CANNING-NORTHERN CARNARVON MULTI-CLIENT MARINE SEISMIC SURVEYS

ENVIRONMENT PLAN: PUBLIC SUMMARY

TGS Australia Pty Ltd

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1. INTRODUCTION

The geophysical company TGS-NOPEC Geophysical Company Pty Ltd (TGS) proposes to acquire multi-client (MC) two-dimensional (2D) and three-dimensional (3D) marine seismic surveys (MSS) within the Canning and Northern Carnarvon Basins in the North-west Marine Region (NWMR) offshore from Western Australia (WA) (see **Figure 1.1**).

The Canning-Northern Carnarvon MC MSS EP is expected to have a duration of up to 18 months. The timing of commencement and duration of individual surveys to be acquired within the operational area has not yet been determined, but it is anticipated that the first survey shall commence in Q2 2015. The commencement of each survey will be dependent on fair sea state conditions suitable for marine seismic acquisition, the availability of a survey vessel(s) for conducting the survey, client data schedule requirements, fauna migration timing and granting of approvals from the appropriate government bodies.

1.1. LOCATION OF THE ACTIVITY

The Canning-Northern Carnarvon MC MSS operational area lies entirely in Commonwealth waters within the NWMR and encompasses an area of ~320,300 km². Water depths range from ~30 m to ~5,700 m, with the deepest water depths located along the north-western boundary of the operational area, and the shallowest water depths located along the eastern boundary (see **Figure 1.1**).

At its closest point, the operational area is ~7 km north of Bedout Island, ~25 km southwest of Imperieuse Island, ~55 km north of Port Hedland and ~65 km northeast from Legendre Island. An exclusion zone has been placed around the Glomar Shoal that ensures seismic acquisition shall only occur in waters 1 km beyond the 50 m contour line.

1.2. COORDINATES OF THE PROPOSED ACTIVITY

Boundary coordinates for the operational area (see **Table 1.1)** are shown in **Figure 1.1.**

Table 1.1- Coordinates of the Canning-Northern Carnarvon MC MSS operational area

Latitude (S)	Longitude (E)
Decimal degrees	
-15.3820664	113.8366528
-16.1372297	114.2338481
-15.9085693	115.7948608
-16.1464511	116.2279769
-16.4464218	116.2279611
-16.4463757	117.6777418
-16.1653090	118.0012848
-16.1653023	119.1679459
-17.0100966	119.1679514
-17.3868194	118.6411985
-17.7667729	118.6412010
-17.7670576	118.6966957
-17.8934246	118.8147457
-17.8915051	119.0375588
-17.7688718	119.1801172
-17.7688321	120.3348061
-18.7667232	120.3347792
-19.5573554	119.5198032
-19.5570958	119.1556097
-19.5300950	119.1329559
-19.5234328	119.0998498
-19.5253450	119.0620284
-19.5504930	119.0378570
-19.5570101	119.0355202
-19.5569819	118.9641308
-19.5568774	118.8493662
-19.8279400	118.2973280
-19.8319950	117.0846405
-19.6653318	117.0136761
-19.6653981	110.5013168
-19.1653862	110.5013123
-16.8249350	112.8221202
-16.6224966	113.0887464
-15.3820664	113.8366528

Datum: WGS 84

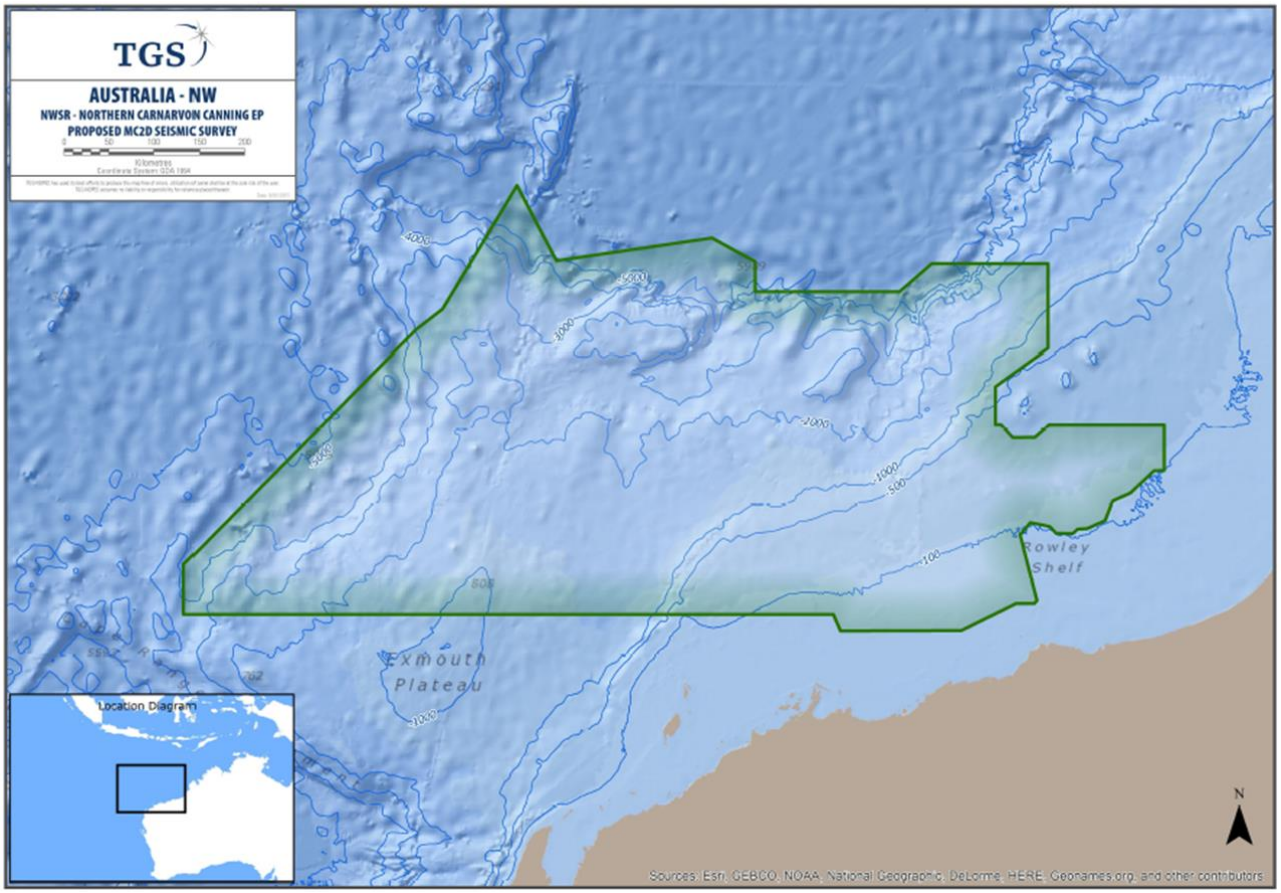


Figure 1.1- Location of the operational area for the Canning-Northern Carnarvon MC MSS

2. DESCRIPTION OF THE RECEIVING ENVIRONMENT

In accordance with Regulation 13(2) of the Environment Regulations, a description of the existing environment that may potentially be affected by planned and unplanned activities relating to the Canning-Northern Carnarvon MC MSS is presented in this section. It includes a description of relevant natural, cultural and socio-economic aspects of the environment, as well as details of relevant values and sensitivities.

The description includes Regional Setting (**Section 2.1**); Physical Environment (**Section 2.2**); Biological Environment (**Section 2.3**) and Socio-Economic Environment (**Section 2.4**) and covers the aspects of the environment that are relevant for consideration of the environmental risks and impacts of the proposed operations.

2.1. REGIONAL SETTING

The Canning-Northern Carnarvon MC MSS operational area lies entirely within Commonwealth marine waters of the NWMR. The NWMR extends from offshore of Kalbarri in Western Australia (WA) to the WA / Northern Territory (NT) border and includes all waters three nautical miles (nm) from the territorial baseline to the 200 nm Exclusive Economic Zone (EEZ) boundary. The region is adjacent to, but does not cover, the State waters of WA.

The NWMR is divided into three large scale ecological systems based on the influence of primary ecological drivers such as the influence of ocean currents, seafloor features and eco-physical processes. These systems are the Kimberley, Pilbara and the Ningaloo-Leeuwin systems. The Canning-Northern Carnarvon MC MSS overlaps the Pilbara system, which extends west of Broome on its northern boundary to the northern edge of the Exmouth Plateau while the southern boundary follows a line west of the North West Cape, along the southern boundary of Exmouth Plateau.

2.2. PHYSICAL ENVIRONMENT

2.2.1. Climate and Meteorology

The NWMR is subject to an arid (mainly summer rain) subtropical climate with tropical cyclone activity from December to March. Weather is largely controlled by the seasonal oscillation of an anti-cyclonic belt. Winters are characterised by clear skies, fine weather and predominantly strong east to southeast winds and infrequent rain. Summer winds are more variable, but west to southwest predominates. Annual rainfall is typically low and highly variable, with most intense falls occurring during the first half of the 'wet' season. The region has a very high cyclone incidence and these occur primarily between December and March. Lower rainfall and humidity are typically associated with the Southeast Monsoon, in contrast to the high levels of rainfall and humidity associated with the Northwest Monsoon. The Pilbara region is characterised by summer daily temperatures ranging between 22°C and 36°C, and winter mean daily temperatures of between 13°C and 32°C.

2.2.2. Oceanography

The NWMR's large scale currents are subject to strong seasonal variations, largely due to annual variation in the alongshore pressure gradient that is the main driver of the region's surface currents. The South Equatorial Current and Eastern Gyral Current intensify during July-September. Similarly the Leeuwin Current is strongest in autumn, and diminishes during the Northwest Monsoon in summer (December-March). This complex system of ocean currents changes between seasons and between years, generally resulting in the surface waters being warm, nutrient poor and of low salinity.

Overall, a key characteristic of the regional oceanography is the poleward flow of the main surface currents. The significant difference in steric height between the Pacific and Indian Oceans drives

Pacific waters through the Indonesian archipelago via the Indonesian Throughflow (ITF) into the Indian Ocean. A portion of these waters eventually travel polewards via a strong alongshore pressure gradient. This pressure gradient is not present along the eastern edge of other major oceans and makes the Western Australian system unique globally.

During the southeast tradewinds (April to September), the predominant direction of the ocean current is west-southwest. In the monsoon season (December to March), winds come from the northwest or west, and the direction of the ocean current reverses, becoming east-northeast.

Astronomical tides on the NWMR are semi-diurnal and generally quite large. Tidal ranges increase in amplitude from south to north, corresponding with the increasing width of the shelf, and range from ~2 m at Exmouth to ~10 m near Broome. The Pilbara system is believed to have the strongest internal tides of the entire NWMR, which are thought to be an important physical driver in water depths of between ~50 and 500 m depth on the shelf. These internal tides result in the drawing up of deeper cooler waters into the photic zone, stirring up nutrients and triggering primary productivity, which is thought to be greatest at the 200 m isobath.

The region typically receives a persistent swell of around 2 m, generated by low-pressure systems in southern latitudes during winter; strong easterly winds can also generate 2 m seas. Both swell and seas tend to be smaller during summer. Tropical cyclones generate waves propagating out in a radial direction from the storm centre, and generate swells from any direction, with wave heights between 0.5 and 9.0 m.

2.2.3. Geomorphology

A range of topographic features such as canyons, plateaus, terraces, ridges, reefs, and banks and shoals are distinguishing features of the seafloor across the NWMR. The slope is relatively flat, but includes a number of large canyon heads that were probably excavated during and after continental break-up by sediment and water movements. Sediment transport on the shelf is largely influenced by tidal currents while on the slope and abyssal plains sediment transport is mostly influenced by large ocean currents and slope processes.

There are a number of reefs and islands in the Pilbara system of the NWMR adjacent to the Canning-Northern Carnarvon MC MSS operational area, including:

- Bedout Island:
  - located ~7 km to the south of the southern boundary of the operational area, and in WA State waters; and
  - important breeding area and foraging area for the brown booby, lesser crested terns, lesser frigatebird, roseate tern.

- Glomar Shoal:
  - high biological diversity and high localised productivity; and
  - Important fishing grounds.

- Rowley Shoals:
  - ~25 km from the boundary of the operational area;
  - includes Imperieuse, Clerke and Mermaid Reef, the first two which are emergent features;
  - important resting area for the little tern; and
  - breeding and foraging area for the white-tailed tropicbird.

2.3. BIOLOGICAL ENVIRONMENT

2.3.1. Biological Productivity

Seasonal changes in the region's oceanography are the primary drivers of biological productivity in the NWMR. These include: weakening of the ITF and Leeuwin Current; the seasonal reversal in wind direction, which supports the development of currents such as the Ningaloo Current; conditions more favourable for upwelling on the North West Shelf (NWS); and episodic events such as cyclones. As a result of the periodic nature of these changes, biological productivity follows boom and bust cycles, is sporadic and significantly geographically dispersed.

The offshore waters of the NWMR are oligotrophic with planktonic abundances most likely low, and is characterised by high species diversity but relatively low endemicity. Bentho-pelagic fish are a vital link in the trophic systems of the region. As they migrate vertically between the pelagic and benthic (seafloor) systems they consume nutrients and aid the transfer of the nutrients between the two systems. Other processes also transfer nutrients from pelagic systems to benthic systems. Many deep-water benthic communities are either attached to the seafloor or have limited ranges and are heavily reliant upon nutrients in the form of detritus falling through the water column into the benthic environment.

Most of the NWMR species are tropical and also found in other parts of the Indian and western Pacific oceans. The NWMR contains more coastal and shelf fish species than anywhere else off the WA coast, particularly in the Kimberley and the NWS and is home to globally significant populations of internationally threatened species. The NWMR also supports internationally important breeding and feeding grounds for a number of threatened and migratory marine species, including humpback whales, which mate and give birth in the waters off the Kimberley coast. Significant turtle rookeries are found on coastal beaches and offshore islands and the surrounding waters provide important resting and internesting (i.e. in between egg laying periods) habitats. The annual aggregation of whale sharks at and around Ningaloo Reef is the highest known density of whale sharks in the world (DEWHA 2007; DEWHA 2008).

2.3.2. Biological Communities

The NWMR has high species diversity, but fewer endemic species than are present in cooler and more temperate waters. The region contains more coastal and shelf fish species than anywhere else on the WA coast, and the high species richness partially reflects its strong biogeographic links with Indonesia and the west Pacific through the ITF.

The high species richness of the NWMR is said to be associated with the diversity of habitats available. These include hard seafloor areas (e.g. limestone pavements on the NWS), submerged cliffs and coral reefs of the Kimberley, and atolls and reefs on the edge of the shelf. These habitats support a high diversity of benthic filter-feeders and producers. Soft bottom substrates include areas of sandy seafloor that support seagrass habitat along the Pilbara coast, muddy substrates on the slope, as well as the deep waters of the Cuvier Abyssal Plain and the Argo Abyssal Plain, which support sparsely distributed sessile organisms such as filter-feeding and deposit-feeding species.

Studies of the NWS show a strong depth related structuring of the benthic environment, with epibenthos (corals and sponges) showing a decrease in observed percentage cover with increasing depths. The information that exists on sediments in the bioregion indicates that benthic communities are likely to include filter feeders and epifauna; however, there are no notable large populations of sponges in this system.

Biologically, the finfish fauna of this system is distinct from the Ningaloo-Leeuwin system. The system supports large prawn, scampi and crab populations, generally in inshore muddy sediments (DoF 2013) along with pearl oysters. As well as being preyed upon by large pelagic fish, crustaceans are also a significant food for cephalopods (squid and octopus species; DEWHA 2008).

Seagrass represents key ecological habitats, are said to provide critical habitats for fish and dugongs, and are important for sustaining many of the fish populations of the NWS (DEWHA 2007). Although seagrasses can occur in large meadows, they also occur in small scattered patches, making them susceptible to degradation from natural disturbances such as seasonal cyclones (DEWHA 2007). Seagrass distribution is largely influenced by light availability and substratum stability.

Algae are dominant on shallow sandbars, platforms, reefs and ridges and are thought to be the major primary producer in this system, followed by mangroves and corals in isolated areas (DEWHA 2007). Two hundred and ten species of marine algae, seagrasses and cyanobacteria have been observed on sub-tidal rocky reefs in coastal waters surrounding just the Dampier Archipelago area alone (Huisman and Borowitzka 2003). Macroalgae occurs predominantly in the intertidal and shallow sub-tidal waters on hard substrates, inshore of the proposed Canning-Northern Carnarvon MC MSS operational area. Macroalgae is present at the Rowley Shoals, North Turtle Island and Bedout Island but is not recognised as a key habitat.

Filter feeding communities within the subtidal zone of Pilbara and lower-west Kimberley coastal waters provide important habitat structure and food for many species, including flatback turtles. They are found on both hard and soft substrates, and include a high diversity of sponges, soft corals (such as gorgonians and sea whips), tunicates and cnidarians (DEC 2011). However, the areas between Port Hedland and Broome are not known for their abundance of sponges, and little is known of the filter feeding communities.

Coral communities, including patch or fringing reefs occur in shallow water, sub-tidal environments of the NWMR, as well as around intertidal areas adjacent to islands and other emergent features (DEWHA 2007). There are relatively few, well-developed coral communities in the Eighty Mile Beach region although a small number exist in the southern end near Cape Keraudren, and in sparse areas on the outer edge of the intertidal mudflats (DEC 2011). The Rowley Shoals are a hotspot for biodiversity in this bioregion and contain intertidal and sub-tidal coral reefs. These reefs support a diverse marine fauna typical of oceanic coral reef communities of the Indo-west Pacific. The reefs are important stepping stones in the maintenance of gene flow among the north-west Australian coral reefs.

