementing CGG procedure for streamer retrieval and recovery |
| | No planned anchoring during the survey unless in the event of an emergency. | Vessel log indicates vessel did not anchor in the survey area. |
| | | Vessel crew induction includes procedures for emergency anchoring. |
| | No seismic acquisition will occur in water <30 m depth | Vessel log indicates seismic vessel did not operate in water depths of <30 m. |
| | No survey vessel shall enter the 250 m buffer zones around the fish protection areas (FPAs) on Glomar Shoal and Rankin Bank. | Vessel logs indicate that no vessels entered the 250 m buffer zones around the FPAs over Glomar Shoal and Rankin Bank. |
| | Streamers equipped with Streamer Recovery Device (SRDs) designed to bring the equipment to the surface if lost accidentally. | Records demonstrate that streamers are equipped with SRDs set to auto-inflate at less than actual water depth. |

| Environmental Performance Outcome | Environmental Performance Standard | Measurement Criteria |
|---|---|---|
| | Streamers not to be closer than 10m from the seabed at all time, as per the CGG Standard Operating Procedure (SOP) – Close Approach Of a Natural Obstacle document (MAR SEO PRC 010E). | Data from survey show the tow depth was at least 10 m above the seabed. |
| | Lost streamer recovery procedure (including shallow water recovery e.g. by grappling) carried on board survey vessel. | On board inspection shows lost streamer recovery procedure includes shallow water recovery without SRD. |
| | Any lost equipment will be recovered where safe and practicable to do so. | Records of streamer loss will be documented |
| | | Records show equipment lost to the marine environment and attempts to recover lost towed equipment |
| | In the event of emergency anchoring all measures will be taken to avoid Glomar Shoal and Rankin Bank shallow areas of <40 m water depth | Record of emergency anchoring on Glomar Shoal and Rankin Bank documents attempt to avoid water <40 m deep. |
| No loss or disturbance to benthic habitats due dropped objects | All large, bulky items are securely fastened for the voyage intended to prevent loss at sea. | Pre-departure deck inspection indicates bulky goods are securely sea-fastened and checked on a regular basis. |
| No loss or disturbance to benthic habitats due vessel grounding | Vessel to be equipped with modern navigational equipment with redundancy (i.e. GPS and gyrocompass) and radar system capable of detecting vessels and above water hazards. | Inspection during activity confirms that vessel is equipped with modern positioning and radar equipment and bridge crew are familiar with the use of the equipment. |
| | | Vessel induction to include awareness of whether depth sounder readings are in “depth below water surface” or “depth below sounder transducer”. If the latter, the bridge crew must also be aware of the depth of the transducer below water level and relative to the vessel draft in order to know the current depth of water beneath the keel (i.e. sea bed clearance |
| | Implement procedures to minimise possibility of grounding. | Vessel Emergency Response Plan (ERP) records kept to include nature of emergency, training of crew in vessel’s anchor deployment/ retrieval procedures and implementation of these procedures. |
| | Vessel operated and bridge manned with adequate watch by suitably qualified crew at all times. | Inspections of crew training qualifications to confirm all crew have the required maritime qualifications. |
| | The seismic vessel will have two independent propulsion systems for redundancy in the event of propulsion failure. | Inspection of vessel specification to confirm two independent propulsion systems. |
| No loss or disturbance to shipwrecks | Encounters with unrecorded marine archaeological resources/wrecks will be recorded and reported in accordance with the *Historic Shipwrecks Act 1976* to the WA Maritime Museum. | Vessel logs confirm unrecorded marine archaeological resources/wrecks have been reported in accordance with the *Historic Shipwrecks Act 1976*. |

### 5.3.3 Risk 3 - Introduction and Establishment of Invasive Marine Species

#### 5.3.3.1 Description of Hazard

The Convention on Biological Diversity (1992) defines a non-native species as "a species introduced outside its natural past or present distribution; includes any part, gametes, seeds, eggs, or propagules of such species that might survive and subsequently reproduce". Non-native species are known from all parts of the world and have been transported by several different anthropogenic means (Carlton and Geller 1993). Australia has over 250 Invasive Marine Species (IMS) and although most do not cause a problem, some may become aggressive pests with detrimental effects on biodiversity and ecology (www.marinepests.gov.au).

The following activities have the potential to lead to the introduction and transfer of IMS during a marine seismic survey:

- discharge of ballast water from the seismic survey vessel
- biofouling on vessel hulls and other external niches (e.g. propulsion units, steering gear and thruster tunnels)
- biofouling of vessel internal niches (e.g. sea chests, strainers, seawater pipe work, anchor cable lockers and bilge spaces)
- marine biofouling of in water equipment (e.g. streamers, tail buoys).

The potential biofouling risk posed by a vessel relates to its history prior to entering the survey area. The main risk factors for marine biofouling are:

- time spent in foreign ports, especially those with known IMS infestations
- transit from similar bioregion
- suitability of survey area habitats for IMS establishment
- time since hull cleaning
- condition and age of anti-fouling
- type of ballast water.

The risks and potential impacts of the introduction and establishment of IMS during seismic surveys are well understood with legislative requirements and industry agreed good practices to manage risks. The application of recognised good practice is generally considered appropriate to manage the risk.

During the stakeholder consultation for the survey, DoF (now DPIRD) raised specific concerns regarding biosecurity and IMS management (Section 8). CGG recognises the department's concerns and has incorporated stringent, industry-standard, control measures to minimise the possibility of introducing IMS.

#### 5.3.3.2 Description of Potential Impacts to Environmental Values

Ballast water exchanges have been implicated in the introduction of marine pest species (DAWR 2016), with sixty marine species becoming established in Western Australia. Although most are temperate species that occur south of Geraldton, six tropical species have become established north of Shark Bay (Wells et al. 2009), for example, *Styela plicata*, a solitary ascidian and marine pest has become established at the Montebello Islands.

In the unlikely event that a species is introduced and it survives in the new environment, it has the potential to colonise a new region and establish a new population. Over time the population may increase and the species become established in the area. This can cause a range of ecological effects, including increased competition with native species. However, the probability of successful establishment of IMS is dependent on a number of factors including survival of the propagules during their transfer to the area, the suitability of the environmental conditions at the recipient site (water temperature, salinity, depth, habitat types, competitors, and predators), the survival of the propagules to reproductive state and the continued success of the introduced population.

#### 5.3.3.3 Inherent Risk Assessment

If established, IMS can compete with native species, modify habitats and can threaten endemic diversity and abundance. This can be of particular concern in areas such as Rankin Bank and Glomar Shoal KEF, the latter which is designated as a KEF for its high levels of biodiversity. The DoEE has identified the risk of IMS (from shipping, fishing vessels, other vessels, land-based activities) as of "potential concern" to the environmental values of the Glomar Shoal KEF. This is therefore a Moderate consequence.

Given the sensitivity of Glomar Shoal and the protection of the wider shoal as a KEF, the likelihood of this impact is Possible. As such, the inherent risk is Medium.

#### 5.3.3.4 Control Measures

The Commonwealth Department of Agriculture and Water Resources (DAWR) is the lead agency for management of ballast water and sediments on international vessels and administers the mandatory Australian Ballast Water Management Requirements (DAWR 2016) under the *Biosecurity Act 2015*. For the petroleum industry, it regulates the condition of vessels and drill rigs entering Australian waters with regard to ballast water and hull fouling. The regulations stipulate that all information regarding the voyage of the vessel and the ballast water is declared correctly to the biosecurity officers.

Under these arrangements, all vessels that have travelled from international waters are obliged to assess and manage their ballast water in accordance with the DAWR requirements. These arrangements prohibit the discharge of high-risk ballast water within Australian territorial seas (within 12 NM of Australian territories) including Australian ports. It is also recommended by DAWR that ballast exchanges be conducted as far as possible away from shore and in water at least 200 m deep.

It is likely that the vessel to be used during the survey will already be operating in Australian waters and pose a lower risk of IMS transfer. CGG will undertake a biofouling risk assessment of the vessel and equipment to determine whether the vessel should be either cleaned (hull, niches, workboat and equipment), or can be cleared as a low risk of introducing marine pest species. The risk assessment will follow the recommended approach of the National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Commonwealth of Australia 2009). The risk assessment will be conducted prior to vessel entry into Australian waters, or mobilisation to the survey area if the vessel is sourced from within Australian waters. If the risk assessment indicates an unacceptable risk of introducing marine species, CGG will require an inspection and clearance to be conducted.

Submersible equipment (i.e. wet equipment) will be cleaned and maintained regularly and will undergo routine inspection prior to, and during, the activity (if recovered during the survey). Submersible equipment that has been dry for more than three days will be considered low risk as attached organisms will die through desiccation and exposure. Any biofouling observed during the survey that could be considered a potential IMS will be reported to the DAWR and treated in accordance with DAWR instructions (e.g. killed with a biocide).

Table 5-40 presents the control measures that CGG during the Davros Extension MC3D MSS to manage any potential impacts associated with the introduction and establishment of IMS.

**Table 5-40: Control Measures for the Introduction and Establishment of Invasive Marine Species**

| Control Measures | |
|---|---|
| Good Practice | No planned ballast water exchanges, but if required, ballast water exchange will occur >12 NM from land<br>No discharge of ballast water from survey and support vessels within 12 NM of land without prior authorisation from the DAWR.<br>Ballast water discharges recorded as >12 NM from land in Ballast Water Management Summary Sheet.<br>Adherence to Australian Ballast Water Management Requirements (DAWR 2016) under the *Biosecurity Act 2015*. |
| | Adherence with National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Commonwealth of Australia 2009):<br>■ Biofouling Record Book kept outlining marine fouling management actions<br>■ Biofouling risk assessment shows low risk of IMS presence prior to entry into Australian waters<br>■ Recent hull inspections (if required based on biofouling risk assessment)<br>■ Survey vessel has a certified anti-fouling coating on the hull and coating is in sound condition. |
| | Routine cleaning and inspection of all wet equipment (e.g. airgun array, streamer, workboats), consistent with the requirements of the National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Commonwealth of Australia 2009). |

### 5.3.3.5 Demonstration of ALARP and Risk Acceptability

#### 5.3.3.5.1 Summary of ALARP Demonstration

CGG is committed to ensuring continual risk reduction and identifying additional control measures where they can further reduce risks to ALARP (Table 5-38). Where the cost of implementing the additional control measures is disproportionate to the benefit gained, they have not been adopted. CGG has applied a precautionary approach for Glomar Shoal and Rankin Bank through adoption of an additional control to preclude ballast water discharge/exchange within the 40 m depth contour of Glomar Shoal and Rankin Bank. As discussed in Section 5.2.5.2, transitional management arrangements were previously in place for the Montebello Marine Park. These transitional arrangements previously only allowed continuous commercial vessel transit therefore precluding any other activity including ballast water exchange and discharge. The publication of the Draft North-west Commonwealth Marine Reserves Network Management Plan on 21 July 2017 now specifically allows activities including ballast water discharge and exchange within all zones except Sanctuary Zones (Director of National Parks 2017). Despite the absence of any shallow water benthic habitats, in the Montebello Marine Park multiple use zone, CGG will apply a precautionary approach in managing ballast water exchange and discharge during the Davros Extension MC3D MSS, by precluding routine discharges within the boundaries of the Montebello Marine Park.

CGG considers the adopted controls to be appropriate in reducing the environmental risks and impacts associated with the introduction and establishment of IMS to ALARP. There are no other controls measures that may practicably or feasibly be adopted to reduce the risks and impacts further without disproportionate costs compared to the benefit of risk reduction.

**Table 5-41: Demonstration of ALARP for the Introduction and Establishment of Invasive Marine Species**

| Additional Control Measures | Practicability / Effectiveness? | Cost Benefit Analysis | Risk Reduction (L/C/RR↓)? | Control Adopted |
|---|---|---|---|---|
| **Precautionary Approach** | | | | |
| Use of freshwater ballast on board the survey vessel to inhibit survival of marine species. | P: No – would require vessel engineering redesign, or limit vessel contracting options.<br>E: Effective (+) | Costs associated with this measure are high, and disproportionate to the benefit. | Yes | No |
| No discharge of ballast water within 40 m depth contour of Glomar Shoal and Rankin Bank | P: Yes – would be practicable to achieve with some small pre-planning<br>E: Effective (+) | Costs associated with this measure are low, with additional benefit to protecting important fish habitats at Glomar Shoal and Rankin Bank; benefits outweigh cost. | Yes | Yes |
| No discharge of ballast water within the Montebello Marine Park | P: Yes<br>E: Effective (+) | This control aligns with the transitional management arrangements under the EPBC Act which only allows commercial vessel transit through Marine Park as *"being continuous passage of a vessel through an area by the shortest direct route without any other activity being carried on"* (Director of National Parks 2013b). Minor cost involved in not discharging ballast within these Marine Park to meet transitional management requirements; benefits outweigh costs. | Yes | Yes |

#### 5.3.3.5.2 Residual Risk

The consequence of the introduction and establishment of IMS in the survey area remains Moderate.

With the implementation of the control measures described in Table 5-40 and additional controls adopted from the ALARP assessment in Table 5-41, the potential for the seismic vessel carry IMS in ballast or on its hull is much reduced. The likelihood of this impact during the survey is reduced to Rare. The residual risk therefore **Low**.

#### 5.3.3.5.3 Acceptability

The residual impact of the introduction and establishment of IMS complies with CGG's internal context (low risk), will be managed in accordance with relevant legislative requirements and complies with industry good practice and the principles of ESD.

Any concerns raised by stakeholders have been assessed and control measures adopted where appropriate. Complete elimination of the risk is not possible as there is no practical alternative to the use of vessels which allow CGG to undertake the activity. The risk assessment has determined that, with the implementation of the adopted control measures, the presence of the seismic and support vessel(s) in the survey area will not result in a significant risk of introduction and establishment of IMS. A further precautionary approach has been taken in view of the importance of fish habitats on Glomar Shoal and Rankin Bank, and in meeting transitional management requirements for approved actions within Marine Parks. The ALARP assessment demonstrates that the adopted controls (Table 5-40 and Table 5-41) are appropriate to reduce the impact to ALARP without the further impact reduction being required.

Given the nature and scale of the activity, CGG consider that the potential impacts are of an acceptable level as the predicted impacts are within and below the defined acceptable levels of impact in accordance with the criteria defined in Table 4-4.

#### 5.3.3.6 Environmental Performance Outcomes, Standards and Measurement Criteria

The environmental performance outcomes, standards and measurement criteria appropriate to measure performance of the adopted control measures for the introduction and establishment of IMS are presented below in Table 5-42. Environmental performance standards and relevant measurement criteria have been developed for each control measure identified in Table 5-40 and each additional control adopted from the ALARP assessment in Table 5-41.

**Table 5-42: Environmental Performance Outcomes, Standards and Measurement Criteria for Introduction and Establishment of Invasive Marine Species**

| Environmental Performance Outcome | Environmental Performance Standard | Measurement Criteria |
|---|---|---|
| Avoid introducing invasive marine species into Australian waters | No planned ballast water exchanges to take place during the activity, but if required, ballast water exchange will occur >12 NM from land (with the exception of an exchange to maintain the stability of the vessel in an emergency)<br>No discharge of ballast water from survey and support vessels within 12 NM of land without prior authorisation from the DAWR.<br>Ballast water discharges recorded as >12 NM from land in Ballast Water Management Summary Sheet.<br>Adherence to Australian Ballast Water Management Requirements (DAWR, 2016) to meet the Australian requirements under the *Biosecurity Act 2015*. | Ballast water exchange records show:<br>■ No recorded occurrence of a ballast water exchange during the survey (with the exception of an exchange to maintain the stability of the vessel in an emergency) without prior authorisation from the DAWR.<br>■ Ballast water discharges recorded as >12 NM from land in Ballast Water Management Summary Sheet<br>■ Adherence to Australian Ballast Water Management Requirements (DAWR 2016): Maritime Arrivals Reporting Systems (MARS) is available and approved by the Director of Biosecurity<br>■ Approved ballast water management options are in place. |
| | Survey vessel and support vessel/s comply with National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Commonwealth of Australia 2009):<br>■ Biofouling Record Book kept outlining marine fouling management actions<br>■ Biofouling risk assessment shows low risk of IMS presence prior to entry into Australian waters<br>■ Recent hull inspections (if required based on biofouling risk assessment)<br>■ Survey vessel has a certified anti-fouling coating on the hull and coating is in sound condition. Anti-fouling system certification is in place in accordance with AMSA Marine Order Part 98 (Anti-fouling systems). | Prior to survey sight operational history since last dry-docking, cleaning, anti-fouling renewal.<br>Biofouling risk assessment report confirming survey vessel poses low risk of introducing IMS.<br>Prior to survey a copy of the International Anti-fouling System Certificate is sighted and is in date. |
| | Routine cleaning and inspection of submersible equipment (airgun array, streamers, tail buoys), consistent with the requirements of the National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Commonwealth of Australia 2009). | Evidence / records confirm submersible equipment inspected and found free of biofouling prior to commencing the activity.<br>In the event that biofouling is observed on equipment, it is cleaning and a record of the type of cleaning is kept. |

| Environmental Performance Outcome | Environmental Performance Standard | Measurement Criteria |
|---|---|---|
| No discharge of ballast water within 40 m depth contour of Glomar Shoal and Rankin Bank | No discharge of ballast water within 40 m depth contour of Glomar Shoal and Rankin Bank | Records show no ballast water discharge carried out within 40 m depth contour of Glomar Shoal and Rankin Bank. |
| No discharge of ballast water within the Montebello and Dampier Commonwealth Marine Reserves (CMRs) | No discharge of ballast water within the Montebello and Dampier Commonwealth Marine Reserves (CMRs) | Records show no ballast water discharge carried out within the boundaries of Montebello or Dampier CMRs. |

### 5.3.4 Risk 4 – Accidental Release of Hazardous and Non-hazardous Substances

#### 5.3.4.1 Description of Hazard

General non-hazardous and hazardous solid wastes will be generated during normal operations for the Davros Extension MC3D MSS. Non-hazardous wastes may include scrap metal, packaging, wood, cardboard, paper, plastics and empty containers, which will be transferred onshore for recycling or disposal at registered facilities. General hazardous solid wastes that may be generated include paints and paint cans, oil contaminated materials (e.g. sorbents, filters and rags), batteries, plastics and fluorescent light tubes. These materials may be harmful to the marine environment if lost overboard. All material will be stored on board for the duration of the surveys.

Non-hazardous and hazardous solid wastes may be released by accidentally dropping objects overboard (e.g. tools, streamer depth controllers) due to human error, equipment failure or adverse weather.

As part of normal seismic survey vessel operations, a range of chemicals and oily substances (such as lubricating oils and hydraulic fluid) will be stored on the deck of the survey and support vessels. Hydraulic fluid is also contained in reservoirs, hoses and lines on hydraulic equipment, such as cranes or winches. There is potential for accidental loss of these fluids through operator error or machinery malfunction. In the event of an accidental on-board spill of oily substances or chemicals (such as a containment leak), there is potential for the spill to be washed overboard and released into the marine environment.

Chemicals (e.g. solvents and detergents) will typically be stored in small containers of 5 to 25 L capacity with a secondary containment measure (e.g. bunds) in place to contain leaks or spills. Chemicals are stored in internal areas where any leak or spill would be retained on board and cleaned up in accordance with the SOPEP and associated spill clean-up procedures. For a spill on deck to result in a release to the marine environment, there would need to be an un-confined spill that flowed overboard. Given that the use of oils or other chemicals on deck would be largely confined to bunded areas, this is highly unlikely to occur and would require the failure of a bund or extreme weather conditions. The realistic worst-case spill volume would be 25 L (largest capacity container) should a chemical spill in an unconfined area eventuate in release to the marine environment, or a drum is compromised during handling.

The risks and potential impacts to due to accidental release of hazardous and non-hazardous substances are well understood, with legislative requirements and industry agreed good practices to manage risks. In general the application of recognised good practice is considered appropriate to manage the risk, particularly due to the distance of the survey area from sensitive receptors and the well-mixed offshore marine waters of the survey area. In addition, the assessment has also considered the site-specific nature and scale of the risk (e.g. to sensitive receptors such as Glomar Shoal KEF and Rankin Bank and to marine fauna).

No specific stakeholder concerns have been raised regarding loss of hazardous or non-hazardous substances.

#### 5.3.4.2 Description of Potential Impacts to Environmental Values

The known and potential environmental impacts from the loss of hazardous and non-hazardous wastes and chemicals include:

- temporary localised decline in water and sediment quality
- temporary toxicity to marine fauna
- potential injury, entanglement or mortality of marine fauna (including seabirds)
- seabed disturbance resulting in localised loss of benthic habitat in footprint of dropped object and smothering
- creating navigation hazards for other vessels if object floats
- providing "rafting" opportunities for marine species (including potential IMS).

Typically, hazardous and non-hazardous materials are stored in accordance with the vessel Garbage Management Plan (GMP) and are not stored on the deck of vessels; therefore, these items are unlikely to be accidentally lost overboard. However, should this occur, then benthic communities may be affected by physical disturbance and/or toxicity.

##### 5.3.4.2.1 Potential Impacts to Water Quality and Marine Habitats and Communities

Should accidental disposal of such wastes occur, the potential impacts will be dependent upon the receiving environment and the nature of the lost object. Larger, heavier items could settle on the seabed, and cause disturbance to benthic communities. There is the potential for fluid storage containers to leak and release their contents on the deck of the vessel. The spilled liquids may be washed overboard or spill overboard in adverse weather.

Benthic habitats on Glomar Shoal and Rankin Bank are dominated by consolidated coralline/turf algal reef and sand/silt habitats, which are not particularly sensitive to physical disturbance from small amounts of solid wastes. Hazardous wastes (such as oily wastes) and chemical spills could however cause localised decreases in water quality if accidentally released in significant quantities, which could indirectly affect marine flora and fauna. In the event a loss to sea does occur, impacts to the marine environment would be minimal, due to the small potential volumes released, and the fact that spilt oil and chemicals will rapidly evaporate, disperse and weather. In the open ocean environment, the spilled liquids would be rapidly dispersed and diluted to concentrations at which they are not harmful.

The survey is located in offshore waters 35 m to 271 m deep and will exclude the shallow water areas within the fish protection areas and 250 m buffers on Glomar Shoal and Rankin Bank (Figure 5-10). Water movement in the vicinity of the Davros Extension MC3D survey area is well mixed by winds and tides. Release of small volumes of oily waste or chemicals would result in a localised adverse effect on water quality. Any effects to pelagic species would be extremely localised and temporary and is unlikely to have any impact on species diversity or abundance within these areas.

Given the small volumes involved (maximum container size of approximately 25 L) any impacts on the marine environment are likely to be limited to short-term toxicity effects on biota and reduced water quality. The high energy nature of the receiving environment will facilitate rapid dispersion and dilution to non-toxic concentrations. The inherent likelihood and consequence of an oil or chemical spill through deck drainage impacting the marine environment are considered Unlikely and Minor, respectively. The inherent risk is therefore **Low**.

##### 5.3.4.2.2 Potential Impacts to Protected Species

Smaller items lost overboard, or larger items as they break down, may be ingested by mobile fauna such as turtles and cetaceans. However, the likelihood of this material being accidentally released is unlikely in the event that the vessel GMP is followed correctly.

Solid objects will tend to sink to the seabed and will therefore be unavailable for ingestion by pelagic fauna. However, ingestion of marine debris may occur by marine turtles foraging in coastal waters (Schuyler 2015). The internal structure of turtle throats prevents regurgitation of swallowed items, trapping them in the gut where organic wastes may decompose, leaking gases into the body cavity that cause the animal to float and ultimately die. White plastic debris (e.g. plastic bags) is of particular concern for leatherback turtles, which may mistake it for jellyfish, a key prey item for the endangered species (Derraik 2002). It can prevent feeding, leading to starvation and can create intestinal blockages that increase buoyancy and stop turtles from diving (Commonwealth of Australia 2017). In addition, toxins from ingested plastics may accumulate in marine turtle tissue with possible health implications (Commonwealth of Australia 2017).

The waters of northern Western Australia support important foraging areas for green, hawksbill, loggerhead, flatback and leatherback turtles. The NCVA defines foraging BIAs for each species of marine turtle identified as potentially occurring in the survey area, apart from leatherback turtles which have a specialist pelagic diet and forage over vast areas. The survey area is not recognised as being of significance for any species of marine turtle. The nearest identified foraging BIA is defined for green turtles and is located inshore of Barrow Island approximately 70 km south of the survey area. The inter-nesting BIA and habitat critical for survival for flatback turtles are the only BIA and habitat critical for survival identified for any marine turtle species that overlaps a part of the Davros Extension MC3D survey area (Figure E). However, there is no evidence that flatback turtles swim out into deep offshore waters during inter-nesting and a habitat suitability map for the for the North West Shelf developed in a recent study by Whitlock et al. (2016) (described in Section 3.1.3.3.2) demonstrates that inter-nesting flatback turtles are unlikely to be encountered in the survey area (Figure E). Post-nesting flatbacks and other marine turtle species may be encountered transiting through the survey area. However, as the survey area is not an important foraging ground or part of any known migration route, the number of marine turtles present within the survey area is likely to be relatively limited. No effects on turtle breeding success or to populations are predicted from material being accidentally released overboard.

While large numbers of marine turtles are known to ingest plastic (Schuyler et al. 2015), the stock level risk from ingestion is largely unknown. The Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017) considers threats to turtle stocks on an individual basis. Ingestion of marine debris has been identified as being of “high risk” for leatherback turtles and “moderate/unknown risk” for Western Australian loggerhead turtle species stocks. The five other marine turtle genetic stocks with a dispersal range that includes the survey area are considered to be at “low risk” from marine debris. The Commonwealth of Australia (2017) recovery plan includes actions to address threats with “high” or “very high risk” ratings, however the actions identified in the recovery plan are not applicable to this EP (e.g. the actions focus on international and domestic partnership arrangements for source reduction and future research requirements).

The survey area overlaps with the humpback whale migratory BIA and northbound whales may pass through the area as evident from mapped migratory routes (Figure B). At least 22 species of toothed whales have been documented in incidents of ingestion of marine debris, with documented cases of entanglements for over 46% of all species of marine mammals (UK Whale and Dolphin Society 2011, California Coastal Commission 2017). Therefore ingestion and potential entanglement (depending on the nature of the debris lost overboard) pose potential impacts.

Hazardous items may be mistakenly ingested and cause discomfort or adverse health effects for individuals. This would be limited to a small number of individual animals and ingesting small volumes of hazardous material; no lethal effects would be expected.

#### 5.3.4.2.3 Potential Impacts to Other Users

Large buoyant objects, such as drums and pallets, lost overboard may create a navigational hazard for other vessels operating in the area.

#### 5.3.4.3 Inherent Risk Assessment

The overboard loss of solid wastes can result in impacts to the marine environment such as localised toxicity, ingestion (by marine fauna) and causing navigation hazards to other marine users. In the event that solid waste is lost overboard, there is a potential for localised (immediate area) and temporary effects on habitats in the immediate footprint of the waste item, or on the health of an individual animal if ingested. Marine fauna, particularly turtles, have been known to ingest waste objects, and for which marine debris is identified as a pressure of potential concerning the Recovery Plan for Marine Turtles (Commonwealth of Australia 2017). However, typically, such material that can be ingested is not stored on deck and is unlikely to be lost overboard. This is a Minor consequence.

Given the survey area is not considered a habitat that is critical to the survival of any listed species and the survey area has been reduced in size in the southern extent to further reduce the likelihood of encounters with inter-nesting turtles and humpback whales, the likelihood of this impact is Unlikely. The highly dispersed distribution of the turtles and seabirds would limit their potential exposure. The inherent risk is Low.

#### 5.3.4.4 Control Measures

Table 5-43 presents the control measures that CGG during the Davros Extension MC3D MSS to manage any potential impacts associated with the accidental release of hazardous and non-hazardous wastes and materials.

**Table 5-43: Control Measures for Accidental Release of Hazardous and Non-hazardous Substances**

| Control Measures | |
|---|---|
| Good Practice | Compliance with MARPOL 73/78 Annex V as applied in Australia *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Part IIIB, Division 2, Section 26D) and have a vessel GMP (Regulation 10.2) that must contain as a minimum:<br>Waste handling equipment, waste storage containers, and closed bins for storing spill response equipment appropriate to the type and volume of waste will be provided at waste storage areas. |
| | No loose solid hazardous or non-hazardous wastes stored on deck during the survey |
| | All waste receptacles in locations with potential for overboard waste loss, covered with tightly fitting, secure lids or netting to prevent any solid wastes from blowing overboard |
| | Solid streamer (or gel-filled), no fluid-filled streamer to be used, reducing potential for toxicity from lost streamer. |
| | Survey vessel crew will be inducted in waste management and made familiar with the vessel GMP. |
| | AMSA and AHS to be advised of the loss of large items of buoyant waste (potential navigational hazards) |
| | Any accidental release of significant wastes to the marine environment will be recovered where safe and practicable to do so. |
| | Compliance with MARPOL 73/78 Annex I (as applied in Australia under Commonwealth *Protection of the Sea (Prevention of Pollution from Ships) Act 1983)*); and AMSA Marine Order - Part 91 Marine Pollution Prevention - Oil):<br>■ current Shipboard Oil Pollution Emergency Plan (SOPEP) in place<br>■ survey vessel holds a valid IOPP certificate, where required, under vessel class. |
| | Hazardous materials will be stored with a form of secondary containment to contain leaks or spills in accordance with their MSDS and CGG's Survey Vessel Handling and Storage of Dangerous Products procedure. |
| | Deck scupper plugs on board vessel. |
| | Equipment located on deck utilising hydrocarbons (e.g. cranes, winches or other hydraulic equipment) will have as a minimum primary bunding (i.e. deck edge lips or up-stands) |
| | Spill response bins/kits are maintained and located in close proximity to hydrocarbon storage areas and deck areas for spill recovery / containment |

| Control Measures | |
|---|---|
| | Spills from fixed internal equipment, such as engines and generators, are enclosed and spills captured via bilges that drain via the OIW separator. |
| | Minor oil/lubricant spills will be mopped up immediately with absorbent materials that will be stored in covered containers and disposed of onshore as hazardous waste in accordance with the vessel SOPEP |
| | Survey vessel crew are inducted in their responsibilities for chemical storage and handling and under the SOPEP |

### 5.3.4.5 Demonstration of ALARP and Risk Acceptability

#### 5.3.4.5.1 Summary of ALARP Demonstration

CGG is committed to ensuring continual risk reduction and identifying if additional control measures may be applied that are not disproportionate to the sacrifice (e.g. cost) of implementation and has considered the additional measures in Table 5-44. Control measures have not been adopted where the cost of implementation is disproportionate to the benefit gained. An additional control of returning any unused chemicals to either the supplier or stored for future use has been identified and adopted to further reduce the risk to ALARP. CGG considers the adopted controls to be appropriate in reducing the environmental risks and impacts associated with the accidental release of hazardous and non-hazardous substances to ALARP. There are no other controls measures that may practicably or feasibly be adopted to reduce the risks and impacts further without disproportionate costs compared to the benefit of the potential risk reduction.

**Table 5-44: Demonstration of ALARP for Accidental Release of Hazardous and Non-Hazardous Substances**

| Additional Control Measures | Practicability / Effectiveness? | Cost Benefit Analysis | Risk Reduction (L/C/RR ↓)? | Control Adopted |
|---|---|---|---|---|
| **Good Practice** | | | | |
| Below-deck storage of all hydrocarbons and chemicals | P: No – access to chemicals and oils on deck is required during operations.<br>E: Effective (+) | This measure would inhibit operations; costs outweigh benefits. Chemicals would still need to be brought onto deck when required during operations. | Yes (limited) | No |
| A reduction in the volumes of chemicals and hydrocarbons stored on board the vessel | P: No – chemical transfer during operations would be required, which has associated risks. Could also result in delays to operations.<br>E: Very ineffective (--) (comes with its own risks) | Costs outweigh benefits due to additional risks associated with transfer of chemicals during the survey. | No | No |
| Any unused chemicals will be returned to suppliers or store for future use, unless needed by the next client | P: Yes<br>E: Effective (+) | Benefits outweigh costs | Yes | Yes |

#### 5.3.4.5.2 Residual Risk

The consequence of localised toxicity, ingestion (by marine fauna) and causing navigation hazards to other marine users caused by accidental release/loss of hazardous and non-hazardous materials remains Minor.

