NORTH WEST SHELF RENAISSANCE NORTH MULTI CLIENT MARINE SEISMIC SURVEYS

ENVIRONMENT PLAN SUMMARY

TGS-NOPEC Geophysical Company Pty Ltd

July 2018

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1 INTRODUCTION

1.1 BACKGROUND

The geophysical company TGS-NOPEC Geophysical Company Pty Ltd (TGS) proposes to acquire multi-client (MC) three-dimensional (3D) marine seismic surveys (MSS), within the North-West Shelf Renaissance North MC (NWSR North) MSS operational area (hereafter known as the 'operational area'), in waters offshore from Western Australia (WA; **Figure 1.1)**.

This EP has the objective of covering a maximum of two multi-client 3D surveys over specific petroleum titles and adjacent vacant acreage for the NWSR North MC MSS operational area over a period of two years. The combined total of the planned acquisition will not exceed 25,000 km^2 of 3D acquisition.

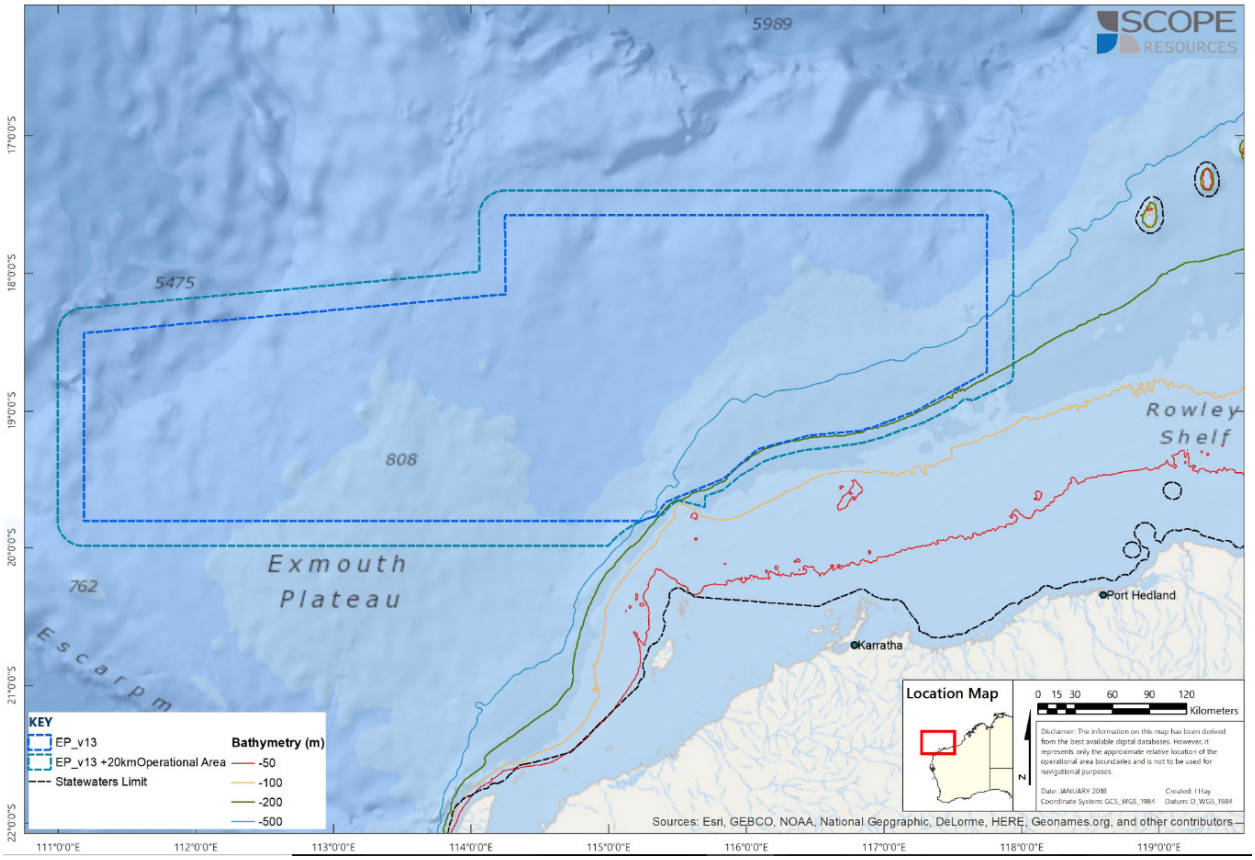

Figure 1.1 - Location of NWSR North operational area

1.2 TITLEHOLDER DETAILS

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2 DESCRIPTION OF ACTIVITY

2.1 LOCATION OF ACTIVITY

The operational area encompasses Commonwealth waters within the North-west Marine Region (NWMR) as indicated in **Figure 1.1**. The operational area is approximately (~) 143,000 km^2 and has water depths ranging from ~200 m to >5,000 m. No acquisition will occur in waters shallower than 200 m or outside the full fold acquisition area. Distances to sensitive environments and shorelines are presented in **Table 2.1.**

Table 2.1 – Approximate distances to sensitive environments or shorelines

Sensitive Environment	Distance from operational area (~ km)	Distance from acquisition area (~ km)
North West Cape	200	220
Karratha	160	170
Dampier Archipelago	130	120
Rowley Shoals	100	120
Montebello Islands	65	65
Glomar Shoal	30	40

Datum: WGS84, distance data estimates from ArcGIS Desktop 10.5[1]

2.2 TIMING OF ACTIVITY

The NWSR North MC MSS EP is designed to cover a period of two years. The timing of commencement and duration of individual surveys to be acquired within the NWSR North MC MSS operational area have not yet been determined. However, the commencement of each survey will be dependent on fair sea state conditions suitable for marine seismic acquisition, the availability of a survey vessel for conducting the survey, client data schedule requirements and granting of approvals from the appropriate government bodies.

2.3 SEISMIC PROGRAMME

2.3.1 SURVEY PARAMETERS

A summary of the acquisition parameters are summarised in **Table 2.2.**

Table 2.2 - NWSR North MC MSS maximum acquisition parameters

Parameter	Value
Source volume (maximum)	4,120 cui in water depths >200 m 3,060 cui in water depths 120 m - 200 m
Operating pressure	~2,000 psi
Source level – 4,120 cui array	260 dB re 1µPa (at 1 m) (SPL_{peak}) 235 dB re 1µPa^2.s (at 1 m) (SEL)
Source level – 3,060 cui array	258 dB re 1µPa (at 1 m) (SPL_{peak})
Source level – 2,680 cui array	256 dB re 1µPa (at 1 m) (SPL_{peak})
Frequency range	1–200 Hz
Source interval	25 m
Source depth	7.0 m (+/-1 m)
No. of streamers	10 - 14 (solid)
Streamer length	~ 8,100 m
Streamer spacing	100–150 m
Streamer depth	7–30 m

[1] *All distance data referred to in this EP is obtained from ArcGIS Desktop 10.5.*

2.4 VESSELS

2.4.1 SEISMIC SURVEY VESSELS

TGS proposes to conduct 3D surveys within the operational area using purpose-built seismic survey vessels. Any survey vessel(s) used 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 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.

2.4.2 SUPPORT VESSEL

During the surveys, it is possible that the survey vessel will be refuelled at sea using a support vessel. At sea refuelling will only take place during daylight hours, and will not take place within a distance of 25 km (at a minimum) from any emergent land or shallow water features (<20 m water depth). The support vessel (if >400 GRT) will have an implemented and tested SOPEP. All vessels 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.

3 DESCRIPTION OF THE ENVIRONMENT

The following description of the environment that may be affected (EMBA) is based on the zone of potential impact (ZPI) associated with a hydrocarbon spill and a conservative distance at which noise may impact on sensitive environments or matters of NES (RL of SPL_{peak} 156 dB re 1uPa/ SEL 126 dB1uPa^2.s). As such, although a broad description may be provided of the region, only sensitivities within 50 km of the operational area are discussed in detail.

3.1 REGIONAL SETTING

The NWSR North MC MSS operational area covers a large area of Commonwealth waters off Western Australia (WA) and sections of the North-west Marine Region (NWMR). Based on the IMCRA regions, there are three bioregions that occur within the operational area, some of which are further broken down into smaller meso-scale bioregions:

- **North-west Marine Region**
  - Northwest IMCRA Province
    - Northwest Shelf
    - Kimberley
    - Canning
  - Northwest Transition
    - Argo Abyssal Plain
  - Northwest Province
    - Northwest Shelf
    - Pilbara Offshore

The NWMR extends from offshore Kalbarri in WA to the WA / NT border. It is distinguished by its predominantly wide continental shelf, very high tidal regimes (especially in the north), very high cyclone incidence, unique current systems and warm, low-nutrient surface waters. The region supports high species-richness of tropical Indo-west Pacific biota, but low levels of endemism (DSEWPaC 2012b).

3.2 KEY ECOLOGICAL FEATURES

Two Key ecological features (KEFs) overlap the NWSR North MC MSS operational area **(Figure 3.1**):

- Exmouth Plateau
- Continental Slope Demersal Fish Communities

Two KEFS are adjacent to the acquisition area:

- Glomar Shoal (~35 km away)
- Ancient coastline at 125 m depth contour (~4 km away)

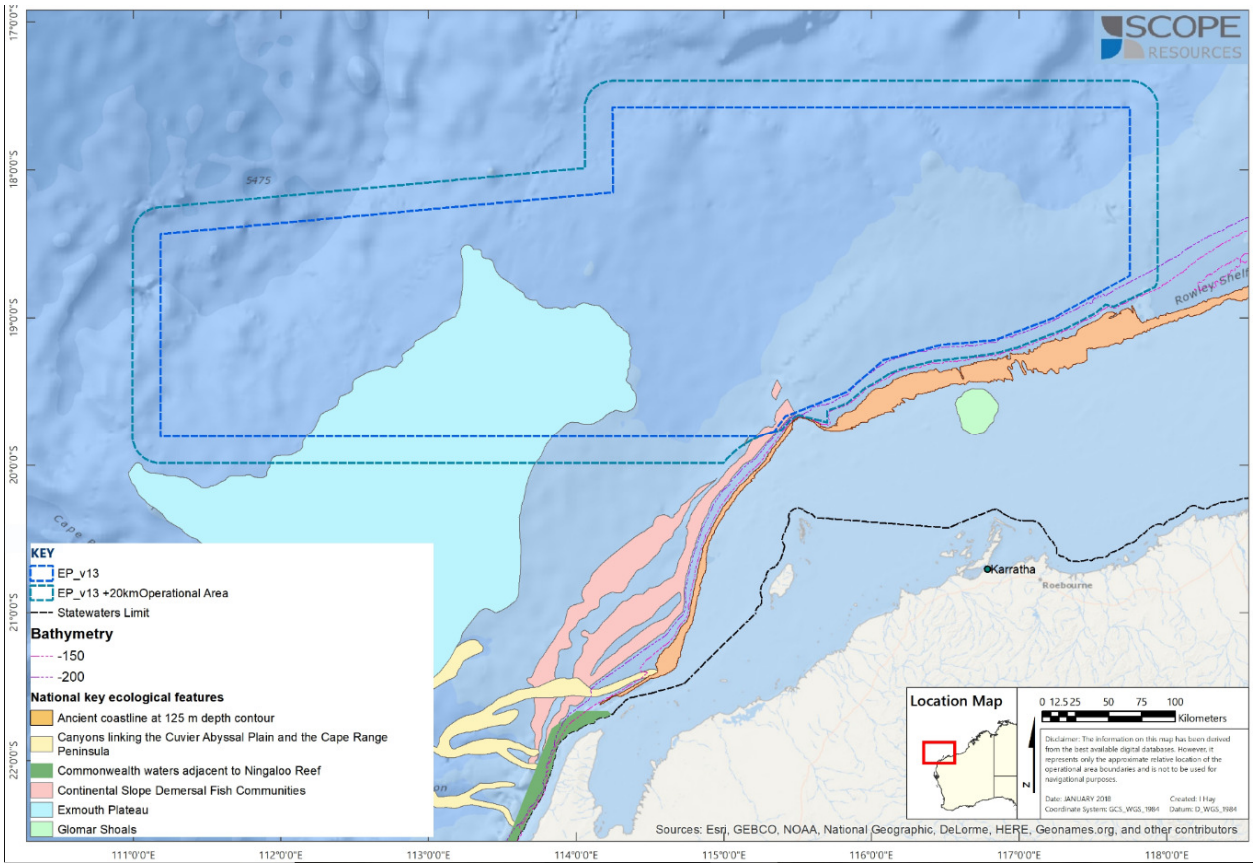


Figure 3.1 - Key Ecological Features within and adjacent to the NWSR North operational area

3.2.1 EXMOUTH PLATEAU

The Exmouth Plateau is thought to be dotted with numerous pinnacles. It is an important sea-floor feature that modifies the flow of deep waters and has been identified as a site where internal waves are generated by internal tides, giving rise to the most dynamic and unique oceanographic feature in the Region. The plateau also receives settling detritus and other matter from the pelagic environment. This key ecological feature is represented in the Gascoyne Commonwealth Marine Reserve (DNP 2013). Minimum water depths within the KEF overlapped by the operational area are ~ 920 m.

3.2.2 CONTINENTAL SLOPE DEMERSAL FISH COMMUNITIES

The continental slope demersal fish communities are a rich assemblage of some 500 fish species, 76 of which are endemic to the bioregion. Although the reasons for the high levels of endemism are not fully understood, the presence of such a diversity of fish and high numbers of endemic species suggests there are important interactions occurring between the physical processes and trophic structures (DNP 2013). Bacteria and fauna present on the continental slope are the basis of the food web for demersal fish and higher-order consumers in this system. Minimum water depths within this KEF overlapped by the operational area are ~220 m.

3.2.3 GLOMAR SHOAL

Glomar Shoal is regionally important for its high biological diversity and high localised productivity. It is an important habitat for commercial and recreational fish species such as Rankin cod, brown striped snapper, red emperor, crimson snapper, bream and yellow-spotted triggerfish (Falkner *et al.* 2009). The shoal is not recognised for site-attached species. The Glomar Shoal KEF is located ~30 km from the boundary of the operational area, and ~40 km from the boundary of the full fold acquisition area.

3.2.4 ANCIENT COASTLINE AT 125 M DEPTH CONTOUR

The shelf of the NWMR contains several terraces and steps that reflect changes in sea level that occurred over the last 100,000 years. The most prominent of these features occurs as an escarpment along the NWS and Sahul Shelf at a depth of 125 m. Where the ancient submerged coastline provides areas of hard substrate it may contribute to higher diversity and enhanced species richness relative to soft sediment habitat. These include sponges, corals, crinoids, molluscs, echinoderms and other benthic invertebrate representative of hard substrate fauna in the bioregion. The escarpment may also facilitate increased availability of nutrients off the Pilbara by interacting with internal waves or regional mixing associated with seasonal changes in currents and winds creating small localised upwellings and enhancing vertical mixing of water layers. This enhanced productivity may attract larger marine life such as whale sharks and large pelagic fish (DEWHA 2007a).

The KEF is not overlapped by the operational area (which is contiguous with the 150 m isobath) and the full fold acquisition area is more than 4 km away at its closest point as the inshore (eastern) boundary of the acquisition area is contiguous with the 200 m isobath.

3.3 PROTECTED MARINE FAUNA

A review of the EPBC Act database (DoE 2017) held by the Commonwealth Department of the Environment (DoE), using the Protected Matters Search Tool (PMST), was conducted for the operational area. Further details of the Protected Matters that the search indicates are likely to occur within, or adjacent to the operational area are provided below in **Table 3.1**.

The 20 listed Threatened species that may occur around, or relate to, the operational area are listed below:

- Cetaceans:
  - Blue whale
  - Fin whale
  - Humpback whale
  - Sei whale
- Marine Reptiles:
  - Flatback turtle
  - Green turtle
  - Hawksbill turtle
  - Leatherback turtle
  - Loggerhead turtle
  - Short-nosed seasnake
- Birds:
  - Abbott's Booby
  - Curlew sandpiper
  - Eastern curlew
  - Red Knot
  - Southern giant-petrel
- Sharks and rays:
  - Dwarf sawfish
  - Green sawfish
  - Grey nurse shark
  - Whale shark
  - White shark

Table 3.1 - EPBC Act Protected Species that may occur in, or relate to, the NWSR North MC MSS operational area and surrounding waters

Species	Common name	Protection status	Threatened status	Migratory status
Cetaceans (Whales and Dolphins)				
Balaenoptera acutorostrata	Minke Whale	Cetacean		
Balaenoptera bonaerensis	Antarctic Minke Whale, Dark-shoulder Minke Whale	Cetacean	-	Migratory
Balaenoptera borealis	Sei Whale	Cetacean	Vulnerable	Migratory
Balaenoptera edeni	Bryde's Whale	Cetacean	-	Migratory
Balaenoptera musculus	Blue Whale	Cetacean	Endangered	Migratory
Balaenoptera physalus	Fin Whale	Cetacean	Vulnerable	Migratory
Delphinus delphis	Common Dolphin, Short-beaked Common Dolphin	Cetacean	-	-
Feresa attenuata	Pygmy Killer Whale	Cetacean	-	-
Globicephala macrorhynchus	Short-finned Pilot Whale	Cetacean	-	-
Grampus griseus	Risso's Dolphin, Grampus	Cetacean	-	-
Kogia breviceps	Pygmy Sperm Whale	Cetacean	-	-
Kogia simus	Dwarf Sperm Whale	Cetacean	-	-
Lagenodelphis hosei	Fraser's Dolphin, Sarawak Dolphin	Cetacean	-	-
Megaptera novaeangliae	Humpback Whale	Cetacean	Vulnerable	Migratory
Mesoplodon densirostris	Blainville's Beaked Whale, Dense-beaked Whale	Cetacean	-	-
Orcinus orca	Killer Whale, Orca	Cetacean	-	Migratory
Peponocephala electra	Melon-headed Whale	Cetacean	-	-
Physeter macrocephalus	Sperm Whale	Cetacean	-	Migratory
Pseudorca crassidens	False Killer Whale	Cetacean	-	-
Stenella attenuata	Spotted Dolphin, Pantropical Spotted Dolphin	Cetacean	-	-
Stenella coeruleoalba	Striped Dolphin, Euphrosyne Dolphin	Cetacean	-	-
Stenella longirostris	Long-snouted Spinner Dolphin	Cetacean	-	-
Steno bredanensis	Rough-toothed Dolphin	Cetacean	-	-
Tursiops aduncus	Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin	Cetacean	-	-
Tursiops aduncus (Arafura/Timor Sea populations)	Spotted Bottlenose Dolphin (Arafura/Timor Sea populations)	Cetacean	-	Migratory
Tursiops truncatus s. str.	Bottlenose Dolphin	Cetacean	-	-
Ziphius cavirostris	Cuvier's Beaked Whale, Goose-beaked Whale	Cetacean	-	-
Fish				
Acentronura larsonae	Helen's Pygmy Pipehorse	Listed Marine	-	-
Bulbonaricus brauni	Braun's Pughead Pipefish, Pug-headed Pipefish	Listed Marine		
Campichthys tricarinatus	Three-keel Pipefish	Listed Marine	-	-
Choeroichthys brachysoma	Pacific Short-bodied Pipefish, Short-bodied Pipefish	Listed Marine	-	-
Choeroichthys latispinosus	Muiron Island Pipefish	Listed Marine		
Choeroichthys suillus	Pig-snouted Pipefish	Listed Marine	-	-
Corythoichthys flavofasciatus	Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish	Listed Marine	-	-
Cosmocampus banneri	Roughridge Pipefish	Listed Marine	-	-

Species	Common name	Protection status	Threatened status	Migratory status
Doryrhamphus dactyliophorus	Banded Pipefish, Ringed Pipefish	Listed Marine	-	-
Doryrhamphus excisus	Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish	Listed Marine	-	-
Doryrhamphus janssi	Cleaner Pipefish, Janss' Pipefish	Listed Marine	-	-
Doryrhamphus multiannulatus	Many-banded Pipefish			
Doryrhamphus negrosensis	Flagtail Pipefish, Masthead Island Pipefish			
Festucalex scalaris	Ladder Pipefish			
Filicampus tigris	Tiger Pipefish	Listed Marine	-	-
Halicampus brocki	Brock's Pipefish	Listed Marine	-	-
Halicampus grayi	Mud Pipefish, Gray's Pipefish	Listed Marine	-	-
Halicampus nitidus	Glittering Pipefish	Listed Marine	-	-
Halicampus spinirostris	Spiny-snout Pipefish	Listed Marine	-	-
Haliichthys taeniophorus	Ribboned Pipehorse, Ribboned Seadragon	Listed Marine	-	-
Hippichthys penicillus	Beady Pipefish, Steep-nosed Pipefish	Listed Marine	-	-
Hippocampus angustus	Western Spiny Seahorse, Narrow-bellied Seahorse	Listed Marine	-	-
Hippocampus histrix	Spiny Seahorse, Thorny Seahorse	Listed Marine	-	-
Hippocampus kuda	Spotted Seahorse, Yellow Seahorse	Listed Marine	-	-
Hippocampus planifrons	Flat-face Seahorse	Listed Marine	-	-
Hippocampus trimaculatus	Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse	Listed Marine		
Hippocampus spinosissimus	Hedgehog Seahorse	Listed Marine	-	-
Micrognathus micronotopterus	Tidepool Pipefish	Listed Marine	-	-
Phoxocampus belcheri	Black Rock Pipefish			
Solegnathus hardwickii	Pallid Pipehorse, Hardwick's Pipehorse	Listed Marine	-	-
Solegnathus lettiensis	Gunther's Pipehorse, Indonesian Pipefish	Listed Marine	-	-
Solenostomus cyanopterus	Robust Ghostpipefish, Blue-finned Ghost Pipefish	Listed Marine	-	-
Solenostomus paegnius	Rough-snout Ghost Pipefish	Listed Marine	-	-
Syngnathoides biaculeatus	Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish	Listed Marine	-	-
Trachyrhamphus bicoarctatus	Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish	Listed Marine	-	-
Trachyrhamphus longirostris	Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish	Listed Marine	-	-
Marine Reptiles (Seasnakes and Turtles)				
Acalyptophis peronii	Horned Seasnake	Listed Marine	-	-
Aipysurus apraefrontalis	Short-nosed Seasnake	Listed Threatened	Critically Endangered	-
Aipysurus duboisii	Dubois' Seasnake	Listed Marine	-	-
Aipysurus eydouxii	Spine-tailed Seasnake	Listed Marine	-	-
Aipysurus laevis	Olive Seasnake	Listed Marine	-	-
Aipysurus tenuis	Brown-lined Seasnake	Listed Marine	-	-
Astrotia stokesii	Stokes' Seasnake	Listed Marine	-	-
Caretta caretta	Loggerhead Turtle	Listed Marine	Endangered	Migratory
Chelonia mydas	Green Turtle	Listed Marine	Vulnerable	Migratory
Dermochelys coriacea	Leatherback Turtle, Leathery Turtle, Luth	Listed Threatened	Endangered	Migratory
Disteira kingii	Spectacled Seasnake	Listed Marine	-	-

Species	Common name	Protection status	Threatened status	Migratory status
Disteira major	Olive-headed Seasnake	Listed Marine	-	-
Ephalophis greyi	North-western Mangrove Seasnake	Listed Marine	-	-
Eretmochelys imbricata	Hawksbill Turtle	Listed Threatened	Vulnerable	Migratory
Hydrophis czeblukovi	Fine-spined seasnake			
Hydrophis elegans	Elegant Seasnake	Listed Marine	-	-
Hydrophis mcdowelli	null	Listed Marine	-	-
Hydrophis ornatus	Spotted Seasnake, Ornate Seasnake	Listed Marine	-	-
Natator depressus	Flatback Turtle	Listed Threatened	Vulnerable	Migratory
Pelamis platurus	Yellow-bellied Seasnake	Listed Marine	-	-
Seabirds and Shorebirds				
Actitis hypoleucos	Common sandpiper	Listed Marine		Migratory Wetland
Anous stolidus	Common Noddy	Listed Marine	-	Migratory
Caldritus acuminate	Sharp-tailed sandpiper	Listed Marine		Migratory Wetland
Calidris ferruginea	Curlew Sandpiper	Listed Threatened	Critically Endangered	Migratory Wetland
Calidris melantos	Pectoral sandpiper	Listed Marine		Migratory Wetland
Calidrus canutus	Red knot	Listed Marine	Endangered	Migratory Wetland
Calonectris leucomelas	Streaked Shearwater	Listed Marine	-	Migratory
Fregata ariel	Lesser Frigatebird, Least Frigatebird	Listed Marine	-	Migratory
Fregata minor	Great Frigatebird, Greater Frigatebird	Listed Marine	-	Migratory
Macronectes giganteus	Southern Giant-Petrel, Southern Giant Petrel	Listed Marine	Endangered	Migratory
Numenius madagascariensis	Eastern Curlew, Far Eastern Curlew	Listed Threatened	Critically Endangered	Migratory Wetland
Pandion haliaetus	Osprey	Listed Marine	-	Migratory Wetland
Papasula abbotti	Abbots booby	Listed Threatened	Endangered	
Phaethon lepturus	White-tailed Tropicbird	Listed Marine	-	Migratory
Sharks and Rays				
Anoxypristis cuspidata	Narrow sawfish	Listed Marine		
Carcharodon carcharias	White Shark, Great White Shark	Listed Threatened	Vulnerable	Migratory
Carcharias taurus	Grey Nurse Shark	Listed Threatened	Vulnerable	
Glyphis garricki	Northern River Shark, New Guinea River Shark	Listed Threatened	Endangered	
Isurus oxyrinchus	Shortfin Mako, Mako Shark	Listed Marine		Migratory
Isurus paucus	Longfin Mako	Listed Marine	-	Migratory
Manta alfredi	Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta	Listed Marine	-	Migratory
Manta birostris	Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray	Listed Marine	-	Migratory
Prisitis clavata	Dwarf Sawfish, Queensland Sawfish	Listed Threatened	Vulnerable	Migratory
Pristis pristis	Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish	Listed Threatened	Vulnerable	Migratory
Pristis zijsron	Green Sawfish, Dindagubba, Narrowsnout Sawfish	Listed Threatened	Vulnerable	Migratory
Rhincodon typus	Whale Shark	Listed Threatened	Vulnerable	Migratory

The proposed 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.