The NWMR is thought to contain a high diversity of crustaceans across a range of habitats, from intertidal sites to the deeper waters of the slope and the abyss. Dominant species groups include copepods, prawns, scampi and crabs. These groups display a strong biogeographic affinity with the Indo-west Pacific, with few endemic species present.

Over 81 species of cephalopod are believed to occur in the NWMR, with area between Kalbarri and the Dampier Archipelago particularly significant for octopus, dumpling squids and several species of cuttlefish (DEWHA 2008). Squid are an important food item for a number of species in the NWMR including sperm whales and seabirds such as black noddies and red-footed boobies.

Other species known within the system include turtles, dugongs and whales (humpback whales aggregate in Exmouth Gulf during their southern migration and pass through the system on their way to and from breeding grounds in the Kimberley).

2.3.3. Protected Marine Fauna

A review of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) database (Protected Matters search tool; PMST) held by the Department of Environment (DoE) was conducted for the operational area described by the boundary coordinates provided in **Table 1.1**, with the application of a 1 km buffer zone. The Protected Matters search indicates a total of 104 marine species listed under the provision of protection status (12 listed as Threatened; 27 as Cetaceans; and 27 as Migratory) that are likely to occur within, or adjacent to, the Canning-Northern Carnarvon MC MSS operational area. The 12 listed Threatened species that may occur in, or relate to, the operational area are as follows:

1. Sei whale
2. Blue whale
3. Humpback whale
4. Short-nosed seasnake
5. Loggerhead turtle
6. Green turtle
7. Leatherback turtle
8. Hawksbill turtle
9. Flatback turtle
10. Grey nurse shark
11. Great white shark
12. Whale shark

The Canning-Northern Carnarvon MC MSS operational area is not considered a habitat that is critical to the survival of any listed species. Similarly, there are no EPBC Act-listed threatened ecological communities (TEC) within the vicinity.

The PMST report identified four Key Ecological Features (KEF) within or adjacent to the Canning-Northern Carnarvon MC MSS operational area:

- Ancient coastline at 125 m isobath;
- Exmouth Plateau;
- Glomar Shoal; and
- Continental Slope Demersal Fish Communities.

The BIA that overlap the Canning-Northern Carnarvon MC MSS operational area are as follows:

- migration area (north and south) for the pygmy blue whale;
- migration area (north and south) for the humpback whale;
- migration/ foraging area for the whale shark;
- internesting buffer for the flatback turtle;
- foraging areas for the green, hawksbill and loggerhead turtles;
- breeding and foraging area for the brown booby, roseate tern, lesser-crested tern, lesser frigatebird;
- foraging area for the white-tailed tropicbird and wedge-tailed shearwater; and
- resting area for the little tern.

The BIA for particular marine species are presented in Appendix 1.

BIA adjacent to the Canning-Northern Carnarvon MC MSS operational area, and so may be affected by an unplanned hydrocarbon (diesel) spill are as follows:

- nesting and internesting areas for the flatback, loggerhead turtle, green turtle, and hawksbill turtle;
- breeding areas for the white-tailed tropicbird; and
- foraging and nursing grounds for the dwarf sawfish, freshwater sawfish and green sawfish (~50 km from operational area).

2.3.4. Cetaceans

The EPBC Act database lists 27 cetacean species that may occur in, or adjacent to, the Canning-Northern Carnarvon MC MSS operational area, all of which are protected under the EPBC Act. One of these is classified as Endangered, the blue whale; and two as Vulnerable, the humpback and sei whale.

Blue/pygmy blue whale

Blue whales are widely distributed throughout the world's oceans. This species has been recorded offshore in all states excluding the Northern Territory. Their migration paths are widespread and do not clearly follow coastlines or particular oceanographic features. The blue whale is rarely present in large numbers outside recognised aggregation areas. Blue whales are believed to calve in tropical waters in winter and births peak in May to June; however, the exact breeding grounds of this species are unknown.

In the NWMR, pygmy blue whales (*Balaenoptera musculus brevicauda*) migrate along the 500 m to 1,000 m depth contour on the edge of the slope, and are likely to be feeding on ephemeral krill aggregations. The northbound component of this migration takes place through the area from late March to early August, with a peak in June-July, and the southbound component occurs from early October to mid-December. The majority of the migration BIA is over 100 km wide where it overlaps the operational area and therefore is not considered a narrow migratory corridor. Towards the south of the polygon, the corridor narrows slightly to ~75 km wide.

The Canning-Northern Carnarvon MC MSS operational area overlaps the BIA for pygmy blue whales. Consequently, there is the possibility that migrating (and possibly feeding) pygmy blue whales may be encountered in the deeper waters of the Canning-Northern Carnarvon MC MSS operational area. However, the pygmy blue whale BIA is not a "biologically important habitat" and there is no justification for avoidance of the BIA during either peak or non-peak migration periods. However, as far as practicable, TGS will attempt to undertake seismic activities outside of the BIA during peak migration periods. Throughout the surveys, TGS will apply Part A Standard Management Procedures.

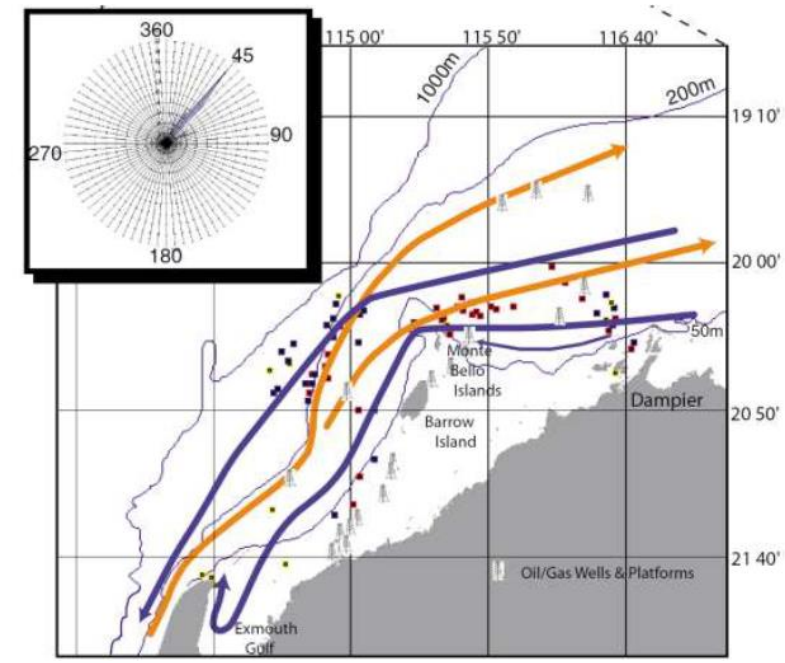
Humpback whale

Humpback whales are listed as Vulnerable and Migratory under the EPBC Act, are protected under the WA *Wildlife Conservation Act 1950* and are the most commonly sighted whale in northern WA waters. The species has been observed seasonally to complete their northern migration in the Camden Sound area of the west Kimberley, after feeding in Antarctic waters during the summer months.

During the northern migration, whales appear to remain on or within the 200 m bathymetry line near the Montebello Islands, ~ 170 km southwest of the Canning Basin operational area. Sightings off Dampier Archipelago (~70 km southwest of the Canning Basin operational area) indicate that the humpbacks whales may extend out to the edge of the continental shelf at ~130 km (70 nm) offshore (Jenner *et al.* 2001). However, studies of populations further north between the Dampier Archipelago and Broome, found that northbound and southbound whales were encountered in

equal numbers near the 30 m depth contour off Eighty Mile beach (~50 km offshore). Even though surveys went further offshore (~60 to 70 m depth contour, which is approximately 100 km), no denser concentrations were found. Similarly, opportunistic observations from a fishing vessel in 1998, identified 31 pods that were both northbound and southbound, along the 30 m contour (Jenner *et al.* 2001). This was further reinforced by a subsequent transit survey conducted by the Centre for Whale Research when travelling from Broome to Fremantle.

The two maps presented in **Figure 2.1** identify where actual sighting of whales were recorded and their proximity to the coastline. It should be noted that the arrows showing the north and south migration routes are only 'estimated' by Jenner *et al.* (2001).



Red dots= northbound, blue = south bound

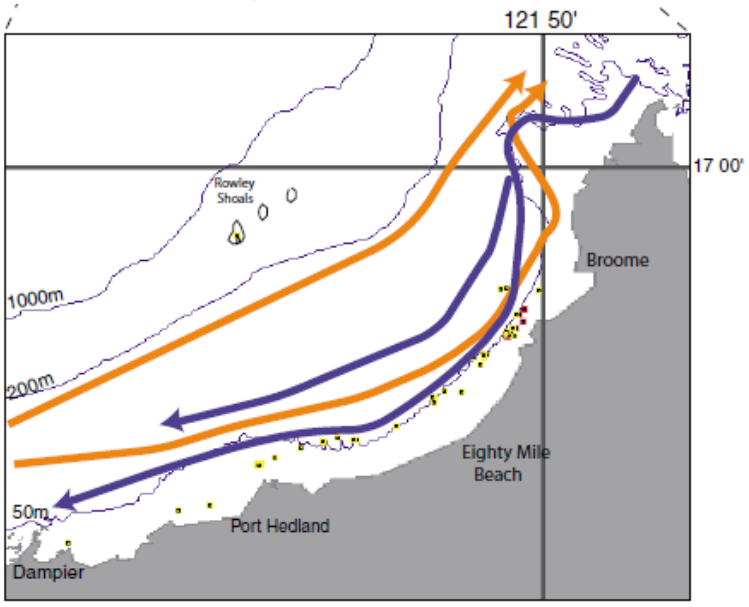


Figure 2.1 - 'Estimated' humpback whale migratory routes and actual observation points near the Dampier Archipelago and Pilbara coast.

Actual sightings are recorded as points (yellow = north bound)

Source: modified from Jenner *et al.* (2001).

The NW Marine Bioregional Plan (DEWHA 2008) states: '*The following BIA have been identified for humpback whales: migration corridor from the southern border of the North-west Marine Region to the breeding and calving grounds in the north of the Kimberley. The migration corridor represents the route for northern and southern migrating humpback whales*." Subsequently, despite some outliers in deeper water, and based on the available scientific evidence, the DoE has determined that the BIA for northern and southern migration extends to approximately 100 km offshore.

The Group IV population migration in the region is characterised by three distinct directional phases:

- Northbound phase - starts April, peaks July and tapers off by August. Around the Port Hedland area, northerly migrating humpback whale numbers peak during late July/early August (Jenner *et al.* 2001).
- Transitional phase (peak numbers expected at this time) – between late August and early September.
- Southbound phase – usually occurring between late August and early September, although smaller numbers may occur until November (this phase of migration is segmented by 2–3 week delay in appearance of peak numbers of cow/calf pods after the main migratory body has passed).

Sei Whales

The sei whales are one of the less studied great whales and their movements and distributions are not predictable nor well documented. Sei whales are similar in appearance to Bryde's whales, resulting in confusion about frequency of occurrence and distributional limits. Available information suggests that sei whales have the same general pattern of migration as most other baleen whales, although the timing is generally later and the current scientific view is that the species does not go to such high latitudes (DEH 2005).

Sei whales are generally not found near coasts and the species is infrequently recorded in Australian waters. Subsequently, it is not anticipated that many shall be encountered during the survey.

Other cetacean species whose broad distributions cover the region include whales that are infrequently observed and usually restricted to cooler or deep waters (e.g. Bryde's and killer whales) and may be encountered in deeper water areas during specific surveys undertaken within the Canning-Northern Carnarvon MC MSS operational area. However, it is unlikely they will be encountered in significant numbers.

Dolphins

Dolphins are relatively common in the waters of the NWS. Species known to occur in this region include the common, bottlenose and Risso's dolphins. The bottlenose dolphin is a cosmopolitan species found in all Australian waters (except the Northern Territory), and is coastal, estuarine, pelagic and oceanic in nature. Common dolphins are recorded in all Australian waters and are not thought to be migratory. Risso's dolphin is distributed through all oceans, occurs inshore and offshore, but is generally considered pelagic and oceanic. The Canning-Northern Carnarvon MC MSS operational area does not contain any significant or limiting habitat or feeding grounds for these dolphin species.

Dugongs

Dugongs generally occur in shallow tropical waters in depths less than 5 m, in areas where there are extensive seagrass meadows. They calve in shallow waters <1 m deep between August and

September although some may calve as late as December. They are known to be present between Exmouth and Eighty Mile Beach, although areas of aggregation are the Exmouth Gulf and further south in Shark Bay. Little information is known about the population trends for dugongs in Pilbara coastal waters adjacent to Eighty Mile Beach.

Seismic surveys generally have minimal effect on marine fauna in shallow waters as the airgun arrays are designed to concentrate their output downwards and most of the sound immediately penetrates the seabed. Dugongs have hearing between 1-2 KHz and thus higher than that produced by most seismic surveys, and so are anticipated to have a low sensitivity to seismic airgun noise.

2.3.5. Sharks

The whale shark (*Rhincodon typus*) is listed as Vulnerable and Migratory under the EPBC Act and is also classified as Vulnerable on the World Conservation Union's (IUCN) Red List of Threatened Species. In WA, whale sharks are protected under the *Wildlife Conservation Act 1950*, the *Conservation and Land Management Act 1984* and the *Fish Resources Management Act 1994*. This species is normally oceanic and cosmopolitan in their distribution occurring in both tropical and temperate waters. They are known to aggregate in the reef front waters adjacent to the Ningaloo Reef between March and July. A BIA (foraging area) for the whale shark overlaps the Canning-Northern Carnarvon MC MSS operational area.

It is possible that whale sharks may be encountered during individual surveys undertaken within the operational area. However, it is not expected that whale sharks will be encountered in significant numbers and those individuals that are encountered are likely to be transient.

The great white shark (*Carcharodon carcharias*) is a protected species listed as Vulnerable and Migratory under the EPBC Act and the species is also listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). They inhabit temperate waters normally close inshore or on the continental shelf and although their range extends into the NWMR it is not commonly found north of North West Cape (DEWHA 2008). There are no known aggregation sites for white sharks in the NWMR, and this species is most likely to be found south of North West Cape, probably in low densities.

The grey nurse shark (*Carcharias taurus*) is listed as Vulnerable under the EPBC Act In Australia. The status of the west coast population is poorly understood although they are reported to remain widely distributed along the WA coast and are still regularly encountered, albeit with low and indeterminate frequency (Chidlow *et al*. 2006). The species has been recorded at varying depths, but is generally found between 15– 40 m. Grey nurse sharks have also been recorded in the surf zone, around coral reefs, and to depths of around 200 m on the continental shelf.

The shortfin mako and longfin mako sharks are listed as Migratory under the EPBC Act. The longfin mako is a widely distributed but rarely encountered oceanic shark that ranges from Geraldton around the north coast to at least Port Stephens. The shortfin mako is an oceanic and pelagic species, although they are occasionally seen inshore. They are found throughout temperate seas but are rarely found in waters colder than 16°C.

2.3.6. Marine Turtles

The PMST identified five species of marine turtle that may occur within or in the waters surrounding the Canning-Northern Carnarvon MC MSS operational area, including the flatback, green and hawksbill turtle, (all listed as Vulnerable and Migratory) and the leatherback and loggerhead turtle (listed as Endangered and Migratory).

Important breeding areas for flatback turtles include islands within the Dampier Archipelago and areas around Port Hedland, Eighty Mile Beach and some islands in the Kimberley region (DoE 2014; Limpus 2007).

There are no green turtle nesting sites or internesting buffers overlapping the Canning-Northern Carnarvon MC MSS operational area, with the closest being identified at North Turtle Island and Dampier Archipelago ~35 km and 65 km respectively from the southern boundary.

The most significant breeding areas or the hawksbill turtle include Rosemary Island within the Dampier Archipelago, Varanus Island in the Lowendal group and some of the Montebello Islands (Pendoley 2005).

Major loggerhead turtle nesting locations close to the Canning-Northern Carnarvon MC MSS operational area can be found on the Dampier Archipelago, in particular Rosemary and Cophen Islands (Pendoley 2005).

Turtles do occur within the Rowley Shoals Marine Park (DEC 2007) and in and around Mermaid Reef (DNP 2013); however, these reefs are not considered to be regionally significant areas for marine turtles. It is possible that all five species of turtles, particularly flatback, green turtles, loggerhead and hawksbill may be present in the inshore regions of the Canning-Northern Carnarvon MC MSS operational area

2.3.7. Sea Snakes

Sea snakes are widespread through the waters of the NWS in offshore and near-shore habitats. They can be highly mobile and cover large distances or they may be restricted to relatively shallow waters and some species must return to land to eat and rest. Most sea snakes have shallow benthic feeding patterns and are rarely found in water depths exceeding 30 m. However, very little is known about the distribution of the individual species of sea snakes in the region. Given the survey water depths are greater than 30 m and distance offshore from the mainland is approximately 50 km, it is unlikely that sea snakes will be encountered during individual surveys undertaken within the Canning-Northern Carnarvon MC MSS operational area.

2.3.8. Seabirds

A search of the EPBC Protected Matters database listed eight species of seabird that may occur in the Canning-Northern Carnarvon MC MSS operational area. Two species of the streaked shearwater are listed under the migratory provision of the EPBC Act; on the China-Australia Migratory Bird Agreement (CAMBA) as *Puffinus leucomelas* and the Japan-Australia Migratory Bird Agreement (JAMBA) as *Calonectris leucomelas*. Seven other species are listed as Migratory. Additionally the common noddy, masked booby, crested tern and silver gull are known to breed in the areas immediately adjacent to the operational area.