With the implementation of the control measures described in Table 5-43 and additional control measure adopted from the ALARP assessment in Table 5-44, there will be no survey operations in protected areas or in the vicinity of shallower waters over Glomar Shoal and Rankin Bank. The survey will not be carried out during the peak migration period for humpback whales and adaptive management to avoid encounters with whales will be implemented throughout the survey area, with additional precautionary measures in the humpback whale adaptive management zone. The survey area has also excised habitats identified as critical for inter-nesting for turtles. These measures reduce the potential for the presence of protected species in the vicinity of the seismic vessel. CGG will manage any potential interactions with fishers through the ongoing stakeholder consultation (Section 8.5) to minimise disruption and to provide early notification of the details of the survey (e.g. timing, location, exclusions). The likelihood of these impacts during the survey is Rare. The residual risk is therefore **Low**.

#### 5.3.4.5.3 Acceptability

The residual impact of accidental release of hazardous and non-hazardous materials complies with CGG's internal context (low risk), will be managed in accordance with relevant legislative requirements and complies with industry good practice and the principles of ESD.

Any concerns raised by stakeholders have been assessed and control measures adopted where appropriate. Complete elimination of the risk is not possible as there is no practical alternative to the use of packaging, lubricants and other hazardous materials and these must be stored on the vessel prior to use and for subsequent disposal onshore. The risk assessment has determined that, with the implementation of the adopted control measures, accidental release of hazardous and non-hazardous wastes or materials will result in no more than possible incidental effects to flora and fauna in the local vicinity of the discharge or footprint of disturbance, and no impact on critical activities or habitats. Due to the absence of areas of sensitive habitats susceptible to long-term effects, recovery of any areas disturbed on Glomar Shoal or on Rankin Bank is expected with no medium to long-term effects on diversity. The ALARP assessment demonstrates that the adopted controls (Table 5-43 and Table 5-44) are appropriate to reduce the impact to ALARP without the further impact reduction being required.

Given the nature and scale of the activity, CGG consider that the potential impacts are of an acceptable level as the predicted impacts are within and below the defined acceptable levels of impact in accordance with the criteria defined in Table 4-4.

### 5.3.4.6 Environmental Performance Outcomes, Standards and Measurement Criteria

The environmental performance outcomes, standards and measurement criteria appropriate to measure performance of the adopted control measures for the accidental release of hazardous and non-hazardous substances are presented below in Table 5-45. Environmental performance standards and relevant measurement criteria have been developed for each control measure identified in Table 5-43, and the additional control adopted from the ALARP assessment in Table 5-44.

**Table 5-45: Environmental Performance Outcomes, Standards and Measurement Criteria for Accidental Release of Hazardous and Non-Hazardous Substances**

| Environmental Performance Outcome | Environmental Performance Standard | Measurement Criteria |
|---|---|---|
| Hazardous and non-hazardous wastes are stored, handled, disposed of and retrieved in a manner that prevents marine pollution. | Compliance with MARPOL 73/78 Annex V as applied in Australia *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Part IIIB, Division 2, Section 26D) and have a vessel GMP (Regulation 10.2) that must contain as a minimum:<br>■ Waste handling equipment, waste storage containers, and spill response equipment appropriate to the type and volume of waste will be provided at waste storage areas. | Vessel Garbage Management Plan (GMP) is carried on board and complies with MARPOL requirements.<br>Vessel audit/inspection confirms waste is managed in accordance with the Garbage Management Plan (GMP). |
| | | Vessel audit/inspection shows that a waste manifest (or Garbage Record Book) is used to track all waste types and volumes transferred to support vessels for onshore disposal. |
| | | Garbage Record Book records verify that all hazardous waste is segregated. |
| | | Vessel audit/inspection shows evidence of waste handling equipment, waste storage containers, and spill response equipment appropriate to the type and volume of waste, available at waste storage areas on board the survey vessel |
| | | Records of any loss of wastes are documented and corrective actions identified and undertaken. |
| | Hazardous wastes materials will be handled and stored in accordance with the corresponding MSDS. | Vessel audit/inspection confirms relevant MSDS' for hazardous waste types are on board the vessel and are being followed. |
| | All waste receptacles in locations with potential for overboard waste loss are covered with tightly fitting, secure lids or netting, labelled and stored to prevent any solid wastes from blowing overboard | Vessel audit/inspection of waste receptacles in locations with potential for overboard waste loss confirms secure tightly fitting and secure lids or netting in place, labelled and stored to prevent overboard loss. |
| | Vessel survey crew will be inducted in waste management procedures and made familiar with the vessel GMP. | Records show that the project induction includes information on waste management requirements, and sign-off register indicates all personnel on board have received the induction. |
| | AMSA and AHS to be advised of the loss of large items of buoyant waste (potential navigational hazards) | Response from AMSA and AHS confirms receipt of notification, in the event of an incident. |
| | Any accidental release of significant wastes to the marine environment will be recovered where safe and practicable to do so | Records demonstrate recovery (or attempts to recover) of large waste items in the event of loss to sea. |

| Environmental Performance Outcome | Environmental Performance Standard | Measurement Criteria |
|---|---|---|
| | Solid streamer (or gel-filled), no fluid filled streamer to be used | Inspection prior to commencement of survey confirms solid (gel-filled) streamers used. |
| Chemicals or oily wastes are stored, handled, disposed and cleaned up in a manner that prevents marine pollution. | Compliance with MARPOL 73/78 Annex I (as applied in Australia under Commonwealth *Protection of the Sea (Prevention of Pollution from Ships) Act 1983)*); and AMSA Marine Order – Part 91 Marine Pollution Prevention – Oil):<br>■ current Shipboard Oil Pollution Emergency Plan (SOPEP) in place<br>■ survey vessel holds a valid IOPP certificate, where required, under vessel class | Vessel audit/inspection confirms SOPEP on board survey vessel |
| | | Vessel audit/inspection demonstrate the survey vessel holds an IOPP certificate, if required under vessel class |
| | | Vessel audit/inspection demonstrate that SOPEP drills have taken place |
| | Chemicals and/or hydrocarbons on deck will be stored with a form of secondary containment measure to contain leaks or spills in accordance with their MSDS and CGG's Survey Vessel Handling and Storage of Dangerous Products procedure. | Inspection during survey records demonstrate that hydrocarbon storage is designed and maintained to prevent and contain deck spills entering the marine environment. |
| | Hydrocarbon and chemical storage areas (e.g. engine room) are bunded and/or stored safely to prevent spills overboard and drain to the bilge water tank. | Vessel audit/inspection verifies that the main deck and hydrocarbon and chemical storage areas are bunded and/or stored safely to prevent spills overboard. |
| | Hazardous wastes materials will be handled and stored in accordance with the corresponding MSDS. | Vessel audit/inspection indicates that hazardous wastes materials are stored in accordance with the corresponding MSDS. |
| | All hazardous substances will be included in the Material Safety Data Sheet (MSDS) registers. | Vessel audit/inspection shows that MSDS' for all hazardous waste types are available on board. |
| | These registers are available in key locations of the vessels (e.g. bridge, chemical locker) and kept up to date so that chemical spills to deck can be safely managed. | Vessel audit/inspection shows that MSDS registers are in key locations (i.e. where chemicals are stored) and a relevant crew member is responsible for ensuring they are kept up to date. |
| | Any unused hydrocarbon and chemicals will be returned to suppliers or store for future use, unless needed by the next client | End of survey records show that any unused hydrocarbon and chemicals have be returned to suppliers or store for future use, unless needed by the next client |
| | Equipment located on deck utilising hydrocarbons (e.g. cranes, winches or other hydraulic equipment) will have as a minimum primary bunding (i.e. deck edge lips or up-stands) | Vessel audit/inspection demonstrates that all equipment located on deck utilising hydraulic fluids have primary bunding |
| | Spills from fixed equipment, such as engines and generators, are enclosed and spills captured via bilges that drain via the OIW separator. | Vessel audit/inspection confirms oily water from machinery spaces collects in bilges. |

| Environmental Performance Outcome | Environmental Performance Standard | Measurement Criteria |
|---|---|---|
| | Minor oil/lubricant spills will be mopped up immediately with absorbent materials that will be disposed of onshore as hazardous waste in accordance with the vessel SOPEP | Vessel audit/inspection shows that response measures for minor oil/lubricant spills were carried out in accordance with the SOPEP, and contaminated clean-up wastes stored on board in covered bins prior to onshore disposal at a licensed waste management facility. |
| | | Vessel audit/inspection of incident reports for minor spills to the marine environment. |
| | Survey vessel crew are inducted in their responsibilities under the SOPEP and is competent in spill response and has appropriate response resources in order to prevent hydrocarbon or chemical spills discharging overboard. | Vessel audit/inspection show that the project induction includes responsibilities of survey crew under the SOPEP and that regular spill drills are being carried out. |
| | | Drill and incident reports record lessons learnt and corrective measures are being implemented on board. |
| | Scupper plugs or equivalent drainage control measures are readily available to the deck crew so that deck drains can be blocked in the event of a hydrocarbon or chemical spill on deck to prevent or minimise discharge to the sea. | Vessel audit/inspection verifies that scupper plugs (or equivalent) are available on the main deck. |
| | Spill response kits are available in relevant locations around each vessel, are fully stocked and used in the event of a spill to deck to prevent or minimise discharge overboard. | Vessel audit/inspection verifies that spill response kits are available in relevant locations in accordance with vessel plans. |

### 5.3.5 Risk 5 - Accidental Oil Spill (Refuelling or Vessel Collision)

#### 5.3.5.1 Description of Hazard

The survey vessel will be fuelled by marine diesel (MGO), carried in separate fuel cells which are inter-connected and isolatable. In the event of an incident such as a catastrophic vessel collision that ruptured a fuel cell, a significant volume of MGO fuel may be released to the marine environment. The total loss of fuel would be reduced by isolating the compromised fuel cell and transferring fuel to adjacent cells.

AMSA recommends the maximum realistic spill scenario for vessel collisions or grounding is the loss of the entire volume of the single largest fuel tank (AMSA 2013). The vessel to be used for the Davros Extension MC3D MSS has not yet been selected, but it will be one of the vessels in the CGG fleet. Consequently, the maximum realistic spill scenario herein is based on the rupture of the largest fuel tank in the fleet with a capacity of 268.5 $m^3$. This is a conservative estimate as the tanks are never completely filled and the other vessels have smaller tanks.

The vessel will need to refuel during the survey and there is potential for an accidental release of fuel during refuelling if, for example, a refuelling hose were to break. If the hose was full and the entire contents were lost to the sea, this could result in a spill of 125 L of diesel. Dry break couplings would prevent any more than the hose volume being spilled in the event of hose failure. In reality, a more likely scenario is that a minor leak from a damaged hose would be detected first and the situation rectified before the hose burst.

A diesel spill as a result of vessel collision represents the scenario that has been used to set the worst-case zone of potential impact (ZPI) for the Davros Extension MC3D MSS. Although this scenario is considered a realistic worst case, it is also an unlikely occurrence, given the control measures in place to manage interactions with other users (Section 5.2.3.6), and the controls in place to mitigate the loss of fuel in the event of a tank rupture (Section 0). It is however credible that a vessel collision could occur due to the high vessel traffic usage in the vicinity of the survey area (Section 3.2.3). Vessel collision spills make up 11.6% of the marine spills over one tonne, with most of these occurring in ports or other areas where vessels work in close proximity (DNV 2011). Based on a review of the Australian Transport Safety Bureau's marine safety database there are no recorded instances of collisions, grounding or sinking of a seismic vessel or its support vessels in Australian waters in at least the last 30 years (http://www.atsb.gov.au/publications/safety-investigation-reports.aspx?Mode=Marine). The Australian registered research vessel Rig Seismic grounded on an uncharted reef while engaged in seismic operations in the Philippines in 1992. The vessel suffered only minor damage and it was refloated without assistance. No pollution occurred.

The risks and potential impacts of a fuel spill (from refuelling or vessel collision) from vessels associated with the oil and gas industry has been the subject of much investigation, and it is accepted that the risks associated with potential oil spills from vessel collisions are much less than those associated with spills from exploratory and operational oil wells. In general, the risks are well understood, with legislative requirements and industry agreed good practices to manage risks. The application of recognised good practice is considered appropriate to manage the risk; particularly due to the distance of the survey area from sensitive receptors and the well-mixed offshore marine waters of the survey area, which would hasten the natural weathering, and dispersion of the plume. In addition, the assessment has considered the site-specific nature and scale of the risk and the environmental values and sensitivities (e.g. presence of habitats susceptible to medium to long-term effects and likely encounters with marine fauna).

A precautionary approach has also been taken in the decision making process, where the oil spill risk assessment presented within this EP is based upon a worst case spill scenario of complete loss of the contents of one fuel tank in the event of vessel collision. Given the extremely low likelihood of two very unlikely events occurring (catastrophic collision/vessel grounding and complete loss of fuel tank) the realistic worst-case spill scenario, the assessment is considered inherently conservative.

No direct concerns related to accidental hydrocarbon spills were raised by stakeholders during the consultation process.

#### 5.3.5.1.1 Fate of Spilled Oil

The environmental impacts of a hydrocarbon spill are due to the toxicity of the oil (generally due to the aromatic components), smothering and its physical persistence. However, MGO is a light oil and in the event of a marine diesel spill in the operational area, adverse effects would primarily involve acute toxicity related to exposure to aromatic hydrocarbons. Marine diesel typically contains a low proportion (3%) of aromatic hydrocarbons. The persistent fraction (as defined by the IMO) of marine diesel constitutes a relatively small component of the fuel, approximately 10%, with the remaining components considered non-permanent, which are further classified as volatile (4%), semi-volatile (32%) and low volatility (54%).

Once released into the marine environment, oil spills dissipate via natural mechanisms. Table 5-46 describes the typical fate of spilled diesel after it reaches the tropical marine environment.

**Table 5-46: Fates of Spilled MGO in the Marine Environment Relevant to the Davros Extension MC3D Survey Area**

| Fate | Description |
|---|---|
| Spreading | MGO will begin to spread on the sea surface immediately upon being spilled. The rate at which a hydrocarbon slick spreads largely depends on the viscosity of the hydrocarbon. MGO is a relatively low viscosity fuel oil and spreads rapidly. Spreading is also influenced by metocean conditions (waves, wind, tides and currents); faster surface currents result in faster spreading. |
| Evaporation | Volatile components of a hydrocarbon spill will evaporate to the atmosphere, with increased wind speeds and ambient temperatures resulting in a higher evaporation rate. Lighter hydrocarbon fractions (boiling point <200 °C) will typically evaporate entirely within 24 hours in temperate conditions. The surface area of a slick (determined by the spread of the slick) also influences the rate at which it will evaporate, with larger surface areas increasing the evaporation rate. Remaining hydrocarbons will have a higher density and viscosities, which will affect how the remaining spill behaves (spread and evaporate more slowly). |
| Dispersion / entrainment | A large proportion of the spilled MGO will become entrained (or dispersed) in the water column; a process whereby droplets of oil become suspended in the upper layer of the water column. Dispersion occurs more readily with relatively low viscosity MGO in the presence of breaking waves and when wind speeds exceed 5–7 knots. Once dispersed into smaller droplets, the oil is prone to faster biodegradation and photo-oxidation. When metocean conditions are no longer suitable to sustain entrainment, the remaining droplets of oil may return to the sea surface, with the rate of return influenced by the buoyancy of the oil particles. On the sea surface, the droplets may form a slick that is subject to further evaporation. Entrained oil is generally more persistent as it no longer subject to evaporation at the surface and it may travel further than the surface slick in subsurface currents. |
| Dissolution | While the majority of components within an MGO spill are not water soluble, some components may dissolve in sea water. The lighter fractions of the oil are typically more soluble (e.g. aromatic hydrocarbons), and these are generally also more toxic than the heavier fractions. Given the relatively small portion of soluble hydrocarbons present in MGO, along with their rapid decomposition, the percentage of spilled oil that will become dissolved in the event of a fuel spill is expected to be small. |

In offshore waters, removed from any emergent land or shallow waters where spilled oil may contact benthic habitats and affect marine habitats, the key concern is one of stakeholder perception. The surface slick of spilled oil generally presents a reasonable representation of the behaviour and fate of all spilled components and is the focus of clean-up efforts because it is the only element that is visible and can be tracked from the air. In shallower waters (<20 m deep), it is more important to also understand the fate of the entrained and dissolved elements.

#### 5.3.5.1.2 Zone of Potential Impact of Spilled Oil

In the event of a spill occurring, the likelihood of an impact is dependent on whether there are sensitive environmental receptors within the Zone of Potential Impact (ZPI). The extent of the ZPI was derived from modelling undertaken for a similar seismic survey in the same general area. The representative modelling selected was undertaken by Polarcus for their Rosemary Environment Plan and key results were published

in the EP Summary (Polarcus Seismic Limited 2014).This modelling was undertaken by RPS APASA, and involved a detailed assessment of the physical factors driving the spread and fate of spilled diesel, the hydrodynamics of the region determining the range of potential trajectories of the slick, and meteorological conditions under a range of spill release scenarios (averaging over all scales of temporal variation). There are two main seasons in the region: Spring-Summer (September to March) and Autumn-Winter (May to July); with short transitions between seasons. The Polarcus EP modelling was based on the October to December period and simulated a large number of spill events (to allow averaging over a wide range of temporal scales) from 20 locations, including one over Glomar Shoal.

The Polarcus EP oil spill modelling is considered more informative (and more accurate) than using simple weathering models, for example ADIOS2, because the simple models do not adequately allow for variation in the key conditions which have a material effect on the fate and trajectory of the spill. For example, surface currents and temperatures must be simplified to single average figures, whereas in the course of the first day after a spoil, these factors can vary significantly, e.g. with tidal changes. CGG considers the Polarcus modelling outputs are appropriate to predict the behaviour of a worst case spill scenario in any season in the survey area and to guide the development of the OSMP in the event of a spill, due to the following:

- Polarcus modelling for the Summer-Spring season (September to March) was for the same area on the North West Shelf and similar fuel type and volume.
- 3D modelling is more accurate and conservative than the ADIOS weathering profiles and wind speed estimates used to predict spill behaviour from a single location and accounts for entrained components
- Weathering models such as ADIOS2 only estimate time to dispersion and do not predict trajectory or distance
- Consistency of predominant wind fields within this season (as seen in wind roses), supports confidence in extrapolating from the modelled window to the entire Summer-Spring season.
- Maximum wind speeds in the other main season are the same strength (10 to 12 m/s); therefore it can be assumed that the spill will travel a similar distance.
- In the non-modelled season (May-July) winds tend to blow more from the east-southeast - blowing a spill offshore; adding a level of conservatism if spring-summer pattern is also applied for this season.
- In the transitional months (April and August) winds are lighter; adding a level of conservatism in using the summer outputs
- Given the offshore location, there is low risk of fuel contacting any sensitive shoreline habitats
- CGG conservatively assumes that a spill may travel in any direction (as the modelling demonstrates in summer) and therefore spill response planning incorporates an assumption that the slick may pass over shallow areas at Glomar Shoal and Rankin Bank.

The modelling was used to set the ZPI on the basis of the maximum extent of floating oil at a concentration of at least 10 g/m$^2$. The modelled spill volume (280 m$^3$ of MGO) was larger than the worst-case scenario for the Davros Extension MC3D MSS and so it provides an extra level of conservatism.

The Polarcus Rosemary EP Summary shows the maximum extent of the surface slick of spilled diesel is approximately 50 km in all directions. While the modelled scenarios only cover the spring to summer period and dominant wind directions change with season, the omnidirectional trajectories of similar length indicate that dominant wind direction does not have a big influence of the range of possible trajectories of the spilled diesel. In summer, the wind predominantly blows from the south-west and west; however, the slick may travel equally in all directions under the influence of currents and eddies in summer and would similarly be expected to in winter. CGG have committed to avoiding the peak humpback whale migration period from July to September, and the risk of an oil spill during winter is therefore unlikely, with June being the only winter month a spill could occur. The Polarcus EP oil spill modelling carried out for the summer period is therefore extremely relevant to the timing proposed by CGG for the Davros Extension MC3D MSS.

The 50 km ZPI buffer around the entire survey area, based on a larger spill volume, has been used as a conservative estimate of the range of potential effects from a worst-case diesel spill during the Davros Extension MC3D MSS.

#### 5.3.5.2 Description of Potential Impacts to Environmental Values

In the event of a diesel spill, surface slicks and plumes of entrained hydrocarbons can cause a localised reduction in water quality and may have toxic effects on marine fauna and flora. Potentially affected biota includes plankton, fish, seabirds, cetaceans, turtles and whale sharks that may come into contact with a surface hydrocarbon slicks. If surface slicks or entrained diesel were to contact shallow waters or emergent features adjacent to the operational area, then a range of benthic habitats and communities could be at risk of impacts. However, even if the spill travelled twice as far as predicted, it would still not reach the coast. Commercial fishing and shipping in the area could also be impacted for a short period in the event of a major diesel spill.

The environmental values and sensitivities within the ZPI that are could be affected in the event of a large spill are:

- water quality
- marine habitats and communities
- protected species
- open water pelagic and benthic habitats
- Glomar Shoal KEF (within the survey area)
- Rankin Bank (within the Rankin Bank Exclusion Zone)
- Montebello Marine Park (survey area is 9 km from the park boundary, and the operational area 15 km buffer lies within the park boundary buffer)
- Rosemary Island, Dampier Archipelago (approximately 29 km south-east of the survey area)
- Dampier Marine Park (approximately 36 km south-east of the survey area)
- Montebello Islands Marine Park (approximately 50 km from the survey area).

##### 5.3.5.2.1 Potential Impacts on Water Quality and Planktonic Organisms

In the event of an oil spill during the activity, the majority of spilled oil will be concentrated in surface waters, either as a surface slick or as entrained oil in near surface waters. The elevated concentrations of dissolved aromatic hydrocarbons associated with surface diesel slicks would likely cause a localised reduction in water quality and may be acutely toxic to organisms present in surface waters in the area of a spill.

Hydrocarbons have been shown to result in detrimental impacts to phytoplankton (González et al. 2009), however studies of planktonic communities following spills of a similar nature to that of a vessel fuel tank spill did not detect statistically significant impacts resulting from hydrocarbon exposure (Varela et al. 2006). Any impacts of a diesel spill to planktonic communities in the pelagic environment would be of short duration given the rate at which the spill would disperse and weather and the dynamic nature of planktonic communities (Davenport et al. 1982).

Consultation with the DoF (now DPIRD) and the Western Australian Fishing Industry Council (WAFIC) indicated the Davros Extension MC3D survey area might overlap the spawning range of several species that may be exploited commercially within the region (Table 3-1). No other fishery stakeholders consulted (Section 8) identified concerns over fish spawning in the survey area. Most fish species in the region have a planktonic egg and larval phase, during which they will not be able to avoid dissolved or entrained hydrocarbon plumes. However, species with long spawning seasons will likely have a smaller part of the larval population affected by an oil spill (Langangen et al. 2017). Both dissolved and entrained hydrocarbons

have been shown to affect the development of fish eggs and larvae (Tilseth et al. 1984; Couillard et al. 2005). The entrained and dissolved hydrocarbon concentrations may be high enough during the first few hours after the spill to affect fish eggs or larvae. This localised effect is not expected to have any population level impacts.

#### 5.3.5.2.2 Potential Impacts to Protected Areas and Other Marine Habitats and Communities

Benthic habitats within the ZPI are unlikely to be affected directly by spilled MGO, as the hydrocarbons are buoyant and will remain in the surface waters (either as a surface slick, dissolved or entrained oil). The DoEE has identified the risk of oil pollution (from shipping, oil rigs) as of “less concern” to the environmental values of the Glomar Shoal KEF. The shallowest parts of the Glomar Shoal and Rankin Bank are 22 m and 19 m deep (respectively) and the hydrocarbon plume is unlikely to reach the seabed in these depths. The ancient coastline and continental slope demersal fish communities KEF is even deeper and much less likely to be affected.

Only entrained oil could be expected to potentially impact upon benthic habitats at the Glomar Shoal, as dissolved oil concentrations would be localised to the immediate vicinity of the release location, and surface oil will not contact benthic habitats. The potential for entrained oil to contact benthic habitats is low.

MGO has a low-level of persistence, and will transition from the early stage processes (evaporation and spreading) to the later stage processes (entrainment and dissolution) quicker than a spill of crude oil. Weathering and fate modelling of MGO, under varying current and wave conditions shows that approximately 40% mass is predicted to evaporate over six hours, with 60 to 70% mass expected to evaporate within two days (Inpex 2009). The heavier hydrocarbon compounds remaining after evaporation will remain on the sea surface as a slick and degrade and disperse naturally.

At the boundary between the slick and the seawater, waves and turbulence can cause the slick to fragment and droplets of varying sizes, become mixed with the upper levels of the water column. Larger, denser droplets rise to the surface and coalesce with the slick; however some of the smaller droplets whose densities are closer to that of seawater will remain suspended (“entrained” or “naturally dispersed”) in the water column. Weathering and fate modelling for MGO shows that, under varying current and wave conditions, approximately 35% of the spilled oil could be entrained within the surface waters after five hours (Inpex, 2009).

Initial dispersal of spilled oil into the surface waters (entrainment) is related to the physical conditions on site. Depth of dispersal is related to wave height with buoyancy and further mixing controlling subsequent dispersion. As a rule, the initial dispersal depth is approximately 1.5 times the wave height (Nilsen et al. 1985; Delvigne and Sweeney 1988).

Site conditions at Glomar Shoal and Rankin Bank indicate average wave height of approximately 1 m; therefore highest concentrations of hydrocarbons would extend to approximately 1.5 m from the sea surface. Lower concentrations of weathered oil may reach deeper in the water column under a small subset of sea conditions, where initially entrained hydrocarbons are prevented from surfacing due to ongoing mixing.

Confidential modelling undertaken for the Polarcus Rosemary MSS EP in the same area as the Davros Extension MC3D survey area indicated that the entrained component of spilled diesel would be concentrated in the surface few metres of the water column. There was a <10% chance of low concentrations (10 ppb) contacting the seabed on Glomar Shoal in < 25 m water depth. The toxicity of the entrained oil is low at this concentration. This is a typical fate for spilled diesel, as seen in other spill modelling (APASA pers. comm.).

Benthic macroalgae and filter feeding communities exposed to MGO may experience sub-lethal impacts such as reduced growth and reproduction at lower hydrocarbon concentrations. While most research has been conducted on crude oil and dispersant effects, the results provide an indication of relative sensitivity of various communities. Given the range of benthic habitats in the ZPI are well represented in the region and across other shoals, and the relatively small probability of contact with entrained oil with benthic habitats at the shoal, impacts of an oil spill on protected areas and benthic habitats within the ZPI are expected to be localised and relatively minor, with rapid (<1 year) natural recovery.

#### 5.3.5.2.3 Potential Impacts to Fish and Sharks

Glomar Shoal hosts a variety of species of finfish, including a number of commercially important species in the families Lutjanidae and Lethrinidae. Whale sharks often feed on dense aggregations of prey (e.g. krill, bait fish) close to the sea surface (Colman 1997) and could therefore encounter surface diesel slicks. Sharks and finfish are not likely to be affected by surface oiling, however individuals in surface waters may be affected by dissolved and entrained hydrocarbons from an MGO spill.

Fish may be adversely affected if the oil coats their gills, reducing respiratory efficiency and increasing the incidence of irritation and infection. Fish may also ingest hydrocarbon droplets or contaminated food, leading to reduced growth and hydrocarbon tainting of their flesh, possibly making them unfit for human consumption. Within the NWMR, bony fish are identified as of “less concern” to pressures arising from oil pollution (Commonwealth of Australia 2012d).

Given that sharks and fishes are mobile fauna, they are expected to be able actively avoid high concentrations of dissolved and entrained oil, which would only be present for less than one day. As such, no long-term impacts to sharks and fishes are expected.

#### 5.3.5.2.4 Potential Impacts to Marine Turtles

Marine turtles are vulnerable to the effects of hydrocarbon spills at all life stages (eggs, post-hatchlings, juveniles and adults) whilst in the water or onshore (NOAA 2010). Contact with hydrocarbons can have lethal or sub-lethal physical or toxic effects or impair mobility. Marine turtles are in frequent contact with the sea surface and they may also feed at or below the water surface or rest at the surface. This frequent contact with the sea surface and apparent lack of avoidance behaviour makes turtles susceptible to coating with spilled hydrocarbons and inhalation of toxic hydrocarbon vapours. On contact with surface slicks, turtles may experience irritation and injury to airways or lungs, eyes and mucous membranes of the mouth and nasal or other cavities, with the toxic components affecting respiration, salt gland function and blood chemistry (NOAA 2010; Shigenaka 2010). Hydrocarbons are highly toxic to turtle eggs, if a spill reaches the shore it may be uncovered by marine turtle nesting behaviour resulting in sticky oil adhering to adults, eggs or hatchlings causing both physical (smothering) and physiological (toxic) effects (Commonwealth of Australia 2017).

The inter-nesting BIA and habitat critical for survival for flatback turtles are the only BIA and habitat critical for survival identified for any marine turtle species that overlaps a part of the Davros Extension MC3D survey area (Figure D-2). However, there is no evidence that interesting flatback turtles swim out into deep offshore waters during inter-nesting and a habitat suitability map for the for the North West Shelf, developed in a recent study by Whitlock et al. (2016) (described in Section 3.1.3.3.2), demonstrates that inter-nesting flatback turtles are unlikely to be encountered in the survey area (Figure D-2). Post-nesting flatbacks and other marine turtle species may be encountered, although this is likely to be limited to individuals transiting through the survey area, which is not part of a recognised migration route for any species of marine turtle.

On the basis of current information, acute chemical and terrestrial discharge of pollutants (including spills from land sources, vessels, drilling operations and natural sources) has been identified as being of “high risk” for all marine turtle genetic stocks with a dispersal range that includes the survey area, other than the Western Australian hawksbill turtle (moderate risk) and leatherback turtles (low risk). The relevant actions identified in the Commonwealth of Australia (2017) recovery plan to minimise impacts from chemical and terrestrial discharge and the alignment of the EP are shown in Table 5-47.

Table 5-8Given the limited spatial and temporal extent of the ZPI associated with the worst-case oil spill scenario assessed and the unlikely presence of turtles within the survey area, it is considered extremely unlikely that a significant number of turtles would be impacted in the event of an oil spill.

**Table 5-47: Recovery Plan for Marine Turtles in Australian Waters (Commonwealth of Australia 2017) and Alignment with the Davros Extension MC3D MSS EP**

| Recovery Plan Action | Alignment with EP |
|---|---|
| **Minimise chemical and terrestrial discharge** | |
| Ensure spill risk strategies and response programs adequately include management for marine turtles and their habitats, particularly in reference to slow to recover habitats, e.g. nesting habitat, seagrass meadows or coral reefs. | Best practise spill risk strategies and response programs have been developed. Pollutants will be managed at the source, limiting the potential for discharge to the marine environment. If primary mitigation fails and a minor spill occurs, the Shipboard Oil Pollution Emergency Plan (SOPEP) will be implemented (Section 6.3.5.3) to minimise impacts marine turtles. The Oil Pollution Emergency Plan (OPEP) will be implemented to manage larger spills (Section 7.8).<br>Response actions will be based on a Net Environmental Benefit Analysis (NEBA) approach which considers the advantages and disadvantages of the different spill response options to determine if there would be a net environmental benefit resulting from the implementation of a particular response (Section 6.3.6.3). Key receptors including marine turtles and their associated habitats will be taken into account to determine the appropriate response strategy as part of the NEBA.<br>Type I Operational monitoring will be undertaken to inform AMSA about the behaviour likely trajectory and key sensitivities at risk from a spill. Scientific (Type II) Monitoring would be triggered and implemented if there is a reasonable expectation that there may be adverse impacts to marine biota or habitats in the area. |

#### 5.3.5.2.5 Potential Impacts to Cetaceans

Potential exposure of cetaceans to spilt MGO would require the coincident occurrence of fauna within the area of a recent spill. Direct contact with hydrocarbons appears to have little deleterious effect on whales, although inhalation of evaporated toxic components may pose a greater risk (Volkman et al. 1994). The greatest potential for respiratory damage would be in the first few hours immediately following a spill before the aromatic components evaporate (Kagi et al. 1988; Neff et al. 2000).