All species listed are protected under the EPBC Act. The likelihood of their presence in the operational area and surrounding waters is described in the following sections.

3.3.1 BIOLOGICALLY IMPORTANT AREAS

There are a number of Biologically Important Areas (BIA) (e.g. breeding, nesting, foraging areas) for EPBC Act-listed species of marine fauna that overlap or are immediately adjacent to the operational area

Species	BIA Area
Pygmy Blue Whale	Migration, Known to occur A conservative pygmy blue whale migration period has been identified for the NWSR North operational area as follows: • Northern migration - 1 May–30 July • Southern migration - 15 October–30 December. With *peak* periods for the operational area as follows: • Peak northern migration - 15 May–15 July • Peak southern migration – 1 November–15 December.
Wedge-tailed Shearwater	Breeding area, Foraging Pilbara coastline Peak times Mid-August to May
Whale Shark	Foraging (operational area only) Migration periods: 1 June and 31 September.
White-tailed Tropicbird	Breeding area (operational area only) Rowley Shoals Peak periods May and October

BIA adjacent (within 50 km) of the operational area are as follows:

Species	BIA Area
Flatback Turtle	Internesting buffer (60 km) ~ 5 km from acquisition area
Green Turtle	Internesting buffer > 40 km from acquisition area
Hawksbill Turtle	Internesting buffer > 40 km from acquisition area
Humpback Whale	Migration (north and south). 45 km from acquisition area. Conservative migration periods have been identified: • Northerly – 1 July to 31 August • Southerly – 15 August to 15 October
Lesser Frigatebird	Breeding area, Foraging Peak times March to September

3.4 SOCIO-ECONOMIC ENVIRONMENT

3.4.1 COMMERCIAL FISHERIES

The NWSR North MC MSS operational area encompasses commercial and State fisheries that overlap the North Coast Fisheries Bioregion (NCFB).

3.4.1.1 Western Australia Managed Fisheries

To help inform the assessment of potential impacts on fisheries, information was sourced from all publicly available data including, but not limited to; status reports of the fisheries and aquatic resources of Western Australia (Annual State of the Fisheries Reports: DPIRD), Commonwealth ABARES reports and DPIRD Fish Cube data. These sources help provide details on actively fished areas, catch effort and peak fishing periods.

WA State fisheries that may operate in the operational area and may be affected, include the following:

- Mackerel Managed Fishery (MMF)
- North Coast Demersal Fisheries
    - Pilbara Demersal Scalefish Managed fishery (PDSMF)
        - Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF)
        - Pilbara Trap Managed Fishery (PTMF)
        - Pilbara Line Fishery (PLF)
- North Coast Prawn Managed Fisheries
    - Nickol Bay Prawn Managed Fishery (NBPMF)
    - Onslow Prawn Managed Fishery (OPMF)
- Pearl Oyster Managed Fishery (POMF)
- West Coast Deep Sea Crustacean Managed Fishery (WCDSCF)

Fisheries whose management areas overlap the operational area, but do not actively undertake commercial fishing activities within the area include:

- Beche-de-Mer Fishery
- Marine Aquarium Fish Managed Fishery
- Specimen Shell Managed Fishery
- Northern Shark Fishery
    - Joint Authority Northern Shark Fishery (JANSF)
    - WA North Coast Shark Fishery (WASCF)

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 (*Scomberomorus commerson*). Spanish mackerel are offshore, pelagic fish and live around offshore and coastal reefs. Adults aggregate to feed and spawn in coastal areas. At other times they likely disperse but remain in the same region, although there may be some movement into deeper shelf waters (DPIRD website accessed 2018).

Areas 2 and 3 of the fishery overlaps the operational area and it is possible fishing operations could occur in the vicinity of seismic vessels. However, variations in otolith microchemistry and parasitic fauna suggest along-shore movement is restricted to <100 km in northern Australian waters and the majority of mackerel fishing is undertaken in water depths shallower than the 100 m isobath (FRDC, 2017). Fishing effort is mainly to the north of Exmouth Gulf and centres around surrounding islands, reefs, shoals or headlands as indicated in the Spanish mackerel reported catches. This is supported by information from DPIRD as presented in 'Fishcube' data which indicates that fishing effort is limited to waters shallower less than 200 m. Fish Cube data appears to indicate that there is less fishing effort between December and April and that it is limited to the waters south of Port Hedland. Between May and November, the fleet is spread along the coast but in shallower coastal waters from the Kimberley down to waters off Geraldton.

In 2015 and 2016 season, only between February and April did fishing effort occur in the blocks that overlap the acquisition area (blocks 19150 and 19160). No catch data is available as there were less than 3 vessels working. Therefore, interaction between survey vessels and fishing vessels in the MMF is anticipated to be low.

Pilbara Demersal Scalefish Fisheries

The PDSMF include the Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF), Pilbara Trap Managed Fishery (PTMF), and the Pilbara Line Fishery (PLF). The PFTIMF lands the largest component of the catch of demersal finfish in the Pilbara (and North Coast Bioregion) targeting all the main demersal species, with smaller subsets of species

taken by the PTMF and fewer still by the PLF. The main species landed by these fisheries (and also indicator species) are bluespotted emperor, red emperor, and rankin cod (Fletcher *et al.* 2017). Goldband snapper inhabit hard bottom areas and areas of vertical relief and large epibenthos and are concentrated in depths from 80 to 150 m.

Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF)

The fishery is seaward of the 50 m isobath and landward of the 200 m isobath (Fletcher and Santoro 2017). The fishery consists of two zones; Zone 1 in the south west of the fishery (which is closed to trawling) and Zone 2 in the north, which consists of six management areas. 46% of Zone 2 is currently closed: Areas 3 and 6 are closed while Areas 1, 2, 4 and 5 are open to fishing all year, with separate effort allocations (in hours) in each area, as outlined in the Interim Plan.

The open areas of the PFTIMF are trawled with varying intensity due to differing effort, location, substrate composition and economic considerations (e.g. distance from ports). It is estimated that 14 fishers on 3 vessels were directly employed during 2015 in the Pilbara Fish Trawl Fishery (Fletcher *et al.* 2017). The total demersal scalefish catch in the PFTIMF was within the acceptable catch range in 2015.

The PTIMF does not overlap the acquisition area, but a small section of the operational area overlaps Zone 2 and so it is possible that vessels fishing in these areas could operate in the vicinity of the seismic vessels. Fish Cube data indicates that block 19160 (which covers Areas 1, 2 and 6) is fished every month of the year, but as less than 3 vessels were active, there is no catch data available. Area 6 is closed, and as such, effort is limited to Areas 1 and 2 which are more than 17 km from the operational area.

Pilbara Trap Managed Fishery (PTMF)

The PTMF lies the landward side of a boundary approximating the 200 m isobath and seaward of a line generally following the 30 m isobath (Fletcher and Santoro 2015). There are 8 permits for the PTMF, with the combined effort allocations being consolidated over time onto three (3) full-time vessels which have no seasonal restrictions. Fish Cube data confirms that fishing occurs all year.

The operational area only overlaps the PTMF in waters less than 200 m while the acquisition area does not overlap at all. Therefore, it is possible that vessels fishing in these areas could operate in the vicinity of the 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 (PLF)

The PLF licences are permitted to operate anywhere within "Pilbara waters"**.** Seven fishing boat licenses (with at least 21 fishers) are exempted from this prohibition for any nominated 5-month block period within the year. Fish Cube data indicates that fishing occurs in all months with the exception being January and February.

The total annual catch of scalefish taken by the PLF is historically much lower than is taken by the trawl and trap fisheries, and were within the acceptable catch ranges in 2015. Target Species is Goldband snapper which typically favour waters shallower than 200 m.

The operational area overlaps most of the central and northern portions 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. Fish Cube data for 2015 and 2016 indicates that Blocks 19150 and 19160 (which are mostly in waters < 200 m) were fished 9 months of the year, with block 19140 (deeper than 200 m waters) only fished once over the 2-year period. The data confirms that fishing is limited to shallower waters with many months favouring the waters around the Montebello Islands, and so outside the operational area.

Given the size of the permitted area, that only seven vessels operate with licences (in 2015), that the target species of Goldband snapper typically favour waters less than 200 m (and so outside the operational area), and Fish Cube data supports that the majority of fishing is limited to waters < 200 m, interactions between fishing activities and the survey and support vessels are anticipated to be low.

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 fishing grounds that are confined to the coastal waters of the Pilbara. In 2015, the total landings of major penaeids for the 2015 season was 87 t, which was similar to levels caught over the past 7 years (Fletcher and Santoro 2017). Fishing effort is primarily restricted to shallow coastal waters, and it is highly unlikely that any vessels will 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. Fishing effort is primarily restricted to shallow coastal waters, and it is highly unlikely that any vessels will be present in the operational area (Fletcher and Santoro 2017).

Pearl Oyster Managed Fishery (POMF)

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, targeting silver lipped pearl oyster (*Pinctada maxima*).

P. maxima is widespread in the Indo-West Pacific. In WA, the species has been recorded as far south as Dirk Hartog Island in Shark Bay, but it is not commercially fished south of North West Cape (Fletcher *et al.* 2006). The POMF targets *P. maxima* in WA waters from Exmouth to the NT border. Pearl oyster species are also harvested from WA waters in small quantities for aquaculture purposes. These species include *P. margaritifera, P. albina, P. fucata, Pteria penguin* and *Pteria fulcata* (DoF 2006).*Pinctada* species are mostly found on the sea floor in shelly, rocky gravel areas and reef environments that provide crevices and substrates for their byssus threads to attach to, including live and dead coral, some individuals have been found on sandy bottoms (Southgate 2008). Individuals are mostly found in shallow waters of the littoral and sub-littoral zone, on occasion reaching the maximal recorded depths of 100 to 120 m (Southgate 2008).

In WA, 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 (Fletcher *et al.* 2006).

The operational area overlaps Fishing Zone 1 only of the POMF. In 2014 fishing recommenced in Zone 1 after a hiatus since 2008, but comprised only a small percentage of the total take, as the majority was fished from Zone 2/3. The fishing location in Zone 1 was Turtle Island which is 148 km from the operational area.

POMF is a dive fishery operating in shallow coastal waters (<35 m water depth) generally off the Eighty Mile Beach region. There is limited possibility of interaction with seismic activities, which will be limited to waters deeper than 200 m in this area.

West Coast Deep Sea Crustacean Managed Fishery

The West Coast Deep Sea Crustacean Managed Fishery (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 and Gascoyne Bioregions (Fletcher *et al.* 2017). As indicated in the latest State of the Fisheries Report (Fletcher *et al.* 2017), the North Bioregion is no longer recognised for deep sea crabs, but instead focusses on Blue Swimmer and Mud crabs which are associated with near shore environments and so beyond the scope of this EP.

Crystal crabs are a deep-water species occurring on the continental shelf at depths of 300 – 1200 m. The WCDSCF is a quota based 'pot' fishery that operates mainly in depths of 500-800 m, with the only allowable method for capture being baited pots ('traps'). These are operated in 'long-lines', which have between 80 and 180 pots attached to a main line marked by a float at each end, where the habitat within these depth ranges are generally sand / mud or broken shell (Fletcher and Santoro, 2017).

The operational area overlaps the WCDSCF. Optimal fishing effort occurs in deep offshore waters between 500 and 1,000 m, on the continental shelf slope. Fish Cube data for 2015 and 2016 indicates that no fishing occurred in waters to the North of Carnarvon and as such all effort is well to the south of the operational area.

Given that only two (2) vessels fish the entire west coast, and current fishing effort is south of Exmouth (as supported by stakeholder feedback and Fish Cube data), interaction between survey operations and vessels fishing in the WCDSCF is expected to be very low.

3.4.1.2 Commonwealth Managed Fisheries

There are a total of five Commonwealth fisheries within the NWSR North operational area. Of these, only three are active in the area overlapping the operational area. The skipjack tuna fishery and the southern blue fin tuna fishery do not have active fishing grounds (http://www.afma.gov.au/managing-our-fisheries/fisheries-map/);

Commonwealth fisheries that overlap the operational area include:

- North West Slope Trawl Fishery (NWSTF)
- Western Tuna and Billfish Fishery (WTBF)
- Western Deepwater Trawl Fishery

North West Slope Trawl Fishery (NWSTF)

The NWSTF has traditionally targeted scampi and deep water prawns; however, in recent years Australian scampi has been the main target of the fishery. Fishing for scampi occurs over soft, muddy sediments or sandy habitats, typically at depths of 350–600 m on the continental slope (Patterson et al. 2017) although more commonly in waters of 420-500 metres. Scampi are found in deep waters off Australia's west coast, mainly off Port Hedland. Scampi are only targeted in the North West Slope Trawl Fishery using trawl nets. AFMA manages catches of scampi by limiting the number of fishers allowed to fish. Whilst there are five fishing permits in the NWSTF only two vessels were active in the fishery in 2015-2016, with the majority of fishing activity near the Rowley Shoals and Scott Reef.

There have been very low levels of fishing effort within the fishery over recent years (average of 100 fishing days annually since 2009) and only a small amount of scampi are caught each season (AFMA website; accessed 2018). The NWSTF is open all year but operators generally have chosen to access the fishery on a part-time or opportunistic basis as an adjunct to other Commonwealth, particularly the Northern Prawn Fishery (NPF).

Limited catch disposal records are available for the NWST Fishery on the AFMA website and due to confidentiality reasons, limited data is available on catches. As such, what information is available only provides gross quantities of catch and does supply further details about locations or timings, and of itself provides no further data for interrogation beyond what is available in Abares reports.

Therefore, it is not anticipated that there will be a high level of interaction between fishers and seismic activities.

Southern Bluefin Tuna Fishery

The Southern Bluefin Tuna Fishery (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. The majority of the Australian catch is taken in the Great Australian Bight, with smaller amounts taken from the longline fisheries, mainly off south-eastern Australia (Patterson *et al.* 2017). Throughout the rest of its range, southern bluefin tuna is targeted by

pelagic longliners, with the focus being on domestic longliners operating along Australia's east coast. Therefore, activity in these fisheries does not overlap the NWSR North MC MSS operational area.

Western Skipjack Fishery (WSTF)

The skipjack tuna (*Katsuwonus pelamis*) is the only target species in the fishery. In recent years, activities in the WSTF have largely been confined to waters in the GAB and north-east of Eden in New South Wales (Patterson *et al.* 2017). No Australian vessels were active in either zone (Western or Eastern) since 2008-09. 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 operational area and vessels fishing of the WSTF.

Western Tuna and Billfish Fishery (WTBF)

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*).

Although the NWSR North MC MSS operational area overlaps the WTBF management area, in recent years, effort has concentrated off south-west Western Australia and South Australia (Patterson *et al.* 2017). Currently only 3 vessels are active over the entire management area. As such, although possible, it is unlikely that fishing vessels will operate in the vicinity of survey vessels.

Western Deepwater Trawl Fishery

The WDTF operations in WA 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. Total fishing effort has been comparatively low since 2005–06, although still variable, and mostly targeted at deepwater bugs.

2013-2014 was the last year that catch was recorded in the fishery (Patterson *et al.* 2017). Although the western edge of the operational area overlaps the fishery management area, as there is no fishing effort, the likelihood of any interaction is considered low.

3.4.1.3 Commercial Fisheries and Spawning

To accommodate the numerous multispecies finfish fisheries managed in WA, the approach that has been adopted by DPIRD is to use one or more indicator species to monitor the status of the entire suite of species (Wise *et al.* 2007; DoF 2011). Indicator species for the Pilbara bioregion and adjacent jurisdiction (Gascoyne) that were assessed to determine potential impacts from the survey on fishing and spawning include:

- Pilbara Red emperor (*Lutjanus sebae)* Lutjanidae
- Pilbara Bluespotted emperor (*Lethrinus punctulatus)* Lethrinidae
- Pilbara Rankin cod (*Epinephelus multinotatus)* Epinephelidae
- Gascoyne Goldband snapper (*Pristipomoides multidens*) Lutjanidae
- Gascoyne Pink Snapper (*Pagrus auratus*) Sparidae
- Pelagic Spanish mackerel (*Scomberomorus commerson*)
- Pelagic grey mackerel (*Scomberomorus semifasciatus*)

3.4.2 TRADITIONAL FISHERIES

Traditional fishers are restricted to the north-western Australian coast and around its islands and reefs more than 500 km from the operational area and so will not be discussed any further as their interest or activities will not be affected.

3.4.3 PETROLEUM EXPLORATION AND PRODUCTION

The NWMR has been the target of significant petroleum exploration activity stretching back over the past 40 years. There have been a large number of both 2D and 3D seismic surveys conducted in both regions, plus the drilling of both exploration and appraisal wells. A number of production facilities exist in the regions including Floating Production Storage Offshore (FPSO) facilities, manned and unmanned monopods, larger production platforms and a number of gas pipelines, both existing and under construction.

3.4.4 COMMERCIAL SHIPPING

Within the NWMR, there is significant commercial shipping activity, the majority of which is associated with mining and oil and gas industries. Major shipping routes in the area are associated with entry to Port Hedland and Broome.

3.4.5 TOURISM AND RECREATION

Given the offshore location of the NWSR North MC MSS operational area, there will be very little interaction with tourism and recreation industries. The closest recognised diving locations include the Rowley Shoals, which is more than 80 km from the boundary of the operational area and Montebello Islands which are more than 60 km from the operational area.

Recreational fishing activities are mostly line based fishing from boats which are concentrated in inshore areas around key population centres, with a peak in activity during the dry season (winter months, April/May to September/October; DoF 2012). Charter vessels can venture from Broome to the Rowley Shoals or in the vicinity of Glomar Shoal.

3.4.6 DEFENCE ACTIVITIES

One large area of WA waters overlapped by the operational area is allocated to defence training, including military exercises: Learmonth.

3.4.7 CULTURAL HERITAGE

There are no known Native Title Determinations for the waters and seabed within or immediately adjacent to the operational area, with the closest located >120 km from the operational area boundary.

In the NWMR, two shipwrecks within the vicinity of the operational area are considered protected places:

- *Lively* – off western edge of Mermaid Reef; and
- *Ann Millicent* – southern edge of Cartier Island.

Both wrecks are more than 100 km from the operational area.

3.4.8 HERITAGE PLACES

There are no places listed on the National and Commonwealth Heritage List overlapped by the operational area (DoE 2014f), although the following is in the vicinity of the NWSR North MC MSS operational area:

"Dampier Archipelago", ~130 km from the operational area.

- Dampier Archipelago:
  - Register of the National Estate – Place ID 10101, Place File No 5/08/203/0019.

- Dampier Archipelago (including Burrup Peninsula):
  - National Heritage List – Place ID 105727, Place File No 5/08/203/0056.
- Dampier Archipelago Marine Areas:
  - Register of the National Estate – Place ID 17563, Place File No 5/08/203/0053.

3.4.9 AUSTRALIAN MARINE PARKS

Based on the zone of potential impact (ZPI) associated with a hydrocarbon spill and a conservative distance at which noise may impact on sensitive environments or matters of NES (RL of SPL_{peak} 156 dB re 1uPa/ SEL 126 dB1uPa^2.s), only Australian Marine Parks (AMP) within 50 km of the operational area are discussed any further.

Table 3.2 - Sensitive marine environments within or adjacent to the operational area

Location	Distance to Acquisition area	Distance to Operational area	Protection Category
Australian Marine Parks			
Montebello AMP	~22 km	~20 km	Multiple Use Zone (IUCN VI)
Argo-Rowley Terrace AMP	overlaps	overlaps	Multiple Use Zone (IUCN VI)

3.4.9.1 IUCN Principles

Existing and proposed AMPs are subject to the Australian IUCN reserve management principles as presented in Schedule 8 of the EPBC Regulations.

Until management plans come into effect for the new proposed AMP transitional arrangements apply, and there are no changes on the water for users of the new proposed reserves (i.e. seismic surveys are permitted to take place within any zone of the proposed AMP. However, TGS recognises that during the life of the EP (i.e. two years), the Management Plans for the proposed AMP may come into effect and may vary in relation to the IUCN management areas as currently proposed. Consequently, TGS shall comply with any legislative requirements associated with the proclaimed AMP and ensure that activities being carried out under this EP will be consistent with the requirements of those plans, unless the petroleum activities are authorised by titles issued before 14 December 2013. As part of the pre-survey planning prior to the commencement of any individual survey, TGS shall confirm the status of the proposed AMPs and ensure that activities are not inconsistent with the principles and plans in force.

TGS shall ensure that activities within the AMP will not result in unacceptable impacts to the environment or matters protected under Part 3 within those reserves. TGS will have regard to the Marine Bioregional Plans for the NWMR (DSEWPAC 2012) and will act consistently with a plan of management for a AMP. TGS will have regard to the representative values of the reserves and other information published by the DoE that is relevant to the reserve.

The AMPs sections that may be impacted by the NWSR North activity are both Multiple Use Zone (IUCN VI) which have the following principles:

Managed resource protected area (category VI)

- 7.01 The reserve or zone should be managed mainly for the ecologically sustainable use of natural ecosystems based on the following principles.
- 7.02 The biological diversity and other natural values of the reserve or zone should be protected and maintained in the long term.
- 7.03 Management practices should be applied to ensure ecologically sustainable use of the reserve or zone.
- 7.04 Management of the reserve or zone should contribute to regional and national development to the extent that this is consistent with these principles.

Implementation of this plan and its control measures will ensure that the activity will not be inconsistent with these principles.