Within the region, the Eighty Mile Beach area, located ~50 km to the south of the Canning-Northern Carnarvon MC MSS operational area, has been identified as an internationally important site for migratory birds and is a listed Ramsar site (DNP 2013). Hundreds of thousands of shorebirds have been recorded arriving during the southern migration period between August and November with many birds staying through the non-breeding period from December to February (Bamford *et al.* 2008).

2.4. SOCIO-ECONOMIC ENVIRONMENT

Surveys within the Canning-Northern Carnarvon MC MSS operational area have the potential to interact with several Commonwealth and State-managed fisheries. The following section details the commercial fisheries that may be operating within, or adjacent to, the operational area.

2.4.1. Commonwealth Fisheries

Commonwealth fisheries are managed by the Australian Fisheries Management Authority (AFMA) and operate from 3 nm of baseline out to 200 nm (the extent of the Australian Fishing Zone - AFZ). The Canning-Northern Carnarvon MC MSS has the potential to overlap the following Commonwealth-managed fisheries:

- North West Slope Trawl (NWST);
- Southern Bluefin Tuna Fishery (SBTF);
- Western Deepwater Trawl Fishery (WDTF);
- Western Skipjack Tuna Fishery (WSTF); and
- Western Tuna and Billfish Fishery (WTBF)

North West Slope Trawl Fishery

The NWSTF operates off north Western Australia from 114°E to 125°E, roughly between the 200 m isobath and the outer boundary of the Australian Fishing Zone. The NWSTF has traditionally targeted scampi and deep-water prawns. However, in recent years, Australian scampi has been the main target of the fishery. In recent years (2006-2011) most of the effort and catch within the fishery has occurred in shallower, upper slope waters (350-600 m) to the southwest and northeast of the Rowley Shoals. Therefore, it is possible that vessels fishing in the NWSTF could operate in the vicinity of the Canning-Northern Carnarvon MC MSS operational area during the proposed activities. However, since only one vessel was active in 2012-13, interactions are expected be minimal.

Southern Bluefin Tuna Fishery

The SBTF targets juvenile southern bluefin tuna (2–3 years old) in the Great Australian Bight (GAB) using purse-seine gear, mainly from December to April. Throughout the rest of its range, southern bluefin tuna is targeted by pelagic longliners. Activities in the SBTF are primarily confined to the waters off southern Australia (such as the GAB) with smaller areas along the southeast coastline, such as northeast of Eden in New South Wales. Therefore activity in this fishery does not overlap the Canning-Northern Carnarvon MC MSS operational area.

Western Deepwater Trawl Fishery

The WDTF operations in Western Australia extend from 115°08’ E in the south to 114° E in the north. The fishery catches more than 50 species in waters exceeding 200 m depth in habitats ranging from temperate-subtropical in the southern region to tropical in the north region. Catches in the WDTF were historically dominated by six main commercial finfish species including orange roughy (*Hoplostethus atlanticus*), oreos (Oreosomatidae), boarfish (Pentacerotidae), eteline snapper (Lutjanidae: Etelinae), apsiline snapper (Ludjanidae: Apsilinae) and sea bream (Lethrinidae). Between 2000 and 2005, deepwater bugs emerged as the most important target species. However, there has been a large reduction in effort and catch over the past three years. Although the western edge of the Canning-Northern Carnarvon MSS operational area overlaps the fishery management area, it is not an area historically fished. As only one vessel is active, the likelihood of any interaction is considered low.

Western Skipjack Tuna Fishery

The WSTF is not active in continental shelf waters of the Canning or Carnarvon Basins. The skipjack tuna (*Katsuwonus pelamis*) is the only target species in the fishery and in recent years, activities in the WSTF have largely been confined to waters in the GAB and northeast of Eden in New South Wales. No Australian vessels were active in either zone (Western or Eastern) of the WSTF during the 2012-13 fishing season. The Canning-Northern Carnarvon MC MSS operational area overlaps the fishery but it does not overlap the current catch and effort fishing areas of the WSTF. Therefore, it is highly unlikely that there will be any interactions between surveys in the Canning-Northern Carnarvon MC MSS operational area and vessels fishing in the WSTF.

Western Tuna and Billfish Fishery

The WTBF extends from Cape York westwards around the NT and WA coast and across to the GAB, out to the limit of the AFZ and includes additional areas around Cocos and Christmas Islands. The fishery primarily targets broadbill swordfish (*Xiphias gladius*) yellowfin tuna (*Thunnus albacares*), bigeye tuna (*T. obesus*) and albacore tuna (*T. alalunga*). In 2012-2013, two vessels operated with the majority of catch and effort restricted to areas south of Geraldton (~30°S) and north of the Rowley Shoals (~15°S) (Woodhams *et al*. 2013). Some fishing occurred within the Canning-Northern Carnarvon MC MSS operational area in 2013, but the likelihood of interaction is considered minimal.

2.4.2. State Administered Fisheries

There are a number of State-managed fisheries that are in the vicinity of the Canning-Northern Carnarvon MC MSS operational area. The State fisheries administered by the WA Department of Fisheries (DoF) are:

- Mackerel Managed Fishery (MMF);
- North Coast Prawn Managed Fishery (NCPMF);
    - Broome Prawn Managed Fishery (BPMF);
    - Nickol Bay Prawn Managed Fishery (NBPMF);
    - Onslow Prawn Managed Fishery (OPMF);
- Pilbara Demersal Scalefish Managed Fishery (PDSMF);
    - Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF);
    - Pilbara Trap Managed Fishery (PTMF);
    - Pilbara Line Fishery (PLF);
- Pearl Oyster Managed Fishery (POMF); and
- Western Australian West Coast Deep Sea Crustacean Managed Fishery (WCDSCF).

Mackerel Managed Fishery

The MMF uses near-surface trolling gear from small vessels in coastal areas around reefs, shoals and headlands to target Spanish mackerel. Jig fishing is also used to capture grey mackerel with other species from the genera *Scomberomorus*, *Grammatorcynus* and *Acanthocybium* also contributing to commercial catches. Permit holders may only fish for mackerel by trolling or hand-line.

The fishery extends from the West Coast Bioregion to the WA/NT border, with most effort and catches recorded north of Geraldton, especially from the Kimberley and Pilbara coasts. The fishery is divided into three Areas – Area 1 – Kimberley (121°E to WA/NT border); Area 2 – Pilbara (114°E to 121°E); Area 3 – Gascoyne (27°S to 114°E) and West Coast (Cape Leeuwin to 27°S). There are currently 49 permits in the fishery with 15, 15 and 19 permits in Areas 1, 2 and 3 respectively, with the combined quota allocations being consolidated onto 14 boats operating within the fishery (DoF 2013). The total catch for 2012 was 318.1 t, which was in an acceptable range for the fishery. The

majority of catch occurs in Area 1 (Kimberley), and in 2012 was 180.3 t (DoF 2013); while Area 2 (Pilbara) catch was 88.0 t.

Areas 2 and 3 of the fishery overlaps the Canning-Northern Carnarvon MC MSS operational area and it is possible fishing operations will occur in the vicinity. Fishing in Area 3 centres around Shark Bay and so will not be affected by the seismic vessels. Fishing effort within Area 2 is limited to the eastern half of the proposed Canning-Northern Carnarvon MC MSS operational area and centres around reefs, shoals or headlands such as Glomar Shoal. As only 14 vessels are registered for the entire management area; the majority of catch is from the Kimberley (Area 3); and fishing can occur all year, it is unlikely that there will be interactions between surveys in the Canning-Northern Carnarvon MC MSS operational area and vessels fishing in the MMF.

Broome Prawn Managed Fishery (BPMF)

The BPMF targets western king prawns (*Penaeus latisulcatus).* Although the boundary of the BPMF extends east to 120° longitude and so overlaps the Canning-Northern Carnarvon MC MSS operational area, the actual trawl area is contained within a delineated small area northwest of Broome. The fishery generally opens in May and extends through until October. In 2012, only two boats fished the area catching a total of 12 tonnes. As the major fishing area is outside the Canning-Northern Carnarvon MC MSS operational area, it is unlikely any BPMF vessels will be present during the survey.

Nickol Bay Prawn Managed Fishery (NBPMF)

The NBPMF primarily targets banana prawns (*Penaeus merguiensis*). The boundaries of the NBPMF are all the waters between of the Indian Ocean between 116°45'E and 120°E on the landward side of the 200 m isobaths. The NBMF incorporates the Nickol Bay, extended Nickol Bay, Depuch and De Grey size managed fish grounds that are confined to the coastal waters of the Pilbara. In 2012, the season extended from 17 March to 1 November with a total catch of 129 t of banana prawns (DoF, 2013). Six boats fished for the season. The fishing effort is primarily restricted to shallow coastal waters and there is the possibility that vessels may be present in the operational area.

Onslow Prawn Managed Fishery (OPMF)

The OPMF targets western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), and endeavour prawns (*Metapenaeus* spp.) The boundaries of the OPMF are all the WA waters between the Exmouth Prawn Fishery and the Nickol Bay Prawn Fishery east of 114°39.9' on the landward side of the 200 m depth isobaths. The fleet is composed of trawlers up to 23 m in length. In 2012 no commercial trawling occurred. The fishing season extended from 13 April through 12 October.

Pilbara Fish Trawl (Interim) Managed Fishery

The PFTIMF is situated in the Pilbara region in the north west of Australia. It 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 southwest of the fishery (which is closed to trawling) and Zone 2 in the north, which consists of six management areas. Part of the Canning-Northern Carnarvon MC MSS operational area overlaps Zone 2 of the PFTIMF and so it is possible that vessels fishing in these areas could operate in the vicinity of the seismic vessels. However, as there are only three full-time active vessels; fishing is all year round; Areas 3 and 6 are closed (46% of fishing area); and the overlap is limited to waters less than 200 m, the likelihood of interaction is low.

Pilbara Trap Managed Fishery

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. The Canning-Northern Carnarvon MC MSS operational area only overlaps the PTMF in waters less than 200 m which is a very small portion of the polygon. Therefore, it is possible that vessels fishing in these areas could operate in the vicinity of the Canning-Northern Carnarvon MC MSS operational area. However, as there are only three full-time active vessels; and the fishery is only in waters less than 200 m the likelihood of interaction is low.

Pilbara Line Fishery

The PLF license holders are permitted to operate anywhere within "Pilbara Waters". This means all waters bounded by a line commencing at the intersection of 21°56'S latitude and the high water mark on the western side of the North West Cape on the mainland of Western Australia; then west along the parallel to the intersection of 21°56'S latitude and the boundary of the AFZ and north to longitude 120°E. The total annual catch of scalefish taken by the PLF is historically much lower than is taken by the trawl and trap fisheries.

The Canning-Northern Carnarvon MC MSS operational area overlaps a large portion of the western half of the PLF. Therefore, it is possible that vessels fishing in the PLF could operate in the vicinity of the operational area during the proposed activities. However, given the size of the permitted area, and that only nine vessels operate with licences, it is unlikely that there will be any interactions between the survey and support vessels in the Canning-Northern Carnarvon MC MSS operational area and vessels fishing in the PLF.

Pearl Oyster Managed Fishery

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. 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.

In pearl oyster near Eighty Mile Beach, the reproductive season begins September/October and continues through to April/May, with two distinctive spawning peaks. Although there is variability from month to month, there is a primary spawning period occurring October to December with a smaller secondary spawning in February and March (DoF 2006). The planktonic larvae stage of the pearl oyster is 28 to 35 days, when they are ready to metamorphose they settle to the bottom and test for a suitable habitat.

During the last decade the total number of oysters fished annually from the main fishing grounds of the POMF (Zone 2/3) has remained stable, varying by less than 10%. Generally, pearl divers are not allowed to collect pearl oysters unless they are a minimum size of 120 mm in shell length. However, for the 2012 and 2013 fishing seasons, pearl divers were permitted to take a sustainable amount of pearl oysters of a size no less than 100 mm, on a trial basis, for research purposes.

The Canning-Northern Carnarvon MC MSS operational area is located in Fishing Zones 1, 2 and 3 of the POMF. In 2012, catch was only taken in zones 2/3 with a total of five vessels in use. POMF is a dive fishery operating in shallow coastal waters (<35 m water depth), and so there is the possibility that seismic survey and diving activities may overlap. Mitigation will be in place to ensure that the seismic acquisition and diving activities take place in a safe manner, including ongoing consultation

with the fishery, and notification of activity commencement and completion in waters shallower than 50 m.

West Coast Deep Sea Crustacean Managed Fishery

The boundaries of this fishery include all the waters lying north of latitude 34°24'S (Cape Leeuwin) and west of the Northern Territory border on the seaward side of the 150 m isobath out to the extent of the AFZ. The WCDSCF targets crystal (snow) crabs (*Chaceon albus*), giant (king) crabs (*Pseudocarcinus gigas*) and champagne (spiny) crabs (*Hypothalassia acerba*) using baited pots operated in a long-line formation in the shelf edge waters (>150 m) of the West Coast. The WCDSCF is a quota based 'pot' fishery that operates mainly in depths of 500-800 m. No fishing is permitted in depths <150 m, with the only allowable method for capture being baited pots ('traps').

The Canning-Northern Carnarvon MC MSS operational area overlaps the WCDSCF. Optimal fishing effort occurs in deep offshore waters between 500 and 1,000 m, on the continental shelf slope and the Exmouth Plateau. Therefore, it is possible that vessels fishing in the WCDSCF could operate in the vicinity of the operational area during the proposed activities. However, given that only a small portion of the 'optimal fishing zone' overlaps the Canning-Northern Carnarvon MC MSS operational area and only three vessels fish the entire west coast, it is unlikely that there will be any interactions between surveys in the Canning-Northern Carnarvon MC MSS operational area and vessels fishing in the WCDSCF.

2.4.3. Petroleum Exploration and Production

A number of production facilities are located within the NWMR including Floating Production Storage Offshore (FPSO) facilities, and manned and unmanned platforms and monopods. There are a number of gas pipelines extending from offshore areas to land-based production facilities in coastal areas of the Pilbara. Six platforms/ FPSO are within the Canning-Northern Carnarvon MC MSS operational area.

2.4.4. Commercial Shipping

Within the NWMR, there is significant commercial shipping activity, the majority of which is associated with the mining and oil and gas industry. Major shipping routes in the area are associated with entry to the Port of Dampier, Port Hedland and Barrow Island with less traffic through the Port of Broome.

The Australian Maritime Safety Authority's (AMSA) nautical section was identified as a stakeholder and contacted regarding the proposed Canning-Northern Carnarvon MC MSS and subsequently supplied details of the location of shipping fairways that overlap and are adjacent to the operational area. Consultation with AMSA will be ongoing prior to, and throughout the duration of the survey.

2.4.5. Tourism and Recreation

Water-based tourism activities undertaken across the NWMR include whale watching, bird watching, recreational boating and fishing, charter boat fishing, snorkelling and diving, and surfing. These activities are concentrated in the vicinity of the population centres such as Broome, Exmouth, Dampier, Point Samson and Port Hedland. Snorkelling, diving, surfing and fishing activities are likely to be centred on shallow reefs such as near Point Samson, Bedout Island and the Rowley Shoals. Eighty Mile beach is a popular bird watching and camping location.

At its closest point, the southern edge of the Canning-Northern Carnarvon MC MSS operational area is located ~50 km from the Eighty Mile Beach, ~55 km from Port Hedland and ~65 km from the Dampier Archipelago. At this distance from the mainland, recreation fishing activities are not expected to be significant in the operational area. However, some recreational fishers and divers

are known to visit the waters around Bedout Island and North Turtle Island, which are located ~7 km and 35 km respectively from the operational area.

Occasional recreational fishing occurs at Glomar Shoal; however, due to the distance from land (130 km north of Dampier) it is very sporadic and short in duration. The Rowley Shoals (~25 km from the operational area) do have limited visitation, with the most occurring between August and December. Subsequently, tourism vessels may be in the area, although numbers are expected to be minimal due to the distance from the mainland and suitable boat launching facilities.

2.4.6. Cultural Heritage

There is one Native Title Determination in the vicinity of the Canning-Northern Carnarvon MC MSS operational area: the Ngarla and Ngarla #2 Determination Area (FC_No WAS6185/1998, WAD6003/2000, WAD77/2005; Tribunal_No WCD20078/00). The Canning Basin operational area does not overlap the Determination Area and subsequently activities will not enter these waters. There are no other pending Native Title Determinations for the waters and seabed within or immediately adjacent to the operational area.

A search of the National Shipwrecks Database indicates that one shipwreck (*Koombana*) is located within the operational area, while another seven are within 30 km of the operational area boundary.

2.4.7. National Heritage

There are two National Heritage places in the vicinity of the Canning-Northern Carnarvon MC MSS operational area:

- Rowley Shoals:
  - Imperieuse Reef, ~25 km from operational area;
  - Clerke Reef, ~33 km from operational area; and
  - Mermaid Reef, ~40 km from operational area.

- Dampier Archipelago, ~65 km to the southeast of the western boundary.
  - Dampier Archipelago;
  - Dampier Archipelago (including Burrup Peninsula); and
  - Dampier Archipelago Marine Areas.