Cetaceans may encounter spilled oil if surfacing to breathe within the ZPI, with inhalation of hydrocarbon vapour considered being the most likely exposure pathway. Physical contact with surface slicks and entrained oil from surface fouling or through ingestion of hydrocarbons may result in irritation of sensitive membranes such as the eyes, mouth, digestive and respiratory tracts and organs, impairment of the immune system or neurological damage (Etkins 1997). Cetaceans are generally able to metabolise and excrete limited amounts of hydrocarbons, but acute or chronic exposure poses greater toxicological risks (Grant & Ross 2002). Such impacts may include changes in behaviour and reduced activity, including inflammation of the mucous membranes, lung congestion, pneumonia, liver disorders, and neurological damage (Geraci & St Aubin 1990).

The southern boundary of the survey area lies adjacent to the BIA for humpback whales, and northbound whales may pass through the area as evident from mapped migratory routes (Figure B). On the basis of current information, oil pollution (from shipping, oil rigs) has been identified as being “of less concern” for humpback whales (Commonwealth of Australia 2012a), probably due to the rarity of significant spill events.

In addition, pygmy blue, Bryde’s and Antarctic minke whales as well as other toothed whales (sperm whales, killer whales, dolphins) may be encountered in the vicinity of the survey area, although they are unlikely to be present in significant numbers as the area is not known to be used for feeding, breeding or resting aggregations by any of these species. The survey area is well outside the BIA for migrating pygmy blue whales (Figure B); therefore, this species is unlikely to be encountered during the survey.

Given the relatively small area and rapid dispersion of gas-phase components in the air, volatile hydrocarbons from a fuel tank oil spill will not affect a significant proportion of any population of cetacean.

Other exposure routes such as fouling and direct / indirect ingestion are not expected to result in significant impacts given that cetaceans are unlikely to be present in significant numbers in the survey area or ZPI.

#### 5.3.5.2.6 Potential Impacts to Seabirds

Many seabirds forage widely across the NWMR. Seabirds rafting on the surface of the water are vulnerable to the effects of a hydrocarbon spill as the oil clings to their feathers thereby reducing the insulating properties of their plumage, which may subsequently lead to hypothermia and possibly eventual mortality. Birds are also vulnerable to the toxic effects of hydrocarbons through ingestion of contaminated prey. Critical habitats, particularly sites for overwintering populations feeding in the coastal and near shore waters, are unlikely to be impacted by a spill offshore and are well outside the ZPI.

Seabirds in the vicinity of the operational area may include species such as the wedge-tailed shearwater and the eastern osprey. Shearwaters are considered seasonal visitors to the area, generally arriving in August and departing in April (Johnstone et al. 2013). Nesting sites will not be directly affected in the event of an oil spill; however, adults foraging as sea may encounter spilled oil. The eastern osprey is unlikely to be encountered as this species is found in littoral and coastal habitats and on offshore islands and is unlikely to be present in the survey area due to the absence of emergent features.

A hydrocarbon spill may result in a surface slick(s) at concentrations that may affect seabirds; however, a diesel spill would be short-lived and would not result in significant impacts at a regional population level. Impacts would likely consist of oiling of foraging seabirds in the vicinity of a surface slick, with potentially sub-lethal and lethal effects.

#### 5.3.5.2.7 Potential Socio-Economic Impacts

The potential impacts from a surface slick would likely be indirect, i.e. exclusion of fishers from areas they normally fish due to the presence of surface diesel slicks, and/or oiling of vessel hulls and trap gear (traps, buoys, lines) if the equipment is deployed or retrieved through surface slicks. Direct (toxicity) effects on target demersal species are considered to be unlikely due to the low probability of contact of entrained oil on the seabed or Glomar Shoal.

Hydrocarbon presence on the sea surface may create a safety hazard to other marine users. Volatilisation of hydrocarbons at the sea surface would present a potential fire hazard. Safety hazards associated with the release quickly reduce with distance and time from release. On this basis, safety impacts to third party marine users should only be experienced within very small distance of the spill source and within a short time of release given the weathering characteristics of MGO. Timely warnings would be issued to keep other mariners away from the ZPI.

As described in Section 3.2.1 and Section 5.2.3, interactions with commercial fisheries will be unlikely or limited to a few relevant fisheries. This is due to the large fishing areas the majority of the fisheries operate, the limited or in some cases, absence of fishing activity in recent years and the geographic locations that many of the fisheries operate (e.g. close to the mainland coastline for prawns). The ZPI will therefore overlap only a small portion of the overall fishing area and the slick will only be present for a limited time.

### 5.3.5.3 Inherent Risk Assessment

As fuel is required for the duration of the activity, there is no way to eliminate the potential risks associated with an accidental release of hydrocarbons in the event of a spill. Potential impacts could result in moderate disruption and short-term effects (months) marine fauna (via smothering, ingestion, toxicity) (e.g. inter-nesting flatback turtles, migrating seabirds), and localised/medium term effects (months) on Rankin Bank and Glomar Shoal communities. However, no overall threat to populations is predicted. This is a Severe consequence.

Given the range of benthic habitats in the ZPI are well represented in the region and across other shoals, and the relatively low probability of contact with entrained oil with benthic habitats at >19 or 22 m water depth in the shallowest parts of the exclusion zones on Rankin Bank and Glomar Shoal, impacts of an oil spill on

benthic habitats within the ZPI are expected to be localised and relatively minor, with rapid (<1 year) natural recovery. In addition, mobile fauna (fish, sharks, marine turtles and cetaceans) are expected to avoid high concentrations of dissolved and entrained oil actively. As such, no long-term impacts to mobile marine fauna are expected. The rapid dispersion of the spilled diesel would rapidly reduce the risk of fish tainting and gear contamination to recreational and commercial fishers in the area. The likelihood of this impact is Unlikely. The inherent risk is Medium. Control Measures

Table 5-48 presents the control measures that CGG during the Davros Extension MC3D MSS to manage any potential impacts associated with the accidental oil spill from refuelling or vessel collision.

**Table 5-48: Control Measures for Accidental Oil Spill (Refuelling and Vessel Collision)**

| Control Measures | |
|---|---|
| Good Practice | Compliance with MARPOL 73/78 Annex I (as applied in Australia under the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*)); and AMSA Marine Orders – Part 91 Marine Pollution Prevention – Oil):<br>■ current SOPEP in place<br>■ survey vessels hold a valid IOPP Certificate, where required, under vessel class. |
| | Survey vessel will be compliant with Marine Orders Part 30: Prevention of Collisions (Issue 8) and Marine Orders Part 21: Safety of navigation and emergency procedures, Issue 8, specifically the use of standard maritime safety procedures (including radio contact, display of navigational beacons and lights). |
| | The Australian Hydrographic Service (AHS) advised of the survey details (survey location, timing) four weeks prior to mobilisation and following demobilisation for issue of Notice to Mariners. |
| | AMSA's RCC will be advised of the survey vessel's details (including vessel name, call-sign and Maritime Mobile Service Identity (MMSI)), satellite communications details (including INMARSAT-C and satellite telephone), area of operation and requested clearance from other vessels. This information will be notified to AMSA RCC 24 to 48 hours before operations commence via email address (rccaus@amsa.gov.au) or phone (1800 641 792 or +61 2 6230 6811) |
| | AMSA RCC will be notified at the end of the survey when operations have been completed (via email address (rccaus@amsa.gov.au) or phone: 1800 641 792 or +61 2 6230 6811). |
| | Support vessel(s) will undertake surveillance (during a spill) and manage interactions with other marine users" vessels transiting near the seismic vessel or streamers |
| | Survey vessel only uses MGO fuel oil. |
| | AMSA consulted to ensure agreement in place for SOPEP interface with NATPLAN, once survey vessel has been identified. |
| | The SOPEP and OPEP are approved, tested (emergency response drills) and can be implemented in the event of a spill. |
| | AMSA RCC will be notified verbally immediately in the event of any oil or diesel spills to sea to ensure prompt and appropriate mobilisation of relevant response plans. AMSA will also be provided with a written marine pollution form (POLREP). |
| | Implementation of the SOPEP or OPEP, as required. Support provided to AMSA (Control Agency) in oil spill response if required. |
| | Responsibilities of survey crew under the OPEP and SOPEP are included as part of the project induction |
| | Vessel to maintain appropriate lighting, navigation and communication at all times to inform other users of the position and intentions of the survey vessel, in compliance with the Navigation Act 2012 and Chapter 5 of the SOLAS Convention. |

| Control Measures | |
|---|---|
| | Refuelling at sea subject to CGG Bunkering Offshore Instruction (MAR MSS PRC 007E), and Resupply Operations at Sea Standard Operating Procedure (MAR MSS PRC 002E):<br>■ refuelling of vessels will be undertaken under favourable wind and sea conditions as determined by the Vessel Master<br>■ refuelling will take place during daylight hours only<br>■ Job Hazard Analysis (JHA), bunkering checklist or equivalent in place and reviewed in toolbox meeting before each fuel transfer<br>■ all valves and flexible transfer hoses checked for integrity prior to use; dry break couplings (or similar) in place for all flexible hydrocarbon transfer hoses |
| | Continuous (24 hour) survey operations, with survey team and bridge crew monitoring for other vessels at all times during seismic acquisition |
| | Implementation of response measures within the CGG Event Management Standard Operating and Crisis Management Procedures in the event of a spill |
| | Spill response bins/kits are maintained and located in close proximity to hydrocarbon storage areas and deck areas for spill recovery / containment. |
| | Undertake a net environmental benefit assessment (NEBA) of spill response strategies in conjunction with AMSA (if required). |
| | CGG will ensure adequate forms of financial assurance in place to meet the cost of spill response and rehabilitation |

### 5.3.5.4 Demonstration of ALARP and Risk Acceptability

#### 5.3.5.4.1 Summary of ALARP Demonstration

CGG is committed to ensuring continual risk reduction and identifying if additional control measures may be applied that are not disproportionate to the sacrifice (e.g. cost) of implementation and has considered the additional measures in Table 5-49. Control measures have not been adopted where the cost of implementation is disproportionate to the benefit gained. CGG has applied a precautionary approach for Glomar Shoal, Rankin Bank and within the protected marine areas (Commonwealth and State), through adoption of additional controls to preclude routine discharges within the shallow areas over Glomar Shoal and Rankin Bank and also within the boundaries of the CMRs.

CGG considers the adopted controls to be appropriate in reducing the environmental risks and impacts associated with accidental oil spill from refuelling or vessel collision to ALARP. No other controls measures have been identified that may practicably or feasibly be adopted to further reduce the risks and impacts without disproportionate costs compared to the benefit of risk reduction. There are no other controls measures that may practicably or feasibly be adopted to reduce the risks and impacts further without disproportionate costs compared to the benefit of the potential risk reduction.

**Table 5-49: Demonstration of ALARP for Accidental Oil Spill (Refuelling and Vessel Collision)**

| Additional Control Measures | Practicability / Effectiveness? | Cost Benefit Analysis | Risk Reduction (L/C/RR ↓)? | Control Adopted |
|---|---|---|---|---|
| **Precautionary Approach** | | | | |
| No refuelling within 3 NM of 25 m depth contour over Glomar Shoal and Rankin Bank. | P: Yes<br>E: Effective (+) | Glomar Shoal is a Key Ecological Feature and Rankin Bank an important area for fish assemblages. Refuelling at sea is the mostly likely source of a small oil spill taking place. Minor cost involved in planning refuelling to avoid this area of higher sensitivity; benefits outweigh costs. | Yes | Yes |

| Additional Control Measures | Practicability / Effectiveness? | Cost Benefit Analysis | Risk Reduction (L/C/RR ↓)? | Control Adopted |
|---|---|---|---|---|
| No refuelling within 3 NM of Commonwealth and State approved or proposed marine protected areas (including Montebello and Dampier Marine Parks, Montebello Islands Marine Park and Dampier Archipelago Proposed Marine Park) | P: Yes<br>E: Effective (+) | This control aligns with the transitional management arrangements under the EPBC Act which only allows commercial vessel transit through Marine Parks as *"being continuous passage of a vessel through an area by the shortest direct route without any other activity being carried on"* (Director of National Parks 2013b). Also aligns with the Montebello marine park management plan policy of "encouraging zero discharge where alternatives exist" (DEC 2007). Precautionary approach applied in adopting this control for the Dampier Archipelago Proposed Marine Park. Minor cost involved in planning refuelling to avoid these areas to meet transitional management requirements; benefits outweigh costs. | Yes | Yes |
| Avoiding refuelling at sea by bringing seismic vessel to port for refuelling | P: No - Bringing vessel to port will cause project delays and increase vessel costs significantly.<br>E: Fairly effective<br>(0) – risk reduced in survey area. | Costs disproportionate to the benefits gained. | Yes | No |

#### 5.3.5.4.2 Residual Risk

The consequence of moderate disruption and short-term effects (months) marine fauna (via smothering, ingestion, toxicity) (e.g. inter-nesting flatback turtles, migrating seabirds), and localised/medium term effects (months) on Rankin Bank and Glomar Shoal communities remains Severe.

With the implementation of the control measures described in Table 74 and additional controls adopted from the ALARP assessment in Table 75, including implementation of the SOPEP and OPEP, exposure of oil to marine receptors is reduced to in the vicinity of the discharge. Spilled fuel would rapidly evaporate and disperse, the spill would last for less than a day, and the ZPI will not include very shallow waters (<10 m). No contact with benthic habitats is predicted. The likelihood of this impact during the survey is reduced to Rare. The residual impact is therefore **Medium**.

#### 5.3.5.4.3 Acceptability

The residual impact of accidental oil spill (refuelling / vessel collision) complies with CGG's internal context (medium risk with additional controls adopted), will be managed in accordance with relevant legislative requirements and complies with industry good practice and the principles of ESD.

Any concerns raised by stakeholders have been assessed and control measures adopted where appropriate. The risk assessment has determined that, with the implementation of the adopted control measures, accidental oil spill associated with refuelling and/or vessel collision will not result in a potential impact greater than a temporary and localised reduction in water quality and effects on biological receptors in the vicinity of the discharge. The spatial and temporal extents of the spill will depend on the volume of oil spilled, characteristics of the spilled oil, the way in which the oil weathers and the metocean conditions at the time of the spill. However, in the warm, well-mixed marine waters of the Davros Extension MC3D survey area spilled fuel would rapidly evaporate and disperse, the spill would last for less than a day, and the ZPI will not include very shallow waters (<10 m). No contact with benthic habitats is predicted. Further

opportunities have been investigated (including application of a precautionary approach to refuelling over Commonwealth and State marine protected areas, Glomar Shoal KEF and Rankin Bank) to reduce the risks and potential impacts. The ALARP assessment demonstrates that the adopted controls (Table 5-48 and Table 5-49) are appropriate to reduce the impact to ALARP without the further impact reduction being required. Recovery Plan Actions identified for marine turtles to minimise impacts from marine pollution (oil spills) are aligned with the control measures adopted in this EP for the survey (Table 5-47).

Given the nature and scale of the activity, CGG consider that the potential impacts are of an acceptable level as the predicted impacts are within and below the defined acceptable levels of impact in accordance with the criteria defined in Table 4-4.

#### 5.3.5.5 Environmental Performance Outcomes, Standards and Measurement Criteria

The environmental performance outcomes, standards and measurement criteria appropriate to measure performance of the adopted control measures for accidental oil spills are presented below in Table 5-50. Environmental performance standards and relevant measurement criteria have been developed for each control measure identified in Table 5-48 and each additional control adopted from the ALARP assessment in Table 5-49.

**Table 5-50: Environmental Performance Outcomes, Standards and Measurement Criteria for Oil Spills (Refuelling and Vessel Collision)**

| Environmental Performance Outcome | Control Measures / Environmental Performance Standards | Measurement Criteria |
|---|---|---|
| No oil spills in sensitive marine environments during the activity. | Compliance with MARPOL 73/78 Annex I (as applied in Australia under the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*)); and AMSA Marine Orders – Part 91 Marine Pollution Prevention – Oil):<br>■ current SOPEP in place<br>■ survey vessels hold a valid IOPP Certificate, where required, under vessel class. | Records demonstrate the SOPEP is in place on the survey vessel |
| | | Records demonstrate the survey vessel holds an IOPP certificate, if required under vessel class |
| | Survey vessel will be compliant with Marine Orders Part 30: Prevention of Collisions (Issue 8) and Marine Orders Part 21: Safety of navigation and emergency procedures, Issue 8, specifically the use of standard maritime safety procedures (including radio contact, display of navigational beacons and lights). | Records demonstrate compliance with standard maritime safety procedures and equipment. |
| | The SOPEP and OPEP are approved and tested prior to the survey vessel commencing acquisition (emergency response drills) and can be implemented in the event of a spill. | Records demonstrate the SOPEP and OPEP are approved, tested (desktop exercise) and available to relevant persons on the survey vessel. |
| | | Records demonstrate that SOPEP/OPEP drills have taken place immediately prior to the start of the survey. |
| | The Australian Hydrographic Service (AHS) advised of the survey details (survey location, timing) four weeks prior to mobilisation and following demobilisation for issue of Notice to Mariners. | Records of notification of survey details sent to the AHS four weeks prior to survey mobilisation and within two weeks of survey demobilisation. |
| | AMSA's RCC will be advised of the survey vessel's details (including vessel name, call-sign and Maritime Mobile Service Identity (MMSI)), satellite communications details (including INMARSAT-C and satellite telephone), area of operation and requested clearance from other vessels. This information will be notified to AMSA RCC 24 to 48 hours before operations commence via email address (rccaus@amsa.gov.au) or phone (1800 641 792 or +61 2 6230 6811) | Pre-survey notification demonstrates that AMSA RCC have been notified of the survey vessel details and movements 24 to 48 hours prior to the start of the survey. |
| | AMSA RCC will be notified at the end of the survey when operations have been completed (via email address (rccaus@amsa.gov.au) or phone: 1800 641 792 or +61 2 6230 6811). | End of survey notification demonstrates that AMSA RCC have been notified of the completion of survey operations. |
| | Support vessel(s) will undertake surveillance (during a spill) and manage interactions with other marine users vessels transiting near the seismic vessel or streamers | Support vessel log confirms is employed for the duration of the activity and manages |

| Environmental Performance Outcome | Control Measures / Environmental Performance Standards | Measurement Criteria |
|---|---|---|
| | Survey vessel only uses MGO fuel oil | Bunkering records demonstrate MGO fuel oil used |
| | Responsibilities of survey crew under the OPEP and SOPEP are communicated to relevant personnel and included as part of the project induction. | Records show that the project induction (including induction material) includes responsibilities of survey crew for response and notification protocols under the OPEP and SOPEP |
| | All relevant crew trained in implementation of the OPEP and SOPEP. | Training, induction and competency matrix to confirm that crew have been trained on implementation of the OPEP and SOPEP prior to commencing seismic data acquisition. |
| | Survey vessel to maintain appropriate lighting, navigation and communication at all times to inform other users of the position and intentions of the survey vessel, in compliance with the *Navigation Act 2012* and Chapter 5 of the SOLAS Convention. | Records show no failure to comply with requirements for appropriate navigation, lighting and communication during survey, in accordance with the *Navigation Act 2012* and Chapter 5 of the SOLAS Convention. Any records of failure to comply are documented. |
| | Refuelling at sea subject to CGG Bunkering Offshore Instruction (MAR MSS PRC 007E), and Resupply Operations at Sea Standard Operating Procedure (MAR MSS PRC 002E):<br>■ refuelling of vessels will be undertaken under favourable wind and sea conditions as determined by the Vessel Master<br>■ refuelling will take place during daylight hours only<br>■ Job Hazard Analysis (JHA), bunkering checklist or equivalent in place and reviewed in toolbox meeting before each fuel transfer<br>■ both vessels will have a Deck Officer supervising the mooring lines.<br>■ all re-fuelling equipment, including valves and flexible transfer hoses are checked for integrity prior to use; dry break couplings (or similar) in place for all flexible hydrocarbon transfer hoses<br>■ communications between the two vessels will be tested by the Vessel Masters prior to bunkering commencing. | Copies of relevant CGG procedures and work instructions available aboard survey vessel. Records kept of the bridge crew and support vessel confirming receipt of the documents.<br>Records / vessel logs confirm refuelling of vessels undertaken under favourable wind and sea conditions and during daylight hours only.<br>Records of toolbox meeting prior to each fuel transfer, include completed and review of JHA, bunkering checklist or equivalent.<br>Visual inspection (as noted in completed bunkering checklist) verifies that mooring lines were installed.<br>Records shows dry break couplings (or similar) are in place.<br>All re-fuelling equipment, including valves and flexible hydrocarbon transfer hoses have been inspected for integrity prior to use.<br>Completed bunkering checklist is available to verify that communications were tested between both vessels. |
| | All re-fuelling equipment will be maintained in accordance with the PMS to ensure they are operating to design specifications. | PMS records confirm that re-fuelling equipment is maintained to schedule. |
| | No refuelling within 3 NM of the shallowest parts of Glomar Shoal and Rankin Bank (3 NM from 25 m depth contour) for at-sea refuelling operations. | Bunkering records demonstrate that all refuelling operations took place at a distance of >3 NM from 25 m depth contour on Glomar Shoal and Rankin Bank. |

| Environmental Performance Outcome | Control Measures / Environmental Performance Standards | Measurement Criteria |
|---|---|---|
| | No refuelling within 3 NM of Commonwealth and State approved and proposed marine protected areas (including Montebello and Dampier Marine Parks, Montebello Islands Marine Park and Dampier Archipelago Proposed Marine Park). | Bunkering records demonstrate that all refuelling operations took place at a distance of >3 NM from Commonwealth and State approved and proposed marine protected areas. |
| | Continuous (24 hour) survey operations, with survey team and bridge crew monitoring vessel position and depth at all times during seismic acquisition | Records confirm bridge was manned continuously during survey operations, and that survey vessel crew have appropriate qualifications. |
| | Spill response kits are available in relevant locations around each vessel, are fully stocked and used in the event of a spill to deck to prevent or minimise discharge overboard. | Vessel audit/inspection verifies that spill response kits are available in relevant locations in accordance with SOPEP.<br>In the event of spill kit use, the inspection following the spill clean-up confirms used materials (e.g. absorbents) securely stored in covered bins for disposal onshore. |
| | CGG has adequate forms of financial assurance in place to meet the cost of spill response and rehabilitation. | Submission of Financial Assurance Declaration and Financial Assurance Confirmation Forms to NOPSEMA. |
| | | Evidence of financial assurance kept on record by CGG (e.g. copy of insurance certificate of adequate insurance to cover claims associated with credible responses to spill scenarios identified in this EP). |
| | AMSA (via RCC Australia using a POLREP form), NOPSEMA and DMIRS will be notified immediately in the event of any oil spills (>80 L) to sea to ensure prompt and appropriate mobilisation of relevant response plans | Phone records and/or emails to regulatory agencies (AMSA, NOPSEMA and DMIRS) verify contact was made as soon as practicable (or within 2 hours) to report any oil spills >80 L. |
| | Implementation of response measures within the CGG Event Management Standard Operating and Crisis Management Procedures in the event of a spill | Availability of both procedures on survey vessel and record kept of implementation in the event of the spill. |
| | Undertake a net environmental benefit assessment (NEBA) of spill response strategies in conjunction with AMSA (if required). | In the event of a spill, the incident report will include details on the NEBA conducted by AMSA and CGG. |

### 5.3.6 Risk 6 – Oil Spill Response

#### 5.3.6.1 Description of Hazard

In the event of an oil spill, a number of potential responses may be initiated; dependent on advice from the Control Agency (AMSA, refer to Section 6.2), the location and size of the spill, the potential for sensitive environmental receptors to be impacted and the resources available. These responses generally involve additional vessels and may involve equipment and field survey teams. These extra activities introduce additional risks to environmental receptors, as well as increasing the likelihood of many of the risks assessed within this EP.

#### 5.3.6.2 Description of Potential Impacts to Environmental Values

The additional activities associated with a hydrocarbon spill response introduce additional potential impacts and risks to marine fauna and habitats, as well as increasing the likelihood of many of the impacts and risks already described within this EP.

#### 5.3.6.3 Inherent Risk Assessment

Response actions will be based on a Net Environmental Benefit Analysis (NEBA) approach which considers the advantages and disadvantages of the different spill response options to determine if there would be a net environmental benefit resulting from the implementation of a particular response. NEBA takes into account the hydrocarbon type, the sensitivities of the regional area of the spill, and the potential impacts (positive and negative) of the proposed response strategy.

NEBA is used for preliminary assessment to determine the level of spill response required. In the actual event of a spill, the NEBA is revisited regularly as more information becomes available on actual conditions, spill trajectory path and locations of sensitive receptors. This review process allows response strategies to be adjusted to provide optimal results.

#### 5.3.6.4 Control Measures

The following response strategies have been considered for the two credible spill scenarios (Level 1 and Level 2 type spill) under this EP, and are assessed with relevance to the Davros Extension MC3D MSS:

- monitor and evaluate
- mechanical dispersion
- containment and recovery
- shoreline protection
- shoreline clean-up
- chemical dispersion.

Given the location of the proposed Davros Extension MC3D MSS, the preferred strategy for diesel spills will be to allow small spills to disperse and evaporate naturally, and monitor the position and trajectory of any surface slicks to confirm it does not pose a risk to sensitive receptors. Physical break up using propeller wash from the support vessel running repeated transits through the slick may be considered for larger slicks (following consultation with the Combat Agency - AMSA); however, this may affect evaporation rates and increase entrainment, so would generally be avoided. No shoreline contact is expected and diesel rapidly spreads to a very thin sheen, so no clean-up is feasible for spilled diesel on the sea surface. In addition, dispersants would not be used as they are unlikely to be effective on a diesel spill (AMSA 2003) and may reduce the effectiveness of natural degradation processes. This passive response and reliance on natural processes greatly reduces the potential for impacts associated with spill response activities.

Commercial and recreational fishers and other users in the area would be advised of any large spill and associated response activities via CGG's 24-hour 'look-ahead' correspondence. This would minimise the potential for interference with their activities or unnecessary risks to personnel or property.

Table 5-51 presents the control measures that CGG will implement during the activity to manage any potential risks associated with management of oil spill response.

CGG will commit to operational (Type I) monitoring using vessels of opportunity when safe to do so and where the NEBA as agreed with AMSA shows there is a net benefit in doing so. CGG will commit to scientific (Type II) Monitoring would be triggered and implemented if there is a reasonable expectation that there may be adverse impacts to marine biota or habitats in the area.

**Table 5-51: Control Measures for Management of Oil Spill Response**

| Control Measures | |
|---|---|
| Good Practice | In the event of an oil spill, the Survey Vessel Master will implement available controls and resources of the SOPEP. |
| | Response actions will be based on a Net Environmental Benefit Analysis (NEBA) approach which considers the advantages and disadvantages of the different spill response options to determine if there would be a net environmental benefit resulting from the implementation of a particular response. |
| | Commercial and recreational fishers and other users in the area would be advised of any large spill and associated response activities via CGG's 24-hour 'look-ahead' correspondence. |
| | A hydrocarbon spill will be immediately reported to ensure all notifications are provided as per Table 6-1. |
| | Type I Operational monitoring will be undertaken to inform AMSA about the behaviour likely trajectory and key sensitivities at risk from a spill. |
| | Oil spill response training and competencies are to be maintained to avoid unplanned environmental impacts due to human error. |
| | Oil spill response training and competencies are to be maintained to avoid unplanned environmental impacts due to human error. |

### 5.3.6.5 Demonstration of ALARP and Risk Acceptability

#### 5.3.6.5.1 Summary of ALARP Demonstration

CGG is committed to ensuring continual risk reduction and identifying if additional control measures may be applied that are not disproportionate to the sacrifice (e.g. cost) of implementation and has considered the additional measures in Table 5-52. Control measures have not been adopted where the cost of implementation is disproportionate to the benefit gained. CGG considers the adopted controls to be appropriate in reducing the environmental risks and impacts associated with strategies for oil spill response to ALARP. No other controls measures have been identified that may practicably or feasibly be adopted to further reduce the risks and impacts without disproportionate costs compared to the benefit of risk reduction. There are no other controls measures that may practicably or feasibly be adopted to reduce the risks and impacts further without disproportionate costs compared to the benefit of the potential risk reduction.

**Table 5-52: Demonstration of ALARP for Management of Oil Spill Response**

| Additional Control Measures | Practicability / Effectiveness? | Cost Benefit Analysis | Risk Reduction (L/C/RR ↓)? | Control Adopted |
|---|---|---|---|---|
| **Precautionary Approach** | | | | |
| On-call Type II response service agreement | P: Yes<br>E: Effective (+) | CGG recognises the potential for shoreline contact and the values and sensitivities that are present within the ZPI. In the unlikely event that GPS tracking using satellite drift trackers, real-time spill modelling, aerial surveillance, water quality sampling or visual slick estimation is required, CGG can engage 'RPS Australia West' under existing contractual arrangements to provide urgent specialist response services. Given the remote likelihood of the need to implement field response activities using external parties, a response logistics plan has not been developed for the project, but this would be initiated immediately on notification of the spill. The plan would detail logistics, equipment personnel and detailed OSMP plans.<br>The arrangement with RPS provides confidence that based on the priorities of protection and contract conditions, the services for this capacity can be engaged in a timely manner should triggers for initiation be met. | Yes | Yes |
| Pre-activity monitoring program and development of a detailed Type II Monitoring Plan. | P: No<br>E: Fairly Effective (0) | CGG do not consider it practicable to undertake monitoring or development of a detailed Type II monitoring program in response to the unlikely risk of a hydrocarbon spill. The characteristics of MGO described in Section 5.3.5.1.1 will likely result in rapid dispersion. In addition CGG has described controls within this EP that will reduce risks of vessel collision; ensure offshore refuelling activities away from marine protected areas and other areas of high ecological importance; implementation of SOPEP to prevent loss of entire tank contents; and as mentioned above CGG have arrangements in place with RPS for Type II monitoring prior to the commencement of the activity. | No | No |
| Additional response equipment on board support vessel | P: No<br>E: Ineffective (-) | It is not reasonable for additional resources to be provided and maintained on support vessels in the unlikely event of a spill. These vessels are already equipped to best practice levels, supported by the NATPLAN. Additional vessels may be required to carry larger equipment (e.g. booms) which increases the overall risk. | No | No |
| Arrangements for aerial monitoring | P: No<br>E: Very Ineffective (--) | CGG do not believe that these resources could be mobilised faster than what can already be achieved under the NATPLAN. It is also not reasonable for helicopter contracts to be in place with service providers to ensure that these are available as resources of opportunity in the event of a spill. This could limit available helicopters to achieve the primary objectives of a response, and may require additional storage of fuels onboard the vessel.<br>Cost Benefit analysis is not possible as this is not a viable option. | No | No |

| Additional Control Measures | Practicability / Effectiveness? | Cost Benefit Analysis | Risk Reduction (L/C/RR ↓)? | Control Adopted |
|---|---|---|---|---|
| Oiled wildlife response, oil spill modelling or shoreline clean-up arrangements | P: No<br>E: Effective (+) | Not practicable for CGG to pursue. This would require equipment, resources, maintaining appropriate levels of training, maintenance and a number of supporting requirements that will introduce costs to the activity. In addition, the NATPLAN provides for the transitional arrangements for managing this risk with the State arrangements.<br>Oil spill trajectory modelling arrangements are in place under the NATPLAN (AMSA 2014).<br>Shoreline clean-up is unlikely to be needed, though CGG acknowledges the potential risks of shoreline contact. Given that CGG has committed to only using MGO as the primary fuel source, this ensures that persistence of a potential spill is short lived and that shoreline operations are more likely to be required only in a monitoring capacity. There are transitional arrangements in place under the NATPLAN, and CGG do not consider there to be any net benefit in securing resources to achieve the same outcome. | No | No |

#### 5.3.6.5.2 Residual Risk

The consequence of oil spill response will depend on the response strategies adopted as a result of the NEBA. Ecological and socio-economic benefits and drawbacks of each feasible response option would be weighed as part of the NEBA process, and the best response options for a given spill scenario would selected based on which combination of tools and techniques will minimise impacts and to reduce the residual risk of the response to **Low**.