3.4.9.2 Montebello Australian Marine Park (MAMP)

The Montebello AMP provides representation and protection of continental shelf environments and habitats. It is a resting area for migrating humpback whales and supports resident populations of common bottlenose dolphins and Indo-Pacific humpback dolphins. The Montebello Islands (in the adjacent state waters) have been identified as critical nesting and inter-nesting habitat for green, flatback and hawksbill turtles. Summer mating aggregations of green turtles also occur in the area.

The Montebello area is also home to wedge-tailed shearwaters, bridled terns, roseate terns, ospreys, white-bellied sea-eagles, eastern reef egrets, Caspian terns and lesser crested terns. The proposed AMP contains the *Trial*, which is the earliest known shipwreck in Australian waters. It is an English East Indian ship wrecked on Trial Rocks north of the Montebello Islands in 1622.

3.4.9.3 Argo-Rowley Terrace Australian Marine Park

The Argo Rowley Terrace AMP is the largest marine reserve in the NWMR and covers a total area of 146,099 km^2. It abuts the Mermaid Reef AMP (MRAMP) and encloses the WA Rowley Shoals Marine Park. The Argo Rowley Terrace AMP is divided into two zones:

- Multiple Use Zone – IUCN Category VI (83,379 km^2); and
- Marine National Park Zone – IUCN Category II (62,720 km^2) (DoE 2014g).

The proposed IUCN Category II zone covers deeper waters (>3,000 m) of the Abyssal Plain and associated KEF and is approximately 100 km from the operational area. Minimum waters depths within the IUCN Category VI overlapped by the operational area are 1700 m and not associated with any marine fauna BIA.

3.4.10 WA STATE MARINE PARKS AND RESERVES

Based on the zone of potential impact (ZPI) associated with a hydrocarbon spill and the distance at which noise may impact on sensitive environments or matters of NES (RL of SPL_{peak} 156 dB re 1uPa/ SEL 126 $dB1uPa^2.s$), the operational area does not overlap any WA State marine parks or reserves. The closest marine parks are the Montebello Islands and Barrow Island which are ~ 60 km away and so not discussed any further.

3.4.11 RAMSAR WETLANDS

There are no Ramsar Wetlands within or immediately adjacent to the operational area. The Eighty Mile Beach Ramsar wetland is closest at more than 200 km away and so unlikely to be affected by planned or unplanned activities.

3.4.12 WORLD HERITAGE PROPERTIES

There are no World Heritage Properties (WHP) within or immediately adjacent to the operational area.

4 ENVIRONMENTAL RISK ASSESSMENT

An Environmental Risk Assessment (ERA) has been undertaken to understand and manage the environmental impacts and risks associated with the NWSR North MC MSS. This ERA provides:

- details of the environmental impacts and risks for the survey;
- an evaluation of all the impacts and risks, appropriate to the nature and scale of each impact or risk; and
- details of the control measures that will be used to reduce the impacts and risks of the activity to as low as reasonably practicable (ALARP) and to an acceptable level.

4.1 RISK ASSESSMENT METHODOLOGY

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 identifies the sources of risk (aspects) and potential environmental impacts associated with the activity and assigns a level of significance or risk to each impact.

The risk management methodology provides a framework to demonstrate:

- that the identified impacts and risks are reduced to ALARP; and
- the acceptability of impacts and risks.

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

Source: modified from AS/NZS ISO 31000:2009 Risk management.

4.1.1 RISK IDENTIFICATION AND ANALYSIS

The environmental risks associated with the proposed marine seismic survey 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 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.

Risks were identified during the ERA for both planned (routine and non-routine) and unplanned (accidents/incidents) activities. Potential environmental impacts are then determined based on the stressor type.

Risk analysis further develops the understanding of a risk by defining the impacts and assessing appropriate controls. Risk analysis for NWSR North MC MSS considered previous risk assessments for similar activities, review of relevant studies, review of past performance, external stakeholder consultation feedback and review of the existing environment and key sensitivities/values.

The following key steps were undertaken for each identified risk during the risk assessment:

- identification of decision type in accordance with the decision support framework;
- identification of appropriate control measures (preventative and mitigation) aligned with the decision type; and
- determination of the residual risk rating.

4.1.2 DECISION MAKING FRAMEWORK

To support the risk assessment process, the *Guidance on Risk Related Decision Making* (Oil & Gas UK 2014) was utilized to determine the level of supporting evidence that may be required to draw sound conclusions regarding risk level and whether the risk is ALARP and acceptable. This is to ensure that:

- activities do not pose an unacceptable environmental risk;
- appropriate focus is placed on activities where the risk is demonstrated to be ALARP and is anticipated to be acceptable; and
- appropriate effort is applied to the management of risks based on the uncertainty of the risk, the complexity and residual risk rating.

Determining whether risks have been reduced to 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) was adapted from *the Guidance on Risk Related Decision Making* (Oil & Gas UK 2014; see **Figure 4.2**).

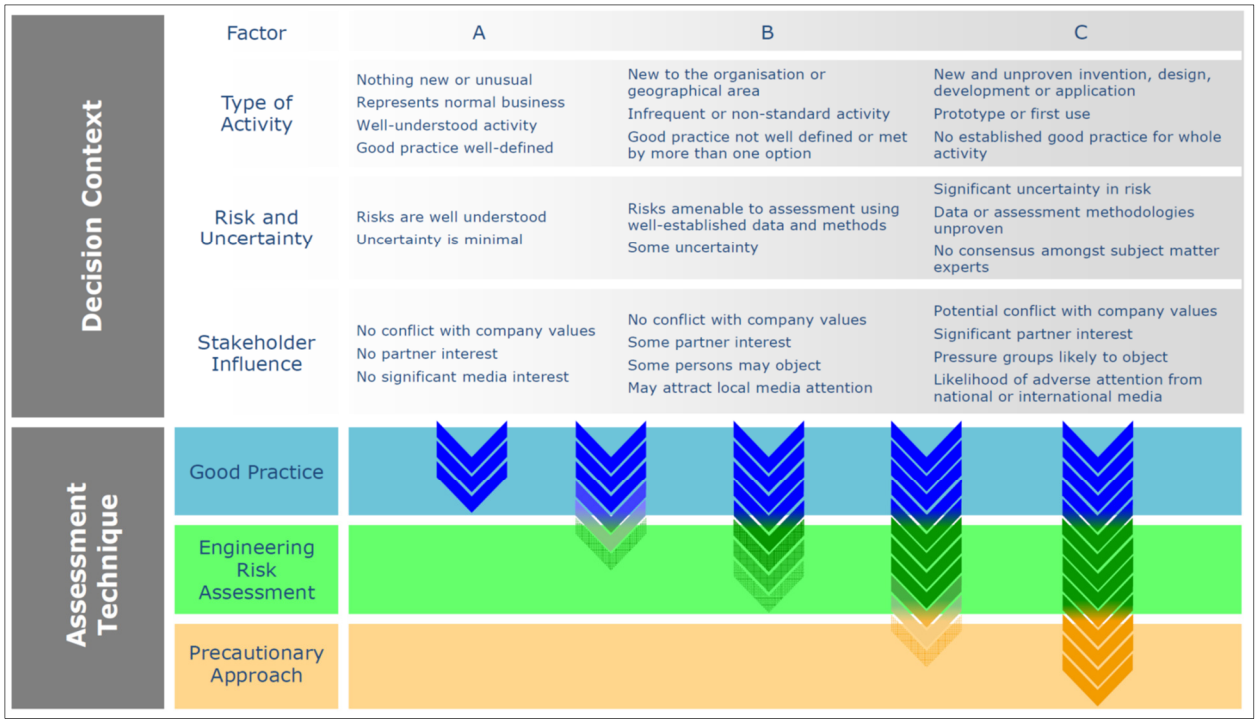


Figure 4.2 - Risk Related Decision Making Framework

Source: Oil & Gas UK (2014).

4.1.3 DECISION MAKING TOOLS

The following framework tools are applied, as appropriate, to assist with identifying control measures based on the decision type described above:

- Legislation, Codes and Standards (LCS) – identifies the requirements of legislation, codes and standards which are to be complied with for the activity.
- Good Industry Practice (GIP) – identifies further engineering control standards and guidelines which may be applied over and above that required to meet the legislation, codes and standards.
- Professional Judgement (PJ) – uses relevant personnel with the knowledge and experience to identify alternative controls. When formulating control measures for each environmental impact or risk, the 'Hierarchy of Controls' philosophy, which is a system used in the industry to minimise or eliminate exposure to impacts or risks, is applied. The Hierarchy of Controls are, in order of effectiveness (**Figure 4.3**).
- Risk Based Analysis (RBA) – assesses the results of probabilistic analyses such as modelling, quantitative risk assessment and/or cost benefit analysis to support the selection of control measures identified during the risk assessment process.
- Company Values (CV) – identifies values identified in TGS's HSE Policy.
- Societal Values (SV) – identifies the views, concerns and perceptions of relevant stakeholders and addresses relevant stakeholder concerns as gathered through consultation.

Note: administrative controls are included, where applicable, under Legislation, Codes and Standards and Good Industry Practice.

Control	Effectiveness	Seismic survey examples
Eliminate		*Get rid of the impact or risk.* Excess chemicals are returned to shore rather than discharged overboard.
Substitute		*Change the impact or risk for a lower one.* Substitute a large airgun array for a smaller one.

Engineering		*Engineer out the impact or risk.* Use solid streamers rather than fluid-filled streamers.
Isolation		*Isolate people or the environment from the impact or risk.* Avoid acquiring data near sensitive turtle nesting beaches during nesting season.
Administrative		*Provide instructions or training to people to lower impact or the risk.* The use of procedures (e.g. at sea refuelling procedures) and pre-work job hazard analysis (JHAs) to assess and minimise the environmental impacts or risks of an activity.
Protective*		*Use of protective equipment.* The provision and use of personnel protective equipment (PPE).

Figure 4.3 - Hierarchy of Controls

Note: *Not used in this ERA – related to safety rather than environment.

4.1.4 CATEGORISATION OF ENVIRONMENTAL CONSEQUENCES

Environmental consequences arising from potential environmental aspects of the survey have been categorised from Slight to Catastrophic (**Table 4.1**).

4.1.5 ASSESSMENT OF LIKELIHOOD OF OCCURRENCE

The next step in the risk analysis process is to identify the likelihood of occurrence for the potential environmental impacts and risks according to the qualitative description in **Table 4.1**. The likelihood of occurrence (from Remote to Highly Likely) for the potential environmental impacts from the proposed seismic survey have been estimated based on industry incident reporting, previous ERA and professional judgement.

Table 4.1 - Environmental consequence categories

Consequence Category	Biodiversity and Ecosystem Function			Environmental Quality			Social	
	Protected Species	Marine Primary Producer Habitat	Ecological Diversity	Water Quality	Sediment Quality	Air Quality	Protected Areas	Cultural
Catastrophic	Local population eradication and/or loss of critical habitats/activities	Permanent eradication at regional scale	Permanent effects at regional scale	Permanent reduction in water quality. Known biological effect on a regional scale	Permanent contamination with known biological on a regional scale	Continuous damage to the environment and/or human health	Significant permanent effects on one or more of protected areas values	Significant, permanent effects on aesthetic, economic or recreational values. Overall societal benefits do not outweigh impacts
Massive	Extensive population-level effects. Significant effect on critical habitats/activities	Large-scale, long term effects. Recovery >10 years, or effects permanent	Large-scale, long term effects. Recovery >10 years or effects permanent	Continuous or regular discharge. Known biological effect concentrations on large scale (1-100 km^2)	Long term contamination above background. Known biological effect concentrations on large scale	Sustained, exceedance over national/international air quality standards. Potential harm to the environment or human health	Significant long term effects on one or more of protected areas values	Significant long term effects on aesthetic, economic or recreational values. Overall societal benefits do not outweigh impacts
Major	Minor disruption to significant portion of population. Minor effects on critical habitats/activities. No threats to population viability	Localised but long term effects. Recovery >10 years, or effects permanent	Localised, long term effects. Community maintains ecological integrity with significant change in composition	Continuous or regular discharge. Known biological effect concentrations on medium scale (1-10 km^2)	Short to medium-term contamination above background. Known biological effect concentrations on large scale	Major and temporary exceedance over national/international air quality standards. Potential harm to the environment or human health	Minor but long term or permanent effects on one or more of protected areas values	Major effects on aesthetic, economic or recreational values. Overall societal benefits do not outweigh impacts
Moderate	Minor disruption to small portion of population. Minor, temporary effects on critical habitats/activities. No threat to population viability	Localised, medium-term effects. Recovery 5-10 years	Localised, medium-term effects. Ecological integrity maintained with insignificant change to species composition	Continuous or regular discharge. Known biological effect concentrations on small scale (<1 km^2)	Short to medium-term contamination above background. Known biological effect concentrations on medium scale	Moderate and temporary exceedance over national/international air quality standards. No harm to the environment or human health expected	Minor and medium-term effects on one or more of protected areas values. Full recovery expected	Moderate effects on aesthetic, economic or recreational values but overall societal benefits outweigh impacts
Minor	Minor and temporary disruption to small portion of population. No effects on critical habitats/activities	Localised, short term effects. Recovery in the timescale of months to <5 years	Localised, short to medium-term effects. Full recovery expected	Temporary discharge with contamination above background levels. Known biological effect concentrations on medium scale (<10 km^2)	Temporary contamination above background. Known biological effect concentrations on medium scale	Minor and temporary exceedance over national/international air quality standards. No harm to the environment or human health expected	Minor and short term effects on one or more of protected areas values. Full recovery expected	Minor and temporary effects on aesthetic, economic or recreational values
Slight	Possible incidental effects to flora and fauna in a locally affected environmental setting	Localised, temporary effects. Recovery in the timescale of days to weeks	Localised, temporary effects. Slight impact on ecological integrity or species composition	Temporary discharge with contamination above background levels. Known biological effect concentrations on small scale (<1 km^2)	Temporary contamination above background. Known biological effect concentrations on small scale	Slight, temporary exceedance over national/international air quality standards. No harm to the environment or human health expected	Slight to negligible effects on any protected area values	Slight to negligible effects on aesthetic, economic or recreational values

Table 4.2 - Operational likelihood categories

Categories	Likelihood Description		
	Frequency Continuous operation	**Probability** Single activity	**Experience** History of occurrence in Company or industry
Remote	Once every 10,000-100,000 years at location	1 in 100,000-1,000,000	Unheard of in the industry
Highly Unlikely	Once every 1,000-10,000 years at location	1 in 10,000-100,000	Has occurred once or twice in the industry
Unlikely	Once every 100-1,000 years at location	1 in 1,000-10,000	Has occurred many times in the industry, but not in the Company
Possible	Once every 10-100 years at location	1 in 100-1,000	Has occurred once or twice in the Company
Likely	Once every 1-10 years at location	1 in 10-100	Has occurred frequently in the Company
Highly Likely	More than once a year at location or continuously	>1 in 10	Has occurred frequently at the location

Table 4.3 - Environmental event potential matrix

		LIKELIHOOD LEVEL					
		Remote	**Highly Unlikely**	**Unlikely**	**Possible**	**Likely**	**Highly Likely**
CONSEQUENCE LEVEL	**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 4.4**, 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.

Table 4.4 - 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.

4.2.2 DEMONSTRATION OF ACCEPTABILITY

The following process has been applied to demonstrate acceptability (as illustrated in **Table 4.5**):

- 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 4.5 - 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 NWSR North 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.

5 ENVIRONMENTAL RISK EVALUATION

This section of the EP describes the results of the risk evaluation for the NWSR North MC MSS using the methodology described in Section 4. As required by the Environment Regulations, this evaluation demonstrates that the impacts and risks associated with the NWSR North MC MSS will be reduced to as low as reasonably practicable (ALARP) and will be of an acceptable level.

5.1 PLANNED ACTIVITIES (ROUTINE AND NON-ROUTINE)

5.1.1 NOISE EMISSIONS (NON- SEISMIC)

Description of Risk
The source of environmental risk discussed within this section is noise emitted from the survey vessel and support vessel(s) (i.e. engines, propellers, hull flow noise – excluding noise generated by the seismic acoustic source) or from helicopter operations causing potential short-term localised disturbance to marine fauna, such as alteration of behaviour and localised displacement.

Potential Environmental Impacts

Vessels

During the survey, underwater noise will be generated from the survey vessel and support vessel(s). Studies of underwater noise associated with petroleum operations have generally reported that the main source of noise relates to the use of thrusters to maintain vessel position, rather than cruising.

Noise characteristics and levels vary considerably between vessel types, size, speed and the particular activity being conducted. When idle or moving between sites, vessels generally emit low-level noise. Tugboats, crewboats, supply ships, and many research vessels in the 50–100 m size class typically have broadband source levels in the 165–180 dB re 1µPa range (Gotz *et al.* 2009). In comparison, underwater noise levels generated by fishing trawlers can peak at around 175 dB re 1µPa, and large ships can produce levels exceeding 190 dB re 1µPa (Gotz *et al* 2009). These levels are significantly lower than the seismic source noise levels.

Underwater noise generated by the presence of the survey vessel may result in incidental changes in behaviour of marine fauna (primarily cetaceans, whale sharks and marine turtles), such as disturbance, avoidance or attraction. However, these impacts are likely to be localized and temporary. The recommended root-mean-square (RMS) SPL threshold (Southall *et al.* 2007) that could result in possible avoidance is 120 dB re 1µPa at 1 m. The recommended RMS SPL threshold (Southall *et al.* 2007) that could result in physical injury is not expected to be exceeded by non-pulse noise sources (e.g. vessel noise).

Furthermore, underwater noise from the survey vessel is transient, in that the vessel will be moving across large areas rather than concentrating activities in a small area, and the type of noise is not 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.

Helicopters

The intensity of sound travelling from a source in the air (e.g. helicopter) to a receiver underwater depends on source altitude and lateral distance, receiver depth, water depth, and other variables. Richardson *et al.* (1995) reports figures for a Bell 214 helicopter (stated to be one of the noisiest) as audible in air for four minutes before it passed over underwater hydrophones, but detectable underwater for only 38 seconds at 3 m depth and 11 seconds at 18 m depth. The maximum received level was 109 dB re 1uPa.

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.

Summary of Environmental Impact Assessment

Potential Environmental Impact	Environmental Values and Sensitivities Affected	Decision Type
Short-term, localised disturbance to marine fauna, such as alteration of behaviours and localised displacement	Marine fauna: cetaceans, whale sharks and marine turtles	A

Residual Risk Assessment				
Potential Environmental Impact		**Consequence**	**Likelihood**	**Residual Risk**
Short-term, localised disturbance to marine fauna, such as alteration of behaviours and localised displacement	Cetaceans Whale sharks Marine turtles	Slight	Unlikely	Low
Summary of Control Measures				
Interaction between vessels (not including a vessel that is towing or retrieving/deploying a seismic array) and helicopters with cetaceans in the operational area will be consistent with relevant parts of the EPBC Regulations Part 8.1 (Regulation 8.05) – Interacting with cetaceans.				
Vessel operations will maintain a safe distance from whale sharks.				
Interaction between vessels (not including a vessel that is towing or retrieving/deploying a seismic array) and turtles within the operational area will be consistent with the EP's vessel fauna interaction procedure.				
The survey vessel will go no closer than 20 km from any emergent feature/ mainland				

5.1.2 VESSEL LIGHT EMISSIONS

Description of Risk
Lighting on both the survey and support vessels is required for safe navigation and work practices at night and has the potential to create light pollution. This may, consequently, affect some marine species, primarily seabirds and turtles.
Potential Environmental Impacts
Behavioural responses to light can alter foraging and breeding activity in turtles, seabirds, fish and dolphins, conferring competitive advantage to some species and reducing reproductive success and/or survival in others. In turtles, light pollution reaching nesting beaches is widely considered detrimental owing to its ability to alter important nocturnal activities, including choice of nesting sites and orientation/navigation to the sea by post-nesting females and hatchlings (Witherington and Martin 2003). However, Pendoley (2005) noted that on-shore light influences hatchling orientation more than offshore light, since an offshore light will assist in attracting hatchlings in the direction of the ocean whilst they are traversing the beach. Once in the ocean, hatchlings are thought to remain close to the surface, orient by wave fronts and swim into deep offshore waters for several days to escape the predator-filled shallow in-shore waters. During this period, light spill from coastal port infrastructure and ships may 'entrap' hatchling swimming behaviour, reducing the success of their seaward dispersion and potentially increasing their exposure to predation via silhouetting (Salmon *et al.* 1992). Within the NWSR North MC MSS operational area, the potential for lighting from the survey vessel to disorient or attract turtle hatchlings is likely to be minimal. As mitigation against lighting impacts from vessels, the WA Environmental Protection Authority (EPA) recommends that a darkness zone at least 1.5 km of a significant nesting beach should be maintained (EPA 2010). The closest, recognised turtle nesting BIAs are located on the Montebello Islands which are all more than 60 km from the edge of operational area. Based on their migratory behaviours, all five species of marine turtle are likely to be present throughout the operational area and further offshore. However, as vessels will be moving continually, albeit at low speeds, and are more than 1.5 km from nesting beaches, the artificial lighting effects are likely to be less than the effects from a stationary source, such as a drill rig or FPSO facility. Seabirds may be attracted to vessel lights at night which may cause disorientation. This may be particularly prevalent for nesting birds close to rookeries. While it is possible that seabirds may fly over the operational area, it is not anticipated that surveys undertaken within the operational area will have significant adverse impacts on any seabird species due to their mobility and substantial distance of the potential survey areas to nesting seabird sites. The operational area does not overlap any breeding BIA, and is more than 60 km from the closest rookeries on the Montebello Islands. The operational area is more than 45 km from the lesser frigatebird foraging BIA of Bedout Island, but does slightly overlap the wedgetail shearwater foraging BIA along the Pilbara coast. For other marine fauna, the potential impacts of light emissions from seismic vessels are 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 fauna populations. Lighting from survey vessels will be no greater than the lighting from the other numerous vessels in the area associated with shipping, commercial fishing or petroleum activities.

Summary of Environmental Impact Assessment		
Potential Environmental Impact	**Environmental Values and Sensitivities Affected**	**Decision Type**

Short-term, localised disturbance to marine fauna, such as alteration of behaviours and localised displacement		Marine fauna: marine turtles and seabirds	A
Residual Risk Assessment			
Potential Environmental Impact		**Consequence**	**Likelihood**	**Residual Risk**
Short-term, localised disturbance to marine fauna, such as alteration of behaviours and localised displacement	Marine turtles Seabirds	Slight	Highly Unlikely	Low
Summary of Control Measures			
The survey vessel will go no closer than 20 km from any emergent feature/ mainland			
Operations of the survey vessel lighting must comply with safety requirements of relevant legislation and conventions.			

5.1.3 INTERACTION WITH FISHERIES, DIVING, SHIPPING AND PETROLEUM SERVICE VESSELS

Description of Risk
There are a number of commercial fisheries whose management areas overlap the proposed operational area. Additionally, there is significant commercial shipping activity, much of which is associated with the oil and gas industry. Therefore, there is the possibility that fishing, diving and commercial activities will be disrupted by the physical presence of the seismic and support vessels.
Potential Environmental Impacts

Commercial and Recreational Fisheries

Disruption to commercial fisheries in the area could result from:

- restriction of access to fishing grounds due to vessel movements and operations;
- loss of fishing gear, e.g. buoyed fish traps.
- behavioural responses in target fish species leading to changes in catchability, and consequently catch rates; and
- restriction of access due to diesel spill.

Five Commonwealth-managed fisheries and eight state-managed fisheries have zones that overlap the operational area. Potential consequences to commercial fisheries are a temporary loss of catch due to changes in catchability of target fish (caused by behavioural responses to airgun noise), and a temporary loss of access to fishing grounds when the survey vessel is in the operational area, which could result in reduced catches and income.

An analysis of the current fishery closures, depth range of activity, historical fishing effort data, fishing methods (supported by publicly available information, particularly DPIRD FishCube data) and consultation feedback revealed that there is a potential for interactions with some of the commercial fisheries that overlap the operational area. In particular, the MMF, PFTIMF, PLF, PTMF and NWSTF may be actively fishing in the operational area.