2.4.8. Marine Parks and Reserves

The Canning-Northern Carnarvon MC MSS operational area overlaps the following proposed Commonwealth Marine Reserves:

- Argo-Rowley Terrace Commonwealth Marine Reserve (ATCMR) Multiple Use Zone IUCN Category VI and Marine National Park Zone - IUCN Category II.
- Eighty Mile Beach Commonwealth Marine Reserve (EMBCMR) Multiple Use Zone IUCN Category VI

The ATCMR is the largest reserve in the northwest region. The reserve provides protection for the communities and habitats of the deeper offshore waters of the region in depth ranges from 220 m to over 5,000 m. The ATCMR surrounds the Rowley Shoals as well as parts of the Rowley Terrace, Scott Plateau and Argo Abyssal Plain. The Scott Plateau may be a breeding site for sperm and beaked whales and is a significant seafloor feature in this area. It is fringed by numerous spurs and valleys and is separated from Rowley Terrace by a number of major canyons believed to support large fish aggregations, which in turn attract larger order predators. The upper and mid-slope areas of the continental slope also support rich and diverse demersal fish communities with a high level of

endemism. Clerke and Imperieuse Reefs fall under the jurisdiction of the WA State Government as Bedwell and Cunningham Islands lie above the high water mark. Mermaid Reef is incorporated into the Mermaid Reef Commonwealth Marine Reserve.

The EMBCMR abuts the proposed (as at the time of preparing this EP) WA Eighty Mile Beach Marine Park. It covers part of the continental shelf, adjacent to the entire length of Eighty Mile Beach, from Cape Bosset in the north to Commonwealth waters adjacent to Bedout Island. The waters off Eighty Mile Beach are important for a number of species including dugongs, humpback whales, sawfish and migratory seabirds. Eighty Mile Beach is a listed Ramsar Wetland of International Importance and is recognised as one of the three most important areas for migratory shorebirds in Australia.

The Canning-Northern Carnarvon MC MSS operational area is adjacent to the following Commonwealth and State Marine Reserves:

- Proposed Dampier Commonwealth Marine Reserves.
- Mermaid Reef Commonwealth Marine Reserve.
- Rowley Shoals Marine Park.
- Proposed Eighty Mile Beach Marine Park.
- Proposed Dampier Archipelago Marine Park.
- Proposed Montebello Marine Park.

2.4.1. Other Protected Areas

There are no listed World Heritage Properties within or immediately adjacent to the Canning-Northern Carnarvon MC MSS operational area or surrounding waters.

There is one Ramsar Wetlands of International Importance adjacent to Canning-Northern Carnarvon MC MSS operational area: Eighty Mile Beach. The site comprises of two separate areas: 220 km of beach and associated intertidal mudflats from Cape Missiessy to Cape Keraudren (“the beach”) and Mandora Salt Marsh 40 km to the east. Eighty Mile Beach contains the major concentrations of migratory shorebirds in northwest Australia and was nominated as a Ramsar site in 1990. At its closest point, the southern end of the Eighty Mile Beach is ~50 km from the northeastern boundary of the Canning-Northern Carnarvon MC MSS operational area.

It is estimated that more than 500,000 shorebirds use Eighty Mile Beach as a migration terminus each year, while another 150,000-200,000 use the site as a migration stop-over site on their way to southwestern, southern and southeastern Australian coasts. In terms of total numbers, the site is one of the most important non-breeding and migratory stopover areas in the East Asian – Australasian Flyway for use by migrant shorebirds. The waters of the reserve provide a vital food source for many of these species (DNP 2013).

2.4.2. Defence Activities

There are no defence activities overlapping the Canning-Northern Carnarvon MC MSS operational area.

3. DESCRIPTION OF ACTIVITY

The proposed marine seismic surveys will be typical 2D and 3D surveys similar to most others conducted in Australian marine waters (in terms of technical methods and procedures). No unique or unusual equipment or operations are proposed. The proposed surveys will be conducted using purpose-built seismic survey vessels.

During the proposed activities, the survey vessels will traverse a series of pre-determined sail lines within the Canning-Northern Carnarvon MC MSS operational area at a speed of ~4.5 knots. As the vessels travel along the survey lines a series of noise pulses (no less than every 5 seconds) will be directed down through the water column and seabed. The released sound is attenuated and reflected at geological boundaries and the reflected signals are detected using sensitive microphones arranged along a number of hydrophone cables (streamers) towed behind the survey vessel(s). The reflected sound is then processed to provide information about the structure and composition of geological formations below the seabed in an attempt to identify hydrocarbon reservoirs.

For 3D surveys, the seismic array will comprise of 12 to 14 solid streamers, with a length of 8,000 m. The source (airgun array) tow depth will be ~7.5 m and the streamer tow depth may vary between 8–30 m. Water depths range from 30 m to ~5,700 m. Steamers will be towed at a depth that will not allow them to be closer than 10 m from the seabed. Subsequently in waters less than 50 m, the streamer depth will be between 8–18 m, while in waters deeper than 50 m, streamer depth may be up to 30 m. These parameters will ensure it is impossible for any of the towed equipment to make contact with the seabed or benthic communities.

The operating pressure for the seismic energy source for both 2D and 3D will be approximately 2,000 psi. The 3D source will be deployed in two arrays, each with a maximum volume of 4,000 cubic inches (cui). These arrays will be activated alternately, every 25 m along each acquisition line (i.e. 50 m per array) and will produce at source (i.e. within a few metres of the airguns) sound pulses in the order of 243 dB re 1µPa2.s (at 1 m) (sound pressure level - SPL), at frequencies extending up to ~200 Hz.

Two-dimensional surveys will involve the use of only one airgun array, with a maximum volume of 4,000 cui and only the use of a single solid streamer with a maximum length of 10,000 m. The size of the source has been selected as low as reasonably possible to work in water depths from 30 m to 5,700 m, and to ensure the geophysical targets below the sea surface are imaged to an acceptable level. The volume of the source that has been chosen is as low as reasonably practicable (ALARP) when considering the geological target being aimed for.

3.1.1. Seismic Survey Vessels

TGS proposes to conduct the 2D and 3D surveys within the Canning-Northern Carnarvon MC MSS operational area using a purpose-built seismic survey vessel such as the MV Polar Duchess or similar. Any survey vessel(s) used for MC2D and MC3D surveys will have all necessary certification/registration and be fully compliant with all relevant MARPOL and SOLAS convention requirements specific for the vessels' size and purpose. The seismic survey vessels will have an implemented and tested Shipboard Oil Pollution Emergency Plan (SOPEP), in accordance with Regulation 37 of Annex I of MARPOL 73/78.

The vessel(s) will travel within the Canning-Northern Carnarvon MC MSS operational area at an average speed of ~4.5 knots. The use of helicopters may be required for the transfer of personnel to and from the survey vessel.

3.1.2. Support Vessel

During the surveys, it is possible that the seismic survey vessel will be refuelled at sea using a support vessel, either within or immediately adjacent to the survey area. At sea refuelling will only take place during daylight hours, and will not take place within a distance of 25 km from any emergent land or shallow water features (<20 m water depth). TGS at sea refuelling procedures are outlined in Section 5.4.5 of this EP.

A support vessel may also be utilised to re-supply the survey vessel with other logistical supplies, accompany the survey vessel to maintain a safe distance between the towed array and other vessels, and also to manage interactions with shipping and fishing activities, if required. If required (i.e. for vessels over 400 GRT) the support vessel will have an implemented and tested SOPEP.

4. DETAILS OF ENVIRONMENTAL IMPACTS AND RISKS

4.1. ENVIRONMENTAL RISK ASSESSMENT METHODOLOGY

An Environmental Risk Assessment (ERA) of the proposed Canning-Northern Carnarvon MC MSS has been undertaken to understand and manage the environmental risks associated with the activity to a level that minimises impacts on the environment and meets the objectives of the proposed survey. The ERA methodology applied is consistent with the *Australian/New Zealand Standard AS/NZS ISO 31000:2009 Risk management–Principles and guidelines*, *Handbook HB 203:2012 Managing environment-related risk*, and *Handbook HB 89-2012 Risk management - Guidelines on risk assessment techniques*. The risk assessment has been undertaken to identify the sources of risk (aspects) and potential environmental impacts associated with the activity and to assign a level of significance or risk to each impact. This subsequently assists in prioritising mitigation measures to ensure that the environmental impacts are managed to ALARP.

The risk has been measured in terms of likelihood and consequence, where consequence is defined as the outcome or impact of an event, and likelihood as a description of the probability or frequency of the identified consequence occurring. The key steps used for the risk assessment are shown in **Figure 4.1**.

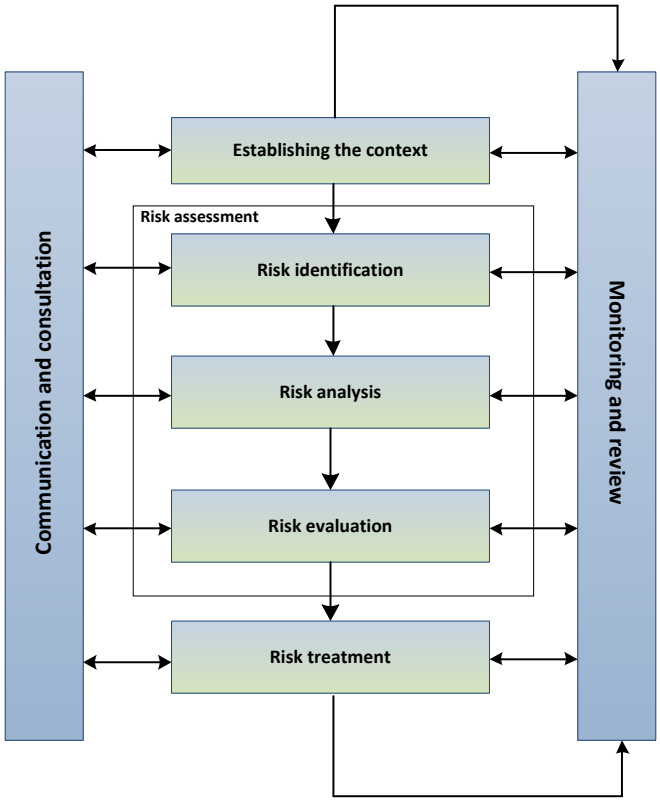


Figure 4.1 - Key Steps used for Risk Assessment

The environmental risks associated with the proposed seismic survey operations have been assessed by a methodology that:

- identifies the activities and the environmental aspects associated with them;
- identifies the values/attributes at risk within and adjacent to the Canning-Northern Carnarvon MC MSS operational area;
- defines the potential environmental effects of the activities;

- identifies the likelihood of occurrence and potential consequences; and
- determines overall environmental risk levels using a likelihood and consequence matrix.

4.1.1. Decision Making Framework

Determining whether risks have been reduced to as low as reasonable practicable (ALARP) requires an understanding of the nature and cause of the risk to be avoided and the sacrifice (in terms of safety, time, effort and cost) involved in avoiding that risk. The hierarchy of decision tools used in this case (from lowest risk to highest risk) has been adapted from the UKOOA Industry Guidance on Risk Related Decision Making. **Figure 4.2** illustrates the UKOOA framework.

Within the context of a specific decision situation, the framework provides a means to:

- Determine the relative importance of the various methods of assessing risk (e.g. by reference to standards, cost benefit analysis, or societal values).
- Judge which of these methods is best placed to determine whether the risks are tolerable and ALARP.

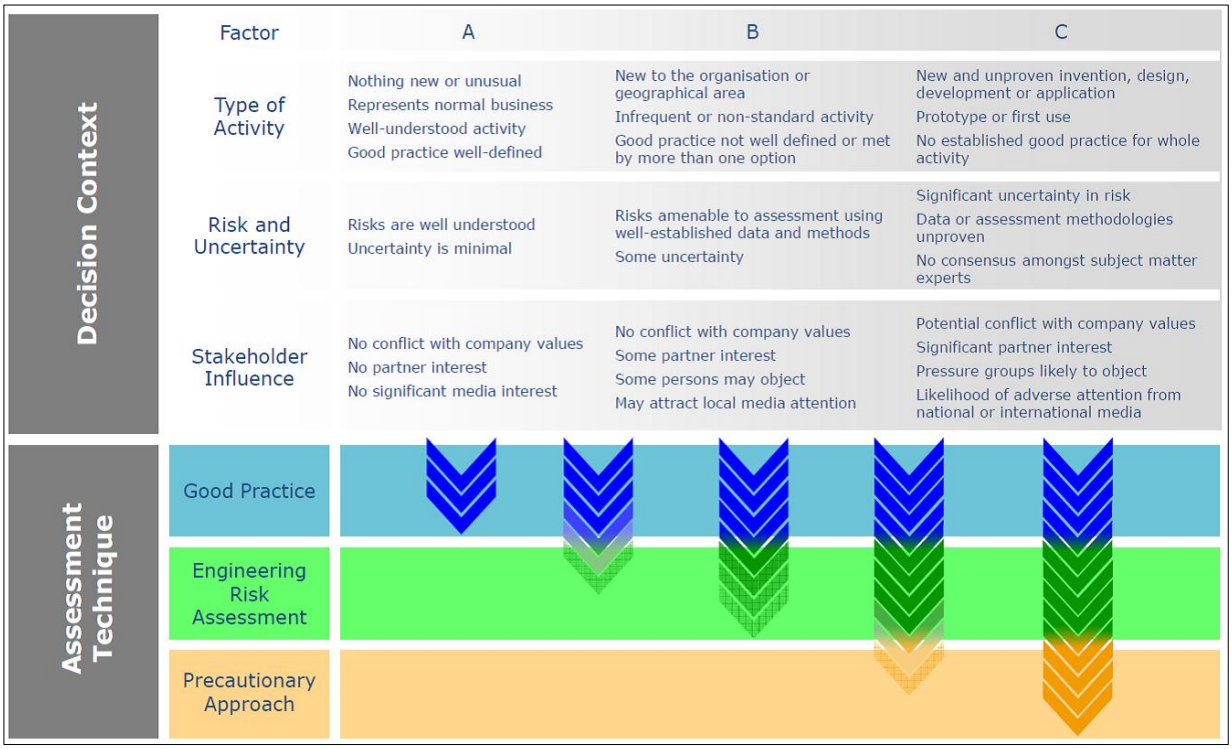


Figure 4.2 - Risk Related Decision Making Framework

The UKOOA guidance describes a range of appropriate bases (i.e. tools or protocols) for risk decision-making. These bases provide a means to assess the relative importance of adherence to, and reliance on, the following when making decisions to either accept or further treat risks:

- Legislation, Codes and Standards.
- Good Industry Practice.
- Professional Judgement.
- Risk Analysis.
- Company Value.
- Societal Values.

Table 4.1 shows the overall environmental risk assessment matrix (also referred to as an event potential matrix) that compares the likelihood and consequences of potential environmental impacts arising from the Canning-Northern Carnarvon MC MSS and assigns a level of risk.

Table 4.1- Generic Environmental Risk Assessment Matrix

		LIKELIHOOD LEVEL					
CONSEQUENCE LEVEL		Remote	Highly Unlikely	Unlikely	Possible	Likely	Highly Likely
	Catastrophic	2	2	1	1	1	1
	Massive	3	2	2	1	1	1
	Major	3	3	2	2	1	1
	Moderate	4	3	3	2	2	1
	Minor	4	4	3	3	2	2
	Slight	4	4	4	3	3	2

Operational Risk Levels
Risk Level 1: **SEVERE** risk, apply strict Precautionary Principle.
Risk Level 2: **HIGH** risk, apply industry best practice to reduce to ALARP.
Risk Level 3: **MEDIUM** risk, apply standard cost-benefit approach to reduce risk to ALARP.
Risk Level 4: **LOW** risk, apply normal business management practice to avoid impact.

4.2. RISK EVALUATION

Environmental risks cover a wider range of issues, multiple species, persistence, reversibility, resilience, cumulative effects and variability in severity. The degree of environmental risk and the corresponding threshold for acceptability has been adapted to include principles of ecological sustainability (given as an objective in the Environment Regulations and defined in the EPBC Act), the Precautionary Principle and the corresponding environmental risk threshold decision-making principles used to determine acceptability.

4.2.1. Demonstration of ALARP

As outlined in **Table 4.2**, impacts and risks are reduced to ALARP where:

- The residual risk is **LOW**:

- good industry practice or comparable standards have been applied to control the risk, because any further effort towards risk reduction is not reasonably practicable without sacrifices grossly disproportionate to the benefit gained.

- The residual risk is **MEDIUM** or **HIGH**:
  - good industry practice is applied for the situation/ risk; or
  - alternatives have been identified and the control measures selected to reduce the impacts and risks to ALARP. This may require assessment of Company and industry benchmarking, review of local and international codes and standards, consultation with stakeholders etc.

4.2.2. Demonstration of Acceptability

The following process has been applied to demonstrate acceptability (as illustrated in **Table 4.3**):

- **LOW** residual risks are 'Broadly Acceptable', if they meet legislative requirements, industry codes and standards, regulator expectations, the TGS Environmental Policy and industry guidelines.
- **MEDIUM** and **HIGH** residual risks are 'Broadly Acceptable' if ALARP can be demonstrated using good industry practice, risk based analysis, if societal concerns are accounted for and the alternative control measures are disproportionate to the benefit gained.
- **SEVERE** residual risks are 'Intolerable' and therefore 'Unacceptable'. Risks will require further investigation and mitigation to reduce the risk to a lower and more acceptable level. If after further investigation the risk remains in the severe category, the risk requires appropriate business sign-off to accept the risk.