#### 5.3.6.5.3 Acceptability

The residual impact of oil spill response complies with CGG's internal context (low risk), will be managed in accordance with relevant legislative requirements and complies with industry good practice and the principles of ESD. Any concerns raised by stakeholders will be assessed and taken into account where feasible and appropriate during the NEBA process.

Given the nature and scale of the activity, CGG consider that the potential impacts are of an acceptable level as the predicted impacts are within and below the defined acceptable levels of impact in accordance with the criteria defined in Table 4-4.

### 5.3.6.6 Environmental Performance Outcomes, Standards and Measurement Criteria

The environmental performance outcomes, standards and measurement criteria appropriate to measure performance of the adopted control measures for accidental oil spills are presented below in Table 5-53. Environmental performance standards and relevant measurement criteria have been developed for each control measure identified in Table 5-51 and each additional control adopted from the ALARP assessment in Table 5-52.

**Table 5-53: Environmental Performance Outcomes, Standards (Control Measures) and Measurement Criteria for Management of Oil Spill Response**

| Environmental Performance Outcome | Control Measure / Environmental Performance Standard | Measurement Criteria |
|---|---|---|
| Spill response arrangements to minimise impacts to the environment implemented in accordance with the vessel SOPEP and OPEP in this EP | In the event of an oil spill, the Survey Vessel Master will implement available controls and resources of the SOPEP. | Incident and POLREP reports. |
| | Response actions will be based on a Net Environmental Benefit Analysis (NEBA) approach agreed with AMSA. | NEBA report. |
| | Notifications in the event of a Level 1 or Level 2 spills will be carried out as per Table 6-1. | Copies of written notifications and POLREP report(s) required as per Table 6-1. |
| | The Survey Vessel Master is responsible for notification (verbal) of a spill to the sea to the AMSA RCC and reporting. | Copies of marine pollution report (POLREP) report and situation reports (SITREPs) |
| | Commercial and recreational fishers and other users in the area would be advised of any large spill and associated response activities via CGG's 24-hour 'look-ahead' correspondence. | Copies of stakeholder notifications and incident report in the event of a spill. |
| | Support vessels undertaking the MSS are used as vessels of opportunity to monitor the spill (Type I operational monitoring) if safe to do so and where NEBA identifies a net benefit to do so (as agreed with AMSA). | Incident Report / Consultation records<br>NEBA Report |
| | On-call Type II response service agreement. | Copy of service contract with RPS prior to commencement of the survey. |

# 6.0 Implementation Strategy

Regulation 14 of the OPGGS (E) Regulations requires the activity to have an implementation strategy in place that describes the specific measures and arrangements that will be implemented for the duration of the activity to ensure that:

- All of the environmental impacts and risks of the activity will be continually identified and reduced to a level that is ALARP.
- Control measures detailed in the EP are effective in reducing the environmental impacts and risks of the activity to ALARP and acceptable levels.
- Environmental performance outcomes and standards set out in the EP are being met.
- Adequate arrangements are in place to respond to, and monitor impacts of, oil pollution emergencies.
- Stakeholder consultation with relevant authorities and other relevant interested persons is maintained throughout the activity as appropriate.

CGG's implementation strategy for this EP has been developed to comply with the above requirements and aims to enforce the objectives described in CGG's environmental management system (EMS).

The Implementation Strategy in the EP describes:

- CGG's HSE Management System
- Review of environmental performance
- Roles and responsibilities
- Training and competencies
- Monitoring, auditing and management of non-compliance
- Reporting
- Ongoing stakeholder consultation
- Emergency response; and
- Oil Pollution Emergency Plan

## 6.1 Environmental Performance Monitoring

CGG will monitor the performance of the control measures during the activity in line with the Project-specific HSE Plan. Environmental performance during the survey will be reviewed to ensure that:

- EPOs and EPS' are being met, reviewed and where necessary amended (in order to continue to reduce the environmental impacts and risks of the activity to ALARP).
- Potential non-compliances and opportunities for continuous improvement are identified and corrective actions implemented.
- All environmental monitoring requirements have been met before completing the activity.

The following arrangements will be established to review the environmental performance of the activity:

- Inspections of the vessels will be carried out before and during the survey to ensure that procedures and equipment for managing routine discharges and emissions are in place to enable compliance with the EP.
- The performance of key equipment as described in this EP (i.e. oil in water separator) will be checked at least weekly to ensure ongoing reduction of risks and impacts to ALARP, and any potential issues (i.e.

observations of poor operating condition/performance or non-conformances) are continually monitored and raised as soon as practicable.

- A summary of the EP commitments for the activity will be distributed aboard the survey vessel, and implementation of the environmental performance standards will be monitored by the CGG Client Site Representative.

Any non-compliance with the EPS outlined in this EP will be subject to investigation and follow-up action.

CGG will also undertake an internal review of the environmental performance of the Davros Extension MC3D MSS at the conclusion of the survey. The review will consider:

- an evaluation of conformance with the Compliance Register
- improvements to the implementation strategy included within the EP
- compliance with CGG Policies, Manuals and Procedures
- the management of any non-conformances identified during the survey, including reportable and recordable incidents
- any concerns identified by stakeholders during and after the completion of the survey, followed by appropriate liaison as required
- outcomes of any NOPSEMA audit reports and feedback.

## 6.2 Audits and Inspections

CGG will maintain a Compliance Register which will serve as an audit tool during the Davros Extension MC3D MSS. The register will be sufficiently detailed in order to demonstrate that the environmental performance outcomes and standards included in this EP have been met. The register will detail:

- the EPO and EPS for the Davros Extension MC3D MSS
- measurement criteria to enable an auditor to determine if the Davros Extension MC3D MSS has complied with the relevant performance standards
- the person/party responsible for implementing management measures to meet the environmental performance objective.

Prior to the survey, CGG will undertake:

- a vessel audit/inspection to confirm that the vessel management systems are consistent with the environmental management controls detailed in this EP. This will ensure that procedures and equipment for managing routine discharges and emissions are in place to enable compliance with the EP. The audit will be documented and any corrective actions closed out
- a review of the risk of IMS, potentially including an inspection to confirm that the vessel does not pose an unacceptable risk of IMS
- an audit of the on-board spill response capability of the CGG vessel against its SOPEP and relevant controls in this EP, to verify spill preparedness.

Compliance will be monitored on a regular basis by the Client Site Representative, or delegate, via mechanisms including fortnightly audits during the activity. Compliance auditing or inspection during the Davros Extension MC3D MSS will be based on the Compliance Register and will target the following:

- compliance with regulatory requirements detailed in this EP
- demonstrating that EPO have been monitored, measured and evaluated in accordance with the Compliance Register
- emissions and discharges are being monitored, measured and documented

- management strategies and procedures to ensure the EPO are in place and being implemented effectively.

Any non-compliance with the EPS outlined in this EP will be subject to investigation and follow-up action.

The findings and recommendations of audits/inspections will be documented and distributed to relevant personnel for comments. It is likely that inspections and audits will result in recommendations for improvement opportunities. The audit or inspection may also identify breaches in environmental performance. Any non-compliance are noted and communicated immediately to the Client Site Representative and the Party Chief, as well as being documented in the audit or inspection report.

HSE performance of the survey will be discussed within CGG during daily management phone calls between the vessel and head office, and weekly during onboard HSE meetings.

The environmental inspection results will be included with the EP performance report submitted to NOPSEMA after completion of the survey.

## 6.3 Emergency Response

CGG's emergency preparedness and response arrangements are documented within the Crisis Management Procedure (GRP_HSE_GEI_06E) and will be included within the Project HSE Plan. In addition, the seismic vessel will be expected to have a vessel-specific Emergency Response Plan (ERP) and SOPEP. The ERP, SOPEP and OPEP will be tested prior to the commencement of the survey.

## 6.4 Oil Pollution Emergency Plan

The OPEP for the Davros Extension MC3D MSS comprises the National Plan for Maritime Environmental Emergencies (NATPLAN) (AMSA 2016) and relevant components of the seismic vessel contractor's SOPEP. Once the seismic vessel has been selected for the activity, the vessel's approved SOPEP will be incorporated into the OPEP arrangements for the activity under this EP. CGG will make arrangements for testing of the vessel's SOPEP; including response arrangements prior to the commencement of the survey.

NATPLAN applies to all spill incidents from ships in Commonwealth waters. The vessel's SOPEP recognises the divisions of responsibility as defined under NATPLAN to provide effective response to marine pollution incidents. The vessel SOPEP would be the principal working document for vessel and crew in the event of a marine oil spill, providing specific management response provisions to mitigate oil spills originating from vessels. Specific emergency procedures include steps to control discharges for bunkering spills, hull damage, fire and explosions, collisions, tank failure, sinking and vapour release.

### 6.4.1 First Contact in the Event of a Spill

The first external point of contact in the event of an oil spill is the Control Agency (CA), AMSA Rescue Co-ordination Centre (RCC). Details for reporting of Level 1 and Level 2 oil spills are outlined in Table 6-1.

In the event of an oil spill reaching Western Australian State waters, the WA Department of Transport (DoT) is the Hazard Management Agency for marine oil pollution incidents (contact: Maritime Environmental Emergency Response (MEER) unit on the 24 hour emergency phone number: (08) 9480 9924).

In the event that a hydrocarbon spill occurs within a port, the relevant Port Authority must be contacted. Hydrocarbon spill reporting details for major ports in the region include:

- Broome Port Authority: 08 9194 3100
- Dampier Port Authority: 08 9159 6556
- Port Hedland Port Authority: 08 9173 0030.

**Table 6-1: Notifications and Timeframes**

| Incident Category | Notification Timing | Authority / Company | Contact Number | Instruction |
|---|---|---|---|---|
| Level 1 and Level 2 | Immediately | AMSA RCC | Phone: 02 6230 6811 (24 hours)<br>Fax: 02 6230 6868<br>Telex: 62349<br>Free call: 1800 641 792<br>AFTN: YSARYCYX<br>Email: rccaus@amsa.gov.au | Survey Vessel Master verbally notify AMSA RCC of the hydrocarbon spill.<br>Follow up with a written marine pollution report (POLREP) as soon as practicable following verbal notification. |
| | Immediately | CGG Technical Operations Manager | (08) 9420 4801 | Client Site Representative verbally notify of event and estimated volume and hydrocarbon type. |
| | Within 2 hours | NOPSEMA | (08) 6461 7090 | Verbal notification to NOPSEMA as soon as practicable and no later than 2 hours, of an oil spill occurring. |
| | Within 3 days | | Submit via NOPSEMA online 'Secure File Transfer' service or by email to submissions@nopsema.gov.au | Provide a written POLREP as soon as practicable (no later than 3 days after notification). |
| | As soon as practicable or within 2 hours of a spill reaching WA State waters | DoT | Phone: (08) 9480 9924 (24 hours)<br>Email: marine.pollution@transport.wa.gov.au | Spill in State waters:<br>Verbally notify the Maritime Environmental Emergency Response (MEER) Unit.<br>Follow up with a written POLREP as soon as practicable following verbal notification. |
| | As soon as practicable or within 2 hours of a spill reaching WA State waters | Department of Mine, Industry Regulation and Safety (DMIRS) | Phone: 0419 960 621 (24 hours)<br>Email: petroleum.environment@dmp.wa.gov.au | Spill in State waters:<br>Verbally notify the Petroleum Environment Duty Officer.<br>Follow up with a written POLREP as soon as practicable following verbal notification. |
| Level 2 only | Within 2 hours | Type II Monitoring Service Provider | To be confirmed prior to activity | Verbally notify the nominated emergency contact person for the Type II Monitoring service provider. Note that the initial notification may not be able to provide key details (i.e. meeting the scientific monitoring program initiation criteria), however will allow the service provider to commence planning activities to be at the ready.<br>Follow up with more formal notification (includes written documentation), if and when a scientific monitoring program initiation criteria is met. |

# 7.0 Stakeholder Consultation

CGG is committed to open, on-going and effective engagement with the communities in which it operates and recognises that effective stakeholder consultation and engagement is critical to project success.

To meet and address their obligations under the OPGGS(E) Regulations, CGG has developed an inclusive and ongoing stakeholder consultation process.

Consultation for the Davros Extension MC3D MSS has been carried out in accordance with the NOPSEMA (2017b) Guideline (N-04750-GL1721): *Environment plan decision making guideline*, NOPSEMA (2014b) Information Paper (N-04750-IP1411): *Consultation requirements under the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009*, the *Guidance statement for oil and gas industry consultation with the Department of Fisheries* (Occasional Publication No. 113) (DoF 2013a), and APPEA's *Stakeholder Consultation and Engagement Principles and Methodology* (April 2017).

## 7.1 Stakeholder Identification

CGG conducted an assessment to identify relevant stakeholders, based on the location of proposed operations and mapping of impacts to stakeholder functions, interests and/or activities. CGG has maintained a database of all relevant persons identified during the preparation of this EP, which will be kept current through to completion of the activity in accordance with the ongoing consultation process. The full list of stakeholders engaged in the consultation process is provided in Appendix A.

## 7.2 Consultation during Preparation of the Environment Plan

Stakeholder consultation for the Davros Extension MC3D MSS has been carried out over four consultation rounds at the time of writing this EP. The consultation process involved a range of methods including provision of a consultation letter providing high-level information on the location and nature of the planned activities, web, email, telephone and written correspondence, and face-to-face meetings so that relevant persons can comment on the proposed activity and/or provide feedback to CGG.

All feedback received from stakeholders was responded to in writing, confirming that CGG was aware of any concerns raised, and presenting the planned control measures in place to reduce effects. Where merited responses were provided by stakeholders, CGG has considered the risk associated and incorporated appropriate control measures within this EP. Appendix B presents the stakeholder consultation responses and merit assessment at the time of EP submission. This table focuses on key stakeholders who have been identified as 'relevant persons' whose functions, interests or activities may be affected by the survey.

## 7.3 Ongoing Consultation

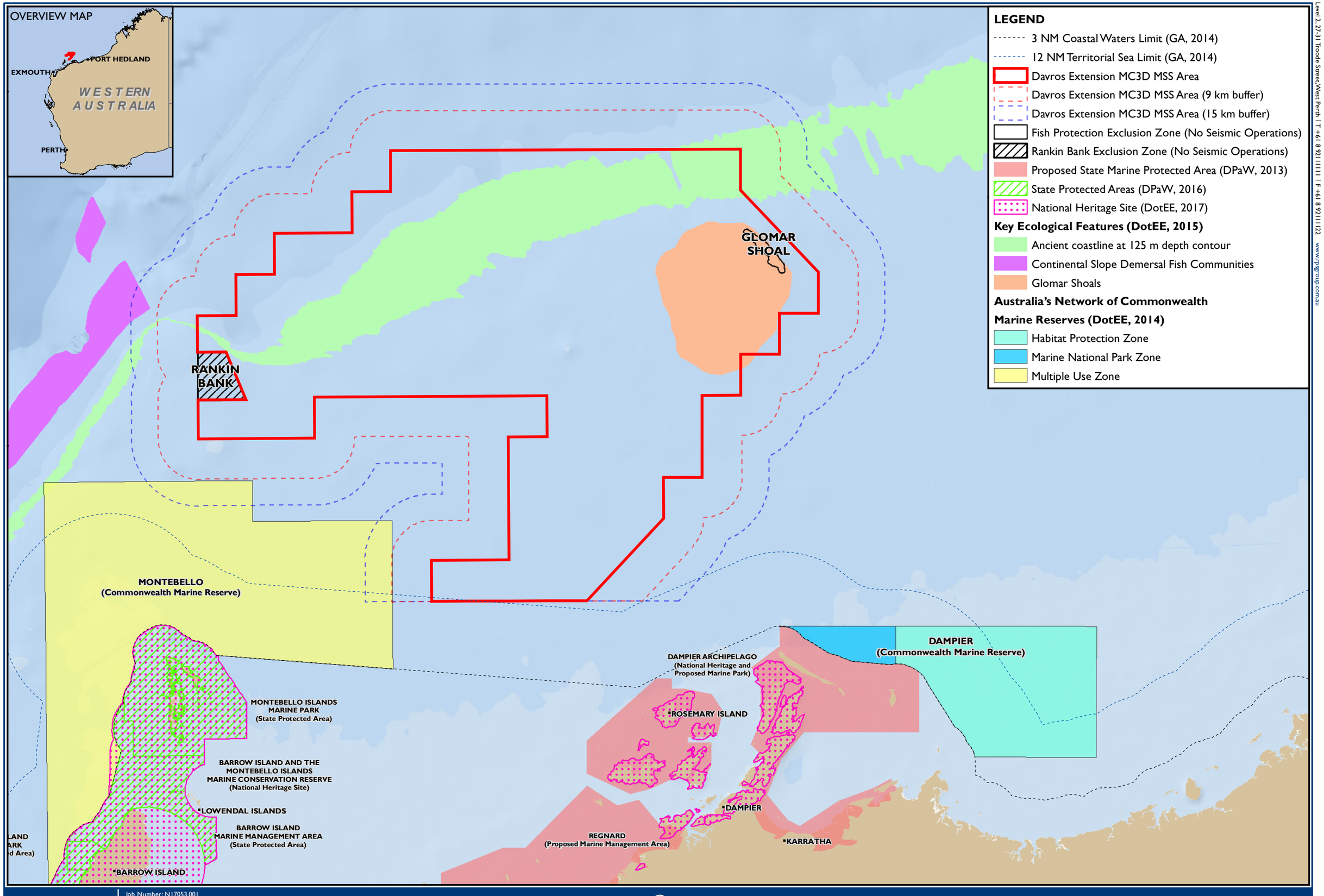
Consultation with stakeholders will be ongoing throughout the Davros Extension MC3D MSS. Relevant persons may self-identify and are encouraged to provide comment to CGG at any time. CGG will undertake a review every six months following approval of the EP and two months prior to commencement of activities to ensure that any new stakeholders are identified and consulted. In the event that an objection or claim is presented by a stakeholder either prior to or during the activity, CGG will assess the merit of the objection/claim and, where deemed necessary, will implement additional control measures to ensure all impacts and risks are managed to ALARP and are acceptable.

In the event new information received by stakeholders' objections, concerns or claims indicates a new or increased environmental impact or risk, an assessment of the significance of the new or increased risk will be undertaken in accordance with CGG's MoC process. This will inform the potential resubmission of an EP revision, as is prescribed by Regulation 17(5),(6) of the OPGGS(E) Regulations.

All ongoing communications and consultation including new objections, concerns or claims that may be raised by a stakeholder shall be entered into the Stakeholder Consultation Log.

# Figures

## A - H

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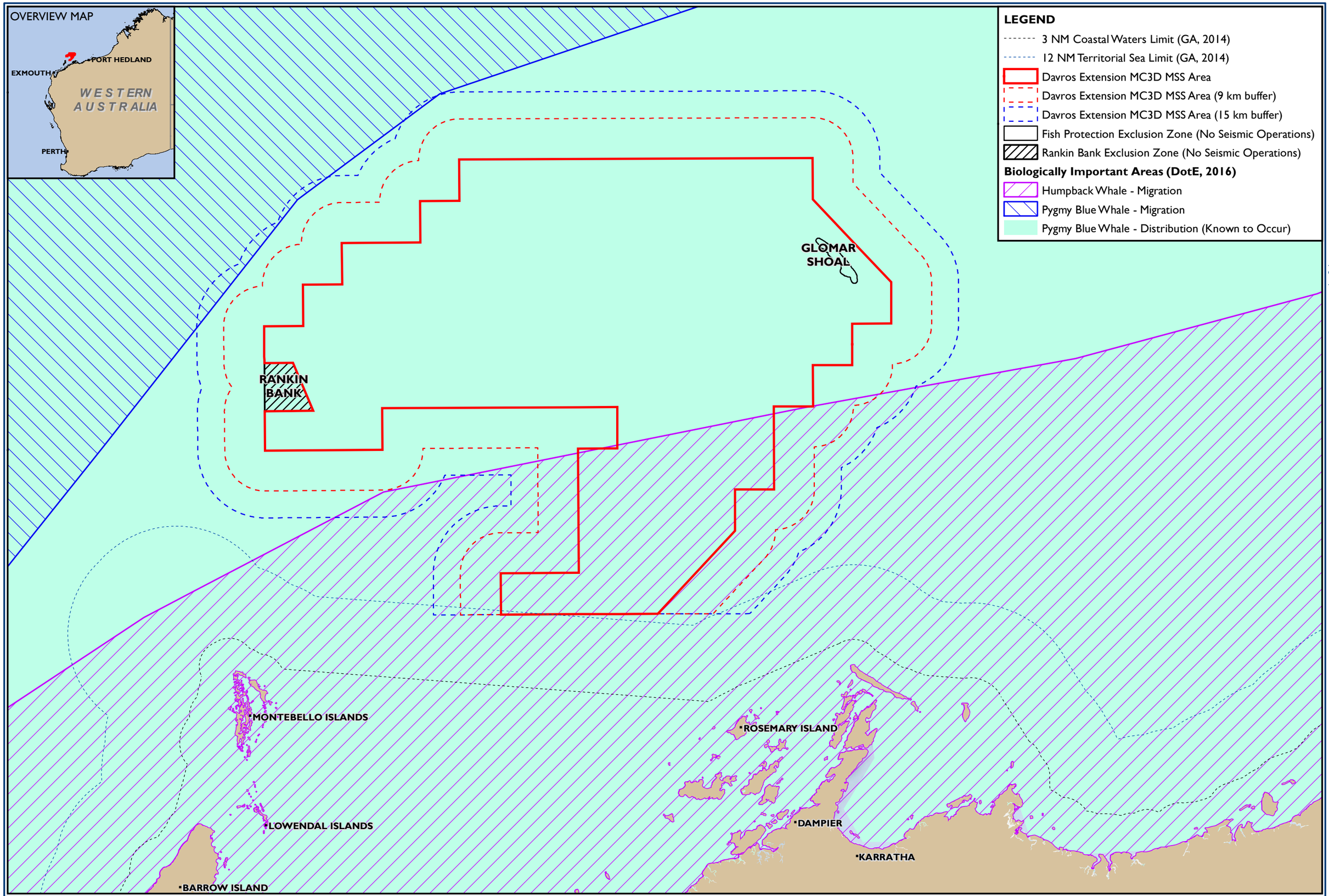
Date: 01.12.17
Scale: 1:750,000 @ A3
Created by: MA
Source: CGG, 2017 RPS, 2017

GDA 1994 MGA Zone 50

0 5 10 20 30 40 km

**Figure A**
**Marine Protected Areas and Key Ecological Features in the Vicinity of the Davros Extension MC3D MSS**

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Scale: 1:750,000 @ A3
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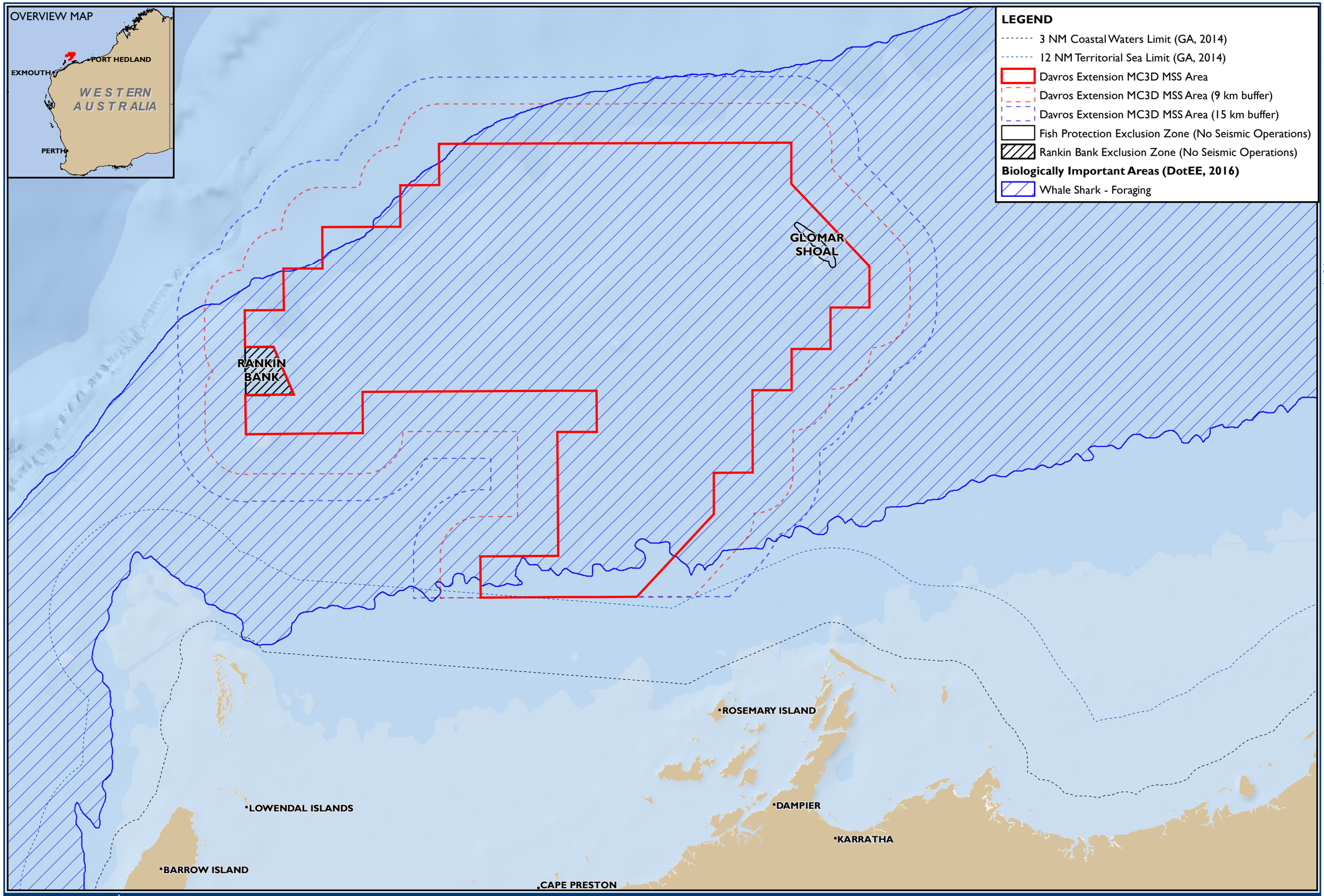
Source: CGG, 2017 RPS, 2017

GDA 1994 MGA Zone 50

0 5 10 20 30 40 km

**Figure B**
**Biologically Important Areas for Humpback and Pygmy Blue Whales in the Vicinity of the Davros Extension MC3D MSS**

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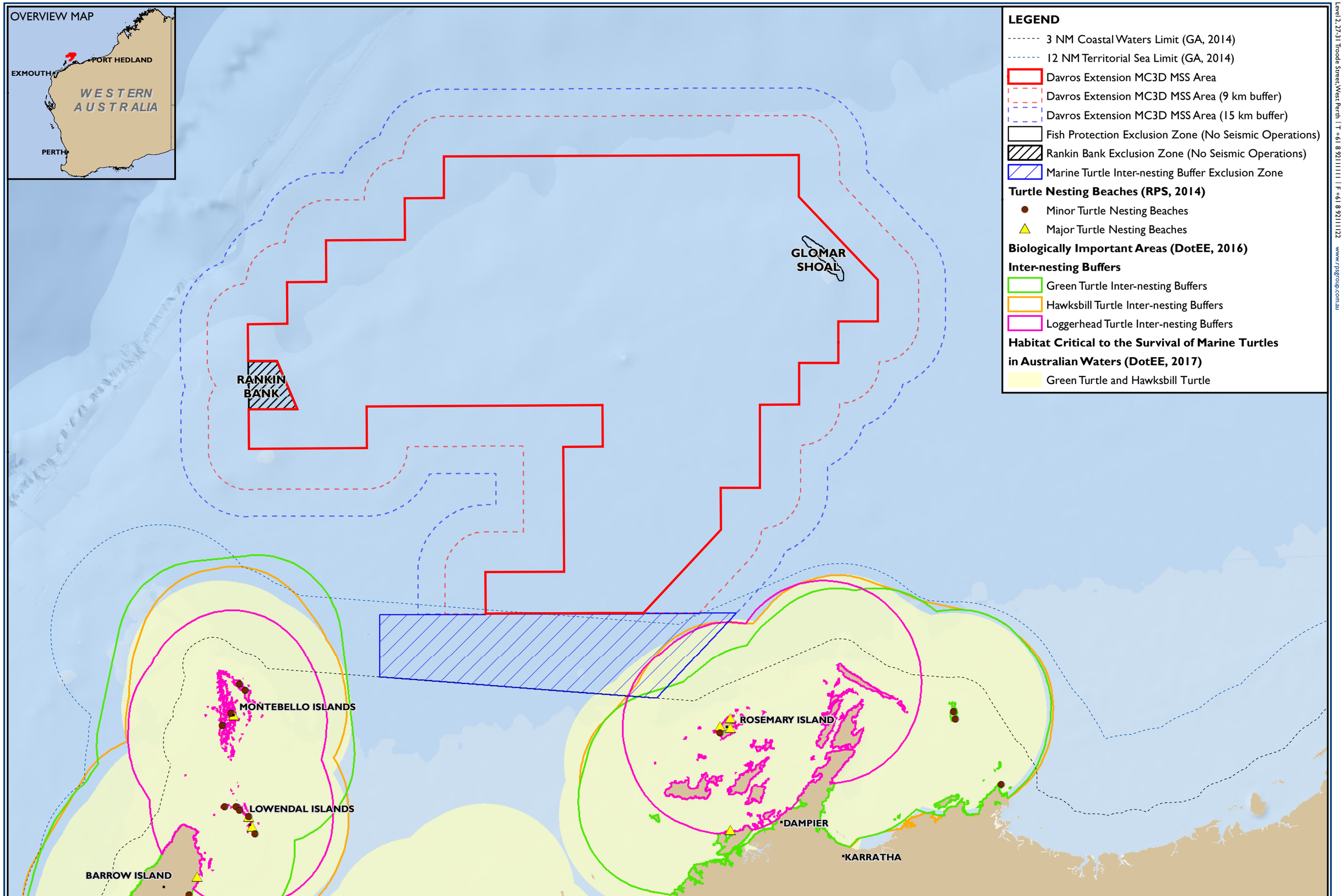
Scale: 1:750,000 @ A3
Created by: MA
Source: CGG, 2017 RPS, 2017