However, based on the description of the different commercial fisheries, the current fishing effort of a number of fisheries either does not overlap the proposed operational area, or the area is no longer fished.

Spatial Analysis

Spatial analysis was undertaken to assess the potential overlap with the various commercial fisheries that may be actively fishing in the operational area. The concept is based on the selection of a number of possible 3D survey areas, and then the spatial overlay of these on the various fishery licence areas that are actively fished within the operational area. This gives an indication of the possible overlap with fishing activity and hence the potential level of interaction.

The following table shows that the spatial overlap between the six 3D survey area sizes and the selected fisheries is, in general, quite small. Some fisheries such as the WDTF and WTBF are not actively fishing and so unlikely to be impacted. The PTIMF and PTMF are only overlapped by the operational buffer with the former being in a closed area and so unlikely to be impacted.

Table 5.1 – Summary of spatial overlap with fisheries

Fishery	3D survey size (km²)						Notes
	25,000	10,000	7,500	3,000	1,500	500	
MMF Area 2	4.95%	1.98%	1.48%	0.59%	0.30%	0.10%	Active fishing generally restricted to < 200m
MMF Area 3	3.45%	1.38%	1.04%	0.41%	0.21%	0.07%	
PTIMF	Only operational area (buffer) is overlapped, so no acquisition overlaps						Area 6 overlapped is closed to trawling
PLF	4.54%	1.82%	1.36%	0.55%	0.27%	0.09%	Target spp. favours waters < 200 m
PTMF	Only operational area (buffer) is overlapped, so no acquisition overlaps						2.7% overlapped by operational area
WCDSMF	1.55%	0.62%	0.46%	0.19%	0.09%	0.03%	Fishing further south of Exmouth
NWST	6.30%	2.52%	1.89%	0.76%	0.38%	0.13%	Only 2 vessels active and 117 fishing days in 15/16. Low level fishing. Majority of catch in waters 420-500m deep. Only overlaps 1.1% of area scampi most likely found
WDTF	3.49%	1.39%	1.05%	0.42%	0.21%	0.07%	No fishing activity since 2013
WTBF	1.04%	0.42%	0.31%	0.12%	0.06%	0.02%	Not actively fishing in area

The maximum loss-of-access area for fishers (based on 25,000 km^2 over the life of the EP) are less than 5% with the exception being the NWST with a potential 6.3% overlap.

TGS assessed the possibility of avoiding periods that are more likely to have NWST fishing vessels present, but with exclusion periods to be implemented to account for pygmy blue whale migration periods, this would allow a window of only ~ 4 months in a year to undertake surveys. Based on the fact that only 2 vessels are active, catch effort in the fishery is low, and there is a minimal overlap with the preferred habitat of scampi (350 – 600 m depth), interaction with fishing vessels is anticipated to be limited.

Based on publicly available data and stakeholder responses, TGS has assessed that the temporal avoidance of fishing management areas is not possible or required. With the exception of the PLF, who did not fish in January or February over the 2015 and 2016 period, all fisheries were active all year and so cannot be avoided. However, as fishing effort (and therefore vessels) are generally limited to waters < 200 m, TGS has ensured minimal impact through physical exclusion/ avoidance, as opposed to temporal avoidance.

It is clear that the main concern for interactions between seismic acquisition and commercial fisheries is those fisheries with relatively small licence areas. In the case of the PFTIMF and PTMF, TGS has discussed with stakeholders both spatial and/or temporal avoidance options to eliminate or minimise overlap with their fishing activities (see operational restrictions below), and thereby to eliminate or minimise the likelihood of interactions and potential impacts. As a result, the acquisition area was reduced to not overlap the PFTIMF and PTMF.

Indonesian Traditional Fisheries

Due to the distances between recognised traditional fishing shoals and reefs and the operational area, no interaction or negative impacts are anticipated and so shall not be assessed any further.

Shipping

Within the NWSR North operational area, there is significant commercial shipping activity, including that associated with the oil and gas industry. A number of commercial shipping fairways are located within the operational area, with increased activity out of Port Hedland, Karratha and Broome.

A Closest Point of Approach (CPA; exclusion zone for other vessels) will be in-place for the duration of the NWSR North MC MSS. The extent of this CPA will be determined in-field, will be determined upon commencement of the survey and will be specific to the survey vessel and extent of the towed array. The CPA is likely to cover at least 10 km astern from the survey vessel to account for the length of the towed streamer array.

Defence Activities

If the survey period coincides with planned aerial military exercise activities, there is the potential for the activities of helicopters to interfere with training flights and military exercises within the Learmonth air weapons range. Defence also made it known that unexploded ordinances may be present on and in the sea floor within the NWS where activities may be undertaken. Due to the depths and mode of surveys, it is unlikely these shall be of concern.

Diving

Divers exposed to high levels of underwater sound can suffer from dizziness, hearing damage or other injuries to other sensitive organs, depending on the frequency and intensity of the sound.

Underwater auditory threshold curves indicate that the human auditory system is most sensitive to waterborne sound at frequencies between 400 Hz to 1 kHz (Parvin *et al.* (as cited in Anthony *et al.* 2009), and these frequencies have the greatest potential for damage. In general, within this frequency band, underwater hearing is 35–40 dB less sensitive than in air.

Parvin *et al.* (2002; as cited in Anthony *et al.* 2009) further developed the weighting scale to enable the allowable level of noise underwater to be assessed and directly compared to air levels. Based on this scale, at 200 Hz, the weighting applied is 52.8 dB, and at 100 Hz, the weighting applied is 61 dB. The NSWR North MC MSS acoustic source will have maximum frequency level of 200 Hz. Within literature (all as cited in Ainslie *et al.* 2008), there is some variation in acceptable received sound levels for divers:

- NATO military divers: 160 dB re 1 µPa (125–4,000 Hz)
- NATO recreational divers: 154 dB re 1 µPa (600–2,500 Hz)
- DMAC commercial diver guidelines: 201 dB re 1 µPa
- Commercial or recreational divers (Parvin *et al.* 2002*)*: 155 dB re 1 µPa (500–2500 Hz).

DMAC guidance (DMAC 12) is currently being revised and proposes the following:

- Where diving and seismic activity are scheduled to occur within a distance of 60 km, all parties should be made aware of the planned activity.
- Where seismic survey/diving SIMOPS are proposed within a distance of 30 km, a joint risk assessment should be undertaken. The risk assessment should consider ramp-up trials as well as other risk control measures e.g. reduction in source sizes, changes to firing intervals, timeshare/prioritisation etc.
- If the risk assessment generates a requirement for a ramp-up trial the starting point for the trial will also need to be determined by the risk assessment.

Favoured diving areas such as Montebello Islands (also potentially for commercial pearl diving and closest to the acquisition area) are more than 65 km from the operational area, at which point received sound levels are anticipated to be less than noise associated with many powerboats (Anthony *et al.* 2009). The Rowley Shoals and Dampier Archipelago are even further away (> 100 km). It should be noted that the acquisition area was reduced along the south-east boundary to ensure a minimum distance of 60 km is maintained between it and the Montebello Islands. At these distances, acoustic impairment is anticipated to be minimal to negligible.

The closest shipwrecks to the acquisition area are the Trial at Tryall Rocks and the McCormack/McDermott off Eagle Hawk Island which are more than 55 km away. As both sites are more than 100 km off the mainland and exposed to large Indian Ocean swells making them a dangerous place to dive, they are not frequented by private recreational divers although some charter companies may visit them. Consequently, limited interaction with recognised, recreational diving activities is anticipated.

As a conservative measure, if a seismic survey may occur within 60 km of the Trial or other potential dive locations as determined through pre-survey research, TGS shall implement the proposed DMAC 12 control measures including consulting with charter boat operators in the area prior to the activity commencing as part of the consultation process and risk assessments if required.

Summary of Environmental Impact Assessment

Potential Environmental Impact	Environmental Values and Sensitivities Affected	Decision Type
Restriction of access to fishing grounds due to survey vessel operations	Commercial fisheries	A
Temporary disruption/exclusion of shipping traffic	Commercial vessels/shipping industry	
Temporary disruption of aircraft activities from helicopter operations in military exercise areas	Defence activities	
Temporary disruption/ visual impairment of diving activities	Recreational diving	

Residual Risk Assessment

Potential Environmental Impact		Consequence	Likelihood	Residual Risk
Restriction of access to fishing grounds due to survey vessel operations	Commercial fisheries	Minor	Possible	Medium
Temporary disruption/exclusion of shipping traffic	Shipping			
Temporary disruption of aircraft activities from helicopter operations in military exercise areas	Defence	Slight	Remote	Low
Temporary impacts (visual and noise) to divers	Recreational and commercial divers	Slight	Unlikely	Low

Summary of Control Measures

Operations of the survey vessel must comply with operational standards for navigation and safety in accordance with relevant legislation and conventions:

- International Regulations for Preventing Collisions at Sea 1972 (COLREG);
- Standards of Training, Certification & Watchkeeping (STCW) Convention; and
- *Navigation Act 2012*:

○ Marine Orders Part 21 (Safety of navigation and emergency procedures) 2012; ○ Marine Orders Part 30 (Prevention of collisions) 2009; ○ Marine Order Part 59 (Offshore industry vessel operations); and Marine Order 28 (Operations standards and procedures)
Adherence to the prohibition of vessel entry into designated petroleum safety zones surrounding petroleum wells, structures or equipment.
Tail buoys are visible to third parties (e.g. reflective tape/ strobes/ radar reflector, etc.).
Operations of the survey vessel will comply with advice provided by AMSA and AHS to ensure that maritime notices (e.g. NAVAREA X and AUSCOAST warnings and Notice to Mariners) can be issued and kept up-to-date.
TGS will undertake consultation in accordance with the Consultation Plan in this EP.
In-water equipment loss will be recovered (where possible) and recorded appropriately.
Incident involving negative interactions with commercial fishing vessels or shipping will be reported
TGS will consider the implementation of reasonable temporal or physical exclusion zones, or other control measures, if: • appropriate evidence is provided such as peer-reviewed literature or applicable historical catch data; and • a robust risk assessment has been undertaken; and it is assessed that without the implementation of further measures, the activity will not be ALARP.
No full-fold seismic acquisition will occur in waters < 200 m.
TGS will implement a closest point of approach (CPA) to alert other marine users of survey vessels' presence and extent of towed array.
Implementation of the TGS NWSR North MC MSS Communications and Management Protocol
TGS will implement the following proposed DMAC 12 recommendations: • Where diving and seismic activity are scheduled to occur within a distance of 60 km, all parties should be made aware of the planned activity. • Where seismic survey/diving SIMOPS are proposed within a distance of 30 km, a joint risk assessment should be undertaken. If the risk assessment generates a requirement for a ramp-up trial the starting point for the trial will also need to be determined by the risk assessment.
TGS shall survey no more than a total of 25,000 km^2 over the 2-year life of the EP.

5.1.4 BALLAST WATER DISCHARGE, AND BIOFOULING OF VESSEL HULL, OTHER NICHES AND IMMERSIBLE EQUIPMENT

Description of Risk
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 from one region to another depending on various environmental factors, such as water temperature, salinity, nutrient levels and habitat type. These factors dictate their survival and invasive capabilities. IMS have been introduced and translocated around Australia by a variety of natural and human means, for example discharge of ballast water, biofouling, aquaculture operations and aquarium imports. In the case of TGS' proposed activities during the NWSR North MC MSS, the key vectors requiring management attention 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. Following their establishment, eradication of IMS populations is often impossible, limiting management options to ongoing control or impact minimisation. For this reason, increased management requirements have been implemented in recent years by Commonwealth and State/Territory regulatory agencies with further legislation currently under development. Reducing the risk of IMS introduction and establishment represents by far the most effective and cost-efficient means of managing the threat of IMS introduction.
Potential Environmental Impacts
<u>Ballast Water</u> Ballast water which may potentially harbour IMS can be released by seismic and support vessels during marine seismic surveys. Ballast water taken-up at international ports and coastal waters outside Australia's territorial sea is considered a high risk (DAWR, 2017). Vessels that have taken-up high-risk ballast water should only discharge in Australian seas if the biosecurity risk of the ballast water has been managed using an approved method. Australia is implementing the agreed implementation schedule for the Ballast Water Convention that requires vessels to phase out ballast water exchange in favour of a method that is compliant with the D-2 discharge standard. In order to achieve this, vessels will be required to install an IMO approved BWMS, or use one of the other approved methods of management. The approved methods of ballast water management are: • use of a BWMS; • ballast water exchange conducted in an acceptable area;

- use of low risk ballast water (such as fresh potable water, high seas water or fresh water from an on-board fresh water production facility);
- retention of high-risk ballast water on board the vessel;
- discharge to an approved ballast water reception facility.

For vessels entering Australia, the *Biosecurity Act 2015* (Chapter 4, Part 2) requires pre-arrival reporting in a form approved by the Director of Biosecurity, which is the Maritime Arrivals Reporting System (MARS). MARS is an online portal to submit pre-arrival documents required of all international vessels seeking Australian biosecurity clearance.

As such, TGS will implement all regulations and control measures to reduce impacts and risks from ballast water discharges (DAWR, 2017). Vessels carrying internationally-sourced, ballast water must conduct ballast water exchanges as far as possible from the nearest land, which is at least 12 nautical miles from the nearest emergent land, in water > 50 m deep; and where possible, more than 200 nautical miles from the nearest emergent land and in water > 200 m deep. Vessels carrying Australian-sourced ballast water must conduct ballast water exchanges at least 12 nautical miles from the nearest emergent land and in water > 50 m deep. Ballast water must not be discharged or exchanged within the Ningaloo Reef ballast water exchange exclusion area. Also, all internationally operating vessels entering Australia will require an approved Ballast Water Management Plan and an International Ballast Water Management Certificate. These documents must be in the form prescribed by the Ballast Water Management Convention.

Biofouling

The growth and accumulation of aquatic organisms (biofouling) on vessel hulls, other external niche areas, on internal niches and on equipment routinely-immersed in water pose a potential risk of introducing IMS into Australia. Accidental release of biofouling organisms during cleaning operations can facilitate the spread of invasive aquatic species threatening human health, the aquatic environment, and social, cultural and economic values.

The potential biofouling risk presented by the seismic survey and support vessels within the operational area will relate to the length of time that these vessels have already been operating in Australian waters, or operating outside Australian waters, the location(s) of the surveys undertaken, the length of time spent at these location(s) and whether the vessels undergone hull inspections, cleaning and application of new antifoulant coating prior to operating in Australian waters. On this basis, all vessels will have an IMS Risk assessment done prior to arriving in Australia, and all the necessary clearances to operate within Australia waters, as required. This includes meeting the biosecurity standards of the DAWR and the WA Department of Fisheries (DoF), who have significant powers to prevent the arrival and establishment of IMS of concern.

Furthermore, any vessel or marine infrastructure destined for WA waters is required to meet the aquatic biosecurity standards set out under the *Fisheries Resources Management Act 1994*, including a Marine Biosecurity Inspection for the presence of known and potential IMS to ensure compliance with Regulation 176. No target marine species of concern to Australian waters can be observed during the in-water inspection in order to ensure that the vessel will be considered to pose a low risk of introducing any IMS of concern to Australian waters. As such, an independent IMS inspection will be undertaken to ensure compliance with the aquatic biosecurity standards set out under this Act.

Anti-fouling coatings are commonly used to protect submerged surfaces and prevent biofouling accumulation. 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 (IMO document AFS/CONF/26). As such, TGS will implement these control measures to reduce environmental impacts and risks from biofouling.

Summary of Environmental Impact Assessment		
Potential Environmental Impact	**Environmental Values and Sensitivities Affected**	**Decision Type**
Introduction and establishment of IMS	• Native marine species	A

		Other marine users: commercial fisheries, shipping, tourism and human health		
Residual Risk Assessment				
Potential Environmental Impact		**Consequence**	**Likelihood**	**Residual Risk**
Introduction and establishment of IMS	Other marine users: commercial fisheries, shipping, tourism industry and human health	Slight	Highly Unlikely	Low
	Native marine species			
Summary of Control Measures				
Ballast water discharges must comply with the relevant requirements of the *Biosecurity Act 2015* and Australian Ballast Water Management Requirements (2017).				
• The survey vessel chosen for an individual survey will be assessed using the DoF Vessel Check tool: https://vesselcheck.fish.wa.gov.au • immersible equipment and the survey vessel hull, sea chests and other niches must be 'clean' before the survey vessel enters WA waters and ports • Equipment will be new, or thoroughly cleaned, then dried for at least 24 hours and inspected for marine pests before use in WA waters. The suspected or confirmed presence of any marine pests or disease must be reported within 24 hours by email (biosecurity@fish.gov.au) or telephone (FishWatch tel: 1800 815 507).				
• If not previously located in Australian waters, vessels will have had a recent dry dock, IMS inspection (hull and equipment) or antifoulant application prior to mobilising. • Adherence to the Anti-fouling and In-Water Cleaning Guidelines.				

5.1.5 UNDERWATER NOISE EMISSIONS FROM DISCHARGE OF ACOUSTIC ARRAY

Description of Risk
Surveys in the proposed operational area will utilise seismic acoustic sources with a maximum capacity of ~4,120 cui, which will generate acoustic pulses by periodically discharging compressed air into the water column at intervals of no less than every five seconds. The 4,120 cui acoustic source array will produce a maximum actual sound pressure levels (SPL) of 243 dB re 1µPa @ 1 m (260 dB equivalent source level), at frequencies extending up to ~200 Hz. The primary environmental risk from seismic surveys is sound emissions caused by the discharge of underwater seismic pulses. The level of impact to marine fauna depends on multiple factors, such as sound intensity and duration, distance from the source, fauna species and the mitigation measures employed. Potential impacts range from mortality or pathological damage from close exposure to high sound levels, to various behavioural responses such as area avoidance (McCauley 1994).
Potential Environmental Impacts

NWSR North Modelling Results

Independent sound propagation modelling for the 4,120 cui array proposed for use during surveys in the NWSR North operational area has been conducted by the CMST (CMST 2016).

The CMST modelling provided far-field source levels of 235.3 dB re 1 µPa^2.s at 1 m (SEL) and 259.8 dB re 1 µPa at 1 m (SPL_{peak}) for the 4,120 cui array in the vertically downward direction (CMST 2016). For an acoustic source in water depth of 100 m, modelling results indicated received sound levels drop below 220 dB re 1 µPa (SPL_{peak}) within a horizontal plane of ~45 m which is a closer horizontal distance than predicted using a spherical spreading transmission loss (TL) alone (i.e. 20logR). These received sound levels apply at all depths within the water column. Results also indicated that within 1 km of the acoustic source, received SEL were between ~163 – 173 dB re 1µPa^2.s.

The CMST horizontal propagation modelling for predicted SPL_{peak} and SEL at any depth in the water column extended to a maximum distance of 2 km from the source and indicate that RL will be lower than those predicted using spherical spreading, however as a show of conservatism, the formula has been used. Table 5.2 shows the predicted received SPL_{peak} and SEL for the 4,120 cui array out to a maximum horizontal distance of 60 km.

Table 5.2 - Horizontal SPL and SEL values for 4,120 cui array to 10 km distance

Distance from Source (m)	SEL (dB re 1µPa^2.s)[1]	SPL_{peak} (dB re 1 µPa)^2
50	201	226
100	195	220
225	188	213
400	183	208
500	181	206
1,000	175	200
2,000	169	194
3,000	165	190
5,000	160	185
7,000	157	182
10,000	155	180
20,000	144	174
30,000	137	167
40,000	130	160
50,000	126	156
60,000	124	154

Table 5.3 shows the predicted received SPL_{peak} and SEL for the 4,120 cui array vertically below the source.

Table 5.3 - Vertical SPL and SEL values for 4,120 cui source to 400 m water depth

Water depth (m)	Calculated RL	
	SEL (dB re 1 µPa^2.s)	SPL_{peak} (dB re 1 µPa)
50 (43)	205.7	230.2
100 (93)	199.0	223.5
125 (118)	197.0	221.5
150 (143)	195.3	219.8
175 (168)	193.9	218.4
200 (193)	192.7	217.2
250 (243)	190.7	215.2
275 (268)	189.8	214.3
300 (293)	189.1	213.6
325 (318)	188.4	212.9
350 (343)	187.7	212.2
400 (393)	186.5	211.0
500 (493)	181.6	209.1
800 (793)	180.5	204.9
920 (913)	179.2	203.7
1000 (993)	178.5	203.0
2000 (1993)	172.4	196.9

5.1.5.1 Exposure Criteria

Table 5.7 and **Table 5.8** provide the threshold criteria (and corresponding range estimates) for different fauna that is used to inform the evaluation of impacts within this EP. Threshold criteria selected are considered the most appropriate based on current relevant scientific literature available and accepted industry and international standards.

Temporary threshold shifts (TTS) occur when an animal's hearing threshold is temporarily increased during and immediately after an exposure event to a loud sound source (Richardson *et al.* 1995). Permanent threshold shifts (PTS) occur when an animal experiences a shift in their hearing threshold from permanent and irreversible damage caused by prolonged or repeated exposure to high sound levels (Richardson *et al.* 1995). Scientifically measuring PTS is difficult and not always possible, and thus, TTS measurements over time are used to predict likely occurrences of PTS.

Cetaceans

Table 5.4 shows the summary of the final US NOAA threshold levels (based on Southall *et al.* 2007) for TTS and PTS-onset for low-frequency (LF) cetaceans (e.g. baleen whales), mid-frequency (MF) cetaceans and high-frequency (HF) cetaceans for impulsive sources of noise such as seismic airgun arrays (NMFS 2016).

Table 5.4- Summary of final NMFS threshold levels for TTS and PTS onset for LF, MF and HF cetaceans

Hearing group	PTS onset thresholds	TTS onset threshold
LF Cetaceans	219 dB SPL_{peak} 183 dB SEL_{cum}	213 dB SPL_{peak} 168 dB SEL_{cum}
MF Cetaceans	230 dB SPL_{peak} 185 dB SEL_{cum}	224 dB SPL_{peak} 170 dB SEL_{cum}
HF Cetaceans	202 dB SPL_{peak} 155 dB SEL_{cum}	196 dB SPL_{peak} 140 dB SEL_{cum}

Note: dB_{peak} (dB re 1 µPa); SEL_{cum} (dB re 1 µPa^2.s); thresholds are unweighted for SPL_{peak} and unweighted for SEL_{cum}
Source: NMFS (2016).

Fish, turtles and larvae

Popper *et al.* (2014) proposed minimum levels that may result in recoverable injury or mortality and potential mortal injury in fish, turtles, eggs and larvae as outlined in the table below**.**

Table 5.5 - Proposed sound exposure criteria for mortality and impairment in fish, turtles, eggs & larvae

Type of animal	Mortality or potential mortal injury	Impairment		Behavioural
		Recoverable injury	TTS	
Fish: no swim bladder	>219 dB SEL_{cum} or >213 dB_{peak} >220 dB_{peak}^	>216 dB SEL_{cum} or >213 dB_{peak} >220 dB_{peak}^	>186 dB SEL_{cum} 176 – 180 dB SEL_{ss}* 205-210 dB_{peak}*	(N) High (I) Moderate (F) Low
Fish: swim bladder but not involved in hearing	>210 dB SEL_{cum} or >207 dB_{peak} >220 dB_{peak}^	>203 dB SEL_{cum} or >207 dB_{peak} >220 dB_{peak}^	>186 dB SEL_{cum} 176 – 180 dB SEL_{ss}* 205-210 dB_{peak}*	(N) High (I) Moderate (F) Low
Fish: swim bladder involved in hearing	>207 dB SEL_{cum} or >207 dB_{peak} >220 dB_{peak}^	>203 dB SEL_{cum} or >207 dB_{peak} >220 dB_{peak}^	>186 dB SEL_{cum} 176 – 180 dB SEL_{ss}* 205-210 dB_{peak}*	(N) High (I) High (F) Moderate
Sea Turtles	>210 dB SEL_{cum} or >207 dB_{peak}	-	-	(N) High (I) Moderate (F) Low
Eggs and Larvae	>210 dB SEL_{cum} or >207 dB_{peak}	-	-	(N) Moderate (I) Low (F) Low

dB_{peak} (dB re 1 µPa); SEL_{cum} (dB re 1 μPa^2.s)

Source: Popper *et al.* (2014); * Popper and Hastings (2009); ^ various references as cited within this EP

The Canadian Science Advisory Secretariat (CSAS 2006) undertook a literature review of 23 experimental and opportunistic studies on the effects of seismic energy on fish. From these reviews of seismic specific data the following levels were identified for various effects (levels are reported in SPL dB re 1 µPa):

- Mortality >220 dB
- Physical damage (swim bladders, ablated ears): 208 to 246 dB (NB - of the seven studies reviewed in relation to physical damage, six indicated levels above 212 dB. The lowest level of 208 dB was actually discounted from the final results of the experiment as the dislocated tissue was likely unrelated to airgun pressure)
- Hearing loss: 205-210 dB
- No hearing loss: 205 -210 dB
- No physical damage: 142 – 240 dB
- Physiological effects: 194 - 210 dB
- Behavioural: 148 – 218 dB

There are no documented cases of fish mortality from exposure to seismic airgun noise under field-operating conditions (DFO 2004). This is supported by findings by Popper *et al.* 2007; Hastings *et al.* 2008; McCauley and Kent 2012 (as cited in Popper *et al.* 2014).