Table 4.2 - Residual risk levels and associated decision making tools and principles

Residual Risk Level	Environmental Threshold	Decision Making Tools	Environmental Decision Principles
LOW Broadly Acceptable Zone	No substantial risk (i.e. negligible risk) of harm to species or communities	Comparison to codes and standards, good oilfield practice and professional judgement are used to assess risk acceptability	If the environmental risk of the hazard has been found to be 'Broadly Acceptable' and the control measures are consistent with applicable standards and good industry practice then no further action is required to reduce the risk further. However, if a control measure that would further reduce the impact or risk is readily available, and the cost of implementation is not disproportionate to the benefit gained, then it is considered 'reasonably practicable' and should be implemented.
MEDIUM / HIGH ALARP Zone	Likely to cause, or substantial risk of causing serious harm to non-listed species or communities	Risk based analysis are used in addition to comparison to codes and standards, good oilfield practice and professional judgement to assess risk acceptability.	An iterative process to identify alternative / additional control mechanisms has been conducted to reduce the risk to the 'Broadly Acceptable' zone. However, if the risk cannot be reasonably reduced to the 'Broadly Acceptable' zone without grossly disproportionate sacrifice; then the mitigated environmental risk is considered to be ALARP.
SEVERE Intolerable Zone	Likely to cause, or substantial risk of causing significant impact to protected species or communities	All of above decision making tools apply plus consideration of company values and societal values	If the environmental impact or risk has been found to fall within this zone then the activity should not be carried out. Work to reduce the level of risk should be assessed against the Precautionary Principle with the burden of proof requiring demonstration that the risk has been reduced to the ALARP Zone before the activity can be commenced.

Table 4.3 - Acceptability criteria

Criteria	Question	Acceptability demonstrated
Policy compliance	Is the proposed management of the impact or risk aligned with the TGS Environmental Policy?	The impact or risk must be compliant with the objectives of the company policies.
Management System compliance	Is the proposed management of the impact or risk aligned with the TGS Management System?	Where specific TGS procedures and work instructions are in place for management of the impact or risk in question, acceptability is demonstrated.
Social acceptability	Have stakeholders raised any concerns about activity impacts or risks, and if so, are measures in place to manage those concerns?	Stakeholder concerns must have been adequately addressed and closed out.
Laws and standards	Is the impact or risk being managed in accordance with existing Australian or international laws or standards, such as EPBC Policy Statements, MARPOL, AMSA Marine Orders, Marine Notices etc.?	Compliance with specific laws or standards is demonstrated.
Industry best practice	Is the impact or risk being managed in line with industry best practice, such as APPEA Code of Environmental Practice, IAGC guidelines etc.?	Management of the impact or risk complies with relevant industry best practice.
Environmental context	Is the impact or risk being managed pursuant to the nature of the receiving environment (e.g. sensitive or unique environmental features generally require more management measures to protect them than environments widely represented in a region)?	The proposed impact or risk controls, EPO and EPS must be consistent with the nature of the receiving environment.
Environmentally Sustainable Development (ESD) Principles	Does the proposed impact or risk comply with the APPEA Principles of Conduct (APPEA 2003), which includes that ESD principles be integrated into company decision-making.	The Canning-Northern Carnarvon MC MSS is consistent with the APPEA Principles of Conduct.
ALARP	Are there any further reasonable and practicable controls that can be implemented to further reduce the impact or risk?	There is a consensus that residual risk has been demonstrated to be ALARP.

4.3. IDENTIFICATION OF RISKS AND IMPACTS

The environmental risks and potential environmental impacts of the proposed Canning-Northern Carnarvon MC MSS have been determined on the basis of TGS's previous seismic survey experience in the region and the outcomes of the ERA.

4.3.1. Environmental Aspects

A summary of the key sources of environmental risk (aspects) for the proposed activity include:

- discharge of underwater seismic pulses;
- Vessel noise emissions (non-seismic);
- light generation from vessels;
- interactions with stakeholders, including commercial fishing and shipping;
- discharge of ballast water and vessel biological fouling (biofouling);
- interactions of vessels with marine fauna;
- routine discharge of wastewater and waste to the ocean from survey and support vessels;
- anchoring or grounding of vessels used for the activity;
- dragging or loss of streamers and associated equipment; and
- accidental discharge of hydrocarbons and chemicals to the ocean from survey and support vessels.

4.3.2. Environmental Impacts

A summary of the potential environmental impacts associated with the sources of environmental risk listed above include:

- disturbance to marine fauna including cetaceans, whale sharks, turtles and fish;
- disturbance to the seabed and benthic habitats and communities;

- introduction of invasive marine species as a result of ballast water discharge and vessel biological fouling;
- marine pollution from routine discharges including sewage water, bilge water and other solid wastes;
- marine pollution from accidental discharges including hydrocarbon spills and hazardous materials;
- disturbance to social and community values due to interactions with commercial fishing vessels, shipping and defence activities;

4.4. ASSESSMENT OF ENVIRONMENTAL IMPACTS AND RISKS

This section briefly describes the potential risks and impacts that could occur as a result of the proposed activity. **Section 4** details the risk assessment and **Section 6** summarises the control measures that will be implemented to minimise impacts to receptors described herein.

4.4.1. Discharge of Underwater Seismic Pulses

Studies relating to the environmental effect of marine seismic surveys have largely focused on the potential effects to fish stocks and marine mammals from the sound waves associated with the seismic energy source. Concerns have included:

- pathological effects (lethal and sub-lethal injuries) – immediate and delayed mortality and physiological effects to nearby marine organisms;
- behavioural change to populations of marine organisms;
- disruptions to feeding, mating, breeding or nursery activities of marine organisms in such a way as to affect the vitality or abundance of populations;
- disruptions to the abundance and behaviour of prey species for marine mammals, seabirds and fish; and
- changed behaviour or breeding patterns of commercially targeted marine species, either directly, or indirectly, in such a way that commercial or recreational fishing activities are compromised.

Based on empirical measurements of a number of seismic airgun sources in western and southern Australian waters (Dr Rob McCauley, CMST Curtin University, pers. comm., June 2009), the sound pulses from this airgun array are expected to decrease to SEL in the order of 165 to 175 dB re 1µPa^2.s within 1 km of the source and ~160 dB re 1µPa^2.s within 2 km, dependent on the sound propagation characteristics of the area.

In relation to cumulative noise levels, an environmental review recently published by the Bureau of Ocean Energy Management (BOEM 2014) indicated that the typical radii for a 160 dB threshold for a large airgun array was measured at no more than 10 km. Furthermore, the review suggests the implementation of a 40 km geographic spacing between survey vessels working simultaneously to leave a potential 20 km 'corridor' between vessels.

Disturbance to Benthic Invertebrates

Few marine invertebrates have sensory organs that can perceive sound pressure, but many have organs or elaborate arrays of mechanoreceptors that are sensitive to hydro-acoustic disturbances. 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.

In a summary of impacts of seismic airguns on marine invertebrates it was found that "very limited numbers of experiments were scientifically and reasonably conducted", but the results of nine quantitative studies showed five cases of immediate (lethal or physical) impacts of seismic airguns on invertebrate species and four cases of no impacts. One study showed physiological impacts and another showed no physiological impact. Three cases showed behavioural impacts and one study showed no impact on behaviour.

Disturbance to Planktonic Organisms

Except for fish eggs, larvae and other minute planktonic organisms within a few metres of an airgun, no planktonic organisms are likely to be affected significantly by airgun array discharges. The range of pathological effects on fish eggs and larvae is likely to be restricted to less than approximately 2 m, and calculations show that less than 0.02% of plankton in the area would be affected. Any effect on the planktonic organisms from the seismic discharge is insignificant compared with the size of the planktonic population in a survey area or natural mortality rates for planktonic organisms.

Disturbance to Bivalve Molluscs

Many molluscs, including bivalves, possess fluid-filled, capsule-like sensory organs called statocysts, which assist the organism in maintaining balance and orientation in its immediate environment. It has been postulated that statocyst organs may be receptive to the particle acceleration component of a sound waves. No information is available concerning the distances over which bivalve molluscs may be able to detect either the pressure or particle motion components of a sound wave, particularly for animals suspended in mid-water. A review of studies (Parry *et al*. 2002) suggested that molluscs are at risk of damage from seismic airgun noise only when they are closer than 1–2 m.

Several species of bivalve, including two oyster species, are remarkably resilient to the shock waves created by the detonation of high explosives underwater. The one study that examined the effects of underwater explosions on the pearl oyster (LeProvost *et al*. 1986), found that no mortality occurred in the exposed animals over a 13 week period, at a minimum exposure range of 1 m from the blast centre. Seismic airguns cause fewer impacts on benthic invertebrates than explosives, hence bivalves, such as *P. maxima*, would have to be within a very close range of an airgun source to experience pathological damage or mortality: evidence suggests in the order of less than 1-2 m. It is difficult to determine at what distances from an airgun array morphological, biochemical and physiological changes could occur. However, a study on the venerid clam showed evidence of stress caused by acoustic noise was at a minimum range of 7.5 m.

Based on the available information, it would appear that significant impacts on bivalve molluscs, such as the pearl oyster, from airgun noise emissions will only occur within very short distances from the source. A conservative estimate for a minimum distance beyond which significant effects are unlikely, is approximately 10 m.

Disturbance to Fish

Potential impacts on fish species related to the operation of survey airgun arrays include pathological trauma or mortality, and behavioural avoidance of seismic sound sources. Indirect effects include reduced catches resulting from changes in feeding behaviour and vertical/horizontal distribution.

Based on existing information, significant impacts on fish populations resulting from seismic survey noise are likely to be restricted to the following:

- short ranges and high sound intensities (i.e. <200 m range from source);
- populations that cannot move away from operating arrays (e.g. site-attached reef species);

- surveys that take place over protracted periods close to areas important for the purposes of feeding, spawning or breeding; and
- surveys that take place over protracted periods close to areas that constitute narrow, restricted migratory paths.

Available evidence suggests that behavioural changes for some fish species may be no more than a nuisance factor. For example, the temporary, short range, displacement of pelagic or migratory fish populations may have insignificant repercussions at a population level.

There is a high likelihood that seismic airgun noise could cause the following effects in some finfish:

- avoidance;
- startle/alarm response;
- changes in swimming patterns (including change in swimming speed and direction); and
- changes in vertical distribution.

These effects are expected to be short-lived, with duration of effect less than or equal to the duration of exposure, are expected to vary between species and individuals, and be dependent on the properties of received sound. There are no documented cases of fish mortality upon exposure to seismic airgun noise under field operating conditions.

Disturbance to Whale Sharks
Limited research has been conducted on shark responses to marine seismic surveys. Sharks differ from bony fish in that they have no accessory organs of hearing such as a swim bladder and therefore are unlikely to respond to acoustical pressure. Other reports indicate that sharks are highly sensitive to sound between ~40 and 800 Hz, which overlaps with seismic sound frequencies. The available evidence indicates sharks will generally avoid seismic sources and the likely impacts on whale sharks

Dugongs
Dugongs are believed to have acute hearing within narrow sound thresholds (Lawler *et al*. 2002) ranging from1 to 8 kHz that are outside the frequencies of the survey (1-200 Hz). This, combined with the fact that dugongs generally remain in very shallow waters, makes it very unlikely that seismic activity will have any effect on dugongs.

Disturbance to Marine Turtles
Electro-physical studies have indicated that the best hearing range for marine turtles is in the range 100 to 700 Hz, which overlaps with the frequency range of maximum energy in the horizontally propagating component of a seismic array 'shot'. Airgun exposure tests on a caged green turtle and loggerhead turtle that were extrapolated to response levels for a typical airgun array operating at full power in 100 m water depth concluded that turtles would, in general, probably show behavioural responses at 2 km and avoidance behaviour at 1 km from such operations. However, it was also noted that such rules of thumb for acoustic sources with frequencies within the range of turtle hearing (<1 kHz), cannot be reliably applied to shallow coastal waters near reefs, islands and nesting beaches, where transmission losses are typically much higher than in deeper, open water areas.

Marine turtles may possibly be exposed to noise levels sufficient to cause physical damage if airgun arrays start suddenly with turtles nearby (less than 30 m). In circumstances where arrays are already

operating, (i.e., as a vessel moves along an acquisition line) individuals would be expected to implement avoidance measures before entering ranges at which physical damage might take place.

Based on current information, it would appear that significant impacts on marine turtle populations resulting from seismic survey noise are likely to be restricted to:

- short ranges and high sound intensities (perhaps less than 30 m range from source);
- surveys that take place over protracted periods close to areas important for feeding, breeding and nesting; and
- surveys that take place over protracted periods close to areas that constitute narrow, restricted migratory paths.

The Canning-Northern Carnarvon MC MSS operational area is at least 35 km from the nearest recognised flatback nesting beach on North Turtle Island. However, the 80 km internesting buffer BIA defined by the DoE covers the maximum extent of inter-nesting movements as based on satellite tracking studies, and is highly conservative. Turtles (including hatchlings) will generally remain closer to the nesting beaches with their densities reducing the greater the distance from the beaches.

As the operational area overlaps the internesting BIA for flatback turtles and the foraging areas for another three species, additional controls such as observation and shutdown zones during sensitive periods will be applied. On balance, it is considered that any behavioural response or avoidance behaviour that may still be expressed would be localised to a few individuals that may travel/ rest directly under the source.

Disturbance to Cetaceans

Baleen Whales

Baleen whales produce a rich and complex range of underwater sounds and studies of their hearing apparatus suggests that their hearing is also best adapted for low frequency sound. Baleen whales make individual sounds that are believed to be used in social interactions and communication between individuals and groups that may reach levels as high as 192 dB re 1µPa^2 (McCauley *et al.* 2003).

Physical damage to the auditory system of cetaceans may occur at noise levels of about 230 to 240 dB re 1µPa (Gausland 2000), which is equivalent to a distance of about 1-2 m from the energy source, while McCauley *et al*. (2003) found that migrating humpback whales show a general avoidance of an operating seismic source at 157 to 164 dB re 1µPa.

Noise associated with airguns used during seismic surveys can cause behavioural changes in whales. With regards to avoidance behaviour by baleen whales, it is known that baleen whales will avoid operating seismic vessels and the distance over which the avoidance occurs seems to be highly variable between species and even within species. It is considered that this avoidance behaviour represents only a minor effect on either the individual or the species unless avoidance results in displacement of whales from nursery, resting or feeding areas, at an important period for the species. Because of the good swimming abilities of marine mammals and their avoidance of either the vessel or the airgun array, it is highly unlikely that any marine mammals will be exposed to levels likely to cause pathological damage. The Canning-Northern Carnarvon MC MSS operational area does not overlap known critical habitats for any cetacean species.

Toothed Whales

Toothed whales produce a wide range of whistles, clicks, pulsed sounds and echolocation clicks. The sounds produced other than echolocation clicks are very complex in many species and appear to be

used for communication between members of a pod in socialising and coordinating feeding activities.

There is little systematic data on the behavioural response of toothed whales to seismic surveys. Smaller toothed cetaceans have poor hearing in the low frequency range of airgun array noise (10 to 300 Hz) and seismic operators sometimes report dolphins and other small toothed whales near operating airgun arrays. However, there are components of seismic pulses in the higher spectrum and in general most toothed whales do show some limited avoidance of operating seismic vessels. The hearing capability of larger toothed whales (such as the killer whale) is unknown, but it is possible that they can hear better in the lower frequencies than the smaller toothed cetaceans. If this is the case, in lieu of any other information, their reactions to seismic survey vessels may be akin to those of the baleen whales. It is considered that the potential adverse effect on toothed whales would only occur if the whale was within close range (i.e., less than a few hundred metres). The Canning-Northern Carnarvon MC MSS operational area does not overlap known critical habitats for any cetacean species.

4.4.2. Noise Emissions from Non-seismic Sources

Noise emitted from the survey vessel and support vessel (i.e. engines, propellers) or from helicopter operations could cause potential short-term localised disturbance to marine fauna, such as alteration of behaviour and localised displacement. Vessel noise levels are significantly lower than the seismic source noise levels discussed above and are below levels that could result in physical injury. Furthermore, underwater noise from the survey vessel is transient and will be no different to that emitted by the commercial shipping traffic and fishing vessels operating in these areas. Given the slow operating speed (generally less than 4-5 knots), and the low numbers of marine fauna anticipated to be in the area at the time of the survey, the probability of significant impacts from disturbance to marine fauna is assessed to be low.

Noise from helicopters is transient and within the bounds of ambient noise conditions. Therefore it is not considered to pose any risk of physiological hazard or behavioural effects to marine fauna unless they hover above the animal for an extended period.

4.4.3. Light Generation

Owing to their migratory habits, all five species of turtle have the potential to be present in open ocean habitats throughout the Canning-Northern Carnarvon MC MSS operational area, albeit in low densities. Therefore, the probability of artificial light impacts on turtles is also low; particularly given the distance between the operational area and the nearest shallow water/emergent feature (North Turtle Island ~35 km to the southeast of the operational area).

Although it is possible that seabirds may fly over the Canning-Northern Carnarvon MC MSS operational area it is not anticipated that the activities will have an impact on any species of seabird, due to their mobility and distance of the survey area to any nesting sites for seabirds.

The potential impacts to other marine fauna of light emissions from seismic vessels is expected to be restricted to localised attraction, temporary disorientation and increased predation and as such, any impacts arising from light emissions are considered to be minor and localised to a small proportion of the population.

4.4.4. Interaction with Commercial or Recreational Fishers, Shipping and Petroleum Service Vessels

As described in **Section 2.4**, there are a number of commercial fisheries operating within the area of the Canning-Northern Carnarvon MC MSS operational area.

Disruption to commercial fisheries in the area could result from:

- restriction of access to fishing grounds due to vessel movements and operations;
- restriction of access due to diesel spill;
- loss of fishing gear e.g. buoyed fish traps; and
- recreational take of finfish species from the survey and support vessels.

The risk of potential impacts to commercial fisheries in or adjacent to the Canning-Northern Carnarvon MC MSS operational area is considered to be minimal, given the small overlap of active fishing area. Fishing companies, individual licence holders and/or appropriate peak fishing industry organisations that potentially overlapped the operational area have been contacted by TGS and informed of the location of the proposed operational area. Further correspondence will be made at least four weeks prior to commencing the survey with detailed information for the proposed activity (including timing, duration and locations etc.). Once in the field, the survey vessel shall contact vessels where required, to prevent disturbance or avoid interaction within the operational area.