GDA 1994 MGA Zone 50

0 5 10 20 30 40 km

**Figure C**
**Biologically Important Areas for Whale Sharks in the Vicinity of the Davros Extension MC3D MSS**

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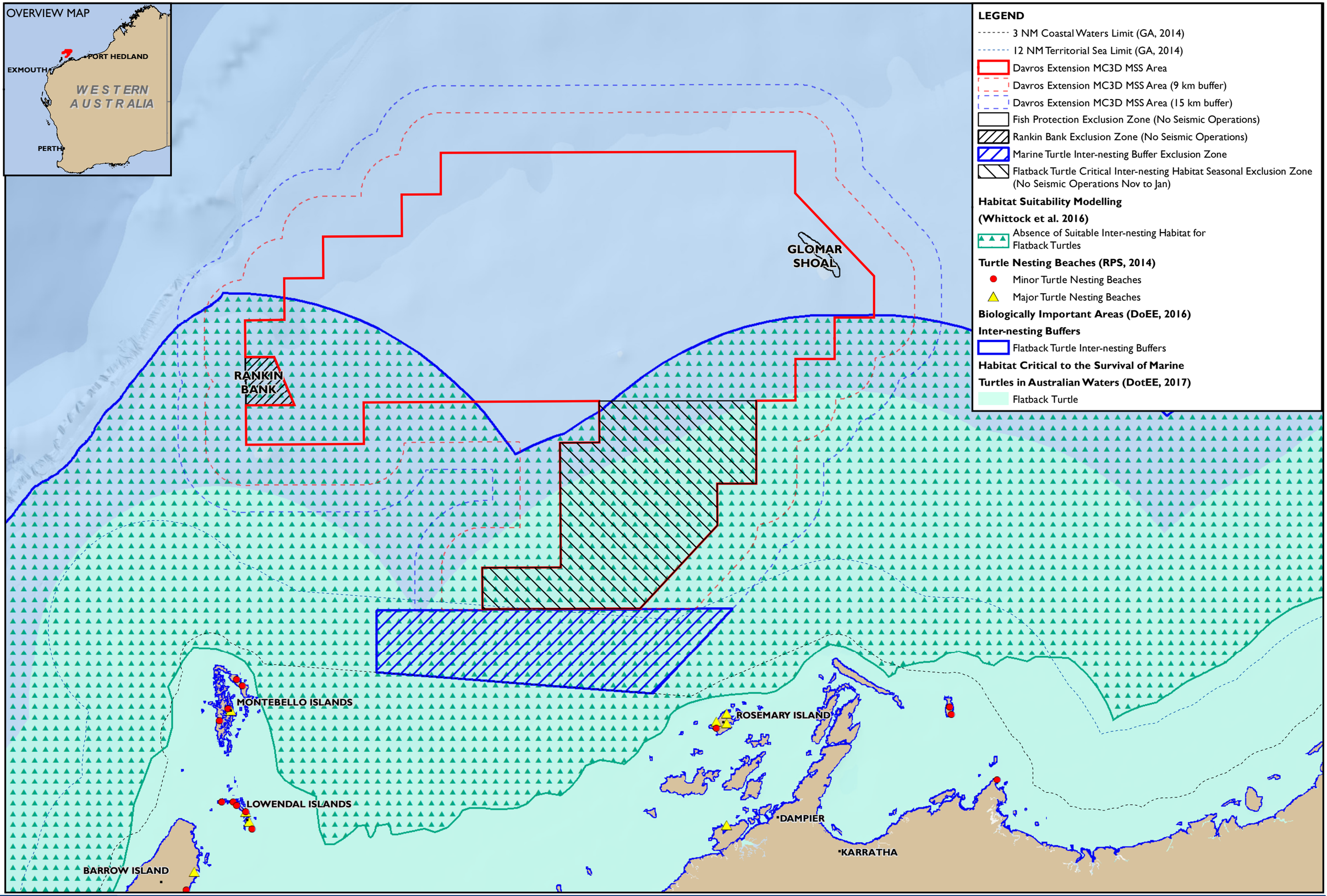
Date: 19.12.17
Scale: 1:750,000 @ A3
Created by: MA
Source: CGG, 2017 RPS, 2017

GDA 1994 MGA Zone 50

0 5 10 20 30 40 km

**Figure D-1**
**Biologically Important Areas and Habitat Critical to the Survival of Green, Hawksbill and Loggerhead Turtles in the Vicinity of the Davros Extension MC3D MSS**

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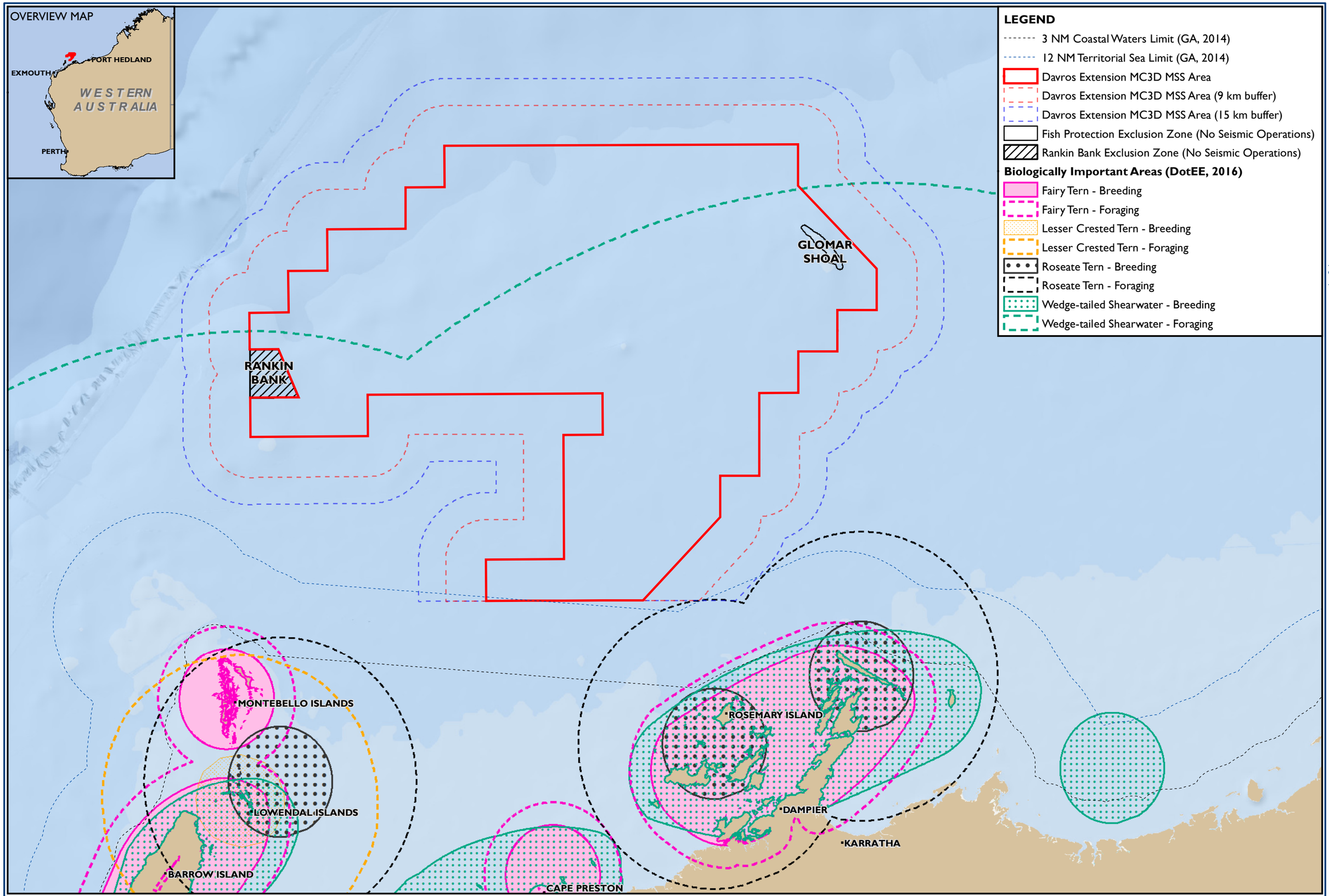
Date: 19.12.17
Scale: 1:750,000 @ A3
Created by: MA
Source: CGG, 2017 RPS, 2017

GDA 1994 MGA Zone 50

0 5 10 20 30 40 km

**Figure D-2**
**Biologically Important Areas and Habitat Critical to the Survival of Flatback Turtles in the Vicinity of the Davros Extension MC3D MSS**

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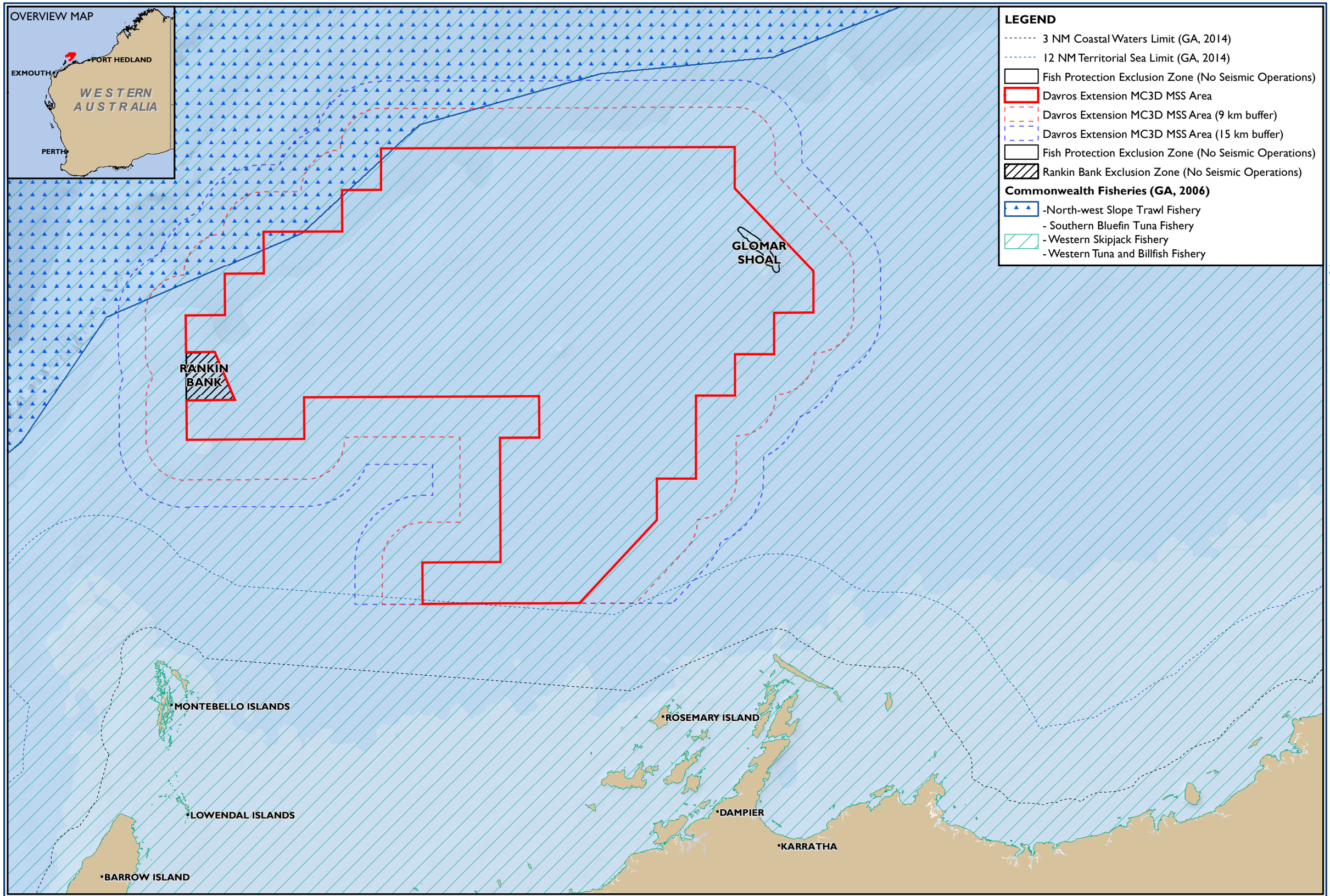
Doc Number: 005
Date: 26.07.17
Scale: 1:750,000 @ A3
Created by: MA
Source: CGG, 2017 RPS, 2017

GDA 1994 MGA Zone 50

0 5 10 20 30 40 km

**Figure E**
**Biologically Important Areas for Seabirds in the Vicinity of the Davros Extension MC3D MSS**

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Date: 01.12.17
Scale: 1:750,000 @ A3
Created by: MA
Source: CGG, 2017 RPS, 2017

GDA 1994 MGA Zone 50

0 5 10 20 30 40 km

**Figure F**
**Commonwealth Fisheries in the Vicinity of the Davros Extension MC3D MSS**

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3 NM State Waters Limit
12 NM Territorial Sea Limit
Davros Extension MC3D MSS Area (9 km buffer)
Davros Extension MC3 DMSS Area (15 km buffer)
Davros Extension MC3D MSS Area
Fish Protection Exclusion Zone (No Seismic Operations)
Rankin Bank Exclusion Zone (No Seismic Operations)

GLOMAR SHOAL
RANKIN BANK
PORT HEDLAND
MONTEBELLO ISLANDS
CAPE LAMBERT
DAMPIER
KARRATHA
BARROW ISLAND
CAPE PRESTON
GREAT SANDY ISLAND
MARY ANNE ISLANDS
THEVENARD ISLAND
MANGROVE ISLANDS
SERRURIER ISLAND
MUIRON ISLANDS
ONSLOW
NORTH WEST CAPE
EXMOUTH

**LEGEND**
**Fisheries (DoF, 2015)**
Abalone Managed Fishery
Mackerel Managed Fishery

AREA 4
AREA 1
AREA 4 TRAWLED
SIZE MANAGEMENT FISH GROUND (SMFG)

**LEGEND**
**Fisheries (DoF, 2015)**
Nickol Bay Prawn Managed Fishery
Onslow Prawn Managed Fishery
North Coast Shark Fishery

AREA 6
AREA4
ZONE 2
AREA 2
AREA 3
AREA 1
ZONE 1
PROHIBITED FISHING AREA

**LEGEND**
**Fisheries (DoF, 2015)**
Pearling Leases
Pearl Oyster Fishery
Pilbara Fish Trawl Fishery

SCHEDULE 3 - OFFSHORE CLOSED WATERS
SCHEDULE 2 - INSHORE CLOSED WATERS

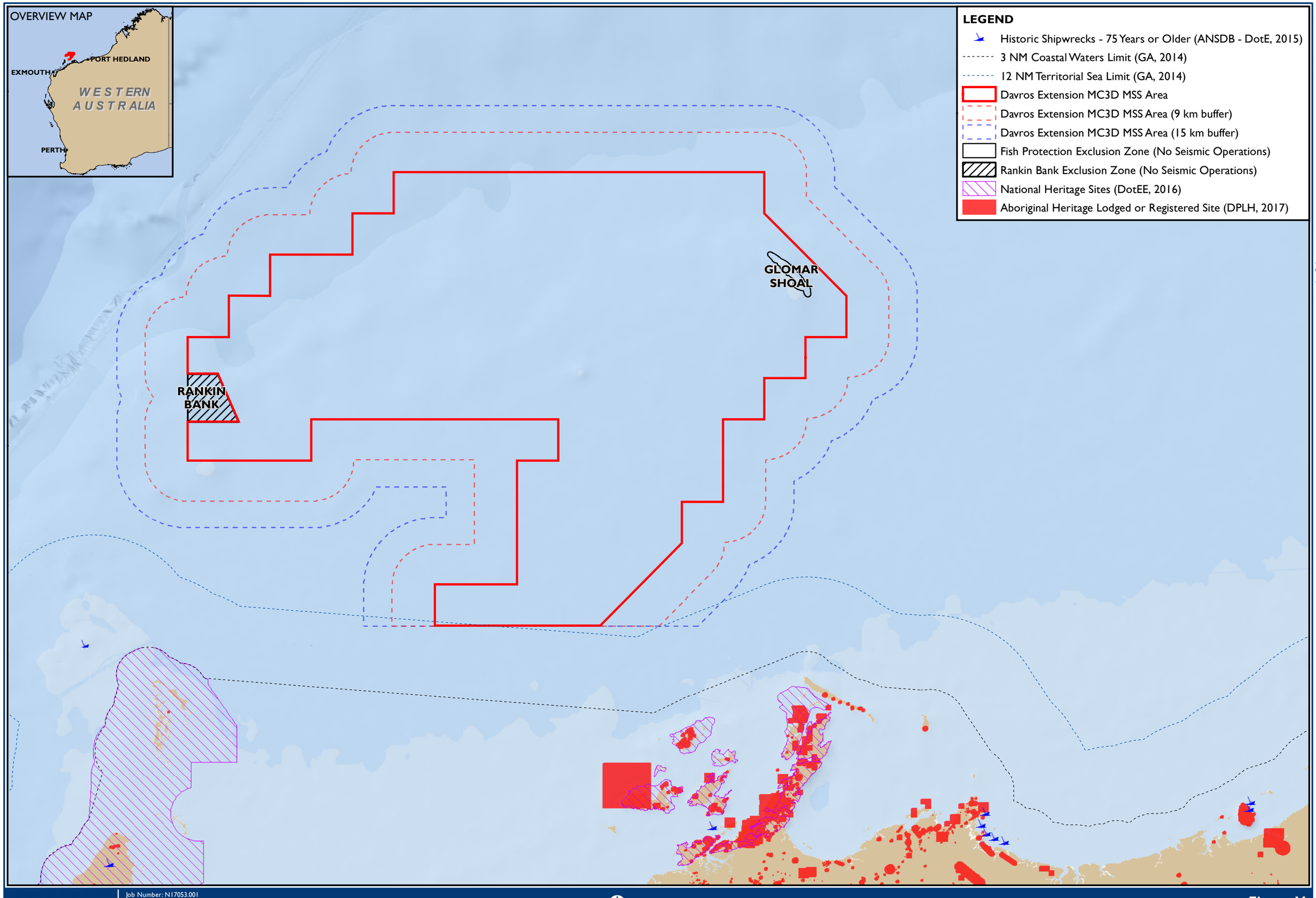
**LEGEND**
**Fisheries (DoF, 2015)**
Pilbara Trap Managed Fishery
Pilbara Line Fishery
West Coast Deep Sea Crustacean Managed Fishery

RPS

Job Number: N17053.001
Doc Number: 007
Date: 01.12.17
Scale: 1:2,600,000 @ A3
Created by: MA
Source: CGG, 2017 RPS, 2017

GCS GDA 1994
0 12.5 25 50 75 100 km

**Figure G**
**Western Australian State Fisheries in the Vicinity of the Davros Extension MC3D MSS**

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Doc Number: 001
Date: 01.12.17
Scale: 1:750,000 @ A3
Created by: MA
Source: CGG, 201 RPS, 2017

GCS WGS 1984

0 5 10 20 30 40 km

**Figure H**
**Heritage Areas and Historical Shipwrecks in the Vicinity of the Davros Extension MC3D MSS**

# Appendix A

# List of Stakeholders Consulted

# Appendix A: List of Stakeholders Consulted

## Commonwealth and State Government Departments

- Australian Department of Defence (DoD)
- Australian Fisheries Management Authority (AFMA)
- Australian Hydrographic Service (AHS)
- Australian Maritime Safety Authority (AMSA)
- WA Department of Primary Industries and Regional Development (DPIRD) (previously WA Department of Fisheries)
- WA Department of Mines, Industry Regulation and Safety (DMIRS) (previously WA Department of Mines and Petroleum)
- WA Department of Transport (DoT)

## Conservation and Research Groups

- Cape Conservation Group (CCG)
- Centre for Whale Research (CWR)
- International Fund for Animal Welfare (IFAW)

## Oil and Gas Industry Operators

- Chevron Australia
- Jadestone Energy
- Quadrant Energy
- Santos
- Vermillion Oil & Gas
- Woodside Energy

## Fisheries Groups

- A. Raptis and Sons
- Austral Fisheries
- Australian Southern Bluefin Tuna Industry Association (ASBTIA)
- Old Brown Dog
- Commonwealth Fisheries Association (CFA)
- Deep Sea Water Services
- Fat Marine Pty Ltd
- Marine Tourism WA
- M.G. Kailis Group
- Northern Fishing Companies Association (NFCA)
- Northern Wildcatch Seafood Australia (NWSA)

- Pearl Producers Association (PPA)
- Recfishwest
- R.N.R. Fisheries
- Southern Trading
- WA Fishing Industry Council (WAFIC)
- WA Seafood Exporters
- Westmore Seafoods

## WA State-managed Fishery Licence Holders (83 Different Licence Holders Including Those Listed Above) from the Following Fisheries

- 31 licence holders from the Mackerel Managed Fishery (MMF)
- 4 licence holders from the Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF)
- 7 licence holders from the Pilbara Line Managed Fishery (PLMF)
- 2 licence holders from the Pilbara Trap Managed Fishery (PTMF)
- 22 licence holders from the Abalone Managed Fishery (AMF)
- 9 licence holders from the Nickol Bay Prawn Managed Fishery (NBPMF)
- 3 licence holders from the North Coast Shark (NCSF)
- 9 licence holders from the Northern Demersal Scalefish Managed Fishery (NDSMF)
- 14 licence holders from the Onslow Prawn Managed Fishery (OPMF)
- 1 licence holders from the Pilbara Developmental Crab Fishery (PDCF)
- 7 licence holders from the West Coast Deep Sea Crustacean Managed Fishery (WCDSCF)

# Appendix B

# Key Stakeholder Concerns and Assessment of Merit

# Appendix B: Key Stakeholder Concerns and Assessment of Merit

| Stakeholder | Engagement by CGG | | Response from Stakeholder | | CGG Merit Assessment and Action/Response |
|---|---|---|---|---|---|
| | Consultation Type | Date Sent | Date | Stakeholder Response | |
| **Commonwealth and State Government Departments** | | | | | |
| Australian Fisheries Management Authority (AFMA) | Initial Consultation | 26 Sep 14 | | No response | |
| | Second Consultation | 26 Nov 14 | | No response | |
| | Third Consultation | 17 Feb 15 | | No response | |
| | Fourth Consultation<br>Follow-up Email<br>Follow-up Phone Call<br>Email | 25 May 17<br>22 June 17<br>03 July 17<br>03 July 17 | 03 July 17 | Via phone (03/07/17), AFMA recommended that CGG see their website. AFMA confirmed they would review the stakeholder consultation fact sheet and provide CGG with any additional comments.<br>Via email (03/07/17), advised that AFMA has no comments on the survey but wishes to continue to be consulted. | Via phone (03/07/17), CGG noted that they had reviewed the information on AFMA's website and that the applicable parts were addressed in the EP. CGG requested that AFMA review the stakeholder consultation fact sheet and provide CGG with specific comments.<br>Via email (03/07/17), CGG acknowledged response and advised that AFMA will continue to be consulted, as requested. |
| Australian Hydrographic Services (AHS) | Initial Consultation<br>Follow-up Email | 26 Sep 14<br>17 Oct 14 | 20 Oct 14 | AHS to be advised of survey details two weeks prior to commencement to enable Notice to Mariners to be circulated. | CGG will provide the requested information to AHS prior to survey commencement to enable Notice to Mariners to be circulated, as requested. |
| | Second Consultation | 26 Nov 14 | | No response | |
| | Third Consultation | 17 Feb 15 | | No response | |
| | Fourth Consultation<br>Email | 25 May 17<br>06 June 17 | 02 June 17 | AHS requested to be informed approximately 3-4 weeks prior to survey commencement, and upon completion of survey. | Via email (06/06/17), CGG acknowledged response and advised that AHS will be informed four weeks prior to survey, and on completion of survey. |
| Australian Maritime Safety Authority (AMSA) | Initial Consultation<br>Follow-up Email | 26 Sep 14<br>17 Oct 14 | 20 Oct 14 | ■ AMSA provided a chart for the Davros Phase II polygon, and noted that the polygon covers extensive regions of the major shipping fairway. It has been requested that the Pilbara Ports Harbour Master be informed to assist with safety messages.<br>■ Support/ chase vessel will need to be active and maintain exceptional communication with all commercial shipping, noting that there will be a considerable speed difference between commercial and survey vessels during operations.<br>■ Survey vessel must display appropriate day shapes, lights and streamers, and reflective tail boys to indicate towing.<br>■ Visual and radar watches must be maintained on the bridge at all times.<br>■ AMSA's RCC to be contacted for Auscoast warning broadcasts before operations commence. AMSA's RCC will require vessel details, area of operations and start/ end dates.<br>■ AHS must be contacted no less than two weeks before survey commencement (reflected in response from AHS)<br>■ AMSA to be contacted after the survey with lessons learned.<br>■ Revised contact details were also provided. | CGG will adhere to the requests of AMSA and has developed appropriate control measures and EPS' in Section 6.2.3. |
| | Second Consultation | 26 Nov 14 | | No response | |
| | Third Consultation | 17 Feb 15 | 23 Feb 15 | ■ New polygon traffic chart provided<br>■ Previous advice reiterated | Information incorporated into the EP. |
| | Fourth Consultation<br>Follow-up Email<br>Follow-up Phone Call | 25 May 17<br>22 May 17<br>03 July 17 | 04 July 17<br>05 July 17 | AMSA emails (04/07/17) acknowledging efforts to contact AMSA and receipt of Stakeholder Consultation Fact Sheet.<br>AMSA email (05/07/17) provided vessel traffic plots for the Davros Extension MC3D survey area, noting that the survey area includes three shipping fairways. AMSA advised that considerable commercial shipping traffic and support vessel traffic will be encountered throughout the length of operation. AMSA made note that any avoiding action by commercial shipping should not increase and/or compound the navigational risk to other ships and remarked that CGG's support vessel will need to be active and maintain | Via email (07/07/17), CGG sent a formal response to AMSA advising that CGG are aware that considerable commercial shipping and support vessel traffic will be encountered throughout the operation and plan to implement controls to ensure there is no significant interruption or disturbance to another user of the marine environment.<br>CGG agreed to continue to consult with AMSA and will inform the AMSA JRCC (24-48 hrs prior and when operations begin/end) and AHS (four weeks prior), as instructed.<br>CGG has developed appropriate control measures and EPS' in Section 6.2.3. |

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| | | | | exceptional communications with commercial shipping in the survey area. AMSA notified CGG that the seismic vessel must display appropriate day shapes, lights, streamers and reflective tail buoys (that indicate the vessel is towing) and that visual and radar watches must be maintained on the bridge at all times.<br>AMSA requested that CGG contact their Joint Rescue Coordination Centre (JRCC) through rccaus@amsa.gov.au (Phone: 1800 641 792 or +61 2 6230 6811) for promulgation of radio-navigation warnings 24-48 hours before operations commence and that the JRCC be advised when operations start and end. AMSA also informed CGG that the AHS must be advised no less than four weeks before operations commence. | |
| Department of Mines and Petroleum (DMIRS) | Fourth Consultation<br>Follow-up Phone Call | 27 June 17 03 July 17<br>10 July 17 | 05 July 17<br>07 July 17 | Via phone (05/07/17) DMIRS noted that they do not have an issue with the proposed survey and requested that the DMIRS be kept informed. Advised that the DMIRS would email CGG a formal response in the coming days.<br>Via email (07/07/17), formal response acknowledging receipt of the stakeholder consultation information and that the proposed activity will be assessed by NOPSEMA rather than the DMIRS. Advised that the DMIRS does not require further information given the activity is an extension to a previously approved EP, however noted that additional information relevant to state waters should be provided for future consultation. Referred to DMIRS (2012) Consultation Guidance Note for the level of detail requested for consultation related to commonwealth activities as well as for information pertaining to the reporting of incidents. | Via email (10/07/17), CGG acknowledged DMIRS advice and advised that the DMIRS has been included in the list of notifications in the event of a reportable incident (refer to Table 7-4).<br>Confirmed that CGG will continue to consult with DMIRS, as requested. |
| DoF (now DPIRD) | Meeting | 11 Aug 14 | | CGG and Scope Resources held a meeting with DoF to discuss a number of concerns of different licensing areas.<br>DoF provided information on the PFTIMF<br>DoF suggested CGG contact the Pilbara Demersal Fish Trawl Licence officer, as they are more familiar with the details of the PFTIMF management plan.<br>DoF suggested that, when referring to “loss of time”, licence holders are likely referring more to displacement and loss of time during the optimal time of year to fish, and not to any limitations placed by their licence conditions. | CGG met with the DoF to discuss the proposed survey, and included in the agenda the concerns raised by Fat Marine and RNR Fisheries in the meeting on 06/07/14, and MG Kailis and Westmore Seafood in the meeting on 07/08/14 (see below).<br>CGG noted that they have already suggested a time-share arrangement to PFTIMF, whereby all companies involved maintained communications and worked together accordingly during the pre-survey data acquisition planning phase to minimise loss of access for the fishing licence holders. They would be interested to find out which months of the year have the lowest productivity for Zone 2, Areas 1 and 2, so that we may advise our client on which months may be a potential “window of opportunity” for data acquisition and the least amount of fishers displaced. |
| | Initial Consultation | 26 Sep 14 | 28 Oct 14 | An initial email confirming receipt of the consultation letter (received on 25/09/14) was followed up by an official response letter from DoF (28/10/14).<br>DoF acknowledges that fish and fishers are regularly impacted by environmental, social and commercial drivers and this can result in significant changes to the fishing industry over relatively short timescales.<br>DoF does not consider that enough information has been provided to assess the potential effects of proposed activities on the Department or stakeholder’s interests, functions or activities. In line with this position, no specific advice has been provided, as there is no current start/end date, or a confirmed spatial extent for individual components of the overall activity.<br>DoF acknowledges the need for certainty and forward planning and provided some overarching information. DoF requested that the overarching issues contained within the advice letter (listed below) be addressed along with all mitigation measures prior to submission of the EP.<br>CGG should consult with WAFIC, Recfishwest, and individual licensed fishers<br>■ Full range of mitigation strategies should be presented in the EP, in line with the Department’s Guidance Statement on Undertaking Seismic Surveys in WA Waters. In particular, the Department requests that analysis be undertaken to ensure that CGG uses the minimum required acoustic capacity to achieve its objectives.<br>■ Following EP approval, further consultation with DoF and other stakeholders on individual components of the EP are expected, a minimum of three months prior to survey commencement, including provision of the following<br>■ start and end dates<br>■ spatial extent of proposed activities, including exclusion zones<br>■ information on identified fishing interests, including previous consultation with individual licensed fishers.<br>■ A number of commercial fishing interests exist in the bioregion associated with the survey (Appendix G), along with customary, recreational and charter fishing.<br>■ Spawning grounds and nursery areas for key fish species should be considered, and | Via email (29/10/14), CGG acknowledged receipt of DoF letter, and presented a formal response to all queries raised.<br>**Consultation**<br>■ WAFIC and Recfishwest were consulted as part of the consultation during EP preparation.<br>■ All communication and consultation with individual licence holders in the POMF was via the peak industry body for this fishery (PPA).<br>■ Letters were sent to 67 licence holders on 26 September 2014. (Note: original correspondence stated 68, which was corrected to 67 by CGG on 07/11/14 via email)<br>■ Further consultation will be undertaken prior to commencement of the survey, a minimum of three weeks prior to planned commencement date. At this point, specific start and end dates will be provided.<br>■ Ongoing consultation with stakeholders prior to, and during, the survey, including notifications of mobilisation/demobilisation, and any changes to survey plan.<br>**Fishing Activities in the Area**<br>CGG has conducted analysis of the state and Commonwealth managed commercial fisheries that overlap the survey area and determined which fisheries may directly or indirectly be affected by the survey. Mitigation measures to deal with the issue of potential impacts on fishers proposed as follows:<br>■ forecast of operations including survey vessel positions – to assist recreational and charter boat fishers with planning fishing trips out to Glomar Shoal while the eight week survey is being undertaken<br>■ communications protocol to manage interactions with fishing and shipping vessels<br>■ use of support vessels to manage vessel interactions<br>■ risk assessment of the impacts of the discharge the seismic pulses over the Davros Phase II survey area.<br>**Fish Spawning**<br>Specific control measures have been included in the EP to minimise the potential impacts |