As indicated by research based on seismic operations as opposed to pile driving, the levels proposed by Popper *et al.* (2014) for fish are not definitive and conservative. Received SPL that may result in TTS may be in the order of 205-210 dB, while levels required to result in permanent injury or potential mortality are likely to be >220 dB. Based on available evidence as presented within the EP, fish are likely more sensitive that other marine fauna such as invertebrates or crustaceans and so these levels are considered conservative. Predictions of received levels in both horizontal and vertical planes at distance from source indicate received levels >220 dB SPL_{peak} may occur within ~100 m of the source horizontally or in water depths of <150 m vertically below the array.

Received SEL and SPL vertically below the array

TGS acknowledges that the use of a 4,120 cui source over more sensitive habitats found in shallower waters may have negative impacts to site-attached or sedentary species. Based on data presented in this EP, benthic

habitats that may support significant assemblages of site-attached fish are mostly limited to waters shallower than 40 m. As such, by committing to no acquisition in waters shallower than 200 m, TGS shall ensure that the sound source is not operating directly over areas that may be inhabited by significant assemblages of site-attached fish (being waters <40 m).

The received levels at the seabed vertically below the 4,120 cui array in 200 m water depth are predicted to be in the order of ~193 dB SEL and~217 dB SPL_{peak} (see **Table 5.3**). These levels are marginally above the defined threshold level for recoverable injury and mortality or potential mortal injury in fish with no swim bladder (213 dB SPL_{peak}) and fish with swim bladders (207 dB SPL_{peak}) (see **Table 5.5**). However, threshold levels used by Popper *et al.* (2014) are conservative and other, more relevant studies based on seismic parameters, indicate that received levels of 210 dB SPL_{peak} will likely not result in injury or mortality but be limited to TTS only, with received levels of more than 220 dB SPL_{peak} required to result in injury.

Use of the 4,120 cui array is predicted to result in received levels at the seabed (vertically below the array) that exceed this 220 dB SPL_{peak} SPL threshold for all water depths shallower than ~150 m.

Received SEL and SPL horizontally from the array

Table 5.7 provides estimates of horizontal distances at which potential impacts could occur to different sensitive receptors, based on the 4,120 cui array and application of both the quantitative and semi-quantitative exposure criteria discussed above. It is important to note that the majority of these range estimates are based on application of the various SPL_{peak} metric exposure criteria. It is not possible to apply the 24 hr SEL_{cum} metric exposure criteria included in NMFS (2016) and Popper *et al.* (2014), as no sound propagation modelling has been conducted for the 4,120 cui array that would provide these data.

Soft starts

To allow for the soft start procedure to commence within the buffer zone along the inshore side of the acquisition area TGS has examined the option of using smaller arrays in water depths shallower than 200 m, during soft starts. Predicted received levels (SPL_{peak}) at the seabed directly below four smaller sized arrays across a range of water depths in shown in **Table 5.6**.

Table 5.6– Predicted received levels (SPL_{peak}) vertically below the source for five different arrays

Water depth (m)[1]	4,120 cui (260 dB SPL_{peak})[2,4]		3,060 cui (258 dB SPL_{peak})[3,4]		2,680 cui (256 dB SPL_{peak})[3,4]		1,940cui (253 dB SPL_{peak})[3,4]		1,420 cui (249 dB SPL_{peak})[3,4]	
	SPL_{peak}	SEL^5	SPL_{peak}	SEL^5	SPL_{peak}	SEL^5	SPL_{peak}	SEL^5	SPL_{peak}	SEL^5
45	231	206	229	204	227	202	224	199	**220**	195
50	230	205	228	203	226	201	223	198	219	194
70	227	202	225	200	223	198	**220**	195	216	191
100	224	199	222	197	**220**	195	217	192	213	188
120	222	197	**220**	195	218	193	215	190	211	186
150	**220**	195	218	193	216	191	213	188	209	184
175	218	193	216	191	214	189	211	186	207	182
200	217	192	215	190	213	188	210	185	206	181

Notes: [1] Based on 7.0 m source depth.
[2] SPL_{peak} from CMST modelling (259.8 dB); and from Nucleus modelling (260.2 dB).
[3] SPL_{peak} from Nucleus modelling.
[4] Seabed reflection coefficients of 0.42 (i.e. +3 dB).
[5] SPL converted to SEL by subtracting 25 dB.

On this basis, TGS commits to using reduced sound sources to ensure that received levels at the seabed will be no greater than 220 dB SPL_{peak} during soft starts within the buffer zone, thus minimising the potential impacts to site-attached fish assemblages or other fauna.

Implementation of this control measure will ensure that waters of the operational area that have been identified as potential habitat for site-attached fish assemblages or other sensitive environments will not be exposed to received levels at the seabed that exceed an SPL_{peak} of 220 dB. m (i.e. the ancient coastline KEF at 125 m). Therefore, no communities of site-attached, sedentary fish or other fauna such as crustaceans across the entire operational area will be exposed to received levels that could potentially result in mortality or potential mortal injury. Whilst there may be the potential for impairment (recoverable injury, TTS) effects occurring to site-attached fish within these communities, these impacts have been demonstrated to be ALARP and acceptable, as described in the following sections.

Table 5.7 – Estimates of horizontal distances from the 4,120 cui array at which potential impacts to marine fauna could occur

Receptor	Potential Impacts									
	Mortality/Potential Mortal Injury		Impairment						Behavioural	
			PTS		Recoverable Injury		TTS			
	Threshold criteria	Distance (m)	Threshold criteria	Distance (m)	Threshold criteria	Distance (m)	Threshold criteria	Distance (m)	Threshold criteria	Distance (m)
Plankton (eggs & larvae)	>207 dB_{peak}[1] or >210 dB SEL_{cum}[1]	<500	NA	-	(N) Moderate[1]	within tens of metres	(N) Moderate[1]	within tens of metres	(N) Moderate[1]	within tens of metres
Benthic invertebrates	ND	-	NA	-	203 dB_{peak}[2]	<700[#]	NA	-	203 dB_{peak}[2] 186 dB_{SEL}[2]	<450[#]
Fish (no swim bladder)	>220 dB_{peak}[3]	<100	ND	-	>213 dB_{peak}[1] or >216 dB_{cum}[1]	<225	>205 dB_{peak}[6]	<550	176-183 dB_{pk}[9] 147-151 dB_{SEL}[10]	< 15,000
Fish (swim bladder)	>220 dB_{peak}[3]	<100	ND	-	>207 dB_{peak}[1] or >203 dB_{cum}[1]	<450	>205 dB_{peak}[6]	<550	176-183 dB_{pk}[9] 147-151 dB_{SEL}[10]	< 15,000
Elasmobranchs	>220 dB_{peak}[3]	<100	ND	-	>213 dB_{peak}[1] or >216 dB_{cum}[1]	<225	>205 dB_{peak}[6]	<550	(N) High[1]	within hundreds of metres
Turtles	>207 dB_{peak}[1] or >210 dB SEL_{cum}[1]	<450	ND	-	(N) High[1]	within tens of metres	(N) High[1]	within tens of metres	166 dB_{rms}[7,9]	<10,000
HF cetaceans	NA	NA	202 dB_{peak}[4] 155 dB SEL_{24}	<800	ND	-	196 dB_{peak}[5] 140 dB SEL_{cum}	< 2,000	160 dB_{rms}[8]	<20,000
MF cetaceans	NA	NA	230 dB_{peak}[4] 185 dB SEL_{24}	<50	ND	-	224 dB_{peak}[5] 170 dB SEL_{cum}	<100	160 dB_{rms}[8]	<20,000
LF cetaceans	NA	NA	219 dB_{peak}[4] 183 dB SEL_{24}	~100	ND	-	213 dB_{peak}[5] 168 dB SEL_{cum}	225	160 dB_{rms}[8]	<20,000

Notes: Distances based on conservative received levels as presented in Table 5.2. Levels are as presented in most relevant references and converted as appropriate to relevant metrics to assist in developing minimum distances.

dB_{peak} (SPL - dB re 1 µPa); SEL_{ss} (per-pulse SEL - dB re 1 $\mu Pa^2.s$); distance calculations based on 259.8 dB SPL_{peak} source levels for 4,120 cui array

LF – low frequency; MF – medium frequency; HF – high frequency.

NA – not applicable; ND – no data; (N) High, (N) Moderate – near distance from source, and relative risk.

Threshold criteria: 1 – Popper *et al.* (2014), Table 7.4; 2 – Day *et al.* (2016); 3 – various references as cited in this Section; 4 – NMFS (2016) – Table 4; 5 – NMFS (2016) – Table A10; 6 – Popper and Hastings (2009); 7 – CoA (2017); 8 – NZ Dept of Conservation (2012: Based on NMFS 2013 criteria); 9 – McCauley *et al* (2000); 10 – Fewtrell and McCauley (2012)

[#] - based on CMST modelling of 4120 cui source for worst case scenario for received levels on seabed and horizontally from the source

Table 5.8 – Estimates of vertical distances from the 4,120 cui array at which potential impacts to marine fauna could occur

Receptor	Potential Impacts									
	Mortality/Potential Mortal Injury		Impairment						Behavioural	
			PTS		Recoverable Injury		TTS			
	Threshold criteria	Distance (m)	Threshold criteria	Distance (m)	Threshold criteria	Distance (m)	Threshold criteria	Distance (m)	Threshold criteria	Distance (m)
Plankton (eggs & larvae)	>207 dB_{peak}[1] or >210 dB SEL_{cum}[1]	<600	NA	-	(N) Moderate[1]	within tens of metres	(N) Moderate[1]	within tens of metres	(N) Moderate[1]	within tens of metres
Benthic invertebrates	ND	-	NA	-	205 dB_{peak}[2]	<800	NA	-	203 dB_{peak} 186 dB_{SEL}	<1000
Fish (no swim bladder)	>220 dB_{peak}[3]	<150	ND	-	>213 dB_{peak}[1] or >216 dB_{cum}[1]	<325	>205 dB_{peak}[6]	<800	176-183 dB_{pk}[9] 147-151 dB_{SEL}[10]	all depths
Fish (swim bladder)	>220 dB_{peak}[3]	<150	ND	-	>207 dB_{peak}[1] or >203 dB_{cum}[1]	<600	>205 dB_{peak}[6]	<800	176-183 dB_{pk}[9] 147-151 dB_{SEL}[10]	all depths
Elasmobranchs	>220 dB_{peak}[3]	<150	ND	-	>213 dB_{peak}[1] or >216 dB_{cum}[1]	<600	>205 dB_{peak}[6]	<800	(N) High[1]	all depths
Turtles	>207 dB_{peak}[1] or >210 dB SEL_{cum}[1]	<600	ND	-	(N) High[1]	within tens of metres	(N) High[1]	within tens of metres	166 dB_{rms}[7,9]	all depths
HF cetaceans	NA	NA	202 dB_{peak}[4] 155 dB SEL_{cum}	<2000	ND	-	196 dB_{peak}[5] 140 dB SEL_{cum}	< 2000	160 dB_{rms}[8]	all depths
MF cetaceans	NA	NA	230 dB_{peak}[4] 185 dB SEL_{cum}	<50	ND	-	224 dB_{peak}[5] 170 dB SEL_{cum}	<100	160 dB_{rms}[8]	all depths
LF cetaceans	NA	NA	219 dB_{peak}[4] 183 dB SEL_{cum}	~175	ND	-	213 dB_{peak}[5] 168 dB SEL_{cum}	325	160 dB_{rms}[8]	all depths

Notes: Distances based on conservative received levels as presented in Table 5.3. Levels are as presented in most relevant references and converted as appropriate to relevant metrics to assist in developing minimum distances.

dB_{peak} (SPL - dB re 1 µPa); SEL_{ss} (per-pulse SEL - dB re 1 $\mu Pa^2.s$); distance calculations based on 259.8 dB SPL_{peak} source levels for 4,120 cui array, and CMST modelling outputs for predicted peak SPL at any depth in water column and at seabed, in 100 m water depth.

LF – low frequency; MF – medium frequency; HF – high frequency.

NA – not applicable; ND – no data; (N) High, (N) Moderate – near distance from source, and relative risk.

Threshold criteria: 1 – Popper *et al.* (2014), Table 7.4; 2 – Day *et al.* (2016); 3 – various references as cited in this Section; 4 – NMFS (2016) – Table 4; 5 – NMFS (2016) – Table A10; 6 – Popper and Hastings (2009); 7 – CoA (2017); 8 – NZ Dept of Conservation (2012: Based on NMFS 2013 criteria); 9 – McCauley *et al* (2000); 10 – Fewtrell and McCauley (2012)

5.1.5.2 Cumulative SEL

If an animal is exposed to repeated sounds, such as repeated pulses from a seismic airgun, effects may be a function of the energy in all the sound events accumulated over time (Popper *et al.* 2014). SEL_{cum} is the linear summation of the individual sound events (SEL_{ss}) over the time period of interest. Table 5.9 shows the received SEL horizontally from a 4,120 cui source to 1 km (worst case scenario with largest possible source) from single pulses (or "strikes" – SEL_{ss}). Using the equation $SEL_{cum} = SEL_{ss}+10\log10(N)$, the number of shots it would take to exceed the SEL_{cum} has been calculated.

Table 5.9- Predicted horizontal SEL_{ss} and number of shots to exceed SEL_{cum} exposure guidelines for 4,120 cui array

Horizontal distance (m)	SEL_{ss}[1]	No. shots to exceed SEL_{cum}[1] exposure guidelines	
		>203 dB	>207 dB
50	201	1	4
100	195	6	16
225	188	32	80
400	183	100	252
500	181	159	400
1,000	175	>600	>1,500

Note: [1] SEL_{ss} and SEL_{cum} in dB re 1 μPa^2.s based on worst case scenario of static source and static receptor.

Similarly, Table 5.10 shows the received SEL on the seabed vertically below a 4,120 cui source in 200 m depth and the number of strikes required to exceed threshold levels of SEL_{cum} 203 dB and 207 dB.

Table 5.10- Predicted vertical SELss and number of shots to exceed SELcum exposure guidelines in water depths of 200 m for 4,120 cui array

Depth below source (m)	SEL_{ss}[1]	No. shots to exceed SEL_{cum}[1] exposure guidelines	
		>203 dB	>207 dB
193	193	10	25

Note: [1] SEL_{ss} and SEL_{cum} in dB re 1 μPa^2.s based on worst case scenario of static source and static receptor.

The above approach of using cumulative received SEL is based on an assumption that all shots along a line section are acquired at the same instant, which is obviously not the case. With a moving source, this will likely never occur, and as the source moves, the received levels will continually reduce ensuring that the SEL_{cum} level of 203 dB re 1 μPa^2.s is not attained. With a 3D array and the use of two sound sources that are ~75 m apart and operate in a 'flip-flop' sequence, the possibility of an area receiving enough shots to reach the 203 dB re 1 μPa^2.s is further reduced. Thus, the equation used by Popper *et al.* (2014) does not take into account the temporal spread of acquisition – shots no less than every eight (8) seconds (18.75 m shotpoint interval minimal, although 25 m is more likely) along each line, and an interval of hours to days between adjacent lines. Thus, the potential for marine fauna, such as fish, to recover from a temporary threshold shift (TTS) or recoverable injury, either between shots or between lines, is not taken into account.

The US National Marine Fisheries Service (NMFS) applies a "resetting" of SEL_{cum} after 12 hours of non-exposure (Stadler and Woodbury 2009). The SEL_{cum} for a fish during a pile driving operation is reset to zero for the next set of exposures, if there is a 12-hour period between the end of one pile driving operation and the start of the next.

5.1.5.3 Potential Impacts

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, and more recently to site-attached fish species. Concerns included:

- pathological effects (lethal and sub-lethal injuries) – immediate and delayed mortality and physiological effects to nearby marine organisms;
- behavioural change to populations;
- disruptions to feeding, mating, breeding or nursery activities of marine organisms in such a way as to affect the survival 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.

The response of marine fauna to marine seismic survey sounds will generally range from no effect to various behavioural changes, and possibly temporary or permanent hearing impairment. Immediate chronic effects are likely to be restricted to very short ranges and high sound intensities and are unlikely to occur for the majority of species, as most free-swimming animals will practice avoidance manoeuvres before reaching ranges at which chronic effects may occur. Site-attached species associated with benthic communities may be at greater risk of negative impacts. Some behavioural disturbance is expected, but this would be localised and short-term.

5.1.5.4 Planktonic Organisms

Except for fish eggs, larvae (including prawn and scampi larvae) and other minute planktonic organisms within a few meters of an acoustic source, are not likely to be affected significantly by seismic source discharges (McCauley 1994).

Mortality/potential mortal injury

Data presented in **Table 5.11** indicates that the range of pathological effect on fish eggs and larvae is likely to be restricted to less than approximately 2 m. Calculations indicate that less than 0.02% of plankton in an area would be affected (this assumes plankton are uniformly distributed, single gun array, 18.75 m shot point interval, maximum range of pathological effect 2 m). Data presented in Popper *et al.* (2014) cite the references and studies outlined in **Table 5.11** and the authors determined that eggs and larvae in very close proximity (<5 m) are likely to suffer mortality and tissue damage. Even with this increased radius of 5 m, the percentage of plankton affected would still be very minor, and the effects from the seismic discharge would be insignificant, compared to the size of the planktonic population in a survey area or natural mortality rates for planktonic organisms.

Table 5.11 - Observed seismic noise pathological effects on fish eggs and larvae

Species	Source	Source level (dB re 1 µPa @ 1m)	Distance from source (m)	Exposure level (dB re 1 µPa)	Observed effect	Reference
Cod (larvae 5 days)	Single airgun	250	1	250	Delamination of the retina	Matishov (1992)
Cod (larvae 2-10 days)	Single airgun	222	1	222	No injuries detected	Dalen and Knutsen (1986)
			10	202	No injuries detected	
Fish eggs (Anchovy)	Single airgun	230 (estimated)	1	230	7.8% of eggs injured relative to control	Kostyvchenko (1973)
			10	210	No injuries detected	
			1	230	No injuries detected	

Species	Source	Source level (dB re 1 µPa @ 1m)	Distance from source (m)	Exposure level (dB re 1 µPa)	Observed effect	Reference
Fish eggs (Red Mullet)			10	210	No injuries detected	
Dungeness Crab (larvae)	Seven airgun array	244 (estimated	1	233.5	No significant difference in survival rate relative to controls	Pearson *et al.* (1994)
			3	230.9		
			10	222.5		
Spiny Lobster (eggs)	Single airgun	45 and 150	n/a	210	No increased mortality or injuries compared to control group	Day *et al.* (2016)
Common Sole (Larvae)	Projector playing pile driving sounds.	n/a	n/a	210	No increased mortality or injuries compared to control group	Bolle (2012)
Lake trout (eggs)	Single airgun	Unknown	2.7	201-232	No increase in egg mortality or larvae survival.	Cox (2011)

Natural mortality rates of marine fish eggs and larvae are generally very high (exceeding 50% per day in some species and commonly exceeding 10% per day). In a review of mortality estimates (Houde and Zastrow 1993), the mean mortality rate for marine fish larvae was M = 0.24, a rate equivalent to a loss of 21.3% per day. Sætre and Ona (1996) calculated that under the 'worst case' scenario, the number of larvae killed during a typical seismic survey was 0.45% of the total population, and they concluded that mortality rates caused by exposure to airgun sounds are so low compared to natural mortality that the impact from seismic surveys must be regarded as insignificant. For a number of fish species, natural mortality is estimated at 5–15% per day. Natural mortality for scampi fished by the NWST Fishery was calculated at 0.46%, while that of prawns is between 0.4 and 0.6% (Larcombe *et al.* 2015).

Currently, there is little understanding of spawning areas and durations for most key indicator species in the NWMR. Glomar Shoal, which has been identified as a potential area important for spawning events due to its high species diversity and supposed productivity, is located ~40 km from the boundary of the full fold acquisition area.

Day *et al.* (2016) looked at the effects of a simulated seismic survey on spiny lobsters and found that "seismic exposure did not result in a decrease in fecundity, either through a reduction in the average number of hatched larvae or as a result of high larval mortality; compromised larvae or morphological abnormalities. These results support the suggestion that early life stage crustaceans may be more resilient to seismic air gun exposure than other marine organisms (Pearson *et al.* 1994 as cited in Day *et al.* 2016)". Received levels were ~211 dB re 1Pa and in agreement with those proposed by Popper *et al.* (2014).

Gausland (2000) in his paper on the impacts of seismic surveys on marine life, noted several studies which confirmed that levels exceeding SPL_{peak} 230-240 dB re 1Pa are necessary for harm to occur and so therefore massive physical damage can only occur within a few metres from the air guns. Consequently, seismic-created mortality is so low that it can be considered to have inconsequential impact on recruitment to the populations.

The recently published study by McCauley *et al.* (2017), conducted in temperate waters of south-east Tasmania, is the first large-scale field experiment on the impact of seismic activity on zooplankton. This study measured zooplankton abundance and the proportion of the population that was dead at three distances from a single 150 cui airgun—0, 200 and 800 m. The experiment estimated the proportion of the zooplankton that was dead, both before and after exposure to airgun noise, using net samples to measure zooplankton abundance, and bioacoustics to identify the distribution of zooplankton. There was movement of water through the experimental area, which made interpreting their results more difficult (Richardson *et al.* 2017).

McCauley *et al.* (2017) provide three findings from the experiment to show that zooplankton were potentially affected by the seismic source:

i) the proportion of the mesozooplankton community that was dead increased two- to three-fold;
ii) the abundance of zooplankton estimated by net samples declined by 64%; and
iii) the opening of a "hole" in the zooplankton backscatter observed via acoustics.

Scientists from CSIRO's Oceans and Atmosphere Business Units were contracted by APPEA to undertake a desktop study that: a) critically reviewed the methodologies and findings of the McCauley *et al.* (2017) experiment; and b) simulated the large-scale impact of a seismic survey on zooplankton in the Northwest Shelf region, based on the mortality rate associated with airgun noise exposure reported by McCauley *et al.* (2017). Separately, the International Association of Geophysical Contractors (IAGC) conducted its own review of the McCauley *et al.* (2017) paper.

Both studies identified potential flaws with the study with the IAGC concluding:

> "*While we found the study interesting, we are also troubled by the small sample sizes, the large day-to-day variability in both the baseline and experimental data, and the large number of speculative conclusions that appear inconsistent with the data collected over a two-day period. Both statistically and methodologically, this project falls short of what would be needed to provide a convincing case for adverse effects from geophysical survey operations.*" (IAGC, 2017).