Fishing may be increased around the Glomar Shoal. Although no seismic activity shall occur over the shoal or in the waters immediately adjacent, Recfishwest, and relevant local fishing organisations/ groups will be provided 7-10 day forecasts of when activities will be occurring within the vicinity.

The survey vessel and towed array represent a potential navigational hazard and vessels will need to avoid the seismic vessel to prevent collisions, entanglement of seismic cables, and other incidents. Any vessels involved in the survey(s) will comply with MARPOL requirements and other applicable maritime laws and operate strictly in accordance with standard operating procedures for marine operations.

4.4.5. Ballast Water Discharge, and Biofouling of Vessel Hull, Other Niches and Immersible Equipment

Invasive Marine Species (IMS) are marine plants or animals that have been introduced into a region beyond their natural range and have the ability to survive, reproduce and establish founder populations. Species of concern vary between regions depending on various environmental factors such as water temperature, salinity, nutrient levels and habitat type.

Key vectors requiring management include:

- discharge of high risk ballast water taken up at international or domestic sources;
- 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 etc.); and
- biofouling on equipment that routinely becomes immersed in water.

Once introduced IMS can cause serious environmental, social and economic impacts through predation or displacement of native species. These direct or indirect impacts also have the potential to threaten a range of sectors including:

- commercial fisheries and aquaculture;
- tourism industry;
- human health;
- shipping; and
- infrastructure

Commonwealth and state regulatory agencies have implemented increased management requirements in recent years, with further legislation currently under development.

All international vessels intending to discharge ballast water anywhere inside the Australian territorial sea are required to manage their ballast water in accordance with Australia's mandatory ballast water management requirements.

Any vessel involved in the Canning-Northern Carnarvon MC MSS, which has not been operating in Australian waters, will be required to meet the biosecurity standards of both the Department of Agriculture (DAFF) and DoF. Vessels will be coated in an appropriate antifouling system that is considered suitable for both coastal and deep sea vessels and is compliant with the International Convention on the Control of Harmful Anti-Fouling Systems on Ships.

4.4.6. Sewage, Grey Water and Putrescible Wastes

Routine discharge of bile water, sewage and food wastes to the ocean will cause a negligible and localised and temporary increase in nutrient concentrations and reduction in water quality. The total nutrient loading from vessel operations during surveys in the Canning-Northern Carnarvon MC MSS operational area will be insignificant in comparison to the natural daily nutrient flux that occurs in marine waters within the region. No significant impacts are anticipated because of the minor quantities involved, localised area of impact, high level of dilution into deep oceanic waters and high biodegradability/low persistence of the wastes.

All wastes will be appropriately treated and discharged as per commonwealth and international legislative requirements.

4.4.7. Collision between Vessels / Towed Array and Marine Fauna

Survey and support vessels working within, and travelling to and from the Canning-Northern Carnarvon MC MSS operational area may present a potential physical hazard (e.g., animal displacement or vessel strike) to marine fauna including whales, dolphins, whale sharks and turtles.
The impact from vessel interactions with marine fauna can be as minimal as behavioural changes by the marine fauna to severe impacts such as mortality resulting from vessel strikes. However, marine seismic surveys involve the use of two or more vessels travelling at slow speed (around 4.5 knots) along defined paths and therefore pose low risk. Support vessel-marine fauna interaction procedures have been prepared to ensure any interactions between the support vessel and cetaceans, whale sharks and turtles are managed in accordance with EPBC Regulations 2000.

4.4.8. Vessel Anchoring, Grounding or Equipment Dragging and loss

The accidental dragging or loss of seismic streamer equipment, vessel grounding or use of anchors has the potential to cause minor physical damage to benthic habitats and biological communities. However, soft sediment benthic areas relatively devoid of sensitive habitats and consisting of sandy /silt substrate is the predominant benthic receiving environment within, and adjacent to, the Canning-Northern Carnarvon MC MSS operational area. The surveys will generally be operating at

depths and distances from emergent land, that preclude any possible contact i.e. vessel is at least 7 km from nearest emergent land, and minimum 30 m water depth.

Equipment Dragging or Loss

In the unlikely event of damage to or loss of a solid seismic streamer, potential environmental effects will be limited to physical impacts on benthic communities arising from the cable and associated equipment sinking to the seabed. Seismic streamers and vanes are fitted with pressure-activated, self-inflating buoys. 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. Six petroleum platforms or FPSOs are present within the Canning Basin operational area. Steaming too close to the structures could result in streamer entanglement, damage or loss. Vessels and associated equipment will not enter the petroleum safety zone (PSZ).

Anchoring

Anchoring is not a planned activity within the Canning-Northern Carnarvon MC MSS operational area and due to the water depths (~30 – ~ 5,700 m) anchoring is not always possible. Anchoring outside the Canning-Northern Carnarvon MC MSS operational area would only occur in emergency circumstances and the survey and support vessels are fitted with highly sophisticated position fixing equipment.

Vessel Grounding

The potential for the survey and support vessel to become grounded while working within the Canning-Northern Carnarvon MC MSS operational area is non-existent due to the absence of shallow waters (<20 m water depth) and any emergent features within or immediately adjacent to the Canning-Northern Carnarvon MC MSS operational area. Water depths in the Canning-Northern Carnarvon MC MSS operational area are ~30 m to ~5,700 m.

4.4.9. Accidental Release of Hazardous or Non-hazardous Materials

The survey and support vessels will store and use a variety of hazardous materials such as paints, cleaning chemicals and batteries. Vessels will also produce a variety of other non-hazardous solid and liquid wastes, including packaging and domestic wastes, such as aluminium cans, bottles, paper and cardboard

Hazardous Materials

These materials have the potential to adversely impact the marine environment if accidentally released in significant quantities. Chemicals e.g. solvents and detergents, will typically be stored in small containers of 5-25 litre capacity and stored / used in internal areas where any leak or spill would be retained on board and cleaned up in accordance with the Shipboard Oil Pollution Emergency Plan (SOPEP) and associated spill clean-up procedures.

Non-hazardous Materials

These materials could potentially impact the marine environment if accidentally released in significant quantities resulting in a reduction in water quality and physical impacts on marine fauna, such as becoming entangled in waste plastics.

4.4.10. Vessel topside hydrocarbon spills

The survey and support vessels store and use small quantities of lubricating oils and hydraulic fluid, which have the potential to spill if not appropriately managed. Hydraulic fluid may also potentially be spilled from a leak in hoses or lines on hydraulic equipment such as cranes or winches.

The size of potential spills to deck of these substances are likely to be between 50 and 200 L (0.05 m³ and 0.2 m³) based on expected volumes of fluids available on deck typically stored in 50 to 200 L steel drums. Storage of these substances aboard the survey vessel would typically be within a designated storage room or a contained (bunded) area on deck. Spills or leaks from hydraulic hoses on cranes, winches or other hydraulically operated equipment are also possible, but typically involve only very small volumes of fluid loss (less than 1 L) and are typically contained within a bund or drip tray under the equipment mounted on deck.

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 hydrocarbons will rapidly evaporate, disperse and weather.

4.4.11. Hydrocarbon Release Caused by Transfer Spill or Vessel Collision

The hazards associated with fuel and oil spills during the Canning Basin MS3D MSS (that are considered most credible) are:

- loss of up to 3,091 litres (~3 m^3) of diesel during refuelling operations, as a result of hose failure; and
- loss of diesel (up to 220 m^3) from a ruptured fuel storage tank, resulting from vessel collision.

The accidental discharge of diesel has the potential to cause toxic effects on marine fauna and flora and a localised reduction in water quality. Potentially affected biota includes 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. Commercial fishing activities and shipping in the area could also be impacted in the event of a major diesel spill.

The fuel that will be used by the survey vessel(s) is Marine Gas Oil (MGO; marine diesel). Based on the characteristics of diesel and given the high energy and warm water environment that prevails in the Canning-Northern Carnarvon MC MSS operational area, diesel is expected to:

- undergo rapid dispersion and evaporation;
- spread rapidly in the direction of prevailing wind and current;
- evaporate rapidly from the sea surface (under calm conditions this will be the dominant process removing oil from the marine environment);

During the survey, the survey vessel(s) will be refuelled at sea using the support vessel, either within or immediately adjacent to the Canning-Northern Carnarvon MC MSS operational area. Transfer spills have a much greater potential to cause large spills than do vessel collisions. The realistic worst-case volume of diesel spilled during refuelling operations is 3,091 litres, arising from the total loss of the contents of the transfer hose during refuelling. Dry break couplings would prevent any more than the hose volume being spilled in the event of hose failure. At sea refuelling will only take place during daylight hours and will not take place within a distance of 25 km of any emergent land or shallow water features (<20 m water depth).

Vessel collision spill risk levels from the proposed survey are no different from those presented by any other routine shipping operating in waters off the north-west Australian coastline.

In the extremely unlikely (improbable) event of a ruptured fuel tank as a result of collision, an ADIOS2 (Automated Data Inquiry for Oil Spills) model was run using the worst-case scenario for an oil spill of MGO from the largest tank at maximum capacity of 220 m^3 (90% full). Based on the ADIOS2 modelling output, ~99% of the slick will have dispersed and evaporated within about 17 hours if occurring in the summer months, resulting in a potential radius of 31 km. During the winter period the ADIOS2 modelling output showed that more than 99% of the slick would have evaporated and dispersed after 14 hours, with a potential radius of 28 km.

Contact with Bedout Island could occur within four hours at which time ~74% of the diesel remains on the surface, while in winter 70% remains. Subsequently, shoreline accumulation, albeit minimal, may occur. Contact with Imperieuse Reef would take at least 14 hours at which time most of the toxicity associated with the diesel would have dissipated, with 64% has dispersed, 32% evaporated and that only 4% remains on the surface. In winter after 14 hours, 79% has dispersed, 21% has evaporated and that 1% remains on the surface. Subsequently, effects on these islands would be minimal.

As Clerke Reef is ~31 km from the operational area, it is predicted to only be impacted in the summer months. Based on the modelling, 99% of the slick will have dispersed or evaporated and so the impacts are likely to be minimal.

4.5. SUMMARY OF ENVIRONMENTAL RISK ASSESSMENT RESULTS

The risk assessment indicates that the potential impacts arising from the proposed Canning-Northern Carnarvon MC MSS operational area can be categorised as having Low to Medium risk levels. No risks were assessed as High. **Table 4.3** presents a summary of the assessed level of residual (post-mitigation) environmental risk associated with the proposed seismic survey. The environmental aspects of the survey that have the potential to cause significant environmental effects (Medium or High risk levels) have been determined through an evaluation of the proposed activity, the surrounding environment, including specific sensitivities and values, and legislative requirements. These environmental aspects are:

- Seismic emissions during sensitive periods (ie migrations times)
- Interaction with commercial fishers
- Interaction with commercial shipping
- Accidental fuel and oil spills from the survey or support vessels.
- Vessel collisions resulting in fuel and oil spills.

In this case a number of additional control measures were also assessed, and were found to be not practicable—i.e., the cost, time and effort required to implement the measure is grossly disproportionate to the benefit gained. A summary of the control measures that will be implemented are shown in **Section 5.**

Table 4.3 - Summary of Environment Risk Assessment for Canning-Northern Carnarvon MC MSS

Source of Risk	Key Potential Environmental Impacts[1]	Risk Rating		
		Consequence	Likelihood	Residual Risk
Vessel noise emissions (excluding seismic acoustic emissions) and Helicopter noise emissions	Short-term localised disturbance to marine fauna, such as alteration of behaviours and localised displacement	Slight	Unlikely	**Low**
Vessel light emissions	Short-term localised disturbance to marine fauna, such as alteration of behaviour and localised displacement	Slight	Highly Unlikely	**Low**
Interaction with commercial fisheries	Disruption to fishing vessels Potential direct and indirect noise impacts on target species Restriction of access to fishing grounds, loss/damage to gear Recreational take of finfish	Minor	Possible	**Medium**
Interaction with shipping	Temporary disruption / exclusion of shipping traffic	Minor	Possible	**Medium**
Interaction with defence activities	Temporary disruption of aircraft activities in military exercise areas from helicopter operations	Slight	Remote	**Low**
Biofouling of vessel hull, other niches and immersible equipment	Introduction and establishment of IMS and displacement of native marine species	Slight	Highly Unlikely	**Low**
Underwater noise emissions from discharge of airgun array during standard operating period	Disturbance to marine fauna, particularly whales, marine turtles and whale sharks, involving potential physiological and behavioural effects	Slight	Unlikely	**Low**
Underwater noise emissions from discharge of airgun array during sensitive operating period	Disturbance to marine fauna, particularly whales, marine turtles and whale sharks, involving potential physiological and behavioural effects	Minor	Possible	**Medium**
Emissions from fuel consumption and waste combustion	Localised reduction in air quality Greenhouse gas emissions	Slight	Highly Unlikely	**Low**
Discharge of ballast water	Introduction and establishment of IMS and displacement of native marine species	Slight	Highly Unlikely	**Low**
Discharge of bilge water, sewage, grey water and food wastes	Localised eutrophication of the water column; and localised adverse effect to marine biota	Slight	Unlikely	**Low**
Collision between vessels / towed array and marine fauna	Injury or fatality to protected marine fauna (cetaceans, marine turtles, whale sharks)	Minor	Highly Unlikely	**Low**
Vessel grounding	Localised physical damage to benthic habitats	Slight	Highly Unlikely	**Low**
Deployment and retrieval of anchors	Localised physical damage to benthic habitats	Slight	Highly Unlikely	**Low**
Equipment dragging or loss	Localised physical damage to benthic habitats	Slight	Unlikely	**Low**
Accidental release of hazardous or non-hazardous waste	Pollution and contamination of the environment and secondary impacts of marine fauna (e.g. ingestion, entanglement)	Slight	Unlikely	**Low**
Hydrocarbon release caused by topsides (vessel) loss of containment	Localised and temporary reduction in water quality due to hydrocarbon contamination	Slight	Unlikely	**Low**
Hydrocarbon release during refuelling	Toxic effects on marine fauna and flora Localised and temporary reduction in water quality Direct and indirect effects on commercial and recreational fisheries	Minor	Unlikely	**Medium**

Source of Risk	Key Potential Environmental Impacts[1]	Risk Rating		
		Consequence	Likelihood	Residual Risk
Hydrocarbon release from vessel collision	Toxic effects on marine fauna and flora Localised and temporary reduction in water quality Direct and indirect effects on commercial and recreational fisheries	Moderate	Highly Unlikely	**Medium**

5. SUMMARY OF THE CONTROL MEASURES

Table 5.1 – Summary of Control and Mitigation Measures

Potential Impacts	Control and Mitigation Measures

Potential noise impacts on marine fauna from underwater seismic pulses resulting in potential physiological and behavioural effects	• Adherence to EPBC Act Policy Statement 2.1, Part A Standard Management Procedures with application of 2 km low power zone
	• Adherence to Part B Additional Management Procedures, use of one MFO at all times
	• Adherence to Part B Additional Management Procedures, including:
	  • within the pygmy blue whale BIA, during pygmy blue whale migration periods:
	  ○ 1 May to 30 June (northbound); and 15 October to 15 December (southbound)
	  • within the humpback whale BIA, during humpback whale migration periods:
	  ○ 1 July to 31 August (northbound); and 1 August to 30 September (southbound)
	  • 2 x MFOs
	  • increased 45 min pre-watch before any source activation
	  • increased precaution and buffer zone - 2 km shutdown zone
	  • between the humpback whale BIA and 200 m contour, during humpback whale northern migration periods; if there have been 3 or more whale instigated power-downs or shut-downs in the preceding 24 hour period, or if operations were not previously underway during the preceding 24 hours, the vessel (or a support vessel) has been in the vicinity (approximately 10 km) of the proposed start up position for at least 2 hours (under good visibility conditions) within the preceding 24 hour period, and whales have been sighted:
	  ○ increased 45 min pre-watch before any source activation
	  ○ increased precaution and buffer zone - 2 km shutdown zone
	• During the following sensitive periods:
	  • Whale shark migration BIA (1 August – 31 October)
	  • Flatback turtle internesting buffer BIA (1 December – 1 March)
	  • Flatback, green, hawksbill and loggerhead foraging BIA (all year),
	the following mitigation measures will be implemented:
	  • Have at least one MFO
	  • Maintain a 500 m shut-down zone
	  • Undertake visual observations for at least 10 minutes before the commencement of soft start procedures.
	• Pre-survey induction includes coverage of EPBC Act Policy Statement 2.1 requirements
	• Use of the smallest possible airgun array size
	• No seismic acquisition outside operational area
	• TGS vessels shall not acquire data simultaneously within 50 km of each other
	• Two seismic vessels shall not acquire data simultaneously within the identified pygmy blue migration BIA, where that corridor is less than 100 km wide, during the periods for:
	  • northbound 1 May to 30 July, and
	  • southbound 15 October to 15 December
	• Seismic acquisition shall be limited to the waters 1 km beyond the 50 m contour within Glomar Shoal
	• No seismic acquisition within the 100m contour in waters adjacent to the mainland between 1 February and 31 March, and between 1 October and 31 December

Potential Impacts	Control and Mitigation Measures

Adverse impacts from vessel noise or helicopters resulting short-term localised disturbance to marine fauna, such as alteration of behaviour and localised displacement	• Vessel (not including those towing/retreiving/deploying sesimic array will not:
	  • travel at speeds greater than 6 knots within 300 m of a whale or 150 m of a dolphin (caution zone) ; and
	  • will not drift or knowingly approach closer than 100 m for a whale, or 50 m for a dolphin (with the exception of cetaceans bow riding)
	  • vessels will not knowingly approach closer than 400 m of a whale shark
	  • will not travel at speeds greater than 6 knots within 300 m of a turtle
	  • will not knowingly approach closer than 300 m to a calf (whale or dolphin) (the caution zone)
	  • If a calf appears in the caution zone, then:
	  ○ The vessel must be immediately stopped; and
	  ○ Must either:
	  ▪ Turn off the vessel's engines; or
	  ▪ Disengage the gears; or
	  ▪ Withdraw the vessel from the caution zone at a constant speed of less than 6 knots.
	• A person will not operate a helicopter at a height lower than 1 650 feet or within a horizontal radius of 500m of a cetacean; or approach a cetacean from head on