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| | | | | mitigation measures provided for any potential interactions.<br>■ CGG are reminded of biosecurity risks associated with the proposed activity, and referred to the relevant legislation.<br>DoF requested that all issues raised in their letter were addressed in writing, along with proposed mitigation measures, prior to submission of the EP. | of the proposed survey on fish spawning, including:<br>■ use of the smallest possible seismic source<br>■ use of soft starts.<br>CGG acknowledges that the DPIRD has provided an extensive list of the key fish species that may be spawning within the proposed survey area and has requested that seismic activities do not occur during the time of year that represented spawning/ aggregation times. However, the spawning/ aggregation times identified cover every month of the year, and the Department has not provided specific spatial data of the extent of spawning grounds. Without this information, CGG is unable to implement this request.<br>**Biosecurity**<br>CGG will ensure that all relevant mitigation strategies presented in the Department's *Guidance Statement on Undertaking Seismic Surveys in WA Waters* are considered and included where appropriate. |
| | Second Consultation | 26 Nov 14 | | No response | |
| | Application form | 16 May 17 | | No response | Submitted online form requesting information on fishers in the area. |
| | Email | 17 May 17 | | | Request for meeting to discuss the proposed extension of the survey and how to best to meet requirements for consulting DoF and fishers.<br>Enquired whether the DoF has updated guidance on consultation or seismic and fisheries interactions following the 2016 DoF and oil and gas industry workshop. |
| | Fourth Consultation | 26 May 17 | 18 May 17 | Email regarding availability to meet and request for project summary to review prior to meeting. | Replied with the DoF Stakeholder Consultation Fact Sheet (Appendix I) and requested information from DoF including:<br>■ Details of managed fisheries known to be active within the operational area and surrounding area (within 15 km of survey area boundaries)<br>■ Any information on levels of fishing effort in various parts of the survey area, e.g. over Rankin Bank<br>■ Quote for individual license holder details for all active fisheries<br>■ Updated information on the spawning times for key commercial fish species found in the area. |
| | Email | 31 May 17 | 30 May 17 | DoF notified CGG that it will revise its previous advice provided on the previous version of the EP given it has an improved understanding of the risks associated with seismic surveys.<br>Provided information to enable CGG to consult with relevant fishers considered relevant by the DoF. Emphasised that WAFIC and all fishers from the following fisheries should be engaged during the fourth round of consultation:<br>■ Mackerel Managed Fishery<br>■ Pearl Oyster Managed Fishery Zone 1 (liaison via PPA)<br>■ Pilbara Fish Trawl Interim Managed<br>■ Pilbara Line Fishery<br>■ Pilbara Trap Managed Fishery<br>Supplied CGG with application form for an extract from the Public Register and subsequently (07/06/2017) supplied CGG with the requested fisheries licence holders' postal addresses.<br>On 30/05/17, DoF provided a list of fisheries that are likely to be affected by the survey, and details on how to obtain contact details for the relevant fishers. | Replied to email reiterating the intent to attend a meeting with the DoF.<br>CGG applied (01/06/2017) for an extract from the Public Register for the postal addresses of all WA State-managed fisheries licence holders that may potentially operate in the survey area, not only those recommended by the DoF.<br>On 08/06/2017, CGG sent Fishers Stakeholder Consultation Fact Sheets (Appendix I) to the holders of all licences. |
| | Meeting | 01 June 17 | | DoF confirmed that, given the changes in understanding within DoF since previous consultation by CGG, the EP would be considered as a new EP.<br>DoF advised that they object to the proposed activity due to the shallow water depths within which parts of the survey occur. Following discussion DoF stated that they generally object to all seismic activity in water depths <50 m; however noted there is potential for the minimum acceptable depth to be increased.<br>DoF presented preliminary results of a recent Ecological Risk Assessment (ERA) workshop held between DoF and industry. Although not publicly available, and therefore not possible to reference in the EP, DoF suggested that impacts of seismic on immobile invertebrates (such as scallops) were likely to be a particular concern to DoF. DoF informed CGG that they are in the process of completing a draft ERA report on seismic surveys and that | CGG advised DoF that the EP would be completely revised to address the larger survey area and the existing and new potential impacts and risks identified for the activity.<br>CGG advised that they are aware of the new literature published on the effects of seismic on invertebrates and zooplankton and have addressed the implications of the findings of these publications (and others) in the impact assessment in the EP (Section 6.2.1).<br>CGG expressed interest in receiving a copy of the ERA workshop as soon as it becomes available, and acknowledged that this might be after the EP has been submitted. Through CGG's Management of Change (MoC) process (Section 7.1.1), CGG will assess the findings of any new publications and studies as they become available to determine if they have the potential to increase or change the level of risk or impact, beyond those detailed in the EP. |

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| | | | | following this they will publish an updated guidance statement on undertaking seismic surveys in WA waters. DoF noted that neither document will be available for review by the time the EP is submitted, and as a result their revised advice would be ongoing.<br>CGG was informed that an initial response would be prepared by 16/06/2017. | CGG agreed to wait for DPIRD's formal response. |
| | Email | 20 June 17 | 20 June 17 | DoF informed CGG that its initial response was taking longer than anticipated as they had to meet with Dr Rob McCauley to receive some expert technical advice. | CGG acknowledged. |
| | Email | 21 Aug 17 | 23 June 2017 | DoF informed CGG that it revises its previous advice due to:<br>the extent of the proposed changes to the project since the Davros Phase II EP was accepted by NOPSEMA; and recent progress made on the understanding of seismic activity-related impacts.<br>DoF's primary concern relates to the proposed acquisition parameters, which it considers are likely to pose unacceptable risk of impacts to aquatic resources in the absence of strong management and risk control measures.<br>DoF expressed its view that an increase d spatial extent of the proposed seismic activities and the inclusion of additional fishing grounds and at least one ecological sensitive area resulted in a significant increase in the risk profile of the project, particularly if the proposed 3D survey covers the full area.<br>DoF provided an overview of the progress to date on an ecological risk assessment workshops which is examining the risks and potential impacts associated with seismic surveys on finfish and invertebrates. DoF noted that this work is ongoing.<br>DoF's interim position is to generally object to:<br>■ seismic activities in water depths <50 m<br>■ 3D seismic activities with array capacities >2,000 cui in waters between 50 m and 100 m in depth, unless it is demonstrated that strong management and risk control measures will be implemented that are likely to be successful.<br>In DoF's view the proposed activities in waters <50 m pose unacceptable risks to aquatic resources, and that the management and control measures proposed by CCG for deeper waters are insufficient for mitigating risks associated with the use of high capacity seismic arrays.<br>DoF noted it will request the following information from proponents in the future to allow DoF to conduct an informed assessment of the risks and potential impacts associated with the proposed activities on fisheries and aquatic resources (noting that a revised Guidance Statement on marine seismic surveys was expected to be finalised by December 2017). As a summary, the information requested includes the:<br>■ proposed commencement, duration and special extent of the survey activities<br>■ proposed management and risk control measure<br>■ predicted sound exposure levels at the seabed for that part of the survey area that is in waters <250 m depth and, additionally, for any other parts of the survey area that overlap fishing zones where benthic invertebrates and/or demersal fish may be targeted.<br>DoF additionally noted it encourages proponents to commit to supporting further research efforts relating to the impacts of seismic surveys.<br>DoF's response included a formal objection to the current proposal and a request that their position to be communication to NOPSEMA. | Via email (21/08/17), CGG acknowledged receipt of DoF's (now DPIRD) email, and presented a formal response to all queries raised.<br>**Significant changes to the project:**<br>CGG acknowledges DPIRD's concerns on the increase in risks associated with the increased spatial extent of the survey area. This has been managed through CGG's MoC process (Section 7.1.1), and the impact and risk assessment has been revised to ensure all impacts/risks associated with the change in the nature and scale of the activity have been addressed and assessed to ALARP (Section 6.0).<br>CGG have undertaken a new stakeholder identification exercise and consulted with all existing and newly identified relevant persons to ensure all potential concerns are addressed.<br>CGG is aware of the ecologically sensitive area of Rankin Bank and have taken a precautionary approach in excluding the shallow areas over Rankin Bank and Glomar Shoal from the survey area (see Section 6.2.1).<br>**Acquisition parameters and risk to fisheries and aquatic resources:**<br>CGG acknowledge DoF's interim position for seismic surveys and have developed strong control measures based on a precautionary approach to manage potential impacts and risks to ALARP and to be acceptable (refer to Sections 6.2.1, 6.2.5, 6.3.3 and 6.3.6 for corresponding performance standards):<br>■ The minimum depth within which seismic data will be acquired is 35 m, as CGG have developed exclusion zones and buffers over the Glomar Shoal and Rankin Bank ecologically sensitive areas.<br>■ No seismic activity within the Fish Protection Areas (and 250 m buffers) set over Glomar Shoal and Rankin Bank.<br>■ A much smaller airgun array of 1,800 cubic inch will be used in water all depths within the survey area from 35 to 50 m.<br>■ CGG will implement in-field real-time monitoring during seismic acquisition using the 4,500 cubic inch array to monitor the seismic sound levels of each seismic line. This information will be used to verify the power output of the sound source and compare measured levels with modelled levels.<br>■ If modelled levels under-estimate potential impacts, the array will be changed to the smaller 1,800 cubic inch until such time as the impact assessment can be re-run and an alternative, technically defensible position is reached.<br>■ Precautionary control measures with regard to routine discharges, exchange of ballast and refuelling will be implemented within 3 NM of the 40 m depth contour over Glomar Shoal and Rankin Bank and within Commonwealth marine reserves (Sections 6.25, 6.3.3 and 6.3.6).<br>**Information requirements:**<br>CGG have sent the underwater noise impact assessment section from the EP which describes the full impact assessment and control measures that will be adopted to manage impacts/risks to e.g. seasonal aggregations, spawning/nursery grounds key habitats and species, to ALARP and acceptability. The assessment includes the predicted sound exposure levels for both the modelled large gun (4,630 cubic inch) and modelled small gun (2,220 cubic inch). CGG advised that the survey will use slightly smaller airgun arrays of 4,500 cubic inch and 1,800 cubic inch, so therefore the predicted sound exposure levels are considered to be an overestimate, and therefore deemed conservative.<br>CGG have provided the following information requested by DoF and will continue to consult with the department through the ongoing consultation process:<br>■ Earliest survey commencement will be October 2017 for a maximum duration of 150 days until January 2019, with no operations between the start of July to the end of September.<br>■ Revised map showing survey area and operational area boundaries provided to DPIRD.<br>CGG confirmed that they have consulted directly with all fishery stakeholders with |

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| | | | | | functions, activities or interests in or in the vicinity of the Davros Extension MC3D survey area (including WAFIC, Recfishwest and the list of individual licence holders from the Public Registry sent by DoF). CGG have developed control measures for manage the impacts of underwater noise to ALARP (Section 6.2.1) and will continue to maintain ongoing consultation with fisher/fishery stakeholders to manage any potential interactions (refer to Section 6.2.3):<br>■ As part of the ongoing consultation process, CGG will notify all relevant persons four weeks prior to the start of the survey of the survey details including, timing, location, duration.<br>■ Fat Marine and RNR Fisheries will be advised eight weeks prior to the start of the survey to ensure that meaningful planning can take place, given that these stakeholders were slow to respond during previous rounds of consultation and it is anticipated that ongoing consultation may require a time-sharing agreement to be reached.<br>■ Commercial fishers, Recfishwest and relevant recreational fishing groups/ organisations and will be issued a 7 to 10 day forecast prior to activities commencing adjacent to Glomar Shoal and Rankin Bank.<br>■ Support vessel(s) to manage vessel interactions and maintain communications with commercial shipping in the survey area.<br>CGG is supportive of new research efforts to investigate the impacts of seismic surveys and has developed an in-field real-time monitoring procedure to validate predicted modelled noise levels. The methodology for this monitoring has been peer reviewed by Dr Alexander Gavrilov at the Centre for Marine Science and Technology at Curtin University. CGG have provided a description of the monitoring that will be implemented during seismic acquisition using the 4,500 cubic inch array. This information will be used to compare measured levels with modelled levels to verify impact distances predicted in the impact assessment.<br>CGG will continue to monitor the progress of the new Guidance Statement on marine seismic surveys and note due December 2017. The implications of this guidance will be assessed in the EP, appropriate control measures adopted if/as required. |
| | Email | 20 Dec 17 | 20 Oct 17 | Via email (20/10/17), DPIRD thanked CGG for the additional information but noted that it was provided the day the EP was submitted to NOPSEMA. DPIRD formally requested that if the EP is resubmitted it be provided with sufficient information (as outlined in the "interim guidance" summary under the "new information requirements" heading) and be granted 4-6 to respond. DPIRD advised that it aims to provide proponents with contemporary guidance on its concerns relating to seismic surveys and how these may be addressed. CGG was informed that a draft Guidance Statement DPIRD has been preparing on undertaking seismic surveys is expected to be released Q1 2018 and that in the meantime DPIRD was providing proponents with "interim guidance" regarding the information it expects from proponents in order to make 'make an informed assessment of the possible consequences of the activity on its functions, interests or activities'. CGG was provided with a working summary of the draft guidelines which included the headings and key points outlined below.<br>**New information requirements**<br>DPIRD expects proponents of seismic surveys to demonstrate that: 1. An informed assessment has been conducted of the risks and potential impacts associated with the proposed activities on potentially affected fisheries and aquatic resources; and 2. Appropriate impact management and risk control measures will be in place (where necessary) to ensure residual impacts will be ALARP and acceptable, as defined by the Regulator.<br>The risk assessment should clearly define: the proposed acquisition parameters and other relevant operational details; the proposed commencement, duration and spatial extent of the survey activities; for 3D surveys the predicted sound exposure levels at the seabed for parts of the survey area in waters <250 m depth and parts intersecting fishing zones where benthic invertebrates and/or demersal fish may be targeted; the potential impacts of the proposed activities on fisheries and aquatic resources; the risk level for each potential impact (including a rationale); and the degree of rigour/certainty associated with the predicted impacts.<br>DPIRD expects to provide more guidance on what its views are on ‘acceptable impacts’ when the Guidance Statement is released. Claims and assumptions should be based either on evidence (e.g. from relevant peer-reviewed research) or on the most conservative available information. Factors titleholders should consider in determining ‘acceptable’ levels of impact are: the current status of key or indicator fish/invertebrates in the region; | Via email (20/12/17), CGG sent a formal response addressing the interim guidance provided by DPIRD. CGG provided DPIRD with further updates on the survey and thanked DPIRD for the detailed feedback and ongoing engagement in the process to date. CGG acknowledged the additional information on the Department’s views on seismic risk and impact mitigation in relation to the fishing industry. CGG advised that it has done it's best to meet DPIRD's expectations, while maintaining commercial necessities of running the survey and acquiring seismic data which is critical for the ongoing exploration for petroleum resources of the North West Shelf. CGG noted that it recognises the potential for conflict between industries operating in the same waters and has made significant concessions to minimise and mitigate impacts from its activities on other users, including fishers and the fish stocks they rely on.<br>CGG also provided detailed responses to specific comments in DPIRD previous correspondence but noted that many of the requests for information were generic and previously furnished in the Stakeholder Consultation Fact Sheet provided to DPIRD on 26 May 2017. The responses are outlined below, although it should be noted that these lack supporting information provided in tables and attached documents (these are available with the complete response in Appendix I).<br>**Requests to be provided with a period of 4-6 weeks to respond**<br>CGG first provided information, including the survey and survey parameters, in May 2017 and has since provided updates as they arose. CGG considers the consultation process to be ongoing and welcomes DPIRD’s inputs at any time in the process. Many of DPIRD’s concerns in the email of 20 October 2017 have been previously addressed, for example in the May 2017 information document and our email of 21 August 2017. The seismic survey is not due to commence for another 2-3 months and your further inputs will be welcome during this lead-in time. Any correspondence will be addressed and any necessary revision of survey controls to maintain ALARP and Acceptable levels of risk and impacts will be considered. CGG requested any further comments on this correspondence by the end of t key fish habitat areas, for additional conservatism.<br>**Additional upcoming DPIRD guidance on ‘acceptable impacts’**<br>In the absence of specific DPIRD guidelines on Acceptability of impacts to fish resources, CGG has applied industry standard and regulator mandated approaches to assessing both ALARP and Acceptability in relation to unavoidable risks and impacts of seismic surveys. CGG is confident that NOPSEMA’s assessment of the EP against the three key principles |
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| | | | | the proportion of the relevant population(s) (of each key/indicator species) that may potentially be affected – after taking into consideration (i) management and risk control measures and (ii) known seasonal aggregations, spawning/nursery grounds, key habitats and other relevant specifics; other (cumulative) impacts on the status of key/indicator species.<br>**Uncertainty – commitment to research**<br>DPIRD encourages proponents of seismic surveys to commit to supporting research efforts investigating the impacts in a local setting and/or to undertake validation monitoring to investigate the reliability of sound exposure predictions generated by modelling software in WA waters.<br>**Seismic activities in shallow waters**<br>Preliminary results from the DoF's 2016 seismic survey ERA workshop suggest that seismic activities in shallow waters up to 100 m tend to have the greatest degree of overlap with fisheries and the highest risk of significant impacts on aquatic resources. Thus fisheries strongly encourages proponents to: avoid, where possible, seismic activities in shallow waters <50 m depth; and minimise the intensity of the seismic array as much as possible at all times, but particularly when conducting activities in waters <250m depth. Activities with a higher risk of impact require: (i) a higher degree of rigour (when predicting likely impacts); and (ii) consideration of appropriate management and risk control measures, in order to be considered 'acceptable' by DPIRD. This may require proponents to provide peer-reviewed research in support of assumptions and/or to commit to implementing appropriate monitoring and management frameworks aimed at ensuring actual impacts do not exceed predictions.<br>**Consideration of seismic impacts on zooplankton and benthic invertebrates**<br>DPIRD expects proponents to assess the risk of impacts on potentially vulnerable invertebrates (both in the water column and associated with the benthos); changes to community structure; and flow-on effects to higher trophic levels.<br>**Consultation with other stakeholders**<br>DPIRD expects proponents to initiate and maintain ongoing consultation with the Western Australian Fishing Industry Council, Recfishwest, relevant representative bodies AND directly with licensees in the potentially affected fisheries.<br>**Biosecurity**<br>Vessel, equipment and facility operators must take reasonable measures to minimise the risk of committing offences under the Fish Resources Management Act 1994 and associated regulations related to transferring live non-endemic or noxious fish (including marine pests) into WA waters.<br>Two options exist for most vessels moving into WA waters from overseas or interstate: (i) Utilise Fisheries' biofouling risk assessment tool ("Vessel Check") and complete the actions to manage any activity related vessels to a LOW / ACCEPTABLE risk rating, or (ii) Actively use a biofouling management plan and record book that meets all requirements under the current edition of the International Maritime Organisation's Guidelines for the Control and Management of Ships' Biofouling to Minimise the Transfer of Invasive Aquatic Species. For large offshore facilities (e.g. MODUs and CPFs) management to ALARP is strongly recommended.<br>Operators should also act to manage residual risk of vessels and facilities after arrival in or off WA waters. To address the residual risk DPIRD recommends that a follow-up marine pest inspection or survey using other means is conducted at least 75 days after departure for WA. Any equipment coming from overseas or interstate for this activity should also be either new, or thoroughly cleaned, then dried for at least 24 hours and inspected for marine pests before use in WA waters.<br>DPIRD requests that the presence of any suspected marine pest or disease be reported within 24 hours by email (biosecurity@fish.wa.gov.au) or phone via the FishWatch 24 hour hotline on 1800 815 507. This includes any organism listed in the Western Australian Prevention List for Introduced Marine Pests, and any other non-endemic organism that demonstrates invasive characteristics. It is also important that this information is forwarded directly to all associated vessel operators.<br>DPIRD concluded their response by stating *"In summary: 1. Fisheries expects seismic survey EPs to adequately address the issues as set out above; and 2. Fisheries strongly encourages proponents to give all 'relevant persons' an opportunity to provide comment and advice once the proposed activities are refined and well-defined."*<br>Via email (20/12/17), DPIRD thanked CGG for their response and the additional | that apply to the whole EP will meet DPIRD's expectations, namely:<br>■ the EP must be appropriate for the nature and scale of the activity (subregulation 10A(a))<br>■ the principles of ecologically sustainable development (ESD) (subregulation 3(a))<br>■ the demonstration that environmental impacts and risks of the activity will be reduced to as low as reasonably practicable and will be of an acceptable level (subregulation 10A(b) and 10A(c)<br>NOPSEMA requires the EP to evaluate impacts and risks (including direct and indirect impacts from operational and potential emergency conditions), detail the control measures that will be used to reduce impacts and risks and demonstrate that they are reduced to ALARP and acceptable levels. An 'acceptable level' is the level of impact or risk to the environment that may be considered broadly acceptable with regard to all relevant considerations including, but not limited to:<br>■ Principles of ecologically sustainable development (ESD)<br>■ legislative and other requirements (including laws, policies, standards, conventions)<br>■ internal context (e.g. consistent with titleholder policy, culture and company standards)<br>■ external context (the existing environment and stakeholder expectations)<br>CGG has taken all of these factors into consideration of the level of acceptability of the residual risks and impacts and considers the outcome to be broadly Acceptable.<br>CGG requested a copy of DPIRD's final Guidance Note when it is complete.<br>**Uncertainty – commitment to research**<br>CGG has undertaken extensive sound source verification in the survey area during previous stages of the Davros survey, using both ocean-bottom nodes and streamer hydrophone data. These field measurements have shown the modelling undertaken by Curtin University (CMST) to be a good predictor of underwater sound propagation in the near-field (up to 500 m from source), but to under-estimate sound levels beyond this zone of direct returns. Consequently, CGG has re-assessed the potential impact zones based on the more conservative measured field data. A key outcome of this process was that the buffer around the fish protection area at Glomar Shoal was increased from 250 m to 500 m to add a higher level of conservatism and protection for the shallow water assemblages. It should be noted that the measured data are conservative because the receivers pick up a suite of small-scale pressure and noise artefacts also, for example streamer hum, cable jerk, micro-vortices around the streamers and surface waves, all of which increase measured sound pressure levels but don't reflect levels received by receptors. CGG advised that they will continue to collect measurement data during the upcoming Davros Extension survey and will use this to inform future sound impact assessments in similar areas.<br>**Seismic activities in shallow waters**<br>CGG acknowledged DPIRD's requests for lower source volumes in shallower waters to reduce possible impacts to area of potentially higher importance to fish stocks. Seismic data acquisition has been excluded from areas less than 35 m water depth at Glomar Shoal and less than 50 m deep at Rankin Bank; however, it is not practicable to totally eliminate survey in 35 - 50 m water depth more broadly because there are shallow-water hydrocarbon targets in the survey area which it is commercially imperative to acquire so that titleholders holding these blocks can assess their reserves and plan for exploitation as appropriate. CGG will use a very small array (1,800 $in^3$) in areas less than 50 m deep and has selected a moderately small airgun array at 4,630 $in^3$ (they range up to > 6,000 $in^3$) for the greater part of the survey area. These measures will reduce potential for sound impacts while still meeting survey objectives and making it a commercially feasible activity. A comparison of the subsurface resolution of seabed geology using the 4,360 $in^3$ array and smaller arrays has shown that the smaller array will not provide adequate resolution in deep structures and is not acceptable to meet survey objectives.<br>**Consideration of seismic impacts on zooplankton and benthic invertebrates**<br>CGG advised that potential impacts on invertebrates, including plankton, from all sources of potential impact and the possible flow-on effects have been assessed, mitigated and found acceptable and ALARP. In particular the impact assessment considered the potential for impacts on prawns in the Onslow and Nickol Bay fisheries and to Pearl Oysters, based on recent research including Day et al (2016) and other information. CGG concludes that there will be negligible effects on prawns or prawn catches from underwater sound from operation of the seismic source during the survey due to the limited effect zone and absence of key fishery area in the seismic survey area. Given the lower importance of |

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| | | | | information provided but again made note that it was provided shortly before the EP was submitted. DPIRD advised that they consider the response as an opportunity to make an informed assessment of the possible consequences of the proposed activities on its functions, interests and activities. DPIRD informed CGG that it will be closed for business from 20/12/2017 until 02/01/2018 but would endeavour to respond within 4-6 weeks. | Zone 1 to the overall pearl fishery catch levels, the fishery operating in shallow waters (<35 m water depth), and spawning in the deeper waters (>35 m) contributing little to recruitment in commercially important inshore populations (i.e. Eighty Mile Beach); it is extremely unlikely that there will be long-term effects to pearl oysters, or to the catch, or recruitment to the fishery.<br>Plankton impacts were assessed in light of the recent McCauley et al (*Nature: Ecology and Evolution*, *22 June 2017* ) and Richardson et al (2017) publications. CGG noted that they would be happy to meet for a technical discussion on these outcomes if this is desirable for DPIRD. The preliminary research published by McCauley et al (2017) is inconclusive and the greater body of evidence for impact levels must be taken into account also. Table 6-4 from the EP was included to provide the full context within which impacts to plankton were assessed.<br>**Consultation with other stakeholders**<br>CGG consulted with relevant fishers and industry bodies, including WAFIC and Recfishwest, as outlined in Appendix B of the 26 May 2017 information document provided to DPIRD. Useful feedback, representative of the broader commercial fishing industry was received from WAFIC and a small number of licence holders. This consultation is ongoing and all identified relevant stakeholders will be advised of the improvements to the survey controls and revised timing of the survey. They will be invited and encouraged to provide further feedback also over the next few months.<br>**Biosecurity**<br>CGG noted that this advice from DPIRD was largely targeted at larger offshore facilities, but has been applied to the seismic survey activity equally. CGG has committed to actively mitigate the risks of IMS incursion associated with bringing in a vessel from a foreign port. The controls measures are consistent with DPIRD's recommendations and were included as an attachment in a table (Table 6-41 from the EP). |
| | Phone call | 7 Feb 2018 | | | ■ DPIRD was contacted via a phone call with Hans Kemp on 7 February 2018. During this call, DPIRD advised that they had responded to CGG's most recent consultation information on 16 January 2018. The information had been provided in mid-December 2017. However, DPIRD's email response was not received by CGG, so it was sent again on 7 February. CGG has accounted for the advice of 16 January 2018 and previous communications with DPIRD. DPIRD's concerns have been appropriately addressed in the controls around fish stock protection and consultation will be ongoing.<br>■ DPIRD's list of concerns were addressed in previous communications with the department; however it appears it had not fully assessed the information provided.<br>■ CGG discussed the concerns raised by DPIRD in their most recent response (dated 16 Jan, received 7 Feb), and described in detail the latest evaluation of the impacts on shallow fish habitats (Glomar Shoal, Rankin Bank), and key commercially fished species in the area (including goldband snapper). DPIRD expressed verbal support of CGG's approach to the impact assessment and was generally satisfied with the control measures described.<br>■ CGG has also advised DPIRD that the earliest start date for the survey has been revised to November 2018, thereby providing ample time for ongoing consultation with DPIRD to further clarify the issues.<br>■ CGG has provided a map and detailed description of the revised seasonal exclusion zone for goldband snapper. CGG has also provided the marine invertebrate noise impact assessments for pearl oysters and prawns.<br>In accordance with CGG's Management of Change process, CGG has a commitment to undertake a review of the impact and risk assessment for the activity in the event of changes to external aspects, including outcomes of ongoing stakeholder consultation. DPIRD has made CGG aware of their new in-house fisheries database ('Fishcube') which contains spatial catch data for all fisheries in the north-west of WA. In acknowledgement of this, CGG has sent a request for spatial data covering the Davros Extension survey area, and will commit to reviewing the impact and noise assessment following receipt of these data, and develop further changes to the activity or additional control measures (if merited). These data were not available at the time of writing the EP. |
| DoT - Maritime Environmental Emergency | Initial Consultation | 06 Oct 14 | | No response | |
| | Second Consultation | 26 Nov 14 | | No response | |

| Stakeholder | Engagement by CGG | | Response from Stakeholder | | CGG Merit Assessment and Action/Response |
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| Response Division | Third Consultation | 17 Feb 15 | | No response | |
| | Fourth Consultation<br>Follow-up Email<br>Follow-up Phone Call | 25 May 17<br>22 June 17<br>03 July 17 | 03 July 17 | Via phone (03/07/17), DoT - Maritime Environmental Emergency Response Division acknowledged receipt of consultation letters. Advised that DoT is not the responsible authority. Requested to be informed throughout but noted that they will be unlikely to respond following regular DoT policy. | Via phone (03/07/17), CGG acknowledged that the survey area is outside DoT jurisdiction. Confirmed that CGG will continue to consult with DoT - Maritime Environmental Emergency Response Division, as requested. |
| DoT - Navigational Safety Division | Fourth Consultation<br>Follow-up Email<br>Follow-up Phone Call | 25 May 17<br>22 June 17<br>03 July 17 | 03 July 17 | Via phone (03/07/17), DoT - Navigational Safety Division acknowledged receipt of consultation letters. Advised that DoT is not the responsible authority. Requested to be informed throughout but noted that they will be unlikely to respond following regular DoT policy. | Via phone (03/07/17), CGG acknowledged that the survey area is outside DoT jurisdiction. Confirmed that CGG will continue to consult with DoT - Navigational Safety Division, as requested. |
| **Conservation and Research Groups** | | | | | |
| Centre for Whale Research | Initial Consultation | 26 Sep 14 | | No response | |
| | Second Consultation | 26 Nov 14 | | No response | |
| | Third Consultation | 17 Feb 15 | | No response | |
| | Fourth Consultation<br>Follow-up Email | 25 May 17<br>22 June 17<br>21 Aug 17 | 24 June 17 | CWR strongly recommended that the survey not go ahead following the findings of the McCauley et al. (2017) study assessing marine seismic impacts on krill and the high probability that the time period and location will overlap areas where krill form the basis of the food chain for a variety of marine megafauna. | Via email (21/08/17), CGG advised that they are aware of the new literature published on the effects of seismic on zooplankton (incl. krill) and have addressed the implications of the findings this study, as well as the subsequent CSIRO study on the impacts of seismic on zooplankton (Richardson et al. 2017) in the impact assessment in the EP (Section 6.2.1). CGG provided this assessment to CWR for comment.<br>CGG also advised that they have developed an in-field real-time monitoring procedure to validate predicted modelled noise levels. The methodology for this monitoring has been peer reviewed by Dr Alexander Gavrilov at the Centre for Marine Science and Technology at Curtin University. |
| Cape Conservation Group (CCG) | Initial Consultation | 26 Sep 14 | 27 Oct 14 | CCG advised CGG that the survey area was a little outside of their area of interest and considered that whale experts make comments regarding whale migration routes. | |
| | Second Consultation | 26 Nov 14 | | No response | |
| | Fourth Consultation<br>Follow-up Email<br>Follow-up Phone Call | 25 May 17<br>22 June 17<br>03 July 17 | | No response | |
| International Fund for Animal Welfare (IFAW) | Initial Consultation | 26 Sep 14 | | No response | |
| | Second Consultation | 26 Nov 14 | | No response | |
| | Fourth Consultation<br>Follow-up Email | 25 May 17<br>22 June 17 | 22 June 17 | Advised that IFAW have limited capacity to respond to consultation requests but this should not be taken as an endorsement of proposed activities. Requested updates and will endeavour to respond. | Via email (22/06/17), CGG acknowledged the burden placed on stakeholders with limited capacity to respond but nevertheless encouraged IFAW to respond with any specific concerns. Confirmed that CGG will continue to consult with IFAW. |
| **Commercial Fishing Industry Groups and Associations** | | | | | |
| A Raptis & Sons | Initial Consultation | 26 Sep 14 | | No response | |
| | Second Consultation | 26 Nov 14 | | No response | |
| | Third Consultation | 17 Feb 15 | | No response | |
| | Fourth Consultation<br>Follow-up Email<br>Follow-up Phone Call | 25 May 17<br>22 June 2017<br>03 July 17 | | Via phone (03/07/17), A Raptis & Sons noted that they had not read the stakeholder consultation letter. Upon being informed of the location and proposed timing of the survey, CGG was advised that A Raptis & Sons had not been fishing the area. Requested to be kept informed. | Via phone (03/07/17), CGG encouraged A Raptis & Sons to read the stakeholder consultation letter. CGG noted that A Raptis & Sons do not fish in the or in the vicinity of the survey area and confirmed commitment for continued consultation. |