The major findings of the CSIRO study were that although there was substantial impact of seismic activity on zooplankton populations on a local scale within or close to the survey area, on a regional scale the impacts were minimal and were not discernible over the entire Northwest Shelf Bioregion. Additionally, the study found that the time for the zooplankton biomass to recover to pre-seismic levels inside the survey area was only three days following the completion of the survey (Richardson *et al.* 2017).

Studies (**Table 5.11**) using seismic sources indicate that levels required to result in injury are higher than those presented by Popper *et al.* (2014). Based on the research findings summarised above mortality and potential mortal injury to planktonic organisms, including fish eggs and larvae, are likely to be restricted to very close ranges (tens of metres or less) from the source, and any impacts will be insignificant when compared to rates of natural mortality in planktonic communities. Consequently, mortality and potential mortal injury impacts from airgun noise emissions on planktonic organisms, including the eggs and larvae of species targeted by commercial fisheries, are likely to be minimal, especially when compared to rates of natural mortality in planktonic communities.

Based on the noise modelling, the area where the Popper *et al.* (2014) sound source levels exceed the mortality or mortal injury threshold for fish eggs and larvae is restricted to a distance of <500 m from the 4,120 cui array operating at full power (**Table 5.7**). Consequently, the area where the seismic source will be at full power within the survey area (25,000 km^2; including a buffer zone of 500 m outside the extended area) has been applied to the maximum survey area size giving a total area of 25,600 km^2. However, to be conservative, for this assessment the impact regions as applied in the CSIRO modelling study (Richardson *et al*., 2017) have been used – i.e. survey acquisition area + 2.5 km (~26,400 km^2), and survey acquisition area + 15 km (~33,500 km^2).

From this analysis, mortality or mortal injury may occur to plankton, including fish eggs and larvae, potential impacts are localised (within the operational area) and short term based on estimated recovery times (three days). These potential impacts are not significant when compared to rates of natural mortality in planktonic populations (10 – 50% per day), and impacts are not expected at a regional scale.

Impairment

Based on the application of the Popper *et al.* (2014) semi-quantitative exposure criteria (**Table 5.5**) there is a moderate risk of potential impairment (recoverable injury and TTS) effects to fish eggs and larvae within tens of metres of the source (**Table 5.7**).

Behavioural

Similarly, based on the application of the Popper *et al.* (2014) semi-quantitative exposure criteria (**Table 5.5**) there is a moderate risk of behavioural effects to fish eggs and larvae within tens of metres of the source (**Table 5.7**).

5.1.5.5 Benthic Invertebrates

Receptor sensitivity

The limited acoustic sensitivity of decapods (including crabs, prawns and scampi) is mainly due to their lack of gas-filled spaces, such as swim bladders, and are unable to detect the pressure component of sound waves (Parry & Gason 2006; Carroll *et al.* 2016). Instead, most decapod crustaceans have organs or elaborate arrays of tactile 'hairs', known as mechanoreceptors, that are sensitive to hydro-acoustic disturbances and generally understood to detect seismic sounds at close range (McCauley 1994; Christian *et al.* 2003; Parry & Gason 2006; Edmonds *et al.* 2016; Carroll *et al.* 2016). No long term community or population level impacts on invertebrate's communities have been found to occur from seismic exposure.

In a review, Moriyasu *et al.* (2004) provided a summary of impacts of seismic airguns on marine invertebrates based on literature reviews. They concluded 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 (see Table 5.12). One study showed physiological impacts, and another showed no physiological impact. Three cases showed behavioural impacts, and one study showed no impact on behaviour.

Caged squid (*Sepioteuthis australis*) subjected to an individual operating airgun showed behavioural changes and avoidance (McCauley *et al.* 2003; cited in Moriyasu *et al.* 2004 as McCauley *et al.* 2000a). They found an alarm response at 156–161 dB re1µPa, and a strong startle response at 174 dB re 1µPa involving ink ejection and rapid swimming. The caged squid also moved to the sound shadowed area of the cage. The authors suggested thresholds for affecting squid's behaviour were at 161–166 dB re 1 µPa.

Table 5.12 - Summary of impacts on marine invertebrates based on literature reviews

	Lethal / physical	Physiological / pathological	Behavioural	Catch rate
Negative impacts observed	*Loligo vulgaris* *Chionoecetes opilio* (eggs) *Chlamys islandicus* Sea urchins *Architeuthis dux*	*Bolinus brandaris*	*Alloteuthis sublata* *Sepioteuthis australs* *Architeuthis dux*	*Bolinus brandaris*
No impacts observed	*Chionoecetes opilio* *Mytilus edulis* *Gammarus locusta* *Crangon*	*Chionoecetes opilio*	*Chionoecetes opilio*	*Crangon* *Penaeus blebejus* *Nephrops norvegicus* *Illes coindetti* *Squilla mantis* *Paphia aurea* *Anadara inaequivalvis*

Crustaceans

There has recently been a number of comprehensive reviews of seismic noise impacts to invertebrates—e.g. Carroll *et al.* (2017), Edmonds *et al.* (2016) and Salgado Kent *et al.* (2016). Studies specific to prawn species are limited, however, a number of studies have been undertaken on decapods with a range of effects to no effects identified.

Mortality/potential mortal injury

The review by Salgado Kent *et al.* (2016) supported a finding that there was no evidence in the current literature of direct mortality of crustaceans from seismic exposure. A range of physiological responses have been

identified in some studies, however; the received sound levels are typically at levels that would be received within a few hundred metres from the sound source or have been from repeated exposure at the same sound levels which is not realistic in an actual survey.

As summarised by Carroll *et al.* (2017) "*Previous field-based studies on adult populations revealed no evidence of increased mortality due to airgun exposure in …..lobsters up to eight months after exposure (Payne et al., 2007; Day et al., 2016a). Similarly, there was no evidence of mortality-associated population effects such as reduced abundance or catch rates in …… reef-associated invertebrates four days after exposure (Wardle et al., 2001), snow crabs up to 12 days after exposure (Christian et al., 2003), shrimp two days after exposure (Andriguetto-Filho et al., 2005), or lobsters weeks or years after exposure (Parry and Gason, 2006).*"

No exposure criteria currently exist to enable an evaluation of potential mortality/potential mortal injury effects in crustaceans. However, based on the research findings to date these effects are likely to be confined to extremely close ranges (i.e. <10 m) from the source.

Impairment / behavioural

Edmonds *et al.* (2016) identified that sensitivity to underwater noise is shown by the Norway lobster and closely related crustacean species, including juvenile stages. They concluded that current evidence supports physiological sensitivity to local, particle motion effects of sound production.

Christian *et al.* (2003; as cited in Moriyasu *et al.* 2004) examined a series of morphological and physiological characteristics, i.e. haemolymph, hepatopancreas, heart, heads (statocysts, green glands, and brains), gills and gonads. They did not find significant effects on the physiological components of tested animals, but they noted that embryonic development of external eggs may be delayed after being exposed to seismic airguns (Christian *et al.* 2003; as cited in Moriyasu *et al.* 2004).

Day *et al.* (2016) evaluated the acoustic impacts from seismic exposure on southern rock lobsters (*Jasus edwardsii*) in Australia. The results showed no evidence of lobster mortality for any experiment, nor evidence of impact to lobster embryos, which were described as resilient to the acoustic exposure. Haemolymph biochemistry showed little effect from exposure. However, reflex behaviours, sensory hairs and biochemistry indicated increased levels of impairment and/or damage, all of which have the potential to compromise other behaviours and biological responses, although any long-term effects were only hypothesised. Although overall the impacts to lobsters were limited, the results still need to be interpreted with caution as the individuals were maintained in pots and prevented from swimming away to avoid the sound source, and were undertaken in water much shallower (10–12 m) than the NWSR North acquisition area (>200 m depth).

In the Day *et al.* (2016) study the measured exposures observed in any experiment from the sea noise loggers were 186-190 dB re 1µPa^2.s SEL and 209 -212 dB re 1µPa SPL_{pk-pk}, the latter being equivalent to an SPL_{peak} of ~203-206 dB re 1µPa. For the purposes of this assessment a threshold exposure criterion of 203 dB SPL_{peak} has been applied with respect to determining potential impairment and behavioural impacts in benthic crustaceans, including prawns, crabs, scampi and bugs. Based on the CMST modelling, predicted SPL_{peak} level of 203 dB could occur at the seabed directly under the source in as much as 1000 m water depth. Further modelling indicates that in 100 m water depth, 203 dB_{peak} may occur out to a maximum distance of 450 m from the 4,120 cui array (or 200 m based on SEL 186dB). As the use of the 4120 cui source is limited to 200m, this distance of effect will likely be reduced. Thus, there is the potential for impairment and behavioural effects to occur in crustaceans (**Table 5.8**).

Catch rates

A number of studies examined the potential effects of seismic surveys on catch levels in fisheries targeting benthic crustaceans, such as prawns and rock lobster. After being exposed to sound levels of 197–237 dB from an airgun array, Christian *et al.* (2003; as cited in Moriyasu *et al.* 2004) did not detect effects on the behaviour of snow crabs (*Chionoecetes opilio*) placed in cages and put on the ocean bottom at a depth of 50 m. Additionally, this study found no effects on catch rate of snow crab by comparing pre- and post-seismic testing. The catch rates were even higher in post-seismic fishing than pre-seismic fishing. The authors concluded that this was likely due to physical, biological or behavioural factors unrelated to the seismic source.

Andriguetto-Filho *et al.* (2005) investigated the effect of seismic surveys on prawn fisheries in relatively shallow waters (2–15 m) in Camamu Bay, north-western Brazil. Catch rates of various shrimp species were measured before and after use of a four-airgun array with a source peak pressure of 196 dB re 1µPa at 1 m. Catch rates were found to be unaffected. The experiment was carried-out over a period of a few days, whereby in-migration would not be a confounding factor. It is also noted that the authors carried out histopathological studies on gonadal and hepatopancreatic tissue and reported no damage associated with sound exposure. This study did not detect any significant deleterious impacts of seismic airgun noise on various penaeid species, suggesting that prawn stocks are resilient to the disturbance by airguns under the experimental conditions applied.

This study is supported by pilot observations carried out by the DFO on commercially-important northern shrimp (*Pandulus borealis*), in which "flight or fright" reactions were not found in animals exposed to relatively high sound levels in the laboratory (DFO 2008). Although crustaceans can be expected to detect the particle motion component of sound (as revealed by sensitive electrophysiological or other techniques), this did not mean that they would be "scared" and subsequently move away from a seismic operation, thereby causing ramifications for catchability.

In 1991, commercial trawl catches of prawns off Sydney, New South Wales, declined over the four months that followed a seismic survey, but this was consistent with a seasonal decline in catches over those months during the previous 15 years (Steffe and Murphy 1992 as cited in NSW DPI 2014). Likewise, following 33 seismic surveys conducted offshore from western Victoria between 1978 and 2004, there was no evidence of long-term declines in commercial catch rates of rock lobsters, and no short-term changes in catch rates were detected in three areas subject to more intensive 3D seismic surveys (Parry and Gason 2006). In contrast, anecdotal information from Newfoundland indicated that a school of shrimp observed via a fishing vessel sounder shifted temporarily downwards and away from a nearby seismic airgun sound source.

Impacts to State and Commonwealth Commercial Crustacean Fisheries

Crustacean fisheries with management areas that overlap the operational area include:

- North Coast Prawn Managed Fisheries:
  - Nickol Bay Prawn Managed Fishery
  - Onslow Prawn Managed Fishery
- West Coast Deep Sea Crustacean Managed Fishery
- North West Slope Trawl Fishery
- Western Deepwater Trawl Fishery

As the areas actively fished by the North Coast Prawn Managed Fisheries are generally restricted to shallow, inshore waters, the NWSR North operational area is more than 100 km away at which point received levels are below threshold levels that may result in impairment or behavioural changes in prawns. Consequently, it is assessed that seismic surveys being undertaken within the NWSR North operational area will have limited impact on the north coast prawn managed fisheries.

The WCDSCF targets deep sea crabs in waters deeper than 150 m, although it mainly operates in waters between 500-800 m. At such depths, anticipated received levels would be between SPL_{pk} 209 dB re 1Pa to less than 198 dB re 1Pa. Based on a behavioural threshold of SPL_{pk} 203 dB re 1Pa, there may be some impacts to individuals in waters shallower than 1000 m and some catch rates could be affected. As indicated in information presented above, it is unlikely that seismic activities will result in mortality but could result in impairment/ behavioural changes only in individuals. However, the majority of catch is south of Exmouth and outside the operational area. This is also confirmed through stakeholder consultation in which it was stated "I confirm to you that we have no interest in receiving seismic survey advices for any surveys being conducted north of Exmouth". Consequently, it is assessed that seismic surveys being undertaken within the NWSR North operational area will have limited impact on deep sea crabs or WCDSCF fishing activities.

The NWSTF mainly targets scampi which typically occurs at depths of 350–600 m (although more commonly in waters of 420-500 m on the continental slope). At these depths, received levels may be between SPL_{pk} 212

dB re 1Pa to less than 207 dB re 1Pa. Based on a recoverable injury and behavioural thresholds of SPL_{pk} 203 dB re 1Pa, there may be some impacts and catch rates could be affected on a short-term basis only. As indicated in information presented above, it is unlikely that seismic activities will result in mortality but could result in impairment/ behavioural changes. The operational area only overlaps a portion (~ 38,000 km^2) of the recognised 2015-2016 fishing areas within the larger fishery management area. The largest survey that TGS may undertake under the EP is 25,000 km^2 which only covers 6.3% of the NWST fishery (even accounting for impacts out 450 m from the vessel, possible overlap is not significantly different, increasing to only 6.4%). However, assuming that fishing occurs where the target species are located (based on catch data available through FishCube), only 1.1% of the fishery is likely to be overlapped and affected by the seismic activity.

As the fishery operates year-round, it is not possible to avoid fishing periods, and peak fishing times have not been identified. No responses to consultation (AFMA, CFA or individual vessel operators) have been received in relation to this fishery. Only two vessels are currently operating in the fishery and fishing levels are low. Consequently, with proposed control measures in place including a reduced operational area, limits on the size of acquisition (25,000 km^2) to be undertaken over the 2 years life of the EP, the large fishing area to be targeted by only 2 vessels and that the majority of fishing occurs around the Rowley Shoals (and so it is assumed that this is where the majority of scampi will be living and spawning), it is assessed that seismic surveys being undertaken within the NWSR North operational area will have limited impact on individual scampi or prawns or NWST fishing activities and catch rates.

Between 2000 and 2005, deepwater bugs emerged as the most important target species for the WDTF. At depths of 200 m, received levels would be SPL_{pk} ~217 dB and so could result in behavioural changes and possible loss of catches to the fishery. Based on evidence presented above, such levels are unlikely to result in mortality, but could result in impairment. Although the WDTF has not operated since 2013-2014, if it was to recommence, the largest survey size (being 25,000km^2) that TGS could undertake under the scope of this EP would only overlap the fishery by 3.49%. Based on the above information, seismic operations within the NWSR North operational area will have limited impact (impairment/ behavioural) on deepwater bugs and the WDTF fishery.

Molluscs

Little is known about sound detection in invertebrates. Many molluscs, including bivalves, possess statocysts, which are organs that assist the organism in maintaining balance and orientation in its immediate environment. Limited 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. Wethey and Woodin (2005) concluded that coquina clams could probably detect defecation signals generated by a polychaete worm at a distance of 60 cm in sediment.

Mortality/potential mortal injury and impairment

Based on a number of previous papers, including a comprehensive literature review (Moriyasu *et al.* 2004), studies on the effects of underwater noise from seismic airguns on molluscs are very limited. Earlier studies examined the impacts of explosives, used as a sound source in seismic refraction surveys, on a number of bivalve molluscs including the pearl oyster (*P. maxima*) and the American oyster (*Crassostrea virginica*).

Seismic airguns cause less impacts on benthic invertebrates than explosives and generate a lower maximum pressure. They cause a lower rate of pressure change, and pathological effects (particularly for organisms with gas-filled internal organs such as swim bladders) are only likely at extremely close distances (within a few metres) of an acoustic source. No bivalve molluscs possess gas-filled internal organs that would make them more susceptible to pathological effects from underwater noise sources.

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. However, other studies have also suggested that most effects on invertebrates without gas-filled cavities are likely to be too subtle to be measured in the field (Parry and Gason 2006).

There are only a handful of studies that examined the potential effects of seismic airgun noise on bivalve molluscs. **Table 5.13** presents a summary of the results of these studies.

From 2013–2015, a long-term study evaluated the acoustic impacts from seismic exposure on scallops (*Pecten fumatus*) in Australia (Day *et al.* 2016). The experimental field research maintained the scallops in mesh enclosures while a vessel with the acoustic source passed within close proximity to the animals. Sea noise loggers measured maximum sound levels at SEL 188 dB re 1 $\mu Pa^2.s$ and SPL_{pk-pk} 213 dB re 1 µPa. There was no mass mortality after acoustic exposure. Although Day *et al.* (2016) indicated that mortality risk increased significantly with time, this actually translates to a minimal increase of only ~1%- "*Compared with unexposed scallops, the daily mortality odds were found to be 0.1%, 1.2% and 1.3% higher in scallops exposed to 1, 2 and 4 passes respectively*".

Scallop behaviours, osmoregulation and biochemistry levels were altered following acoustic exposure, and further investigation will be required to determine ecological and long-term impacts to the species and relevant commercial fisheries. Scallop larvae were not used in this experiment (i.e. adults only), and potential impacts to other life stages were not measured and remain unknown. The ecological implications of these impacts were not evaluated within the scope of the experiments, and the results should be interpreted with caution, particularly as the scallops were maintained in mesh enclosures and prevented from swimming away to avoid the sound source and were undertaken in shallow waters (10–12 m).

Another recent study on the potential short-term impacts of marine seismic surveys on scallops in the Gippsland Basin was undertaken in response to stakeholder concerns from the fishing industry about an April 2015 seismic survey in the Gippsland Basin (Przeslawski *et al.* 2016). Sound monitoring was undertaken for the 2015 seismic survey using four calibrated acoustic recording units that were moored at varying seafloor depths (44–70 m) within the study area, including one control >25 km from seismic survey operations, with a dynamic range of SPL up to 165 dB re 1 µPa. The highest SEL recorded by the hydrophones was 146 dB re 1 $\mu Pa^2.s$ at 51 m water depth, at a distance of 1.4 km from the airguns (Przeslawski *et al.* 2016). The authors concluded that these SELs did not cause mass mortalities two months after sound exposure, such as that observed previously in 2010. Scallop density was low, and long-term and sub-lethal effects remain unknown. Such mortality events are more likely due to other stressors (e.g. disease outbreaks, heat waves, etc.) or a combination of stressors of which noise exposure may be included. However, this theory warrants further research.

Although studies have not necessarily looked at the effects of seismic sources on the pearl oyster directly, it is apparent that 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 and at a minimum exposure range of 1 m from the blast centre.

Seismic sources cause less impacts on benthic invertebrates than explosives, hence it is likely that bivalves, such as *P. maxima*, would have to be within a very close range of an airgun source to experience pathological damage or mortality: available evidence would suggest ~1–2 m. It is more difficult to determine the distances at which sub-lethal effects (such as morphological, biochemical and physiological changes being indicators of some level of stress in an animal) could occur. Again, there are limited studies done specifically on the pearl oyster, and so conclusions must be drawn from studies done on similar bivalve species.

La Bella *et al.* (1996) examined biochemical indicators of stress in bivalves exposed to seismic airgun noise and found that hydrocortisone, glucose and lactate levels between test and control animals were significantly different ($P > 0.05$) in the venerid clam, showing evidence of stress caused by acoustic noise. This was at a minimum exposure range of 7.5 m.

Table 5.13 - Impacts of seismic acoustic sources on several bivalve molluscs

Species	Noise Source	Source Level (dB re 1µPa at 1 m)	Distance from source (m)	Estimated Exposure Level (dB re 1µPa)	Observed Effects	Reference
Blue mussel (*Mytilus edulis*)	Single airgun, 60-80 cui	223 (assumed)	0.5 -2.0	229	No detectable effect over 30 days at distance of 0.5 m.	Kosheleva (1992)
Icelandic scallop (*Chlamys islandicus*)	Single airgun	223 (assumed)	2.0	217	Shell split in one of three animals exposed at 2.0 m.	Matishov (1992)
Venerid clam (*Paphia* aurea) Arc clam (*Anadara inaequivalvis*)	16 airgun array	210	7.5	N/A	No difference in *P. aurea* and *A. inaequivalvis* catch levels caught by hydraulic dredge. Hydrocortisone, glucose and lactate levels between test and control animals were significantly different (P >0.05) in *P. aurea*, showing an evidence of stress caused by acoustic noise.	La Bella *et al.* (1996)
Scallop	Airgun array	N/A	N/A	N/A	No evidence that seismic surveys had affected CPUE of scallops and attributed a decline in scallop CPUE coincident with a 3D seismic survey to two years of poor recruitment prior to the seismic survey.	Brand and Wilson (1996); cited in Parry and Gason (2006)
Commercial scallop (*Pecten fumatus*)	24 airgun array	255	11.7	230	No increase in mortality over 17 days when compared to controls. No difference in adductor muscle strength between exposed and control animals. No major difference in the abundance of plankton (including bivalve larvae) behind the seismic survey vessel from their abundance before the passage of the vessel or 2 km distant from the vessel.	Parry *et al.* (2002)
Sea scallop (*Placopecten magellanicus*)	Single airgun, 8 cui	N/A	1.0	N/A	No immediate mortality within 48 hours.	Payne and Christian (unpublished); cited in Moriyasu *et al.* (2004)
Commercial scallop (*Pecten fumatus*)	Airgun array, 4,130 cui	264	N/A	N/A	No change in the abundance of live scallops (or related change in dead scallop categories) or macroscopic gonad and meat condition was detected after seismic surveying within either the control, impacted or semi-impacted strata. No observable change in the size frequency distribution of scallops in the impacted and semi-impacted strata following seismic surveying. The conclusion was that no short-term (<2 months impacts on the survival or health of adult commercial scallops were detected post the seismic survey.	Harrington *et al.* (2010)

Behavioural

In the Day *et al.* (2016) study, the measured exposures observed in any experiment from the sea noise loggers were 181-189 dB re 1µPa^2.s SEL and 191-213 dB re 1µPa $_{pk-pk}$. Based on this broad spectrum, it is reasonable to assume that behavioural impacts may be associated with the lower received levels and so could occur in depth to 700 m. Modelling indicates that in 100 m of water, levels of 181 dB re 1µPa^2.s SEL will be received ~400-500 m away on the seafloor. For surveys conducted under the NWSR North EP there will be no seismic acquisition in water depths <200 m at which point levels would be decreased and so impacts would be limited to closer distances.

Catch rates

La Bella *et al.* (1996; as cited in Moriyasu *et al.* 2004) reported that no apparent changes in trawl catches were found in short-finned squid (*Illex coindetti*) nor in Norway lobster (*Nephrops norvegicus*) in the area prospected one day before at sound source levels of 210 dB re 1µPa at 1 m (corresponding to levels of 149 dB re 1µPa at animal location). The same authors reported no apparent catch reductions in mantis shrimp (*Squilla mantis*), golden carpet shell (*Paphia aurea*), inaequivalvis ark shell (*Anadara inaequivalvis*) or purple die murex (*Bolinus brandaris*) exposed to the same sound level mentioned above. However, purple die murex showed a significant difference in catch rate, and it was concluded that this is a change in behavioural reaction to seismic guns rather than immediate mortality (La Bella *et al.* 1996; as cited in Moriyasu *et al.* 2004).

In the past, commercial scallop fishermen expressed concerns about the potential impacts of seismic surveys on their catch levels. In a study off the Isle of Man, Brand and Wilson (1996) assessed the effect of seismic surveys in the field by comparing long-term catch-per-unit-effort (CPUE) of commercial scallops with CPUE following a seismic survey. They found no evidence that seismic surveys affected CPUE of scallops and instead attributed a decline (coincident with a 3D seismic survey) to two years of poor recruitment prior to the seismic survey.