Potential disturbance from light emissions resulting short-term localised disturbance to marine fauna, such as alteration of behaviours and localised displacement	• External lighting of survey vessel is minimised to that required for navigation, vessel safety, safety of deck operations • Seismic activities will not occur outside operational area
Potential negative interactions with stakeholders leading to loss of fishing grounds, impacts on fish, temporary disruption of vessel traffic	• Adherence to Marine Orders – Part 21, Part 28, Part 30, Part 59, COLREGS and STCW • Relevant stakeholders notified of proposed activities in advance of survey operations commencing • Consultation with AMSA (Nautical Advice) prior to survey commencing to determine level of commercial shipping • Use of a support vessel to manage vessel interactions • Issuing of appropriate NTM by AHS and Auscoast warnings via RCC Australia • Survey and support vessels will use approved navigation systems and adhere to standard maritime safety / navigation procedures • Other mariners alerted of vessels presence and extent of towed array • Establishment of a vessel exclusion zone around the survey vessel(s) • In-water equipment lost will be recovered, if retrievable. • Recreational fishing from survey and support vessels is prohibited • Reflective tailbuoys • Pre-survey notifcations • Diving pear diving SIMOPS if required • Aquisiiton limited to waters 1 km beyond 50 m contour at Glomar Shoal

Potential Impacts	Control and Mitigation Measures
Introduction and establishment of IMS and displacement of native marine species	• Ballast water discharge will meet requirements of Australian Ballast Water Management Requirements (as enforced under the Quarantine Act 1908 [Section 27A]; and Quarantine Regulations 2000): • Adherence to the requirements of Vessel Ballast Water Management Plan • Ballast water to be discharged in waters deeper than 200 m • Survey vessel must operate in accordance with the conditions detailed in the "Approval to Berth" issued by DAFF • Recent IMS Risk Assessment and anti-fouling coating application for survey and support vessels • AF coating meets IMO 2001 Convention requirements

Non-compliant discharges of bilge water, sewage and food wastes resulting in localised eutrophication of the water column; and localised adverse effect to marine biota	• Sewage discharges from the survey and chase vessel must comply with the requirements of:
	  • MARPOL Annex IV – Sewage
	  • Protection of the Sea (Prevention of Pollution from Ships) Act 1983 - Section 26D
	  • Marine Order 96 (Marine pollution prevention — sewage) 2013
	• Food waste discharges from the survey and chase vessels must comply with the requirements of:
	  • MARPOL Annex V – Garbage
	  • Protection of the Sea (Prevention of Pollution from Ships) Act 1983 - Section 26F
	  • Marine Order 95 (Marine pollution prevention - garbage) 2013
	• Bilge water discharges (machinery space bilges) from the survey and support vessel must comply with the requirements of:
	  • MARPOL Annex I - Oil
	  • Protection of the Sea (Prevention of Pollution from Ships) Act 1983 - Section 9
	• Incineration of any oil sludge onboard, or disposal of any oil sludges/slops in port, must be recorded in the survey vessel Oil Record Book (a requirement under MARPOL 73/78)
	• Compliance will be in accordance with Marine Notice 6/2012: Revised Garbage Discharge Regulations for Ships

Potential behavioural or physical impacts on cetaceans, whale sharks and turtles from vessel interactions	• Application of support vessel-marine fauna interaction procedures modified from the Australian National Guidelines for Whale and Dolphin Watching • Turtle guards will be fitted to tail buoys throughout the surveys • Incidents shall be reported

Physical damage to benthic habitats and communities from vessel grounding, anchoring, dragging or loss of the streamer and associated equipment	• Operations of the survey vessel must comply with the following:
	  • International Regulations for Preventing Collisions at Sea 1972 (COLREG);
	  • Standards of Training, Certification & Watchkeeping (STCW) Convention; and
	  • Navigation Act 2012;
	• Survey and support vessels equipped with approved electronic navigation systems and radar
	• Use of approved navigation systems and depth sounders
	• Steamers will be towed at a depth that will not allow them to be closer than 10 m from the seabed
	• Solid streamers equipped with pressure-activated, self-inflating buoys designed to bring the equipment to the surface if lost accidentally
	• Pre-deployment check of equipment

Potential Impacts	Control and Mitigation Measures

	• Adherence to relevant shipboard safety procedures:
	  • Master Standing Orders/Night Order Book Operational Procedures.
	  • Vessel Grounding Operational Procedures.
	  • Navigational Instructions Including Duties of the Officer On Watch Operational Procedures
	  • Workboat/Streamer Section Change operational procedures
	• Anchoring will not occur except in the event of an emergency.
	• Vessel and equipment shall not enter PSZ
	• Vessel Master shall communicate with the relevant petroleum operator when undertaking activities adjacent to a PSZ

Localised reduction in water quality
 	
Acute toxicity effects on marine fauna and flora
 	
Physical impacts on marine fauna i.e. from plastics
	• Handling of hazardous wastes must comply with the requirements of:
	  • MARPOL Annex III – Harmful Substances
	  • Protection of the Sea (Prevention of Pollution from Ships) Act 1983 - Section 26AB
	  • Marine Order 94 (Marine pollution prevention — packaged harmful substances) 2014
	  • Marine Order 95 (Marine pollution prevention - garbage) 2013
	• Handling of non-hazardous wastes (garbage) aboard the survey and support vessels must comply with the requirements of:
	  • MARPOL Annex V – Garbage
	  • Protection of the Sea (Prevention of Pollution from Ships) Act 1983 - Section 26F
	  • Marine Order 95 (Marine pollution prevention - garbage) 2013:
	  ○ No discharge of plastics or plastic products of any kind from vessel or support vessel(s)
	  ○ No discharge of domestic wastes or maintenance wastes from survey and support vessel
	  ○ All waste receptacles aboard survey and support vessel covered with tightly fitting, secure lids to prevent any solid wastes from blowing overboard
	  ○ All solid, liquid and hazardous wastes (other than sewage, grey water and putrescible wastes) will be incinerated or compacted (if possible) and stored in designated areas and sent ashore for recycling, disposal or treatment
	  ○ Hydrocarbons located above deck stored with some form of secondary containment to contain leaks or spills (e.g. bund, containment pallet, transport packs)
	  ○ Correct segregation of solid and hazardous wastes
	• All solid, liquid and hazardous wastes (other than sewage, grey water and putrescible wastes) will be incinerated or compacted (if possible) and stored in designated areas and sent ashore for recycling, disposal or treatment.
	• Incinerators used are compliant with MARPOL and IMO requirements and operated in accordance with manufacturers specs
	• Spill kits available

Potential Impacts	Control and Mitigation Measures
Release of hydrocarbons to the sea resulting in toxic effects on marine fauna and flora, Localised reduction in water quality or Indirect effects on commercial fisheries	• Adherence to Marine Orders – Part 21, Part 30, Part 37, Part 59, Part 91, Part 94 and COLREGS • The survey vessel must have a valid International Oil Pollution Prevention Certificate (IOPPC]) applicable to vessel class • All storage facilities and handling equipment will be in good working order and designed in such a way as to prevent and contain any spillage as far as practicable • Deck equipment will have at least one primary bunding and well maintained • SOPEP implemented and tested as required. Drill conducted in Australian waters prior to commencement of survey or during project mobilisation phase prior to commencement of operations of the survey • Four schedules SOPEP drills per annum for seismic vessel • Response arrangements will be tested n significantly amended • Spill response bins/kits located in close proximity to hydrocarbon storage areas, and will be checked and replenished on a regular basis • Refuelling at sea subject to Vessel SOP and specific additional requirements: - AMSA will be notified - application of 25 km exclusion zone from emergent land or shallow water features (20 m or less depth) for at sea refuelling operations - refuelling of vessels will be undertaken under favourable wind and sea conditions as determined by the Vessel Masters; - refuelling will take place during daylight hours only; - Job Hazard Analysis (JHA) or equivalent in place and reviewed before each fuel transfer; - all valves and flexible transfer hoses certified for use; - dry break couplings (or similar) in place for all flexible hydrocarbon transfer hoses • In the event of any fuel or oil spills to sea SOPEP / OPEP procedures will be followed for notification and consultation with AMSA and DoT, to ensure prompt and appropriate mobilisation of NATPLAN or MOSCP, as appropriate • Allow small diesel spills to disperse and evaporate naturally, and monitor position and trajectory of any surface slicks • Physical break up (using propwash from the support vessel) by repeated transits through slick may be considered for larger diesel slicks (after consultation with Combat Agency [AMSA or DoT]) • Implementation of NATPLAN (by AMSA) or MOSCP (by DoT), if required • AMSA and DoT consulted to ensure agreement in place for SOPEP interface with NATPLAN and MOSCP • Notification and engagement with appropriate stakeholders • Issuing of appropriate NTM by the AHS, and Auscoast warnings via RCC Australia • When a fuel/oil spill to sea occurs the Vessel Master will inform the RCC Australia using POLREP. RCC Australia, in turn, notify AMSA and or/DoT • Type I Operational Monitoring implemented for spill surveillance and tracking

6. SUMMARY OF THE ARRANGEMENTS FOR ONGOING MONITORING OF THE TITLEHOLDERS ENVIRONMENTAL PERFORMANCE

Environmental performance of all proposed surveys within the Canning-Northern Carnarvon MC MSS operational area will be reviewed in a number of ways. These reviews are undertaken to ensure:

- all significant environmental aspects of the activity are covered in the EP;
- that environmental management measures to achieve EPO and EPS are being implemented, reviewed and where necessary amended;
- identification of potential non-conformances and opportunities for continuous improvement;
- that all EPO and EPS have been met before completing the activity: and
- that all environmental commitments contained in the Environmental Commitments Register (ECR) have been fulfilled.

The following arrangements will be established to review environmental performance of the activity:

- A summary of the EPO, EPS and MC for the activity (ECR) will be distributed aboard the survey vessel(s). These will be monitored on a regular basis for each phase, by the Survey Environmental Adviser (SEA) via mechanisms such as audits and inspections.
- An inspection(s) of the vessels will be carried out before or during each phase of the activity to ensure that procedures and equipment for managing routine discharges and emissions are in place to ensure compliance with the EP.
- A test of the oil spill emergency response arrangements will be conducted during the mobilisation phase of the survey (unless a test has already been undertaken in Australian waters within a month prior to mobilisation) to ensure vessel SOPEP is current and applicable.

Any non-conformances shall be reported, tracked and closed-out. The collection of the above data will form the basis of demonstration that the EPO and EPS are being met, that specified mitigation measures are in place to manage environmental risks, and that they remain working, and contribute to continually reducing risks and impacts to ALARP.

TGS Management will review environmental performance upon completion of each phase of the activity. The results of the review and any identified improvements or recommendations will be incorporated into processes and procedures for future surveys to help facilitate continuous improvement.

Management of changes to scope (e.g. timing, location or survey details described in this EP) are the responsibility of the TGS Vessel Operations Manager. A risk assessment will be undertaken for all changes in scope to assess potential impacts of the change. If the change meets any of the criteria detailed above, a revision/resubmission of the EP will occur, and the proposed change to the activity will not commence until the revised EP has been accepted by NOPSEMA.

Notification to other government authorities, where required, will be undertaken by the TGS Vessel Operations Manager. Notifications will include details of the change and procedures that will be put in place for managing or mitigating the additional or modified risks.

7. SUMMARY OF THE RESPONSE ARRANGEMENTS IN THE OIL POLLUTION EMERGENCY PLAN

7.1. OIL POLLUTION EMERGENCY PLAN

The Oil Pollution Emergency Plan (OPEP) for the Canning-Northern Carnarvon MC MSS, taking into account the nature and scale of the activity and the potential spill risks involved, comprises components of the survey vessel SOPEP that manage the environmental impacts of a spill, supported as required by applicable established, statutory OPEPs. The following plans are in place as a contingency in the unlikely event of an oil spill, which as a whole, represent the OPEP for this activity:

- Survey vessel SOPEP - deals with spills which are either contained on the vessel or which can be dealt with from / by the vessel.
- National Plan for Maritime Emergencies (NATPLAN): the Australian Maritime Safety Authority (AMSA) - is the Jurisdictional Authority (JA) and Control Agency (CA) for spills from vessel which affect Commonwealth waters, i.e. outside of 3 nm from the coast.
- WA State Emergency Management Plan for Marine Oil Pollution (WestPlan MOP) and Department of Transport (DoT) Marine Oil Spill Contingency Plan (MOSCP) for spills (from vessels) which affect WA State waters.

7.2. VESSEL SOPEP

The vessel(s) SOPEP, which has been prepared in accordance with the IMO guidelines for the development of shipboard oil pollution emergency plans (resolution MEPC.54(32) as amended by resolution MEPC.86(44)), includes emergency response arrangements and provisions for testing the SOPEP (oil pollution emergency drills), as required under Regulations 14(8AA), 14(8A) and 14(8B) to 14(8E) of the Environment Regulations.

7.2.1. Drills and Training

A test of the oil spill emergency response arrangements will be conducted prior to commencement of survey activities. If response arrangements are significantly amended, testing of the updated response arrangements shall occur.

All drill tests will be reported as per MARPOL Annex I (Regulation 15) requirements and reviewed after each drill as part of the ongoing monitoring and improvement of emergency control measures. Identified improvements or recommendations shall be addressed. The objective of testing is to ensure that the vessel SOPEP is current and applicable (including contact details) for dealing with a spill specific to the nature and location associated with an individual survey conducted within the Canning-Northern Carnarvon MC MSS operational area.

In compliance with Regulation 14(4) and 14(5) a designated Oil Pollution Prevention Team (OPPT) will be trained to ensure they are familiar with their tasks and the equipment in the event of an oil spill.

Implementation and testing of the survey vessel(s) SOPEP will enable TGS to demonstrate that environmental risks from fuel and oil spills during the proposed survey have been reduced to ALARP.

7.3. EMERGENCY RESPONSE ARRANGEMENTS

The Vessel Master will initiate the vessel SOPEP and first strike actions as outlined within it.

Due to the nature and scale of the activity, credible spill scenarios and characteristics of diesel, the initial response to any spill will be to monitor and evaluate. 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. Physical break up (using prop wash from the support vessel) by repeated transits through the slick may be considered for larger slicks (following consultation with the Combat Agency – AMSA or DoT).

Priority actions in the event of a fuel or oil spill are to make the area safe and to stop the leak and ensure that further spillage is not possible. All deck spills aboard vessel(s) will be cleaned-up immediately, using appropriate equipment from the on board spill response kits (e.g., absorbent materials etc.) to minimise any likelihood of discharge of spilt hydrocarbons or chemicals to the sea. A planned maintenance system (PMS) will be implemented on the survey vessel(s), to ensure that all equipment used during operations is in full working order, and does not represent a hydrocarbon spill risk.

7.3.1. Commonwealth Waters

For Commonwealth waters, initial actions will be undertaken by the survey vessel(s) with subsequent actions determined in consultation with the regulatory authorities (AMSA) under NATPLAN, having regard to the potential impacts posed by the spill. AMSA has indicated that it does not require titleholders to directly consult on OPEPs for seismic surveys or those addressing the operations of offshore supply vessels (AMSA 2014). Such operations are already covered by existing NATPLAN arrangements. AMSA is the responsible Combat Agency (CA) for oil spills from vessels within the Commonwealth jurisdiction and will respond in accordance with its Marine Pollution Response Plan as approved by the AMSA Executive. Upon notification of an incident, AMSA will assume control of the incident (AMSA 2014).

7.3.2. State Waters

For State waters, the survey vessel will undertake initial actions in accordance with the vessel(s) SOPEP, with subsequent actions determined in consultation with DoT, under the WestPlan MOP and OSCP. The DoT is the designated Hazard Management Agency (HMA) for oil spills from vessels within the WA State jurisdiction.

7.3.3. Type I Operational Monitoring

In the event of an incident that results in a diesel spill to the waters surrounding the survey or support vessels, TGS would be responsible for undertaking Type I “Operational Monitoring” that would have the primary objective of spill surveillance and tracking. This monitoring will be implemented to:

- determine the extent and character of a spill;
- track the movement and trajectory of surface diesel slicks;
- identify areas/ resources potentially affected by surface slicks; and
- determine sea conditions/ other constraints.

This monitoring will enable the Vessel Master to provide the necessary information to the relevant Combat Agency (AMSA or DoT), via a POLREP form, to determine and plan appropriate response actions under NATPLAN or the WestPlan MOP / MOSCP (if either of these plans are actually activated). Operational monitoring and observation in the event of a spill will inform an adaptive spill response and scientific monitoring of relevant key sensitive receptors.

This operational monitoring will be restricted to daylight hours only, when surface slicks will be visible from the support vessel and/or chase vessel surveillance. The information gathered from this monitoring will be passed on to the relevant Combat Agency, via the POLREP form, but also via ongoing SITREP reports following the initial spill notification to RCC Australia.

ADIOS2 spill modelling indicates that surface slicks, and possibly entrained oil, from an MGO spill of 220 m^3 may contact Bedout Island, North Turtle Island and Imperiuese Island. However, if this scenario occurs, TGS will work with the relevant stakeholders to develop and implement appropriate Type II "Scientific Monitoring" to understand the effects of the spill and any response activities on the marine environment. This scientific monitoring will have a focus on relevant environmental and social values and sensitive receptors.