| Stakeholder | Engagement by CGG | | Response from Stakeholder | | CGG Merit Assessment and Action/Response |
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| Austral Fisheries | Email | 5 Aug 14 | 7 Aug 14 | Austral Fisheries replied to confirm that no fishing is conducted in the survey region at present.<br>CGG was provided with the contact details for John Duffy, Communications and Programs Officer with WAFIC. It was recommended that he would be a better contact. | 08/08/2014: CGG replied to acknowledge the response received, and confirm that CGG was already in the process of consulting with John Duffy. |
| | Initial Consultation | 26 Sep 14 | | No response | |
| | Second Consultation | 26 Nov 14 | | Acknowledged information received | No response or action required. |
| | Third Consultation | 17 Feb 15 | | No response | |
| | Fourth Consultation<br>Follow-up Email<br>Re-sent Fact Sheet | 25 May 17<br>22 June 17<br>23 June 17 | 22 June 17 | David Carter (Austral CEO) replied to follow up email and noted it was the he had heard of this consultation. | CGG response to David Carter (Austral CEO) via email (25/06/2017) acknowledged that David Carter had not received the previous stakeholder consultation letter from Austral reception and provided him with another copy of the information sent to Austral. CGG will include his email as a direct recipient going forward. |
| | Email | | 23 June 17 | David Carter (Austral CEO) deferred comment to Andy Prendergast (NFCA representative and also Austral Northern Division Manager).<br>*Refer to the NFCA response to the Fourth Consultation (below) for further information* | *Refer to the NFCA response to the Fourth Consultation (below) for further information* |
| Australian Southern Bluefin Tuna Industry Association (ASBTIA) | Initial Consultation | 26 Sep 14 | | No response | |
| | Second Consultation | 26 Nov 14 | | No response | |
| | Third Consultation | 17 Feb 15 | | Advised that ABSTIA do not require updates on the survey. | No impacts to ABSTIA fisher activities. |
| | Fourth Consultation<br>Follow-up Email<br>Follow-up Phone Call<br>Email | 25 May 17<br>22 June 17<br>03 July 17<br>03 July 17 | | Via phone (03/07/17), ABSTIA requested their contact details be updated. Advised that given the location the survey was unlikely to impact its activities, although ABSTIA would review the information provided by CGG.<br>Via email (04/07/17), ABSTIA confirmed that the survey location is outside their area of concern and requested not to be updated. | Via email (03/07/17), ASBTIA contact details updated. No further actions necessary. |
| Brown Dog Fishing Co. (BDFC)<br>(Pilbara Trap Managed Fishery (PTMF) licence holder) | Fourth Consultation<br>Follow-up Email<br>Follow-up Phone Call<br>Email<br>Email | 08 June 17<br>20 July 17<br>20 July 17<br>20 July 17<br>21 Aug 17 | 20 July 17 | Via phone (20/07/17), BDFC advised that they had not read the stakeholder consultation letter sent 08/06/2017 and noted that they receive numerous requests for consultation which go unanswered. BDFC informed CGG that they were strongly opposed to seismic activities in the region but were not currently fishing the survey area. BDFC advised that they have the same general concerns as other commercial fishers, such as:<br>■ lack of knowledge of seismic impacts of commercially targeted fish<br>■ poor understanding of trophic effects and potential indirect impacts to fisheries<br>■ fishers being displaced to accommodate seismic vessels (forced to lose ~$15,000 per day as a result)<br>■ the environmental approvals process favouring oil and gas proponents over commercial fishers.<br>BDFC noted that they could not attend a meeting but advised CGG to contact Mannie Shea (WAFIC) as an industry representative. | Via email (20/07/17), CGG sent BDFC a record of the telephone conversation for review. Advised BDFC to contact CGG at any time should they have further comments. Advised that CGG have engaged WAFIC and will continue to consult them on an ongoing basis.<br>Via email (21/08/17), CGG provided a summary of the WAFIC/Fat Marine face-to-face meeting and email addressing all raised concerns. Although BDFC do not currently fish the area, the survey footprint overlaps the prime water depth range for trap fishing so it is possible that PTMF could be active in the area in future. CGG have assessed all potential impacts and risks associated with the Davros Extension MC3D MSS, including addressing recent published literature on the impacts of seismic on the marine environment (e.g. shellfish, zooplankton) and have developed precautionary control measures reduce impacts/risks to ALARP (Section 6.2.1). CGG will maintain ongoing engagement with BDFC as follows (Section 6.2.3):<br>■ As part of the ongoing consultation process, CGG will notify all relevant persons four weeks prior to the start of the survey of the survey details including, timing, location, duration.<br>■ Commercial fishers, Recfishwest and relevant recreational fishing groups/ organisations and will be issued a 7 to 10 day forecast prior to activities commencing adjacent to Glomar Shoal and Rankin Bank<br>■ Commercial and recreational fishers are kept informed of daily survey activities through CGG's 24-hour look-ahead communication. |
| Commonwealth Fisheries Association (CFA) | Initial Consultation | 26 Sep 14 | | No response | |
| | Second Consultation | 26 Nov 14 | | No response | |
| | Third Consultation | 17 Feb 15 | | No response | |
| | Fourth Consultation<br>Follow-up Email | 25 May 17<br>22 June 17 | 22 June 17 | Email response from CFA advising CGG to consult directly with WAFIC and any other fishery association or business that operates in the area. | Via email (23/06/17), CGG sent a formal response to the CFA informing them that WAFIC and all other commercial fishery associations and businesses known to operate in the survey area are being consulted. |

| Stakeholder | Engagement by CGG | | Response from Stakeholder | | CGG Merit Assessment and Action/Response |
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| | Email | 23 June 17 | | | |
| Fat Marine<br>(Pilbara Line Managed Fishery (PLMF) licence holder) | Meeting | 6 Aug 14 | | A meeting was held between Fat Marine, RNR Fisheries and CGG to discuss concerns of licence holders within the PLMF. The PLMF informed CGG that their main concerns are:<br>■ loss of access to fishing grounds<br>■ reduction of catch after seismic survey has been undertaken in the area<br>■ reduction of catch over the past five years<br>■ complaints from fish market that product is being affected (quality and appeal)<br>■ direct noise effects on target fish species and their food resources<br>■ concerns are being ignored by DOF and WAFIC.<br>The PLMF stated they usually do not fish north of Rankin Bank, which is ~100 km to the east of the Davros Phase II MC3D MSS area, therefore CGG do not anticipate any interactions with fishers of the PLMF during the survey. The PLMF stated that they would not support any activity occurring in the PLMF licence area unless they can be assured their catch will not be affected. | In response to the PLMF concerns of impacts to fish and fish behaviour, CGG provided the PLMF with hard copies of the Woodside Maxima 3D MSS monitoring program – impacts of seismic airgun noise on fish behaviour, paper for their review (Woodside 2007). |
| | Email | 20 Aug 14 | 20 Aug 14 | Fat Marine acknowledged receipt of the information received from CGG and stated that they will review the information. | A formal response (20/08/17) was sent to Fat Marine and RNR Fisheries to address concerns of licence holders within the PLMF.<br>Via email (20/08/14), CGG sent a formal response to the PLMF acknowledging their concerns, outlined the management and mitigation procedures in place to address their concerns, and provided information of previously MSS acquired in the vicinity of the Davros Phase II MC3D MSS (Appendix I).<br>■ forecast of operations including survey vessel positions to assist fisheries licence holders with planning<br>■ communications protocol to manage interactions with fishing and shipping vessels,<br>■ a risk assessment of the impacts of the underwater discharge of seismic pulses over the Davros Phase II survey area<br>■ graph of the annual number and area acquired of previously 3D marine seismic surveys in the NWS region up to the 500 m depth contour<br>■ maps of the previously acquired 2D and 3D marine seismic surveys on the NWS (2007–2013) in relation to the proposed Davros MC3D MSS and Davros Phase II MC3D MSS.<br>In addition, CGG provided a graph of annual number and area acquired by previous 3D marine seismic surveys in the NWS region up to the 500 m depth contour, and a map of the previously acquired 2D and 3D marine seismic surveys on the NWS (2007–2013) in relation to the proposed activity area. CGG performed analysis. Analysis performed by CGG on this data was also provided, which shows that 2D and 3D MSS have been consistently acquired within the NWS region on an almost annual basis for over 20 years.<br>CGG will notify fishers of activity details to commercial fisheries management agencies, fishing industry bodies and individual companies and licence holders that were identified in the stakeholder consultation process three weeks prior to the survey commencing, to inform them about the location of the survey area, survey and support vessel specifications, timing of operations, contact phone numbers and to ascertain if proposed operations overlaps any key fishing grounds. |
| | Initial Consultation | 26 Sep 14 | | No response | |
| | Second Consultation | 26 Nov 14 | | No response | |
| | Third Consultation | 17 Feb 15 | | No response | |
| | Fourth Consultation<br>Follow-up Email<br>Follow-up Phone Call<br>Follow-up Phone Call<br>Email<br>Email | 25 May 17<br>22 June 17<br>10 July 17<br>20 July 17<br>20 July 17<br>21 Aug 17 | 20 July 17 | Via phone (20/07/17), Fat Marine advised that they currently fish the survey area and object to the proposed survey. Fat Marine concerned that NOPSEMA continue to approve activities that they believe displace commercial fishers. Fat Marine noted that PLMF fishers had only returned to the survey area this year after fishing west of Barrow Island/north of the Montebello Islands over last few years. Stated that it was necessary to move due to seismic surveys leading to declining catches. Noted that Fat Marine suffered financial difficulties 4-5 years ago that they attribute to a boom in seismic activity in the region.<br>Fat Marine enquired about how CGG planned to address new research showing negative impacts to fisheries from seismic activity occurring repeatedly in areas. Fat Marine believe an increased number of seismic surveys were being proposed because ongoing | Fat Marine is active in the survey area. Important that Fat Marine be aware of the proposed activity, as well as the management control measures in place. CGG believe a face-to-face meeting is likely to be most beneficial method of engagement.<br>Via phone (20/07/17), CGG acknowledged stakeholder consultation fatigue and requested a face-to-face meeting to address this issue and discuss Fat Marine's area of operation, concerns and appropriate control measures.<br>Via email (20/07/17), Confirmed that CGG would be available to meet with Fat Marine when in Perth in early August. Requested further details on Fat Marine's availability at the earliest possible opportunity. |

| Stakeholder | Engagement by CGG | | | Response from Stakeholder | CGG Merit Assessment and Action/Response |
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| | | | | research/upcoming publications would support the concerns that they have been expressing to NOPSEMA since 2011 and lead to reform of the industry. Fat Marine noted that they consider the environment approvals process treats commercial fishers unfairly.<br>Fat Marine informed CGG that they would be in Perth around 02/08/2017 and would be interested in meeting with CGG. | Face-to-face meeting (03/08/17) with CGG, RPS, WAFIC and Jimmy Money from Fat Marine. During this meeting, Fat Marine advised CGG that the Davros Extension MC3D survey area is a relatively new area for their fishing operations and would like to receive bathymetric data collected during the survey. CGG will consult with Fat Marine to determine the format required for supply of bathymetric data.<br>Via 21/08/17, CGG provided a formal response addressing Jimmy's concerns and meeting outcomes/actions. CGG have assessed all potential impacts and risks associated with the Davros Extension MC3D MSS, including addressing recent published literature on the impacts of seismic on the marine environment (e.g. shellfish, zooplankton) and have developed precautionary control measures reduce impacts/risks to ALARP (Section 6.2.1). CGG have provided the underwater noise and fish/larvae/plankton assessments to Fat Marine.<br>CGG will maintain ongoing engagement with Fat Marine and informed them of the following control measures that will be implemented during the survey (Section 6.2.1 and 6.2.3):<br>■ CGG will maximise the acquisition of seismic data within the key fishing depth range identified by the Fat Marine (Pilbara Line Managed Fishery) of 60 to 90 fathoms (110 to 165 m) for goldband snapper during the months of January and February, when the fishery is inactive. In the event that the Fat Marine changes the months that they are inactive, CGG will consult with them to modify the timing of maximising data acquisition within this area accordingly.<br>■ A smaller airgun array volume of 1,800 cui will be used in water depths within the survey area from 35 to 50 m.<br>■ CGG will implement in-field real-time monitoring during seismic acquisition using the 4,500 cubic inch array to monitor the seismic sound levels of each seismic line. This information will be used to verify the power output of the sound source and compare measured levels with modelled levels.<br>■ As part of the ongoing consultation process, CGG will notify all relevant persons four weeks prior to the start of the survey of the survey details including, timing, location, duration.<br>■ Fat Marine and RNR will be advised eight weeks prior to the start of the survey to ensure that meaningful planning can take place, given that these stakeholders were slow to respond during previous rounds of consultation and it is anticipated that ongoing consultation may require a time-sharing agreement to be reached.<br>■ Commercial fishers, Recfishwest and relevant recreational fishing groups/ organisations and will be issued a 7 to 10 day forecast prior to activities commencing adjacent to Glomar Shoal and Rankin Bank.<br>■ Commercial and recreational fishers are kept informed of daily survey activities through CGG's 24-hour look-ahead communication.<br>■ In the event that another vessel is acquiring seismic data in the region, the survey vessel shall not acquire data simultaneously within 50 km of the other seismic vessel in order to avoid cumulative impacts to marine fauna.<br>■ |
| Marine Tourism WA | Fourth Consultation<br>Follow-up Phone Call<br>Follow-up Email | 27 June 17<br>03 July 17<br>21 July 17 | | Via phone (03/07/17), advised that Marine Tourism WA had sent out the Stakeholder Consultation Fact Sheet to its members and that CGG should expect a formal response within a few days. | Await further response from Marine Tourism WA. Continue engagement given broad membership base and their cooperation in sharing information. Keep informed as planning for the survey progresses and further information on survey timing becomes available.<br>Via email (21/07/17), CGG enquired whether Marine Tourism WA had received any comments from its members and advised that feedback would be welcomed at any time. |

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| MG Kailis Group and Westmore Seafoods | Meeting | 7 Aug 14 | 7 Aug 14 | During the meeting held between CGG, MG Kailis Group and Westmore Seafoods, the following were raised as the main concerns:<br>■ declining catch rates<br>■ loss of access to fishing grounds<br>■ vessel interactions and safety<br>■ cumulative impacts i.e. knock on effects such as the placement of wells in Pilbara trawl fishing licence area<br>■ increased amount of vessels transiting the fishing area due to vessel servicing offshore rigs.<br>CGG acknowledges concerns, and expressed willingness to maintain communications with MG Kailis throughout the planning stages of the activity in order to plan operations to minimise the potential displacement of fishermen. MG Kailis and Westmore Seafoods strongly objected to the idea, and informed CGG that while they are displaced from the area they lose time, loss of catch and loss of revenue.<br>MG Kailis and Westmore Seafoods stated that they will not work with CGG in the planning stages of the project, and they do not want any boats in their licence area. | In a formal email response (20/08/14), CGG acknowledged concerns raised and outlined management and mitigation measures which will be in place:<br>■ forecast of operations including survey vessel positions – to assist fisheries licence holders in planning<br>■ communications protocol to manage interactions with fishing and shipping vessels<br>■ risk assessment of the impacts of the underwater discharge of seismic pulses over the activity area<br>In addition, CGG provided a graph of annual number and area acquired by previous 3D marine seismic surveys in the NWS region up to the 500 m depth contour, and a map of the previously acquired 2D and 3D marine seismic surveys on the NWS (2007–2013) in relation to the proposed activity area. CGG performed analysis. Analysis performed by CGG on this data was also provided, which shows that 2D and 3D MSS have been consistently acquired within the NWS region on an almost annual basis for over 20 years. |
| | Email | 20 Aug 14 | 4 Sep 14 | MG Kailis acknowledged receipt of information provided, and informed CGG that they consider the response from CGG inadequate, and expect CGG to take note of the possibility that they may have to suspend fishing operations in the area during seismic operations.<br>MG Kailis to contact NOPSEMA and seek legal action. | In a formal email response (16/09/14), CGG informed MG Kailis that they have noted their concerns and they will respond in due course to discuss their position and hopefully begin working towards a mutually beneficial outcome.<br>In a follow-up email (30/09/14), CGG responded to acknowledge the information received on 04/09/14 from MG Kailis. CGG informed MG Kailis that they have attempted to undertake consultation with the PFTIMF licence holders in order to find out when the majority of fishing will be undertaken within the operational area, so that they can begin working towards an outcome that will allow both industries to conduct their activities under their licensing arrangements.<br>CGG also presented their findings following consultation with the DPIRD regarding PTF, particularly that:<br>■ the Pilbara Fish Trawl Interim Managed Fisheries Management Plan (1997) is in place to specifically manage the sustainable level of catch/ take in the Pilbara Fish Trawl licence area<br>■ licence holders under an entitlement that sets out the total number of fish trawl hours that are permitted in each zone<br>■ licence holders must not accumulate more fish trawl hours in each zone than their entitlement permits, however they can fish their entitlement at any time of the year and there is no time of year restrictions<br>■ licence holders operated with a Vessel Management System (VMS) which tracks where the survey vessel conducts its operations under the licence conditions and the total number of hours accumulated.<br>CGG reiterated the planned management measures, and expressed a desire to work together towards an outcome that will allow both industries to conduct their activities under their licensing arrangements.<br>CGG will notify fishers of activity details to commercial fisheries management agencies, fishing industry bodies and individual companies and licence holders that were identified in the stakeholder consultation process three weeks prior to the survey commencing, to inform them about the location of the survey area, survey and support vessel specifications, timing of operations, contact phone numbers and to ascertain if proposed operations overlaps any key fishing grounds. |
| | Initial Consultation | 26 Sep 14 | | No response | |
| | Second Consultation | 26 Nov 14 | | No response | |
| | Third Consultation | 17 Feb 15 | | No response | |
| | Fourth Consultation<br>Follow-up Email<br>Follow-up Phone Call | 25 May 17<br>22 June 17<br>26 June 17<br>26 June | 26 June 17<br>21 July 17 | Via phone (26/06/17), advised that all three previous contacts no longer work with MG Kailis. CGG was provided with updated contact details.<br>Via email (21/07/17) Janice Bell advised that she would confirm the impact, if any, to MG Kailis Group following a meeting with Daryl Elmer on Monday (24/04/2017). | CGG awaiting feedback from MG Kailis Group. Important that MG Kailis Group be aware of the proposed activity, as well as the management and mitigation procedures in place to address their concerns. CGG will maintain ongoing engagement with potentially impacted commercial fishers to avoid or reduce possible simultaneous operations.<br>Emails sent on 25/05/2017 and 22/06/2017 were not received, however MG Kailis were included in the fishery licence holder mailing list so a stakeholder consultation letter was |

| Stakeholder | Engagement by CGG | | Response from Stakeholder | | CGG Merit Assessment and Action/Response |
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| | Follow-up Email<br>Follow-up Phone Call<br>Follow-up Phone Call<br>Emails | 17<br>03 July 17<br>21 July 17<br>21 July 17 | | | also posted on 08/06/2017. Updated contact details stored for MG Kailis and emailed the Fact Sheet to current Project Manager.<br>Via email (26/06/17), previous emails and Stakeholder Consultation Fact Sheet re-sent to Daryl Elmer. Informed that the email contained the same information as that which was posted to MG Kailis on 08/06/2017. MG Kailis contact details updated.<br>21/07/2017 (phone and email): CGG left message on voice mail of contacts at MG Kailis Group and also with reception. Followed-up with an email to provide context. Informed MG Kailis Group that over the past couple of months CGG have been trying to reach a relevant person to consult with. Noted that the contacts at MG Kailis Group that CGG has engaged with previously have moved on and that Daryl Elmer (now considered the appropriate person) has been at sea. Requested confirmation on whether the stakeholder consultation information has been received and if MG Kailis has any comments or concerns. Advised that CGG would greatly appreciate feedback from MG Kailis Group if there is a possibility they may be active in the survey area.<br>CGG will continue to consult with MG Kailis Group as follows (Section 6.2.3):<br>■ As part of the ongoing consultation process, CGG will notify all relevant persons eight weeks prior to the start of the survey of the survey details including, timing, location, duration.<br>■ Commercial fishers, Recfishwest and relevant recreational fishing groups/ organisations and will be issued a 7 to 10 day forecast prior to activities commencing adjacent to Glomar Shoal and Rankin Bank.<br>■ Commercial and recreational fishers are kept informed of daily survey activities through CGG's 24-hour look-ahead communication. |
| Northern Fishing Companies Association (NFCA) | Initial Consultation | 26 Sep 14 | | No response | |
| | Second Consultation | 26 Nov 14 | | No response | |
| | Third Consultation | 17 Feb 15 | | No response | |
| | Fourth Consultation<br>Follow-up Email<br>Re-sent Fact Sheet<br>Email | 25 May 17<br>22 June 17<br>23 June 17<br>07 June 17 | 22 June 17<br>23 June 17 | Via email (22/07/17), NFCA apologised for not responding to previous email. Requested that stakeholder consultation material be re-sent.<br>Via email (23/07/17), NFCA/Austral informed CGG that NWSTF fishers operate in the general area but are only permitted to fish depths >200 m. Stated that if survey occurs in depths >200 m NWSTF fishers will not be impacted. | *Note that Andy Prendergast (NFCA representative and Austral Northern Division Manager) was consulted on behalf of the NFCA and also Austral at the request of David Carter (Austral CEO).*<br>Via email (07/07/17), CGG informed NFCA/Austral that no impacts on fishers' activities are expected as there is a very small overlap between the north-western operational area boundary and the boundary of the NWSTF fishery zone (Figure G). Referred to the control measures outlined in Attachment C of the Stakeholder Consultation Fact Sheet (and Section 6.2.1). CGG offered to meet NFCA/Austral in person.<br>CGG will continue to consult with NFCA/Austral (Section 6.2.3):<br>■ As part of the ongoing consultation process, CGG will notify all relevant persons eight weeks prior to the start of the survey of the survey details including, timing, location, duration.<br>■ Commercial fishers, Recfishwest and relevant recreational fishing groups/ organisations and will be issued a 7 to 10 day forecast prior to activities commencing adjacent to Glomar Shoal and Rankin Bank.<br>■ Commercial and recreational fishers are kept informed of daily survey activities through CGG's 24-hour look-ahead communication. |
| Pearl Producers Association (PPA) | Meeting | 13 Aug 14 | | Meeting held with representatives of PPA and Western Australian Fishing Industry Council (WAFIC) to discuss the concerns of licence holders in the POMF.<br>WAFIC informed CGG of recent meetings between APPEA and WAFIC and a MOA between the two organisations was in the process of being signed and approved.<br>PPA informed CGG that they met with NOPSEMA recently to discuss the consultation process and how to make it better.<br>PPA requested a map of the operational area with the 50m isobath clearly identified. | In a formal email response (20/08/14), CGG provided a map with the 50 m isobath clearly marked, as requested. |
| | Initial Consultation | 20 Aug 14 | 22 Aug 14 | In an email, PPA formally responded to the meeting held between PPA, CGG and representatives from WAFIC on 13 August 2014.<br>PPA stated that their main concerns are:<br>■ potential for impacts on pearl oyster stocks<br>■ recruitment to the fishery | Via email (16/09/14), CGG informed that PPA that they have noted their concerns and will respond in due course.<br>In a formal email response (10/10/14), CGG responded to the PPA acknowledging their concerns and outlining the management and mitigation procedures in place to address their concerns. They also provided information of previously acquired MSS in the vicinity of the activity, and extracts of the EP relevant to Oyster Managed Fisheries: |

| Stakeholder | Engagement by CGG | | Response from Stakeholder | | CGG Merit Assessment and Action/Response |
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| | | | | ■ quality of pearl oysters<br>■ risk of pollution and treatment of spills<br>■ potential marine pests from rig and support vessels<br>■ stress on a developing pearl oyster<br>■ impact on pearl oyster eggs and larval stages within 17 m of the airgun<br>■ impact on food web supporting pearl oysters. | ■ draft assessment of impacts and risks – discharge of underwater seismic pulses on planktonic organisms and bivalve molluscs<br>■ larval distribution analysis.<br>CGG investigated the proposed implementation of an exclusion zone proposed by the PPA for waters shallower than the 100 m isobath, and have deemed it an unworkable option as it would cut out more than 90% of the proposed survey area.<br>CGG informed the PPA that they have met with the DPIRD, who confirmed that they would not be conducting scientific research into the distribution of pearl oysters anytime in the immediate future. CGG has also contacted the IAGC via email and made a recommendation in support of the PPA and its efforts in driving research into the effects of seismic on pearl oysters.<br>CGG informed the PPA that existing controls are assessed in the EP as reducing the impact by ALARP, and therefore no additional control measures will be implemented to reduce the impacts and risks to the pearl oyster stocks. |
| | | | 16 Oct 14 | In an email response, PPA referred to the letter of 10/10/14.<br>The PPA stated that on several occasions across multiple projects they have expressed concerns about the impacts on pearly oysters from any seismic survey inside the 100 m depth contour between NW Cape and Lacepede Islands. PPA states that this depth is the best estimate of the outer range of the *P. maxima* pearl oyster species. The PPA reiterated that they are concerned with the impacts on all pearl oysters in the area as they support the major fishery around Eighty Mile Beach, and that there are several small but important pearl oyster fishing grounds situated right along this coastline.<br>PPA appreciates CGG's efforts with the IAGC.<br>PPA acknowledges that CGG does not expect a scientific research study to be completed and made available for inclusion in the Davros Phase II MC3D MSS EP.<br>PPA expressed that they appreciate the impact of excluding seismic survey inshore of the 100 m isobath, however they believe that failure of the pearl oyster stocks to effectively provide recruits into the fishery (adjacent to Eighty Mile Beach) or condition of adult pearl oysters being compromised by seismic activity would be severely detrimental to business.<br>PPA stance is that, until research into impacts on pearl oysters from seismic activity is complete, the pearling industry view is that the risk around seismic survey activity in this area of the coast is too high, and the industry position is that they cannot support any proposals for seismic survey activity in the region. | In a formal email response (17/10/14), CGG thanked PPA for their response.<br>CGG will comply with the PPA request for no seismic activity within the 100 m isobath adjacent to the Eighty Mile Beach region. However, as the operational area is approx. 345 km from the boundary of the Eighty Mile Beach Marine Reserve, this request is not relevant for this survey.<br>CGG will notify fishers of activity details to commercial fisheries management agencies, fishing industry bodies and individual companies and licence holders that were identified in the stakeholder consultation process three weeks prior to the survey commencing, to inform them about the location of the survey area, survey and support vessel specifications, timing of operations, contact phone numbers and to ascertain if proposed operations overlaps any key fishing grounds. |
| | Second Consultation | 26 Nov 14 | | No further response | |
| | Third Consultation | 17 Feb 15 | | No further response | |
| | Fourth Consultation<br>Follow-up Email<br>Follow-up Phone Call<br>Follow-up Phone Call<br>Email<br>Email | 25 May 17<br>22 June 17<br>03 July 17<br>05 July 17<br>13 July 17<br>18 Aug 17 | 05 July 17 | Via phone (05/07/17), PPA informed CGG that the survey information had been received and sent to their members.<br>PPA advised that in their view the Pilbara Coast "north of Barrow Island" including the survey area was not a major concern compared to areas such as the Exmouth Gulf or Eighty Mile Beach. PPA explained that this was because (1) pearl oyster distribution is relatively patchy; and (2) there are no longer active pearl farm leases near Dampier. PPA requested information on the water depth in which seismic guns would operate.<br>PPA consider 18 m to 30 m to be prime habitat for pearl oyster but noted that communities may occur in shallow water areas up to 70 m. PPA noted that the survey area included Zone 1 brood stock and that this was a potential concern for recruitment to the fishery. | Via phone (05/07/17), CGG provided information on location and timing of proposed activity. Requested feedback on potential impacts to PPA fishers and comments on potential impacts to be addressed.<br>Via email (13/07/17), CGG sent PPA telephone record and requested that PPA review and respond with any further comments.<br>CGG confirmed minimum depth in which seismic guns will be operational is 35 m and in depths from 35 to 50 m the volume of the seismic array will be reduced from 4,500 cui to 1,800 cui.<br>CGG enquired about the PPA's availability to meet.<br>Via email (18/08/17), CGG have undertaken an assessment of the impacts of seismic noise on pearl oysters and broodstock in the vicinity of the survey area and provided a copy to PPA for comment (Appendix 6 and Section 6.2.1).<br>CGG requested to meet in person to discuss the assessment, proposed control measures to be implemented and any concerns PPA may have.<br>CGG will continue to consult with PPA (Section 6.2.3):<br>■ As part of the ongoing consultation process, CGG will notify all relevant persons four weeks prior to the start of the survey of the survey details including, timing, location, duration.<br>■ Commercial and recreational fishers are kept informed of daily survey activities through CGG's 24-hour look-ahead communication.<br>Via email (18/08/17), CGG provided the PPA with the marine invertebrates underwater noise impact assessment from the EP, including the following control measures that will be |

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| | | | | | implemented during the survey (Section 6.2.1 and 6.2.3):<br>■ The minimum depth within the survey area that seismic data will be acquired is 35 m.<br>■ A smaller airgun array volume of 1,800 cui will be used in water depths within the survey area from 35 to 50 m.<br>■ CGG will implement in-field real-time monitoring during seismic acquisition using the 4,500 cubic inch array to monitor the seismic sound levels of each seismic line. This information will be used to verify the power output of the sound source and compare measured levels with modelled levels.<br>■ As part of the ongoing consultation process, CGG will notify all relevant persons four weeks prior to the start of the survey of the survey details including, timing, location, duration.<br>■ Commercial fishers, Recfishwest and relevant recreational fishing groups/ organisations and will be issued a 7 to 10 day forecast prior to activities commencing adjacent to Glomar Shoal and Rankin Bank.<br>■ Commercial and recreational fishers are kept informed of daily survey activities through CGG's 24-hour look-ahead communication.<br>■ In the event that another vessel is acquiring seismic data in the region, the survey vessel shall not acquire data simultaneously within 50 km of the other seismic vessel in order to avoid cumulative impacts to marine fauna. |
| Recfishwest | Meeting | 5 Aug 14 | 12 Aug 14 | CGG met with Recfishwest, representatives of recreational and charter boat fishermen, to discuss the concerns of licence holders in POMF.<br>Recfishwest informed CGG that the billfish recreational fishermen tend to fish closer to the mainland, in and around Legendre Island.<br>Recfishwest foresees the main concerns as:<br>■ displacement from key fishing grounds<br>■ loss of access.<br>Via follow-up email (12/08/14), Recfishwest informed CGG that the concerns of the charter boat operators and recreational fishermen are as follows:<br>■ loss of access to Glomar Shoal by recreational fishers who have undertaken a two day trip to reach the shoals<br>■ importance of a potential spawning location as large aggregations of billfish species have been reported surrounding the shoals. | |
| | Initial Consultation<br>Email<br>Email | 21 Aug 14<br>16 Sep 14<br>02 Oct 14 | 27 Aug 14 | Recfishwest proposed a 10 NM exclusion zone from the centre of the shoal<br>Via email (27/08/14), Recfishwest welcomes the forecast of operational management and mitigation measures in place.<br>Recfishwest acknowledged that their initial proposal of a 10 NM exclusion zone may result in operational difficulties, but given the uncertainty of seismic activity impact on fish and fish behaviour, Recfishwest believes a level of protection must be applied to the Shoals itself.<br>Recfishwest requested clarification on the 1,500 m buffer zone around the 50 m isobath surrounding Glomar Shoal, and proposed an increase to 3,000 m buffer zone. | In a formal response email (21/08/14), CGG acknowledged Recfishwest concerns and outlined the management and mitigation procedures in place to address their concerns:<br>■ forecast of operations including survey vessel positions – to assist fisheries licence holders in planning<br>■ communications protocol to manage interactions with fishing and shipping vessels<br>■ risk assessment of the impacts of the underwater discharge of seismic pulses over the activity area.<br>Via email (16/09/14), Scope Resources apologies for the delay in response, and confirmed that a formal response would be sent shortly.<br>Via email 02/10/14, CGG requested the contact details for the fishing organisations who wish to receive the weekly forecast of operations.<br>CGG agreed with Recfishwest that there is little understanding of spawning areas and durations for most key indicator species in the NWMR and that Glomar Shoal has been identified as a potential area of importance for spawning events due to its high species diversity and productivity. CGG noted that they have met with DPIRD to seek information about the significance of Glomar Shoal as a spawning area, but this could not be confirmed by DPIRD.<br>CGG conducted an investigation into the proposed 3,000 m buffer surrounding the 50 m isobath. CGG informed Recfishwest that this is an unworkable option, as it would cut out 50% of the survey area. A shallow water exclusion zone will be implemented for areas less than 25 m in water depth, within which no acquisition will occur. A map of the exclusion area was provided.<br>CGG estimates that recreational and commercial fishers will be partially displaced from the area surrounding Glomar Shoal for a maximum of two months.<br>CGG will notify fishers of activity details to commercial fisheries management agencies, fishing industry bodies and individual companies and licence holders that were identified in |

| Stakeholder | Engagement by CGG | | Response from Stakeholder | | CGG Merit Assessment and Action/Response |
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| | | | | | the stakeholder consultation process <u>three weeks</u> prior to the survey commencing, to inform them about the location of the survey area, survey and support vessel specifications, timing of operations, contact phone numbers and to ascertain if proposed operations overlaps any key fishing grounds. |
| | Second Consultation | 26 Nov 14 | | No response | |
| | Third Consultation | 17 Feb 15 | | No response | |
| | Fourth Consultation<br>Follow-up Email<br>Email<br>Email | 25 May 17<br>22 June 17<br>26 June 17<br>24 July 17 | 26 June 17 | Via emails (26/06/17), Recfishwest requested further information regarding the proposed timing of the survey in an initial email but subsequently accepted that it was not possible for CGG to provide additional information. Recfishwest advised that it would discuss the survey with members in the region and provide CGG with feedback in due course. | Await further response from Recfishwest. Continue engagement given broad membership base and their cooperation in sharing information. CGG will keep Recfishwest informed as planning for the survey progresses and further information on survey timing becomes available.<br>Via email (26/06/17), CGG explained that it was not possible to provide Recfishwest with further information on when the survey is due to take place as timing will depend on the granting of approvals, the survey vessel's availability, data requirements and sea state conditions.<br>Via email (24/07/17), CGG enquired whether Recfishwest had received any comments from its members and advised that feedback would be welcomed at any time.<br>CGG will continue to consult with Recfishwest (Section 6.2.3):<br>■ As part of the ongoing consultation process, CGG will notify all relevant persons four weeks prior to the start of the survey of the survey details including, timing, location, duration.<br>■ Commercial fishers, Recfishwest and relevant recreational fishing groups/ organisations and will be issued a 7 to 10 day forecast prior to activities commencing adjacent to Glomar Shoal and Rankin Bank.<br>■ Commercial and recreational fishers are kept informed of daily survey activities through CGG's 24-hour look-ahead communication. |
| RNR Fisheries (RNR)<br>(PLMF licence holder) | Meeting | 6 Aug 14 | | A meeting was held between Fat Marine, RNR Fisheries and CGG to discuss concerns of licence holders within the PLMF. The PLMF informed CGG that their main concerns are:<br>■ loss of access to fishing grounds<br>■ reduction of catch after seismic survey has been undertaken in the area<br>■ reduction of catch over the past five years<br>■ complaints from fish market that product is being affected (quality and appeal)<br>■ direct noise effects on target fish species and their food resources<br>■ concerns are being ignored by DoF and WAFIC.<br>The PLMF stated they usually do not fish north of Rankin Bank, which is ~100 km to the east of the Davros Phase II MC3D MSS area, therefore CGG do not anticipate any interactions with fishers of the PLMF during the survey. The PLMF stated that they would not support any activity occurring in the PLMF licence area unless they can be assured their catch will not be affected. | In response to the PLMF concerns of impacts to fish and fish behaviour, CGG provided the PLMF with hard copies of the Woodside Maxima 3D MSS monitoring program – impacts of seismic airgun noise on fish behaviour, paper for their review (Woodside 2007). |
| | Email | 20 Aug 14 | 20 Aug 14 | RNR Fisheries acknowledged receipt of the information received from CGG and stated that they will review the information. | A formal response (20/08/17) was sent to Fat Marine and RNR Fisheries to address concerns of licence holders within the PLMF.<br>Via email (20/08/14), CGG sent a formal response to the PLMF acknowledging their concerns, outlined the management and mitigation procedures in place to address their concerns, and provided information of previously MSS acquired in the vicinity of the Davros Phase II MC3D MSS (Appendix I).<br>■ forecast of operations including survey vessel positions to assist fisheries licence holders with planning<br>■ communications protocol to manage interactions with fishing and shipping vessels,<br>■ a risk assessment of the impacts of the underwater discharge of seismic pulses over the Davros Phase II survey area<br>■ graph of the annual number and area acquired of previously 3D marine seismic surveys in the NWS region up to the 500 m depth contour<br>■ maps of the previously acquired 2D and 3D marine seismic surveys on the NWS (2007–2013) in relation to the proposed Davros MC3D MSS and Davros Phase II MC3D MSS.<br>In addition, CGG provided a graph of annual number and area acquired by previous 3D |