Similarly, in the Bass Strait, scallop fishermen expressed concern that seismic acquisition might kill scallops (*Pecten fumatus*), weaken their adductor muscles (indicator of sub-lethal effects) or increase the mortality of larval scallops. In a study conducted by the Victorian Marine and Freshwater Research Institute (MAFRI), the effects of seismic airgun noise were measured by comparing the mortality and adductor muscle strength of scallops deployed in an area exposed to passes of a survey vessel towing an operating 24-airgun array, with those in a control area 20 km away from the test area (Parry *et al.* 2002). The effects of seismic testing on plankton, including larval scallops, were measured by comparing plankton communities immediately behind the seismic vessel with those sampled before and 2 km away from the seismic testing. This study found that mortality rate and adductor muscle strength of scallops suspended in the water column and exposed to the operating airgun array (at a minimum distance of 11.7 m) was not significantly different from the controls. Similarly, there was no major difference in the abundance of plankton behind the seismic survey vessel from their abundance before the passage of the vessel or 2 km away from the vessel. High levels of variability in plankton communities meant that only large changes would have been detected, but the available literature suggested that effects on plankton are confined to ranges within 5 m of airguns (Parry *et al.* 2002).

A more recent study conducted by the Tasmanian Aquaculture and Fisheries Institute (TAFI) assessed the immediate impact of seismic surveys on the health and abundance of adult commercial scallops (*P. fumatus*) in the Bass Strait (Harrington *et al.* 2010). Considered to represent sub-lethal impacts, gonad and meat condition were assessed following a three-month seismic acquisition programme using a 4,130 cui seismic source. The study found no change in the condition or abundance of live scallops in the impacted site compared to a control site, with gonad condition, meat size and meat texture remaining relatively unchanged. There was also no observable change in the size frequency distribution of scallops in the impacted and semi-impacted sites following the seismic survey. The conclusion was that no short-term (<2 months) impacts on the survival of adult commercial scallops were detected after the seismic survey.

A recent critical review of the potential impacts of marine seismic surveys on fish and invertebrates (Carroll *et al.* 2017) concluded that:

"*For marine invertebrates, the potential effects of seismic signals on catch rates or abundances have been tested on cephalopods, bivalves, gastropods, decapods, stomatopods, and ophiuroids with no significant differences detected in any of these studies between sites exposed to seismic operations and those not exposed*".

Pearl oyster

The pelagic phase of a pearl oysters lifecycle lasts for 28–35 days, after which they become a benthic sedentary bottom-dweller. Losses in the water column during the planktonic stage are extremely high, and <1% of the fertilised eggs actually survive the veliger stage (PPA 2008). It is during the pelagic phase that they are more likely to be impacted by seismic surveys. Peak spawning periods are from October–December and then again from February–March.

In 2006, the DoF *Ecologically Sustainability Development (ESD) Report for the Pearl Oyster Fishery* stated that pearl oysters are known to occur in water depths of 0–50 m off the coast of WA. However, correspondence with the Pearl Producers Association (PPA) point towards pearls, and thus larval broodstock, as far out as the 100 m contour. This appears to be an overly conservative limit. Email correspondence with Dr Hart (DoF as recalled in personal email via PPA) indicated that a document called *Pearl Ecology* (Eds. Southgate, P.C. and Lucas J.S. 2008) is the source of both the PPA and DoF rationale for the 100 m distribution limit. The document (pg. 59) stated that "the individuals are typically found in shallow waters of littoral and sublittoral zones occasionally reaching the maximal recorded depths of 100–120m", while pg. 313 stated that 'some early reports from the Sulu Islands in the Philippines suggested that maxima live as deep as 120 m'. However, this latter statement is based on observations from 1930 in the Philippines and so not contemporary nor relevant to the operational area.

Another study (Condie *et al.* 2006) investigated recruitment at Eighty Mile Beach, and results indicated that spawning in the region is concentrated between 8 and 15 m water depth, with potential smaller contributions from further northeast. These spawning events were likely to lead to successful recruitment along to the southwest, so that the main pearl oyster producing populations are likely to be self-seeding. These also feed larvae into neighbouring shallow waters and deeper waters to the west (~20 m). High numbers of mother of pearl in deeper waters (~30 m) appear to be the result of larvae transported from in-shore populations.

An assessment of potential control measures to reduce the impacts and risks to the pearl oyster stocks during surveys undertaken in the NWSR North operational area was undertaken and is summarised below. The waters overlapped by the NWSR North acquisition area are outside the 200 m contour and more than 200 km from Eighty Mile beach, and acquisition would occur over areas that are not considered critical to the fishery.

Summary

Based on the best available scientific information, significant impacts on benthic invertebrates from discharge of the acoustic array are likely to be confined to very close ranges to the source (a few tens of metres) and be short to medium term (hours to days) in duration. Lower level impairment and behavioural effects to benthic invertebrates could occur out to greater distances from the source (<1000 m) but similarly, these impacts are likely to be short to medium term (hours to days, perhaps weeks) in duration. Population level effects are highly unlikely to occur as a result of impacts to benthic invertebrates within the NWSR North operational area. For these reasons it is highly unlikely that seismic acquisition within the NWSR North operational area will have any discernible impacts on catch rates of commercial fisheries targeting prawns and molluscs. Given that there will be no acquisition in water depths <200 m there will be no overlap between proposed seismic acquisition and the operations of either prawn fisheries or the pearl oyster fishery.

5.1.5.6 Fish

The critical issue for understanding whether an anthropogenic sound affects hearing is whether it is within the hearing frequency range of a fish and loud enough to be detectable above threshold. For this impact assessment, it is assumed that all fishes have hearing within a frequency range of 0-200 Hz and so can 'hear' the seismic source.

Potential impacts on fish species related to the operation of survey acoustic arrays include behavioural avoidance of seismic sound sources, TTS or PTS, stress, pathological trauma or mortality. Indirect effects may include reduced catches resulting from changes in feeding behaviour or vertical/horizontal distribution (Skalski *et al.* 1992).

Mortality/potential mortal injury

No studies to date have demonstrated direct mortality of adult fish in response to acoustic emissions, even when discharged at close proximity (within 1–7 m; DFO 2004; Boeger *et al.* 2006 as cited in NSW DPI 2014; Popper *et al.* 2014). Caroll et al (2017) conclude that "*For fish, there are few data on the physical effects of seismic airguns (e.g. mortality, barotrauma), and of these none have shown mortality*." Although some fish deaths have been reported during cage experiments, these were more likely caused by experimental artefacts of handling or confinement stress (Hassel *et al.* 2004 as cited in NSW DPI 2014). For free-swimming fish that are able to move away from seismic sources as they approach, the potential for lethal physical damage from acoustic emissions is even further nullified. However, reef or bottom-dwelling fish that show greater site attachment may be less inclined to flee from a seismic sound source and experience greater effects as a consequence.

Other than physiological stress responses or hearing loss, no other physical damage to adult fish or invertebrates have been directly attributed to exposure to airgun discharges, even at close proximity (NSW DPI 2014).

An exposure threshold of >220 dB SPL_{peak} for mortality and potential mortal injury to fish has been applied for this impact assessment, rather than the more conservative criteria included in Popper *et al.* (2014). Based on calculations of noise levels directly beneath 4,120 cui array and the CMST modelling received levels (RL) >220 dB SPL_{peak} could occur at the seabed in water depths <150 m. In the horizontal plane, RL >220 dB could occur within a maximum distance of ~100 m from the source.

Impairment

Based on the application of the exposure criteria for fish described by Popper *et al.* (2014) and the CMST modelling outputs, recoverable injury effects could occur out to horizontal distances of ~225 m (for fish without a swim bladder) or ~450 m (for fish with a swim bladder) from the 4,120 cui array.

The level and duration of exposure that causes TTS varies widely and can be affected by factors, such as repetition rate of the sound, pressure level, frequency, duration and health of the organisms. By definition, hearing recovers after TTS. The extent (how many dB of hearing loss) and duration of the TTS may continue from minutes to days after exposure.

A study of auditory brainstem response (ABR) in four species of tropical reef fishes following exposure to emissions from a 2,055 cui array at Scott Reef showed that none of the four species, including the pinecone soldierfish (a hearing specialist) experienced any hearing sensitivity loss (i.e. TTS) following exposure to SEL_{cum} up to 190 dB re 1 μPa^2.s (Hastings *et al.* 2008). These numbers are similar to sound exposure guidelines proposed in Popper *et al.* (2014), which indicated that TTS may occur at SEL_{cum} levels >186 dB re 1μPa^2.s, while other studies (Popper and Hastings 2009; Song *et al.* 2008) indicate that TTS may occur at levels as high as SPL_{peak} 205-210 dB re 1µPa.

Based on a threshold SPL_{peak} of 205 dB re 1µPa and the CMST modelling outputs, temporary impairment due to TTS could occur within a horizontal distance of ~550 m from the 4,120 cui array. While experiencing TTS, fishes might have decreased fitness in terms of communication, detecting predators or prey, and/or assessing their environment. It is not possible to quantify the number of fish that might experience TTS during a survey. However, the key species found within the operational area have widespread distributions and the operational area does not contain any critical habitat or threatened or listed species. Therefore, whilst fish in close proximity of the array (assuming they do not move away) may suffer TTS, impacts at a population level are not expected to occur.

Fish will recover completely from TTS, and the limited data available for seismic airguns indicates that this occurs within 18-24 hours after exposure (Popper *et al.* 2005), although The US National Marine Fisheries

Service (NMFS) applies a "resetting" of SEL_{cum} after 12 hours of non-exposure (Stadler and Woodbury 2009). Depending on the size of the survey area, and with the racetrack formation utilised by TGS for 3D surveys, it is anticipated that it will be at least 12 to 24 hours before an adjacent area (more than 1 km away based on the size of the array spread) is shot, ensuring minimal cumulative impacts. Within the operational area there are no habitats that could support site attached fish species. Regardless, TTS effects on any site-attached fish communities within the operational area are expected to be limited to a timeframe of hours to one day, with no likelihood of cumulative effects occurring from acquisition of adjacent lines, for the reasons outlined above. Consequently, impacts are anticipated to be no more than temporary and recoverable.

Other sub-lethal effects from exposure to airgun emissions include physiological stress responses. An increase in stress (as indicated by changes in blood and tissue chemistry) was detected in caged European sea bass exposed to air guns fired in the open ocean at a distance of 180-800 m (La Bella *et al.* 1996). Recovery to pre-exposure levels was recorded within 72 hours after emissions ceased and no physical damage was observed (DPI 2014). In contrast, McCauley *et al.* (2000) detected no significant changes in similar stress response blood metabolites in fish that could be directly attributed to air-gun exposure.

The assessment of physiological effects of airgun sounds on fish species have usually involved exposure of captive or caged fish to nearby sound sources. Studies with caged fish (Kosheleva 1992; McCauley *et al.* 2003) have shown that some fish species that are caged, and therefore unable to swim away from the noise source, can suffer physiological damage to eyes and hearing. It is unknown whether free-swimming fish that could move away from the seismic sound source would show similar responses. Furthermore, it is possible that the stress responses have arisen because fish try to escape from the sound source and are unable to because of their confinement, rather than from the sound source itself.

Behavioural

Behavioural responses to sounds are variable but include:

- leaving the area of the noise source (avoidance; Skalski *et al.* 1992; Wardle *et al.* 2001);
- startle/ alarm responses (Pearson *et al.* 1992; Wardle *et al.* 2001);
- spatial changes in schooling behaviour/ swimming patterns (Slotte *et al.* 2004; Woodside 2007); and
- changes in depth/ vertical distribution (Pearson *et al.* 1992; Slotte *et al.* 2004; Woodside 2007).

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 (DFO 2004). The ecological significance of such effects is expected to be low, except where they may influence reproductive activity.

For some fish, strong 'startle' responses have been observed at sound levels of 200 to 205 dB re 1µPa, indicating that sounds at or above this level may cause fish to move away from the vessel. Except for directly under a sound source, sound levels of this level would only occur ~325 m from the 4,120 cui airgun array and thus is the distance at which fish may move away from an operating array and below which physical effects may occur (McCauley 1994). However, a study by Wardle *et al.* (2001) found that only when the airgun bubble oscillations were visible to the fish, did the fish react directionally to the gun. In addition, they found that schooling reef fish swam past the gun rack, apparently undamaged, at an equivalent pressure and rise that would be received at about 20 m below a survey array of 30 airguns.

Other studies (McCauley *et al.* 2000) have found that active avoidance may occur in some fish species at sound levels of ~161–168 dB re 1µPa rms (~175-183 SPL_{peak}), which corresponds to a horizontal distance ~15 km from the 4,120 cui array. These latter levels are more in line with levels as cited by Woodside (Woodside 2007):

- Low level behavioural effects:
    - avoidance at >140 dB re 1µPa^2.s (pelagic species and the more nomadic demersal species), a distance of ~20 km from the 4,120 cui source;
    - startle/alarm at >160 dB re 1µPa^2.s (species with limited home ranges or site-attached and/or territorial strategies), a distance of ~5 km from the 4,120 cui source.

- high level behavioural effects
    - fright/flight at >180 dB re 1µPa^2.s (species with limited home ranges or site-attached and/or territorial strategies; Woodside 2007), a distance of ~500 m from the 4,120 cui source.

Fewtrell and McCauley (2012) identified that fishes tended to remain lower in the water column and/or swim faster and form tighter schools during periods of close air-gun emissions. Similar behavioural responses such as changes in vertical distribution or schooling behaviour were also identified by Wardle *et al.* (2001) as Hassel *et al.* (2004, as cited in Fewtrell and McCauley 2012). A return to normal behavioural patterns was observed within 14-30 minutes after airgun emissions ceased. Wardle *et al.* (2001, as cited in Popper and Hastings 2009) found that fish and invertebrate on a rocky reef in Scotland only showed minor behavioural responses to an airgun with a measured peak level of 210 dB re µPa at 16 m and 195 re µPa at 109 m.

Available evidence suggests that behavioural changes for some fish species may be no more than a nuisance factor, and that within a few seconds they continue their previous activity. The temporary, short-range displacement of pelagic, demersal or migratory fish populations may have insignificant repercussions at a population level (McCauley 1994). For site-attached reef fish, spatial patterns of richness, abundance and diversity did not change after airgun noise emissions (Woodside 2007, Miller and Cripps 2013).

5.1.5.7 Impacts to Commercial Fisheries

Catch Rates

Increased sound levels associated with seismic acquisition may modify the behaviour, local abundance and distribution of commercially targeted fish species in proximity to the operational area, which could affect commercial catch rates.

The potential effects of seismic surveys on fish distribution, local abundance or catch has been examined for some teleost species with varying results (Carroll *et al.* 2017). Studies suggest that fish will generally move away from a loud acoustic source in order to minimise their exposure, but this response might depend on the animal's motivational state.

One comprehensive study by Engås *et al.* (1996) observed cod and haddock moving back to an area 3-5 days after shooting, and Slotte *et al.* (2004) observed movement of large masses of blue whiting and herring towards and into the survey area 3-4 days after seismic shooting, indicating that migrations will proceed as normal, soon after a seismic survey. Similarly, studies on rockfish (Skalski et al 1992) in California and demersal species in Norway (Dalen and Knutsen 1987) indicated that fish moved to the bottom away from the source, as opposed to fleeing the area. Therefore, any disruptions should only be short-term and during the course of the survey, with conditions returning to 'normal' levels soon after.

However, not all results from studies have resulted in behavioural alteration. Feeding Atlantic herring (*Clupea harengus*) schools off northern Norway showed no changes in swimming speed, direction or school size in response to a transmitting seismic vessel as it approached from a distance of 27 to 2 km, over a 6-hour period (Peña *et al.* 2013). As fishing areas are large and commercial fish species are free-swimming, if fish are 'scared' temporarily from an area, based on evidence presented, it is likely they will be displaced temporarily to another area still within the fishing zone, and so able to be caught.

Aside from the possible physical exclusion of fishing vessels from seismic survey areas, changes in the horizontal and vertical distributions of fish or other behavioural changes during or after exposure to seismic signals may influence catches of commercial and recreational fisheries.

Short-term effects on commercial and recreational catches may occur within and around a survey area. However, sound effects on fishing catches are somewhat equivocal because of the lack of determination between natural movements and changes in fish.

Studies undertaken by Lokkeborg *et al.* (2012) demonstrated that gillnet catches increased substantially for redfish (86 % increase) and Greenland halibut (132 % increase) during seismic shooting on a Norwegian fishing

ground. However, longline catch rates fell (16% for Greenland halibut, 25% for haddock). These contrary results were explained by greater swimming activity versus lowered food search behaviour in fish exposed to air-gun sound emissions. Although catch rates changed in all species studied (including saithe and ling), except for saithe, acoustic mapping of fish abundance did not suggest displacement from fishing grounds.

A recent critical review of the potential impacts of marine seismic surveys on fish and invertebrates (Carroll *et al.* 2017) found that other studies on fish have found positive, inconsistent, or no effects of seismic surveys on catch rates or abundance. A desktop study of four species (gummy shark, tiger flathead, silver warehou, school whiting) in Bass Strait, Australia, found no consistent relationships between catch rates and seismic survey activity in the area, although the large historical window of the seismic data may have masked immediate or short-term effects which cannot therefore be excluded (Przeslawki *et al.* 2016). A subsequent desktop study targeting a single seismic survey in 2015 found that catch rates in the six months following the seismic survey were different than predicted in nine out of the 15 species examined. Across two fishing gear types, six species indicated increases in catch subsequent to the seismic survey, and three species indicated decreases in catch. The authors concluded that "*These results support previous work in which the effects of seismic surveys on catch seem transitory and vary among studies, species, and gear types*" (Przeslawski *et al.* 2016).

As noted by Salgado Kent *et al.* (2016) "*The issue of changes in commercial fisheries catch rates due to seismic surveys is almost always contentious in Australia*". They acknowledge that there has been some effort to relate fisheries catch data to seismic survey effort, but to date none of the Australian efforts to relate fin-fish catch rates with seismic surveys have yielded results of any meaning.

Given the potential impacts to fishes described above, there is the potential for impacts to catchability of key species, particularly with regards to behavioural response. However, the body of peer reviewed literature does not indicate any long-term abandonment of fishing grounds by commercial species, with a number of studies indicating that catch levels returned to pre-survey levels after seismic activity had ceased (Carroll *et al.* 2017). Given the evidence of fish returning to survey areas following cessation of the acoustic disturbance, in the event there was an impact to catchability as a result of the activity, fishing effort in surveyed areas post-survey is expected to return to typical catch levels relative to fishing effort.

The risk assessment therefore assesses the risk associated with the effects of dispersion of indicator species out of the operational area during seismic activities. As presented in modelling results and based on the 4,120 cui array and application of both the quantitative and semi-quantitative exposure criteria, it was estimated that potential behavioural impacts on both fish with and without swim bladders would occur approximately 15 km from the source.

It should be noted, TGS have elected to evaluate the potential behavioural impacts on fishes based on the data presented by McCauley *et al.* (2000) being 161-168 dB SPL_{rms} (SPL_{peak} 176-183 dB). This equates to a potential zone of impact out to ~ 15 km.

As supported by communications with DPIRD, it is reasonable to assume that non-site attached demersal fish disperse away from seismic sound, and therefore are expected to move in and out of the areas where acquisition may occur. As noted by Przeslawski *et al.* (2016), it is possible that fish may be displaced from a survey footprint to adjacent areas; however, the total number of fish within the fishery stock remains unchanged. Thus, potential impacts to fish catches may vary: reduced local abundance and catch rates may occur within the area being surveyed and up to ~ 15 km and may last only for the duration of the sound exposure (hours) or up to approximately five days following cessation of the survey. However, as the survey(s) are proposed to be conducted in areas where there is anticipated low fishing activity, disturbance to fishing operations, catch rates and commercial fish stocks is expected to be minimal.

Pelagic and Demersal Fisheries with active fishing effort that overlap the operational area include:

- Pilbara Fish Trawl Interim Managed Fishery (PFTIMF)
- Pilbara Line Fishery (PLF)
- Pilbara Trap Managed Fishery (PTMF)
- Mackerel Managed Fishery (MMF)

TGS evaluated the overlap between the operational area and the various commercial fisheries including those that do not actively fish in the area. Data indicates that the fisheries operate over wider areas than will be exposed to the seismic sound during the survey, particularly as many of them target areas shallower than 200 m.

The following should be noted:

- Only 0.8 % (1,000 km^2) of the full fold acquisition area (being 128,559 km^2) overlaps waters < 250m.
- Only 2.8 % (4,500 km^2) of the operational area (being 161,482km^2) overlaps waters < 250 m.

Pilbara Demersal Fisheries

The three demersal indicator species for the Pilbara region are Rankin cod, red emperor and bluespotted emperor (this also includes the non-indicator species of the Goldband snapper; Newman *et al.* 2008). However, these species often demonstrate some preference for topographical features such as reefs and hard bottom areas, and although inshore demersal species are referenced as occurring in waters between 20-250 m, the majority actually show a preference for shallower waters. This is supported by communications with DPIRD and Fish Cube data.

The acquisition area is limited to waters deeper than 200 m (the majority of the operational area (> 85 %) is in waters deeper than 500 m). Thus, there is an overlap of only ~3-5 km to the 250m contour, which is the recognised limit for inshore demersal species. Nevertheless, it is recognised that target species have a preference for waters < 200 m as supported through consultation with DPIRD.

Assuming a 15-km behavioural impact zone, the source may operate to within 15 km seaward of the 250 m contour before it may impact on demersal species in waters ≤ 250 m. Thus, th area of potential impact is ~ 13,000 km^2. In the Pilbara bioregion, waters of < 250 m depth is ~ 117,500 km^2. Based on this, there is the potential for ~ 11% overlap of waters that may support inshore demersal species. This is a worst-case scenario due to the following:

- Calculations are based on the use of a 4,120 cui source within the operational area buffer, which is not permitted, as a smaller source must be used. Accordingly, this will actually result in a smaller impact radius; and
- A threshold level of 183 dB SPL_{pk} is being used instead of the DPIRD recommended 193 dB SPL_{pk} which would decrease the impact radius to only 6 km, equalling an overlap of < 7%.

Assuming the 15 km behavioural limit, the area that is 15 km seaward of the edge of the 250 m contour is ~6,000 km^2. Assuming acquisition of 100km^2/day, it would take ~ 60 days (i.e. 2 months) to acquire data in this area and thus instigate a potential influence on inshore demersal species, including spawning individuals. Based on the race-track formation to be used by TGS to acquire data, the irregular shape of the acquisition boundary, and that it is unlikely the full power source will be able to be used to the edge of the acquisition area (as a result of line run-in and run-out requirements), it is considered very unlikely that this area will be subjected to survey acquisition for the entire theoretical 2-month period.

For the PTMF, the area that may potentially be affected by seismic noise is closed for fishing and so catches unlikely to be affected. Species that make up the main catch of the Pilbara bioregion are generally found in waters less than 180 m and so the potential behavioural influence on species and negative impacts of catchability are further reduced in the Pilbara trap and line fishery.

The above assessment is based on the assumption that commercially targeted species may be in waters to 250 m. Based on discussions with DPIRD, fishery closures and analysis of fishing data such as Fish Cube it is apparent that fishing effort is mostly limited to waters < 200 m and less, and so outside the acquisition area. It is logical to assume that active fishing areas overlap those areas that support fish populations. Therefore, based on available data, fish populations are generally limited to waters < 200m and areas associated with raised topographic features. As such, it is assessed that there will be limited impact on fisheries catches.

Mackerel Managed Fishery

Spanish mackerel are offshore, pelagic species. In the worst-case scenario, based on a survey of 25,000 km^2, with the potential behavioural impact of 15 km from the source, the maximum area of impact to the biological stock during a seismic survey would be 33,500 km^2 which is ~6.5% of waters that may support this species. This is not considered significant, especially as: the majority of mackerel fishing is undertaken in water depths shallower than the 100 m isobath (FRDC website: Spanish Mackerel; as supported by Fish Cube data); and that mackerel species aggregate to feed and spawn in coastal areas which would also be outside the impact zone.