7.3.4. Reporting, Maintenance and Review

Any fuel or oil spills aboard either the survey or support vessels must be reported to TGS via the internal TGS HSE Reporting Procedures. In the event of spillage of any oil or diesel spills to the sea, AMSA or DoT will be notified by the appropriate Vessel Master immediately (via RCC Australia using a POLREP form) to ensure prompt and appropriate mobilisation of relevant response plans. Any significant spills (greater than 80 L) will be reported to NOPSEMA by TGS, as reportable incidents.

A planned maintenance system (PMS) will be implemented on the survey and support vessels, to ensure that all equipment used during operations is in full working order, and does not represent a hydrocarbon spill risk. Stocks of absorbent materials aboard the survey vessel will be checked for their adequacy and replenished as necessary prior to the commencement of activities.

The OPEP will be regularly reviewed to ensure it is appropriate to the nature and scale of the activities within its scope and to ensure maintenance of the response capability and the operator's preparedness. In compliance with Regulation 14(8AA) the OPEP will be continuously reviewed and kept up-to-date to ensure new information or improved technology can be incorporated as specifies in the SOPEP.

8. DETAILS OF CONSULTATION ALREADY UNDERTAKEN, AND PLANS FOR ONGOING CONSULTATION

The stakeholder consultation has, and will continue, to be undertaken in phases as described below:

- Phase 1: Preparatory Consultation:
    - Stakeholders notified of proposed surveys within the Canning-Northern Carnarvon MC MSS operational area.
- Phase 2: Pre-survey Consultation:
    - Stakeholders notified of individual surveys, including location within the Canning-Northern Carnarvon MC MSS operational area, timing and duration.
- Phase 3: Ongoing Consultation:
    - Includes complying with requests from stakeholders for additional information, survey updates, etc.
- Phase 4: Post-survey Notifications

8.1. PHASE 1 – PREPATORY CONSULTATION

The following fisheries bodies and organisations were originally informed of the survey, via letters or emails sent on 12th September 2014 as part of Phase 1: Preparatory Consultation:

- A Raptis and Sons;
- Austral Fisheries;
- Australian Fisheries Management Authority (AFMA);
- Australian Southern Bluefin Tuna Association (ASBTIA)
- Commonwealth Fisheries Association (CFA);
- MG Kailis;
- Northern Wildcatch Seafood Australia (NWSA);
- Pearl Producers Association (PPA);
- Recfishwest;
- Tuna West Indian Ocean Tuna Association (TWIOTA);
- WA Department of Fisheries (DoF);
- WA Fishing Industry Council (WAFIC);
- WA Seafood Exporters; and
- WestMore Seafoods.

Nine WA State-managed fisheries can operate in the waters overlapped by the Canning-Northern Carnarvon MC MSS operational area (see **Sections 3.4.1**):

- Broome Prawn Managed Fishery (BPMF);
- Mackerel Fishery (MMF);
- Nickol Bay Prawn Managed Fishery (NBPMF);
- Northern Demersal Scalefish Managed Fishery (NDSF);
- Onslow Prawn Managed Fishery (OPMF);
- Pilbara Trap Fishery (PTF);
- Pilbara Line Fishery (PLF);
- Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF); and
- West Coast Deep Sea Crustacean Managed Fishery (WCDSCF).

Forty-six separate individuals or entities holding licences were identified across the nine WA State-managed fisheries. These individuals or entities may hold more than one licence either within a fishery or across multiple fisheries. Stakeholder letters were sent on the 12th September 2014 to all

licence-holding individuals or entities, informing them of the proposed activities. In addition, the following Commonwealth and WA State government departments and agencies were informed of the proposed activities, via letters or emails sent on 12th September 2014:

- Australian Hydrographic Office (AHO);
- Australian Maritime Safety Authority (AMSA);
- Department of Defence (DoD);
- Department of the Environment (DoE);
- WA Department of Mines and Petroleum (DMP);
- WA Department of Environment Regulation (DER);
- WA Department of Transport (DOT); and
- WA Department of Parks and Wildlife (DPAW).

Two non-government organisations (NGO) were contacted via email on 12th September 2014:

- Centre for Whale Research (CWR); and
- International Fund for Animal Welfare (IFAW).

The stakeholder letter provided information concerning the location, timing and nature of the proposed activities, and provided contact details should stakeholders wish to seek further information. A number of stakeholders did not reply or only replied to acknowledge receipt with no further comment.

8.1.1. Phase 1 –1st Update

On 22nd October 2014, all stakeholders were notified of changes to the size and shape of the operational area. Furthermore, three new stakeholders were identified:

- Modec Management Services Pty Ltd;
- Santos Limited; and
- Western Deepwater Trawl Fishery (Commonwealth).

8.1.2. Phase 1 – 2nd Update

On 3rd November 2014 the following stakeholders were notified of another change as it was assessed that their activities or interest may be affected by the change:

- Australian Hydrographic Office (AHO);
- Australian Department of Defence (DoD);
- Australian Department of Environment (DoE);
- Australian Fisheries Management Authority (AFMA);
- Australian Maritime Safety Authority (AMSA);
- Centre for Whale Research (CWR);
- Commonwealth Fisheries Association (CFA);
- Department of Fisheries (DoF);
- International Fund for Animal Welfare (IFAW);
- Tuna West Indian Ocean Tuna Association (TWIOTA);
- WA Department of Transport (DoT); and
- WA Fishing Industry Council (WAFIC).

Individual license holders in the following WA State fisheries:

- Mackerel Managed Fishery (MMF); and
- West Coast Deep Sea Crustacean (Interim) Managed Fishery (WCDSCF).

As at 9th November 2014, no objections or claims have been received from any stakeholders regarding the change to the polygon. PPA reiterated its previous response only. It should be noted, that an email was sent to DoF only days after the second notification, informing them of another increase in the size of the polygon and that they should hold on their response.

8.1.3. Phase 1 – 3rd Update

On 9th January 2015 the following stakeholders were notified of another change to the operational area as it was assessed that their activities or interest may be affected:

- Australian Southern Bluefin Tuna Association (ASBTIA);
- Commonwealth Fisheries Association (CFA);
- WA Department of Mines and Petroleum (DMP);
- WA Department of Parks and Wildlife (DPAW);
- WA Department of Transport (DOT);
- MG Kailis;
- Recfishwest;
- WA Seafood Exporters;
- WA Fishing Industry Council (WAFIC); and
- Westmore Seafoods

Individual licence holders for:

- Mackerel Fishery (MMF);
- Onslow Prawn Managed Fishery (OPMF);
- Pilbara Trap Fishery (PTF);
- Pilbara Line Fishery (PLF);
- Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF); and
- West Coast Deep Sea Crustacean Managed Fishery (WCDSCF).

TGS considers that comprehensive consultation with all persons or organisations whose functions, interests or activities that may be affected by the proposed survey has been carried out and that sufficient information has been provided to allow the relevant person to make an informed assessment of the possible consequences of the activity on the functions, interests or activities of the relevant person.

8.1.4. Assessment of the Merits of Stakeholder Concerns

Responses have been received from eleven stakeholders contacted during Phase 1 – Preparatory Consultation, with the majority supplying information only. An assessment of the merits of objections or claims about the adverse impact of the Canning-Northern Carnarvon MC MSS was made, and where practicable those with merit were incorporated into the survey design. The following objections and claims were identified (note: where possible these have been grouped into common themes):

Marine Safety: AMSA outlined requirements for vessels to maintain exceptional communications with all commercial shipping. Any avoiding action by commercial shipping should not increase navigational risks. Seismic vessel must display all appropriate shapes, lights and streamers with reflective tail buoys. Visual and radar watches maintained at all times. AMSA RCC to be contacted via

rccaus@amsa.gov.au and advised of start and end dates. AHS to be contacted no less than two weeks before commencing to issue a NTM Request that Pilbara Ports be informed of all activities to assist with notification of Agents and ship owners.

Commercial Fishing:
A Concern was raised regarding the potential interruption to fishing operations within the waters of the operational area during the proposed timeframe. Coordinates of the operational area were supplied to the proponent. Two vessels were identified and dates that fishing could be undertaken in the area.

Impacts specifically relating to PPA: Concerns raised in regards to seismic operations:

- Eighty Mile Beach is critical for pearl oyster fishery and one of the last remaining fishing areas in the world. They supply pearls and mother of pearls worldwide.
- The impact of seismic survey activity on pearl oyster stocks, especially the larvae phase, recruitment to the fishery and the quality of the pearl oysters post seismic activity as pearl oyster stocks that feed the fishery may exist out to the 100 m depth contour and maybe beyond.
- Minimising interaction between seismic survey activity and diving activities which are contained to 35 m for safety requirements.
- The paucity of information regarding the effects of seismic activity on the different stages of pearls, and that although this has been acknowledged by other seismic operators their EPs cannot provide information that resolves the concerns.
- Concern in relation to the lack of survey data and research studies to assess seabed habitat in the deeper water areas offshore from Eighty Mile Beach for pearl oyster dependence, plus research studies to provide a better understanding of the impact of seismic airgun noise on pearl oysters, their eggs, larvae and the associated food web, particularly given the increasing offshore petroleum industry activity in the region.

TGS stand by the scientific data which indicates that beyond the immediate vicinity seismic activity has minimal effect on pearl oysters. However as a result of discussions with the PPA and prospective clients, TGS committed to not undertake seismic acquisition within waters in the < 100 m bathymetry contour, and that only 2D shall occur in certain areas. TGS shall ensure SIMOP procedures are developed to minimise impacts between seismic activities and diving operations.

EPBC Protected Matters Impacts: Concerns were raised regarding cumulative impacts and the cumulative deterioration in acoustic habitat for migratory species over the larger area because of concurrent or sequential surveys in these habitats. Stakeholders requested additional information including means of determining species in the area, current gaps in knowledge, steps that will be taken to ensure the best possible chance of detecting cetaceans, measures to minimise risks and impacts and methods used to estimate the level of risk reduction these measures provide. TGS provided relevant information and answers to all queries and have had no further queries.

8.2. PHASE 3 - PRE-SURVEY CONSULTATION

Prior to commencing the Canning-Northern Carnarvon MC MSS, TGS will contact relevant stakeholders to provide detailed information for the proposed activity, location and geographical coordinates for the Canning-Northern Carnarvon MC MSS operational area, timing and duration, parameters for the towed seismic array (airgun array and streamer spread), and details of the survey and support vessels. At this point, stakeholders will have a further opportunity to raise any specific concerns or issues with TGS, regarding the proposed survey.

TGS will also consult a number of additional stakeholders, primarily within the offshore E&P industry. These consultations will include, as far as possible, other geophysical companies operating in Australian waters, plus titleholders of petroleum titles adjacent to the proposed Canning-Northern Carnarvon MC MSS operational area. The primary objective of this consultation will be to ascertain if there are any other seismic surveys proposed for areas adjacent to the Canning-Northern Carnarvon MC MSS operational area over the same time period.

Recfishwest, relevant recreational fishing groups/organisations and commercial fishers can be issued a 7-10 day forecast prior to activities commencing adjacent to the Glomar Shoal.

8.3. PHASE 4 – ONGOING CONSULTATION AND PHASE 5 – POST SURVEY NOTIFICATION

Consultation with stakeholders will be ongoing throughout the period the Canning-Northern Carnarvon MC MSS EP is valid. TGS will comply with requests by stakeholders for additional information and requests for updates during any possible phases undertaken within the Canning-Northern Carnarvon MC MSS operational area. TGS shall assess the merits of any new claims or objections made by a stakeholder whereby they believe the activity may have adverse impacts upon their interest or activities. TGS shall determine at the time of assessment, whether a risk or impact is considered 'significant' based on information available at that time.

On completion of individual surveys, notification will be sent to the relevant stakeholders or those that request post survey notification.

9. DETAILS OF THE TITLEHOLDERS NOMINATED PERSON FOR THE ACTIVITY

For further information about the proposed Canning-Northern Carnarvon MC MSS, please contact:

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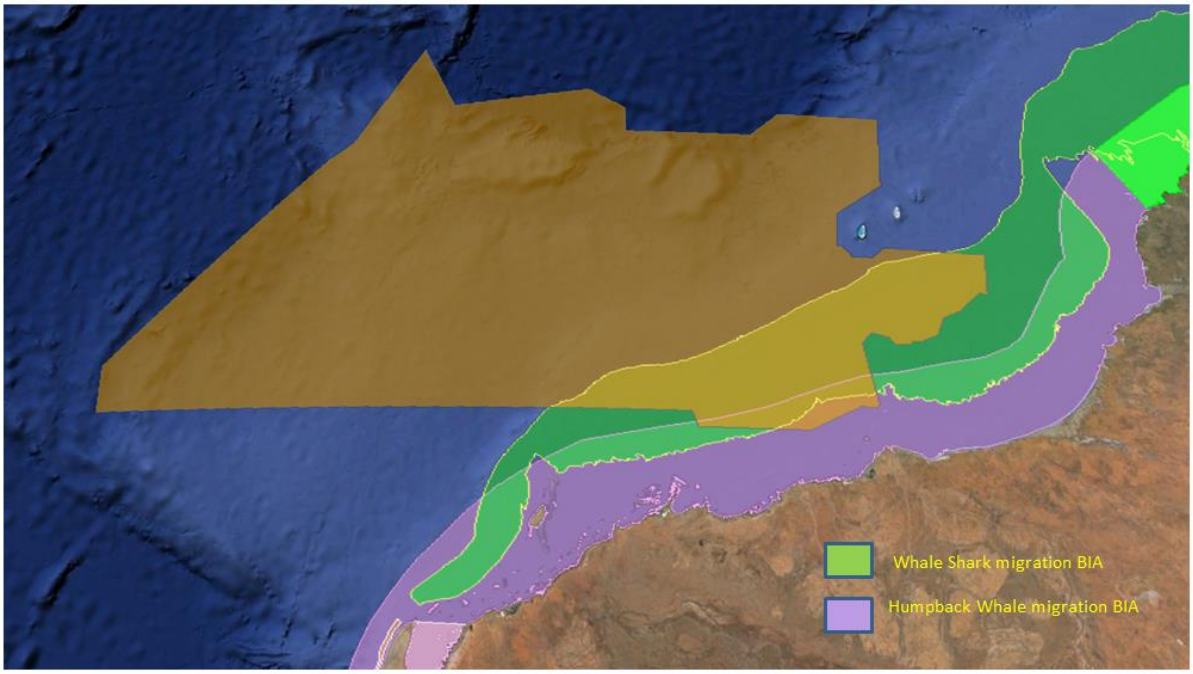
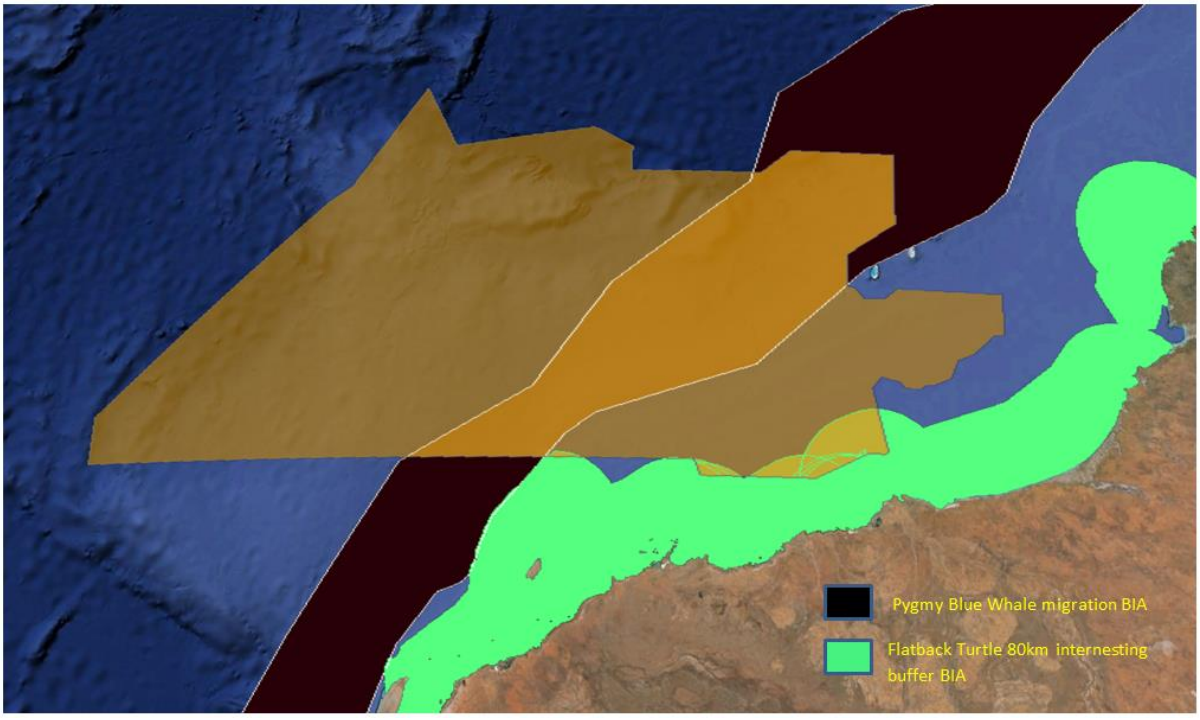
11. APPENDIX 1: BIOLOGICALLY IMPORTANT AREAS IN RELATION TO THE CANNING-NORTHERN CARNARVON OPERATIONAL AREA



BIA for the Whale Shark and Humpback Whale



BIA for the Pygmy Blue Whale and Flatback Turtle