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| | | | | | marine seismic surveys in the NWS region up to the 500 m depth contour, and a map of the previously acquired 2D and 3D marine seismic surveys on the NWS (2007–2013) in relation to the proposed activity area. CGG performed analysis. Analysis performed by CGG on this data was also provided, which shows that 2D and 3D MSS have been consistently acquired within the NWS region on an almost annual basis for over 20 years.<br>CGG will notify fishers of activity details to commercial fisheries management agencies, fishing industry bodies and individual companies and licence holders that were identified in the stakeholder consultation process three weeks prior to the survey commencing, to inform them about the location of the survey area, survey and support vessel specifications, timing of operations, contact phone numbers and to ascertain if proposed operations overlaps any key fishing grounds. |
| | Initial Consultation | 26 Sep 14 | | No response | |
| | Second Consultation | 26 Nov 14 | | No response | |
| | Third Consultation | 17 Feb 15 | | No response | |
| | Fourth Consultation<br>Follow-up Email<br>Follow-up Phone Call<br>Email<br>Email | 25 May 17<br>22 June 17<br>10 July 17<br>13 July 17<br>21 Aug 17 | 10 July 17 | Via phone (10/07/17), RNR informed CGG that they had not read the stakeholder consultation letter. RNR noted that they are overwhelmed with emails so most go unanswered.<br>RNR objected strongly to the proposed survey and claimed that the number of fish in the area had declined significantly as a result of seismic surveys. Complained that seismic activity continued to be approved in spite of consistent objections from fishers over the past six years and expressed discontent with the environmental approvals process. Stressed that RNR were going broke because of declining fish catch (-50% catch per hook compared to >6 years prior) and attributed this to impacts from seismic noise.<br>Stated that the impacts of seismic surveys were not understood and that no research had been completed that was relevant to the MMF or PLMF. Suggested that fishers be contracted to help researchers collect data and complained that this had been suggested previously but never implemented.<br>Advised that RNR would be in Perth appointment around 25/07/17 but were unlikely to have any time available for a meeting with CGG. | RNR is active in the survey area. Important that RNR be aware of the proposed activity, as well as the management and control measures in place. CGG believe a face-to-face meeting is likely to be most beneficial method of engagement.<br>Via phone (10/07/17), CGG acknowledged the burden placed on fishers having to respond to regular stakeholder consultation and encouraged RNR to meet with CGG so that concerns could be discussed directly.<br>CGG informed RNR that further information including assessment of underwater noise from seismic operations on fish could also be provided.<br>CGG requested further information on RNRs availability for a meeting when in Perth around 25/07/17.<br>Via email (13/07/17), CGG sent RNR a typed record of the telephone conversation on 10/07/17 for review. Reiterated that CGG would like to work together with RNR to minimise the possibility of disturbance to their activities. Advised that CGG is a supporter of research into the impacts of seismic noise on fish and would also like to share outcomes from recent studies, as well as discuss further RNR's suggestions for where additional work would be most beneficial. Requested that RNR inform CGG if there was a possibility they may be fit in a meeting with CGG when on Perth on 25/07/17.<br>Via email (21/08/17), CGG have assessed all potential impacts and risks associated with the Davros Extension MC3D MSS, including addressing recent published literature on the impacts of seismic on the marine environment (e.g. shellfish, zooplankton) and have developed precautionary control measures reduce impacts/risks to ALARP (Section 6.2.1). CGG have provided the underwater noise and fish/larvae/plankton assessments to RNR.<br>CGG will maintain ongoing engagement with RNR as follows (Section 6.2.3):<br>■ RNR and Fat Marine will be advised eight weeks prior to the start of the survey to ensure that meaningful planning can take place, given that these stakeholders were slow to respond during previous rounds of consultation and it is anticipated that ongoing consultation may require a time-sharing agreement to be reached.<br>■ As part of the ongoing consultation process, CGG will notify all relevant persons four weeks prior to the start of the survey of the survey details including, timing, location, duration.<br>■ Commercial fishers, Recfishwest and relevant recreational fishing groups/ organisations and will be issued a 7 to 10 day forecast prior to activities commencing adjacent to Glomar Shoal and Rankin Bank.<br>■ Commercial and recreational fishers are kept informed of daily survey activities through CGG's 24-hour look-ahead communication. |
| Southern Trading | Meeting | 13 Aug 14 | | Meeting held between CGG, Southern Trading and Deep Sea Water Service.<br>*Refer to WCDSCF licence holders (below) for further information* | *Refer to WCDSCF licence holders (below) for further information* |
| | Initial Consultation | 21 Aug 14 | | No response | |
| | Second Consultation | 26 Nov 14 | | No response | |
| | Third Consultation | 17 Feb 15 | | No response | |

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| | Fourth Consultation<br><br>Email Follow-up<br><br>Email<br>Emails | 25 May 17<br><br>22 June 17<br><br>26 June 17<br>28 June 17 | 27 June 17<br><br>28 June 17 | Via email (27/06/17), advised that survey is outside of the boundaries within which Southern Trading fish.<br>Via email (28/06/17), Southern Trading informed CGG that they do not want further information on the proposed survey. | No actions necessary as Southern Trading do not fish in the area of the proposed survey.<br>Emails (28/06/17), acknowledged response and advised that CGG will not continue to consult with Southern Trading as they are no longer considered a relevant person. |
| WA Seafood Exporters | Initial Consultation | 26 Sep 14 | | No response | |
| | Second Consultation | 26 Nov 14 | | No response | |
| | Third Consultation | 17 Feb 15 | | No response | |
| | Fourth Consultation<br>Follow-up Email<br>Email | 25 May 17<br>22 June 17<br>26 June 17 | 22 June 17 | Advised that there will be nominal impact on WA Seafood Exporters' fishing operations. | Via email (26/06/17), CGG advised that it will not continue to consult unless requested otherwise. |
| West Coast Deep Sea Crustacean Managed Fishery (WCDSCF) licence holders | Meeting | 13 Aug 14 | | CGG conducted a meeting with representatives from Southern Trading and Deep Sea Water Services to discuss the concerns of licence holders in the WCDSCF.<br>Main concerns with exploratory activities involving towed equipment:<br>■ vessel interactions<br>■ safety and entanglement of fishing equipment.<br>No specific concerns with survey, as they are not currently fishing in the area of the proposed survey.<br>Note: for future surveys conducted south of Exmouth, WCDSCF require advance notification prior to commencement of operations in order to plan the placement of fishing equipment to avoid entanglement. | CGG sent a formal response to WCDSCF via email (21/08/14) to acknowledge concerns and outline management and mitigation procedures. |
| | Email | 08 June 17 | | No response. | CGG do not have access to telephone numbers for licence holders, however will maintain ongoing engagement as follows:<br>■ As part of the ongoing consultation process, CGG will notify all relevant persons four weeks prior to the start of the survey of the survey details including, timing, location, duration.<br>■ Commercial fishers, Recfishwest and relevant recreational fishing groups/organisations and will be issued a 7 to 10 day forecast prior to activities commencing adjacent to Glomar Shoal and Rankin Bank.<br>■ Commercial and recreational fishers are kept informed of daily survey activities through CGG's 24-hour look-ahead communication. |
| Western Australian Fishing Industry Council (WAFIC) | Email | 30 Jul 14 | | No response | CGG contacted WAFIC to request a meeting with them and to forward consultation material to members of the PLMF, PTF, PFTIMF and WCDSCF. |
| | Email to follow-up for a response | 4 Aug 14 | | WAFIC confirmed the email had been received and forwarded on to the Executive. | CGG followed up the meeting request email to WAFIC on 4 August 2014 and requested the following information:<br>■ Has the information for the meeting request been sent out to the requested stakeholders?<br>■ If so, have any responses been received from stakeholders?<br>■ Have any stakeholders indicated that they would like to participate in face-to-face meetings with CGG?<br>CGG requested the information be forwarded to members of the MMF - WAFIC did not reply to this email request. |
| | Email | 11 Aug 14 | | | CGG forwarded the two email requests sent to WAFIC on 30 July and 4 August 2014 to WAFIC CEO. CGG informed WAFIC CEO that WAFIC has not responded to either of the two requests.<br>WAFIC did not reply to this email. |

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| | Meeting | 13 Aug 14 | | During the meeting with representatives of the CGG, PPA and WAFIC on 13 August 2014, CGG queried WAFIC as to why their emails had not been replied. The WAFIC representatives at the meeting (Operations Manager and the Communications and Programs Officer) were unaware of the email correspondence sent and that a response from WAFIC was still outstanding. | CGG forwarded copies of the email requests sent to WAFIC on 30 July and 4 and 11 August 2014 to the WAFIC communications manager. |
| | Email | | 14 Aug 14 | WAFIC Communications and Programs Officer confirmed they will be sending out the meeting requests and requested clarification on the offer of face-to-face meetings. | Via email (14/08/14), CGG confirmed WAFIC's queries that stakeholders can contact CGG via Scope Resources to organise the face-to-face meetings at a time that is convenient for them. CGG asked WAFIC if they would like to be kept informed of the schedule of meetings.<br>WAFIC did not reply to this email. |
| | Initial Consultation | 26 Sep 14 | | No response | |
| | Second Consultation | 26 Nov 14 | | No response | |
| | Email | 28 Nov 14 | | | CGG requested the following information to be forwarded to members of the PTMF:<br>Teleconference request to discuss the proposed Davros Phase II MC3D marine seismic survey.<br>Scope Resources and CGG, would like the opportunity to discuss the proposed Davros Phase II marine seismic survey in the Northwest Marine Region, with licence holders in the Pilbara Trap Managed Fishery. CGG would like to discuss the potential concerns of Licence Holders such as yourself and are willing to work collaboratively with interested parties to find mutually acceptable outcomes.<br>CGG are willing to maintain communications throughout the proposed Davros Phase II MC3D marine seismic survey in order to minimise the potential displacement of fishing activities and avoid entanglement with set fishing gear.<br>If you wish to discuss the Davros Phase II MC3D MSS, Ian Hay the CGG Technical Operations Manager can be contacted at Ian.HayatCGG.com or +61 8 9219 6624. |
| | Third Consultation | 17 Feb 15 | | No response | Consultation round was for information only and CGG did not expect/anticipate a response. CGG will however maintain ongoing consultation prior to the survey commencing and during the survey.<br>CGG will notify fishers of activity details to commercial fisheries management agencies, fishing industry bodies and individual companies and licence holders that were identified in the stakeholder consultation process three weeks prior to the survey commencing, to inform them about the location of the survey area, survey and support vessel specifications, timing of operations, contact phone numbers and to ascertain if proposed operations overlaps any key fishing grounds. |
| | Fourth Consultation | 25 May 17 | | No response | |
| | Email | 01 July 17 | | No response | CGG contacted WAFIC requesting advice on whether there are any industry groups / fisheries representative groups that should be contacted to engage with the fisheries recommended for consultation by the DPIRD. |
| | Follow-up Email | 22 June 17 | 22 June 17 | Automated out of office response from WAFIC CEO John Harrison. | Follow-up email sent to encourage feedback. |
| | Email | 22 June 17 | 23 June 17 | WAFIC EO Mannie Shea replied to CGG after being forwarded the previous follow-up email by WAFIC CEO and requested a copy of the consultation materials sent to other parties and that all consultation enquires to WAFIC be made directly to her.<br>WAFIC requested a phone number and noted that CGG had not tried to contact WAFIC by telephone and had not provided a phone number. | CGG response to Mannie Shea (WAFIC EO) via email (25/06/2017) to acknowledge that she had not received the previous stakeholder consultation email and provide a copy of the information sent to the WAFIC CEO. CGG will consult directly with Mannie Shea on behalf of WAFIC, as requested.<br>CGG sought to arrange a phone dial-in with WAFIC that afternoon (Friday 22/06/17). |
| | Email | 23 June 17 | 23 June 17 | WAFIC requested to be supplied with a phone number and requested a call Monday afternoon (26/06/17). | CGG provided phone contact details and proposed a time for the phone call on Monday afternoon (26/06/17). |
| | Email | 23 June 17 | 23 June 17 | WAFIC proposed a face-to-face meeting. | CGG accepted the proposal for a face-to-face meeting. |
| | Meeting<br>Email | 27 June 17<br>12 July 17 | 27 June 17 | Meeting with representatives from WAFIC (Mannie Shea) and CGG.<br>WAFIC voiced concerns regarding the stakeholder consultation information provided to fishers, stating that:<br>■ the activity description was too technical | CGG acknowledged WAFIC's concerns and agreed to response to their formal response once received. CGG consulted with Marine Tourism WA as directed by WAFIC. |

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| | | | | ■ the map should provide simplified but provide additional information likely to be relevant to fishers<br>■ that stating the minimum water depth as 22 m is confusing as WAFIC think airguns operational at this depth.<br>WAFIC advised a more personalised approach to consultation with fisheries/fishers where possible e.g. calling, texts, meetings; and stating that WAFIC work with fishers to reduce impacts to them.<br>WAFIC advised CGG to contact Marine Tourism WA as this is a peak body for the charter industry.<br>WAFIC advised that it would send a formal response via email. | |
| | Email<br>Meeting<br>Email | 18 July 17<br>03 Aug 17<br>21 Aug 17 | 14 July 17 | Via email (14/07/17): WAFIC noted the following additional points, comments and requests:<br>■ seismic surveys in water depths less than 50 m is unacceptable.<br>■ water depth range for the survey of 22 to 230 m is the prime range for commercial fishing.<br>■ significant increase in the footprint of this survey and a significant swathe of ocean, this raises significant concerns regarding access, resource sharing, resource displacement and impact on spawning fish etc.<br>■ It is essential that the Plan address the cumulative impacts of multiple seismic surveys conducted over the same broad site in past multiple years.<br>■ In recent months additional science has been published demonstrating that seismic surveys do impact the environment, noting lobster and scallop issues in Bass Strait and a recent publication on the impact on plankton (i.e. plankton / food chain mortalities).<br>■ CGG need to demonstrate how they plan to avoid key indicator species spawning and aggregations.<br>■ Request details on spawning and fish aggregation mitigation measures.<br>■ Note the following fishery licence holders will be engaged with, can you please advise the response level (how many licence holders actually responded, if CGG / RPS have met face-to-face with licence holders etc) and a summary of licence holder feedback for the WAFIC record:<br>> Mackerel Managed Fishery (overlap Area 2)<br>> Pearl Oyster Managed Fishery Zone 1 (liaison via PPA);<br>> Pilbara Fish Trawl Interim Managed Fishery (overlap: Zone 2, Areas 1 and 2);<br>> Pilbara Line Fishery (survey footprint overlaps fishery operations);<br>> Pilbara Trap Managed Fishery (survey footprint overlaps prime water depth range for trap fishing)<br>■ It is very important that CGG / RPS provide succinct and clear information.<br>■ The original EP summary on the NOPSEMA web site has incorrect commercial fishing information.<br>■ Note CGG / RPS interest in receiving fishery heat maps. There is often a reluctance for fisheries to specifically disclose this information. | Via email (18/07/17), CGG acknowledged receipt WAFIC's email and their concerns on seismic surveys, and requested a meeting to discuss.<br>A meeting was held on 03/08/17 with CGG, RPS, WAFIC and Jimmy Money from Fat Marine.<br>Via email (21/08/17), CGG provided a formal response addressing WAFIC's email concerns and meeting actions from 03/08/17. WAFIC were also provided with the impact assessments for underwater noise from seismic operations (for fish, invertebrates, plankton, fish larvae) from the EP (refer to Section 6.2.1).<br>The increase in risks associated with the increased spatial extent of the survey area has been managed through CGG's MoC process (Section 7.1.1), and the impact and risk assessment has been revised to ensure all impacts/risks associated with the change in the nature and scale of the activity have been addressed and assessed to ALARP and are acceptable (Section 6.2.1).<br>CGG advised WAFIC that a cumulative impact assessment has also been undertaken with regard to other potential seismic surveys planned in the area at the same time, and also has considered the potential longer term effects from seismic surveys and potential for recovery of populations (including using catch history for species (where available)).<br>CGG have sent the underwater noise impact assessment section from the EP which describes the full impact assessment and control measures that will be adopted to manage impacts/risks to e.g. seasonal aggregations, spawning/nursery grounds key habitats and species, to ALARP and acceptability. The assessment includes the predicted sound exposure levels for both the modelled large gun (4,630 cubic inch) and modelled small gun (2,220 cubic inch). CGG advised that the survey will use slightly smaller airgun arrays of 4,500 cubic inch and 1,800 cubic inch, so therefore the predicted sound exposure levels are considered to be an overestimate, and therefore deemed conservative.<br>CGG advised the following additional precautionary control measures will be implemented for water depths <50 m within the survey area:<br>■ minimum depth within which seismic data will be acquired is 35 m, as CGG have developed exclusion zones and buffers over the Glomar Shoal and Rankin Bank ecologically sensitive areas.<br>■ no seismic activity within the Fish Protection Areas (and 250 m buffers) set over Glomar Shoal and Rankin Bank.<br>■ a much smaller airgun array of 1,800 cubic inch will be used in water all depths within the survey area from 35 to 50 m.<br>■ CGG will maximise the acquisition of seismic data within the key fishing depth range identified by Fat Marine (Pilbara Line Managed Fishery) of 60 to 90 fathoms (110 to 165 m) for goldband snapper during the months of January and February, when the fishery is inactive. In the event that the Fat Marine changes the months that they are inactive, CGG will consult with them to modify the timing of maximising data acquisition within this area accordingly.<br>CGG confirmed that they have consulted directly with licence holders for the fisheries specifically referred to by WAFIC. CGG have provided a summary of the consultation carried out.<br>CGG has aimed to provide fishers with sufficient information so that they can make an informed decision on the activities proposed. WAFICs comments regarding improving succinctness and clarity of information to solicit a response will be taken on board for future correspondence with commercial fishers.<br>CGG has requested fishery catch/effort data as part of the consultation process, however have not had any feedback from stakeholders on this request yet.<br>CGG will continue to maintain ongoing consultation with fisher/fishery stakeholders to |

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| | | | | | manage any potential interactions (refer to Section 6.2.3):<br>■ As part of the ongoing consultation process, CGG will notify all relevant persons four weeks prior to the start of the survey of the survey details including, timing, location, duration.<br>■ Fat Marine and RNR Fisheries will be advised eight weeks prior to the start of the survey to ensure that meaningful planning can take place, given that these stakeholders were slow to respond during previous rounds of consultation and it is anticipated that ongoing consultation may require a time-sharing agreement to be reached.<br>■ Commercial fishers, Recfishwest and relevant recreational fishing groups/ organisations and will be issued a 7 to 10 day forecast prior to activities commencing adjacent to Glomar Shoal and Rankin Bank.<br>■ Support vessel(s) to manage vessel interactions and maintain communications with commercial shipping in the survey area.<br>■ In the event that another vessel is acquiring seismic data in the region, the survey vessel shall not acquire data simultaneously within 50 km of the other seismic vessel in order to avoid cumulative impacts to marine fauna.<br>CGG is supportive of new research efforts to investigate the impacts of seismic surveys and has developed an in-field real-time monitoring procedure to validate predicted modelled noise levels. CGG will implement in-field real-time monitoring during seismic acquisition using the 4,500 cubic inch array to monitor the seismic sound levels of each seismic line. This information will be used to verify the power output of the sound source and compare measured levels with modelled levels. If modelled levels under-estimate potential impacts, the array will be changed to the smaller 1,800 cubic inch until such time as the impact assessment can be re-run and an alternative, technically defensible position is reached. The methodology for this monitoring has been peer reviewed by Dr Alexander Gavrilov at the Centre for Marine Science and Technology at Curtin University. CGG have provided a description of the monitoring that will be implemented during seismic.<br>CGG will continue to maintain ongoing consultation with WAFIC during all stages of the activity. |
| Westmore Seafoods | Meeting | 7 Aug 14 | 7 Aug 14 | Meeting held between CGG, MG Kailis Group and Westmore Seafoods.<br>*Refer to MG Kailis for further information* | CGG will notify fishers of activity details to commercial fisheries management agencies, fishing industry bodies and individual companies and licence holders that were identified in the stakeholder consultation process <u>three weeks</u> prior to the survey commencing, to inform them about the location of the survey area, survey and support vessel specifications, timing of operations, contact phone numbers and to ascertain if proposed operations overlaps any key fishing grounds. |
| | Initial Consultation | 26 Sep 14 | | No response | |
| | Second Consultation | 26 Nov 14 | | No response | |
| | Third Consultation | 17 Feb 15 | | No response | |
| | Fourth Consultation<br>Follow-up Email<br>Follow-up Phone Call<br>Follow-up Phone Call | 25 May 17<br>22 June 17<br>03 July 17<br>21 July 17 | | No response | CGG will maintain ongoing engagement with Westmore Seafoods as follows (Section 6.2.3):<br>■ As part of the ongoing consultation process, CGG will notify all relevant persons four weeks prior to the start of the survey of the survey details including, timing, location, duration.<br>■ Commercial fishers, Recfishwest and relevant recreational fishing groups/ organisations and will be issued a 7 to 10 day forecast prior to activities commencing adjacent to Glomar Shoal and Rankin Bank<br>■ Commercial and recreational fishers are kept informed of daily survey activities through CGG's 24-hour look-ahead communication. |
| **Oil and Gas Industry Operators** | | | | | |
| Woodside Energy | Email<br>Email<br>Email | 09 Jan 15<br>10 July 15<br>18 Jan 16 | 13 Jan 15<br>10 July 17<br>19 Jan 16 | Via email (13/01/15), confirmed up to date contact details for Woodside facilities.<br>Via email (10/07/17), acknowledged that information from CGG was received.<br>Via email 19/01/16), confirmed that Woodside was satisfied with CGG's consultation prior to and during Davros/Davros Phase II MC3D MSS activities. | Via email (09/01/15), CGG requested up to date contact details for relevant Woodside facilities (i.e. North Rankin Complex Angel Platform, Goodwyn Platform Okha FPSO and Pluto LNG) for CGG's CONOPS plan.<br>Via email (10/07/15), CGG advised Woodside that they had completed the Davros MC3D MSS for the season and sent Woodside the marine fauna sighting information for the survey. Noted that CGG's vessel was expected to return later in the year and that new ingress documents would be issued to Woodside at that time.<br>Via email (18/01/16), advised Woodside that NOPSEMA had requested details on CGG's |

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| | | | | | consultation with Woodside for the Davros/Davros Phase II MC3D MSS. Requested confirmation that Woodside were satisfied. Informed Woodside that CGG were still planning to return later in the year and planned to contact Woodside regarding ingress and updates to the CONOPS plan once the date and vessel was confirmed. |
| | Fifth consultation (CONOPS notification letter)<br>Email<br>Meeting | 02 Nov 17<br>03 Nov 17<br>12 Dec 17 | 02 Nov 17<br>12 Dec 17<br>12 Dec 17 | Via email (02/11/17), Woodside acknowledged receipt of consultation material. Requested ArcGIS files and sail line preplots used to create the maps provided. Advised that Woodside would arrange a meeting once the files were received and the CONOPS implications for their facilities were better understood.<br>12/12/2017: Email thanking CGG personnel for attending meeting with Woodside. Schematic of the NWS CONOPS locations / timing for the drilling and pipe lay work over the Greater Western Flank was provided as an attachment. Drilling will occur up to March 2018 then pipe-lay work up to mid-May 2018. Woodside advised that careful planning as both drilling and pipe lay are challenging for CONOPS. Woodside noted that they will provide CGG with the Fortuna CONOPS to indicate the level of the detail necessary. | Via email (03/11/17), re-sent consultation letter to correct table included in previous version in error. Included ArcGIS and SurvOPT files of the sail lines, as requested by Woodside.<br>CGG personnel met with personnel from Woodside's operations team at their office on 12/12/17 to discuss the expansion of the Davros Extension MC3D survey area and Woodside's upcoming operations on the NWS.<br>There is potential for issues to arise from concurrent operations if not managed. Both parties agree that careful planning is required. The advice provided will be used to inform the development of the CONOPS plan. CGG will continue to consult with relevant persons at Woodside to enable the development of a working CONOPS plan. |
| | Fifth consultation (CONOPS notification letter)<br>Email | 02 Nov 17<br>03 Nov 17 | 02 Nov 17 | Via email (02/11/17), Chevron advised that the information provided had been circulated to the relevant people for comments.<br>Via email (03/11/17), Chevron informed CGG that the map of the survey boundaries and the survey coordinates provided in the CONOPS notification letter do not match. Requested that the coordinates of the operational area be confirmed.<br>Via email (15/11/17) Chevron advised that they do not have any issues with the proposed Davros Extension MC3DMarine Seismic Survey. Requested that CGG provide Chevron with 7 day and 24 hour notification of first approach to Wheatstone Platform as the vessel will show up as a converging track on the platform radar causing an alarm in the CCR. | Via email (03/11/17), CGG established that while the maps were correct, some coordinates in the survey location table in the CONOPS notification letter were included in error. Re-sent amended CONOPS notification letter, plus the ArcGis files and sail line preplots used to create the enclosed maps.<br>No issues identified. CGG will continue to consult with relevant persons at Chevron to enable the development of a working CONOPS plan. |
| | Fifth consultation (CONOPS notification letter)<br>Email<br>Follow-up email | 02 Nov 17<br>03 Nov 17<br>08 Dec 17 | 02 Nov 17<br>11 Dec 17 | Via email (02/11/17), Jadestone confirmed receipt of information and advised that it would be circulated to relevant people, who would respond with any comments the following week.<br>Via email (11/12/17), Jadetone advised that they are in the early stages of planning a drilling campaign in Q3 2018 in the Stag Field but noted that this should not affect the Davros Extension MSS as the rig would be located between the Stag platform and Dampier Spirit FSO. | Via email (03/11/17), CGG re-sent consultation letter to correct table included in previous version in error. Included ArcGIS and SurvOPT files of the sail lines.<br>The 2018 drilling campaign is located outside of the Davros Extension MC3D MSS operational area but has been noted and will be considered during development of the CONOPS plan.<br>CGG will continue to consult with relevant persons at Jadestone to enable the development of a working CONOPS plan. |
| | Fifth consultation (CONOPS notification letter)<br>Email | 02 Nov 17<br>03 Nov 17 | 28 Nov 17 | Via email (28/11/17), Quadrant confirmed receipt of information and advised that as no equipment will enter the 500m exclusion zone there is no need to meet the Quadrant Operations Group. Noted that Quadrant will provide relevant contact details for the draft CONOPS plan. | Via email (03/11/17), re-sent consultation letter to correct table included in previous version in error. Included ArcGIS and SurvOPT files of the sail lines.<br>No issues identified. CGG will continue to consult with relevant persons at Quadrant to enable the development of a working CONOPS plan. |
| | Fifth consultation (CONOPS notification letter)<br>Email<br>Phone call | 02 Nov 17<br>03 Nov 17<br>13 Dec 17 | 02 Nov 17<br>13 Dec 17<br>13 Dec 17 | Via email (02/11/17), Santos confirmed receipt of information and advised that it would be circulated to relevant people.<br>Phone call (13/12/17) from Mike Giles (Santos – Manager, Operations Geophysics) in which the need for further discussions and an agreed CONOPS plan was confirmed.<br>Email (13/12/17), advising that Santos agree (in principle) with the survey progressing. Noted that Santos will be happy to discuss any restrictions that may be required to ensure the safety of their facilities once final acquisition plans are in place, and dates are known. | Via email (03/11/17), CGG re-sent consultation letter to correct table included in previous version in error. Included ArcGIS and SurvOPT files of the sail lines.<br>No major issues identified. CGG will continue to consult with relevant persons at Santos to enable the development of a working CONOPS plan. |
| | Fifth consultation (CONOPS notification letter)<br>Email<br>Follow-up email | 02 Nov 17<br>03 Nov 17<br>08 Dec 17 | 02 Nov 17<br>14 Dec 17 | Via email (02/11/17), Vermillion confirmed receipt of information and advised that it would be circulated to relevant people.<br>In a formal letter sent via email (14/12/17), Vermillion advised they had reviewed the CONOPS notification letter and attached materials, as well as the existing Vermillion-CGG Davros MC3D Marine Seismic Survey — Ingress to WA-14L agreement from Jan 2015. Noted that in 2015 CGG was supplied with copies of Vermillion's Marine Operations Checklist and Marine Operations Manual which detailed contact and operational protocols required within WA-14-L, and that these may be used to form the basis of the CONOPS plan.<br>Further advised that Vermillion has an identified Safe Anchorage location, which is the designated anchorage point for in-coming off-take tankers within WA-14-L. Noted that this location was not shown on the map provided by CGG (map #3) and should be added as an exclusion zone. Acknowledged CGG's intention to hold formal meetings with Vermillion's operational staff to enable the development of a working CONOPS plan and noted that they expect these to be scheduled in early 2018 prior to commencement of seismic operations within WA-14L and provided contact details for scheduling formal meetings. | Via email (03/11/17), re-sent consultation letter to correct table included in previous version in error. Included ArcGIS and SurvOPT files of the sail lines.<br>No major issues. The advice provided will be used to inform the development of the CONOPS plan. CGG will continue to consult with relevant persons at Vermillion to enable the development of a working CONOPS plan. |