The MMF (WA) management unit is classified as a sustainable stock. An analysis of community structure of finfish in the bioregions in WA where mackerel fishing has been undertaken has found no evidence of any significant shift over the past 30 years (FRDC website: Spanish Mackerel). Extensive seismic operations have been undertaken during this period within the region and thus do not appear to have negatively affected stocks.

Based on 100 km^2 per day, to complete the maximum 25,000 km^2 survey would take ~ 250 days (approx. 8 months) over the 2-year validity of the EP. It is unlikely this would be done in one survey and would be subject to shut downs due to fauna sightings, technical issues, weather etc. However, as the majority of the acquisition area is outside recognised preferred habitats, it is anticipated that there will be limited impacts on catch rates.

Spawning

Minimal information is currently available on the spawning locations for key target fish species within the operational area, and although spawning timings are known for some major species, it would not be possible to avoid them all as spawning ostensibly occurs all year-round. Based on an assessment of the potential effects of seismic airgun noise on fish eggs and larvae, and the fact that, to date, the peer reviewed literature has not recorded any decline in abundance as a result of seismic survey activities, it is assessed that the activity will have limited impact on fish fecundity, spawning or reproductive potential.

Biological stocks are relatively discrete populations of a fish species, usually in a given geographical area and with limited interbreeding with other biological stocks of the same species. Because of this limited connectivity, impacts from seismic surveys on one may not directly affect others. Therefore, where possible, the risk assessment evaluates the impacts on the biological stocks directly associated with the defined operational area. With the exception of the red emperor and mackerel species, biological stocks for most indicator species are discrete for the Pilbara bioregion.

The primary performance indicator used to evaluate the stock status of indicator species and non-indicator species is spawning biomass. Performance indicators for the red emperor (Gascoyne, Pilbara) and goldband snapper (NDSF: adjacent jurisdiction) require spawning biomass to remain above 40% of the virgin spawning biomass with a lower limit of 30%. (FRDC website: Goldband snapper; DPIRD 2017a). The management objective of the harvest strategy is '*To maintain spawning stock biomass of each retained species above BMSY to maintain high productivity and ensure the main factor affecting recruitment is the environment*.' Based on the percentage overlap that any survey may have over fishery management areas, and that the recognised spawning habitats for the indicator species and generally found in waters shallower than the operational area and so unlikely to be significantly impacted, the potential behavioural impacts to pelagic and demersal fish, and thus spawning biomass are therefore assessed to be low.

The Department of Fisheries (2013) guidance statement on undertaking seismic surveys in Western Australian waters provides key species and spawning periods in the North Coast and Gascoyne Coast Fisheries Bioregions.

Table 5.14 provides an overview of the indicator species and other important commercial species that may be present in the operational area.

Table 5.14 – Overview of Indicator Species within the Operational Area

Species	Stock	Fisheries	Stock Status	Depth-based habitat[4] (common)	Spawning periods	Spawning biomass	Spawning location
Rankin cod	Pilbara[2]	PDSF	Sustainable	Inshore demersal (20 – 110 m)	August to October	Well above threshold	Shallow < 110 m
Red emperor	Pilbara[1]	PDSF	Sustainable	Inshore demersal (20 – 180 m)	January, March, October	Above threshold	Shallow continental shelf waters <180 m
Bluespotted emperor *	Pilbara[3]	PDSF	Sustainable	Inshore demersal (20 – 150 m)	October to December^	Well above threshold	Shallow
Spanish mackerel	Mackerel Managed Fishery[1]	MMF	Sustainable	Pelagic (open ocean, > 20m)	August to November	Adequate-sustainable	Coastal areas
Goldband Snapper	Pilbara	PDSF GSMF	Sustainable	Inshore demersal 60-245 m (80 – 150m) [6]	January-April	Above threshold	60 -245
Pink Snapper	Gascoyne	GSMF	Sustainable	Inshore demersal < 300 m	May-July	Above threshold	Nearshore reefs

[1] Status of Australian Fish Stocks Reports 2016; [2] Stephenson et al. 2001; [3] Newman et al. 2017; [4] DoF 2017; ^ based on spangled emperor; [5] FRDC website 2018; [6] DPIRP 2017a

* The bluespotted emperor, also referred to as the lesser spangled emperor, had no information on spawning times; however, there was spawning information for the spangled emperor (*Lethrinus nebulosus;* Babcock et al. 2017) and this has been used in the table above.

The total area corresponding with a < 250 m water depth provides an indication of the total potential spawning habitat area available to Rankin cod, red emperor, bluespotted emperor, Goldband snapper and Spanish mackerel stock within the Pilbara bioregion. However, it is apparent that fishers target spawning age (adult) fish and therefore, the spawning area is believed to be within the fished depth zone which is actually waters less than 200m. The evaluation of seismic noise impacts on spawning potential is similar for the impact of reduced catch capability as the risk from the increased noise is to alter the behaviour of fish (be they spawning or not) and displacing them from favoured spawning locations. As such, calculations and assessments undertaken in the previous Section on the potential behavioural impacts on these species is also an acceptable indication of the potential impacts to spawning fish, and should be referred to.

Spatial analysis indicates that that the potential area of influence for the Pilbara demersal indicator species may be approximately between 7-11 % based on the total area of waters < 250 m. However, it must be recognised that species tend to favour shallower waters beyond the operational area, Overall, the habitats in the vicinity of the operational area, or the potential area of influence, are not expected to be significant for aggregations of spawning species compared with the rest of the bioregion.

It is important to note that this is simply an indication of the area that may be insonified and where potential spawning aggregations may be influenced. There is no reduction in the total spawning biomass, as the effects are expected to be behavioural and no fish will be lost from the stock. Instead, while some temporary cessation of aggregation and spawning could occur within this potential area of influence, it is possible that adult fish may continue to spawn or may simply aggregate and spawn in a different location further from the seismic source.

The eggs and larvae from all indicator species are pelagic. Spanish mackerel and Red emperor are highly fecund broadcast spawners, releasing numerous batches of eggs over an extended spawning period (Newman et al 2008; Mackie *et al.* 2010). As such, it is likely that many spawning aggregations may escape any impacts of

seismic activity as they are scattered throughout the bioregion, occur over an extended period and limited to shallower waters away from the operational area and any potential area of impact.

Spanish mackerel biological stock in WA is likely shared with the NT and catch and effort data throughout the MMF suggests that the overall spawning stock is stable or increasing. Given that spawning individuals will likely be in shallower waters away from the operational area and the connectivity of mackerel stocks, the impacts to mackerel spawning are predicted to be negligible.

Red emperor stocks occur across northern Australia and biological connectivity and genetic homogeneity is maintained between the different stocks by dispersal of eggs and larvae throughout its range. Given the connectivity of red emperor stocks, and that the species favours shallower waters or those near topographical features not found in the operational area, the impacts to red emperor spawning are predicted to be negligible.

The blue spotted emperor's exhibit limited adult movement and so stocks are assessed and managed separately in the Pilbara. Studies undertaken by CSIRO on the species identified the importance of shallow water habitats for maintaining stock levels. A 2016 assessment of the species in the Pilbara estimated the spawning biomass of the stocks of blue spotted emperor are well above the target spawning biomass levels.

For Rankin cod, the data suggest limited larval dispersal and limited adult movement. Hence, the current area-based management strategy for this species is appropriate and regional populations should be treated as separate stocks for fishery management purposes.

The status report of the fishery highlights that the spawning biomass for indicator species of the PDSF and MMF as a whole were adequate, above or well above their target levels, indicating satisfactory breeding stock levels. However, during the life of the EP, TGS will continue to review new information that we are made aware that may be relevant to the assessment of potential impacts and risks to fish populations and engage with licence holders within the fisheries.

Should further evidence be provided (i.e. by DPIRD) beyond that which has been evaluated, and indicates that further physical or temporal exclusions are required to ensure that impacts to fisheries are not significantly increased beyond those which may be accounted for by natural mortality or environmental parameters, this will be assessed according to the risk assessment requirements.

Site-attached Species

Available information indicates that there is limited habitat in waters deeper than 50 m that supports site-attached fish species. On the shoals in the NWMR, there is clear evidence that site-attached reef fish are associated with the upper levels of the structures, most notably in waters shallower than 30 m near shoal rims. Individuals have been identified at deeper levels if substrate and supporting habitat are available, but much less abundant.

The majority of the benthos within the operational area is sand/mud containing limited infauna. Furthermore, many areas have been the subject of intense trawling by the PTIMF and as a result benthic communities associated with waters deeper than 50 m have been affected, thereby potentially destroying habitat at this depth that could support site-attached fish. Therefore, in open waters, fish and other marine fauna have the ability to move away from increase noise levels and are unlikely to be significantly affected by seismic sound exposure.

Wardle *et al.* (2001, as cited in Popper and Hastings 2009) found that fish and invertebrate on a rocky reef showed only minor behavioural responses and no observed damage when exposed to a measured peak level of 210 dB re 1 µPa. In a tropical coral reef habitat exposed to a full commercial 3D seismic survey off WA, no significant changes in the diversity or abundance of the reef fish community were detected via underwater visual transect surveys (Miller and Cripps 2013). There was also no evidence of direct mortality or indirect mortality from sub-lethal effects among site attached species (NSW DPI 2014).

Conditions that could result in fish being trapped (site-attached/territorial species) and unable to move more than a few metres from the noise source as the survey vessel(s) traverses the area include areas of reef or raised topographical features.

The closest reef or raised topographic feature is that of Rankin Bank. However, this is more than 15 km from the boundary of the acquisition area, and more than 6 km from the edge of the operational area/buffer. At 15 km noise from the 4120 cui source will be ~SPL_{pk} 170 dB re 1 µPa/ SEL 151 dB re 1 μPa^2.s and so below threshold levels that may result in impairment, TTS or possibly behavioural changes. Furthermore, no cumulative impacts on site-attached fish are expected. As such it is evaluated that impacts to any site attached species associated with shoals will be minimal and acceptable.

5.1.5.8 Elasmobranchs

Limited research has been conducted on shark responses to marine seismic surveys. Myberg (2001) stated that sharks differ from bony fish in that they have no accessory organs of hearing such as a swim bladder and therefore are unlikely to respond to acoustical pressure. The study also suggested that the lateral line system does not respond to normal acoustical stimuli, and is unable to detect sound-induced water displacements beyond a few body lengths, even with large sound intensities. Other reports indicate that sharks are highly sensitive to sound between approximately 40 and 800 Hz, which overlaps with seismic sound frequencies. Klimley and Myrberg (1979) established that an individual shark will suddenly turn and withdraw from a sound source of high intensity (more than 20 dB re 1µPa above broadband ambient SPL) when approaching within 10 m of the sound source.

The available evidence indicates sharks will generally avoid seismic sources and the likely impacts on sharks are expected to be limited to short-term behavioural responses, possibly including avoidance of the operating airgun array. The operational area boundary is located at least 150 km from the green and dwarf sawfish foraging BIA in King Sound and Camden Sound. It is highly unlikely that underwater noise emissions from the airgun array would cause any pathological effects (lethal and sub-lethal injuries) resulting in immediate or delayed mortality or physiological effects on shark species, including but not limited to, great white sharks, mako, reef sharks, northern river shark and sawfish.

Whale sharks

It is expected that the potential effects to whale sharks associated with acoustic noise will be the same as for other pelagic fish species, resulting in permanent injury or mortality if received sound levels exceed 220 dB re 1 µPa. Although there are no known studies on the auditory bandwidth for whale sharks, it is thought to be similar to that of other sharks (40 and 800 Hz).

While the Whale Shark Recovery Plan (2005-2010; DEH 2005a) identified numerous possible threats to whale sharks, those applicable to surveys within the NWSR North MC MSS operational area include pollution and marine debris, or interference. Acoustic damage was not identified.

The full fold acquisition area (water depths >200 m) does not overlap the whale shark foraging and migration BIA in the NWMR, but the operational area buffer zone does overlap the BIA. Thus, it is possible that whale sharks may be encountered in the inshore buffer zone component of the operational area, particularly during the spring and summer months. Although the migratory corridor narrows to ~35 km in a small section, it is more than 15 km from the acquisition area, (at which point RL would be ~176 dB SPL_{peak}) and low numbers of whale sharks are anticipated to be migrating through the region. Also, predicted received sound levels will be <194 dB re 1 µPa SPL_{peak} at a horizontal distance of 2 km from the sound source (Low-power zone; Table 5.2) and thus do not exceed the exposure criteria thresholds for mortality/potential mortal injury, recoverable injury or TTS onset in elasmobranchs (i.e. 220 dB SPL_{peak}, 213 dB SPL_{peak} and 205 dB SPL_{peak}, respectively).

5.1.5.9 Marine Turtles

It has been speculated that migrating turtles may use various acoustic cues and that acoustic disturbances might interfere with their navigational ability (McCauley 1994). The auditory sensitivity of marine turtles is reported to be centred in the 400–1,000 Hz range, with a rapid drop-off in noise perception on either side of

this range (Richardson *et al.* 1995). This auditory range matches their weak vocalisation abilities, which are also in the low frequency range (100–700 Hz).

Electrophysiological responses, specifically auditory evoked potentials (AEPs), are the most widely-accepted technique for measuring hearing in situations in which normal behavioural testing is impractical. AEP studies on hearing have been conducted on various species and stages of life and indicate that the best hearing range for marine turtles is in the range 100–700 Hz, which overlaps with the frequency range of maximum energy in the horizontally propagating component of a seismic array 'shot' (McCauley 1994).

Bartol *et al.* (1999 as cited in BOEM 2014a) found that juvenile loggerhead turtles detect in the low frequency range between 250–1,000Hz, with the most sensitive around the 250 Hz. Later though, Bartol and Ketten (2006) found that the juveniles responded to 100–400 Hz. Bartol and Ketten (2006) studied hatchling and juvenile loggerhead and juvenile green turtles. All turtles responded to sounds in the low frequency range from 100–900 Hz. However, hatchling loggerheads had the greatest range of hearing (100-900 Hz), while the larger juveniles responded to a much narrower range (100–400 Hz). Hearing sensitivity of green turtles also varied with size, with smaller greens had a broader range of hearing (100–800 Hz) than that detected in larger subjects (100–500 Hz).

Piniak *et al.* (2012) found that leatherback sea turtle hatchlings are able to detect sounds between 50 and 1200 Hz, with maximum sensitivity between 100 and 400 Hz. Like other species of sea turtle, they appear to have a relatively narrow, low-frequency range of hearing sensitivity.

Lavender *et al.* (2014) detected no significant differences in behaviour-derived auditory thresholds or AEP-derived auditory thresholds between post-hatchling and juvenile loggerhead turtles. Sea turtles reside in different acoustic environments with each life history stage and may have different hearing capacity throughout ontogeny. However, research indicates that hearing frequency range (50–1,100 Hz) and highest sensitivity (100–400 Hz) were consistent indicating that that post-hatchling and juvenile loggerhead sea turtles are low-frequency specialists, exhibiting little differences in threshold sensitivity and frequency bandwidth despite residence in acoustically distinct environments throughout ontogeny. Consequently, the effects of seismic on hatchlings are anticipated to be similar to those of juveniles and adults.

Mortality/potential mortal injury

Popper *et al.* (2014) provided possible threshold levels that may result in potential mortal injury being 207 dB SPL_{peak} or 210 dB SEL_{cum}, which equates to a horizontal distance of ~450 m from the source. However, as described earlier, these levels are likely high and conservative as they are based on pile drive studies with a static source and not actual seismic results with a moving vessel and receptor. Marine turtles would only be exposed to noise levels sufficient to cause physical damage if an airgun array started suddenly at full power with turtles nearby. 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. With soft start procedures, it is extremely unlikely that an individual will be exposed to levels that may result in mortality/potential mortal injury.

Impairment

There are no defined quantitative noise exposure criteria for impairment effects (PTS, recoverable injury and TTS) in turtles. Based on the application of the Popper *et al.* (2014) semi-quantitative exposure criteria there is a high risk of potential impairment (recoverable injury and TTS) effects to turtles within tens of metres of the 4,120 cui array proposed for use during surveys within the NWSR North operational area.

Behavioural

Pendoley (1997) identified that surveys in shallow waters (<15 m) near nesting beaches may expose both mating and internesting females, and hatchlings to increased sound levels. Mating turtles and internesting females are not thought to favour deeper waters (>15 m) and while the air gun discharges may be audible in the deeper water it is unlikely the sound would be of sufficient intensity to cause a startle response in the animals The NWSR North acquisition area is limited to waters >200 m.

Similarly, Pendoley (1997) believed that it is unlikely that the noise associated with seismic discharges would override the biologically imprinted drive in turtle hatchlings to complete the initial 24 hour 'swim frenzy' that takes them out to sea as quickly as possible. At most, the sound may cause the hatchlings to deviate from their course to sea. Given the very high mortality rate in hatchlings, it is unlikely the effects of seismic discharge on them would be measurable. Observations of turtle behaviour were made during a seismic survey on NWS showed no signs of panic or distress in the turtles in the vicinity of the vessel during discharge of the air guns. The behaviour noted consisted of either 'steady swimming' or 'diving' to avoid the vessel (Pendoley 1997).

Despite some variation in test results, the hearing ranges overlap the frequency range of maximum energy in the horizontally propagating component of a seismic array 'shot' (McCauley 1994). Studies indicate that marine turtles may begin to show behavioural responses to an approaching seismic array at received sound levels of ~166 dB re 1 µPa (SPL_{rms} ; ~181 dB SPL_{peak}), and avoidance at around 175 dB re 1 µPa (SPL_{rms}; 190 dB SPL_{peak}; McCauley *et al.* 2000). This corresponded to behavioural changes at ~8 km, and avoidance from ~3 km. Consistent with these findings, a 166 dB re 1 µPa SPL_{rms} has been used as the threshold level for a behavioural disturbance response by NMFS in the U.S. (NSF 2011)

From airgun exposure tests on a caged green turtle and loggerhead turtle (see **Table 5.19**) that were extrapolated to response levels for a typical airgun array operating at full power in 100 m water depth, McCauley *et al.* (2003) concluded that turtles would, in general, probably show behavioural responses at 2 km and avoidance behaviour at 1 km from such operations. However, they 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.

Table 5.15 - Results of airgun exposure to marine turtles

Species	Received level (dB re 1 µPa rms)	Effect	Source
Loggerhead turtle	175–176	Avoidance response	O'Hara and Wilcox (1990)
One green and one loggerhead turtle	166	Noticeable increase in swimming behaviour, presumed avoidance response	McCauley *et al.* (2000)
One green and one loggerhead turtle	175	Behaviour becomes increasingly erratic, presumed alarm response	McCauley *et al.* (2003)

There is no evidence implying that turtles actively avoid or are attracted to close range (less than 500 m) encounters with operating airgun arrays. However, Moein *et al.* (1994) tested if hearing sensitivity of caged loggerhead turtles altered after exposure to several hundred pulses within 30-65 m of a single airgun (pulse numbers and received sound levels not stated). Hearing was tested before, within a day, then two weeks after exposure. Approximately 50% of the exposed individuals indicated altered hearing sensitivity when tested within a day of their exposure, but none provided any sign of altered hearing two weeks later, compared to the pre-exposure tests.

For most species of marine turtles, foraging individuals are likely to be limited to waters less than 60 m. This is supported by a study that looked at the incidental bycatch of turtles in the Northern Prawn Fishery, in which Poiner and Harris (1996) found that all five species of turtles were captured with the highest rates from trawls in water between 20 and 30 m deep, with less captured in water deeper than 40 m. This is further supported by the diet of most turtles which feed on algae, seagrass and other invertebrates that often require reefs or shallower environments.

Based on studies undertaken by McCauley, Limpus (2008a) recommends that a buffer zone of at least 2 km radius should be maintained between seismic surveys and significant aggregations of marine turtles such as internesting, courtship or *dense* foraging aggregations, with the highest priority to avoid causing disruptive behaviour for the turtles during the time-limited reproductive period.

The 2017 DoEE Marine turtle recovery plan identifies internesting habitat critical to the survival of marine turtles is located immediately seaward of designated nesting habitat critical to the survival of marine turtles. However, no "Critical Habitat" as defined under Section 207A of the EPBC Act (Register of Critical Habitat) has been identified and listed for marine turtles.

The internesting habitat critical buffer for green, loggerhead, hawksbill, olive ridley and leatherback turtles is 20 km and 60 km for flatback turtles (DoEE 2017a). The NWSR North acquisition area is 80 km from the closest recognised nesting beaches on the Montebello islands and so ~ 20 km beyond the outer edge of the flatback internesting buffer and 60 km from the other species. At this distance received levels are less than those predicted to result in behavioural changes.

The recovery plan for marine turtles in Australia recommends soft start procedures where seismic surveys overlap distribution of marine turtles (DoEE 2017a). Soft starts and shut downs are standard procedure and will be implemented.

Significant impacts on turtles from discharge of the acoustic array are likely to be confined to close ranges to the source (a few hundreds of metres) and be short to medium term (hours to days) in duration. Mortality/potential mortal injury impacts are highly unlikely to occur, as turtles will not be exposed to received levels high enough to cause these effects. Population level effects are highly unlikely to occur as a result of impacts to individual turtles within the NWSR North operational area.

5.1.5.10 Sea Snakes

Little information is available about the effects of seismic surveys on sea snakes. From a research and monitoring programme conducted at Scott Reef, Woodside's 2007 Maxima 3D survey on marine fauna did not result in observed physiological effects or mortality in marine fauna, including sea snakes. As most sea snakes spend the majority of their time in shallow waters, which are mostly outside the boundary of the operational area, they are not sedentary and can swim away from the sound source. Based on turtle responses, it is reasonable to conclude that they may show avoidance at ~1 km from a source. With the use of mitigation such as soft starts, impacts are anticipated to be minimal and limited to individuals only.

5.1.5.11 Avifauna

Seismic noise is not anticipated to have a direct effect on avifauna, due to the method of the activity and that birds and vessels are transient. Only those bird species that plunge dive such as brown boobies and tropicbirds could be exposed to underwater noise, although little or no impact is expected. Stemp (1985, as cited in LGL 2012) conducted observations on the effects of seismic exploration on seabirds, and did not observe any negative effects. Lacroix *et al.* (2003 as cited in LGL 2012) investigated the effect of nearshore seismic surveys on moulting long-tailed ducks in the Beaufort Sea, Alaska, and also failed to detect any negative effects. Furthermore, they noted that seismic activity did not appear to change the diving intensity of the ducks significantly. However, avifauna may be affected indirectly by:

1. Localised, temporary displacement
2. Modified prey abundance
3. Disturbance to breeding birds
4. Chance injury or mortality

Birds may be affected slightly by seismic sounds from the proposed survey, but the impacts are not expected to be significant to individual birds or their populations.

5.1.5.12 Toothed Whales

Toothed whales include both medium frequency (MF) and high frequency (HF) species. MF cetaceans include dolphins, toothed whales, beaked whales and bottlenose whales, while HF cetaceans include true porpoises, river dolphins, cephalorhynchid etc. HF cetaceans are not anticipated to be encountered within the NWSR North Operational area. MF cetaceans, such as sperm whales, may be encountered but in low numbers.

Mortality/potential mortal injury

There are no defined noise exposure criteria for mortality and potential mortal injury impacts in either MF or HF cetaceans. These effects are extremely unlikely to occur as received sound levels of sufficient magnitude to cause mortality/potential mortal injury may only occur at extremely close range (i.e. <10 m) to an operating airgun array. This scenario is extremely unlikely to occur given the control and mitigation measures that are routinely implemented for marine seismic surveys in Australian waters, in compliance with EPBC Policy Statement 2.1 (i.e. use of MFOs; observation, low-power and shutdown zones; soft starts etc.).

Impairment

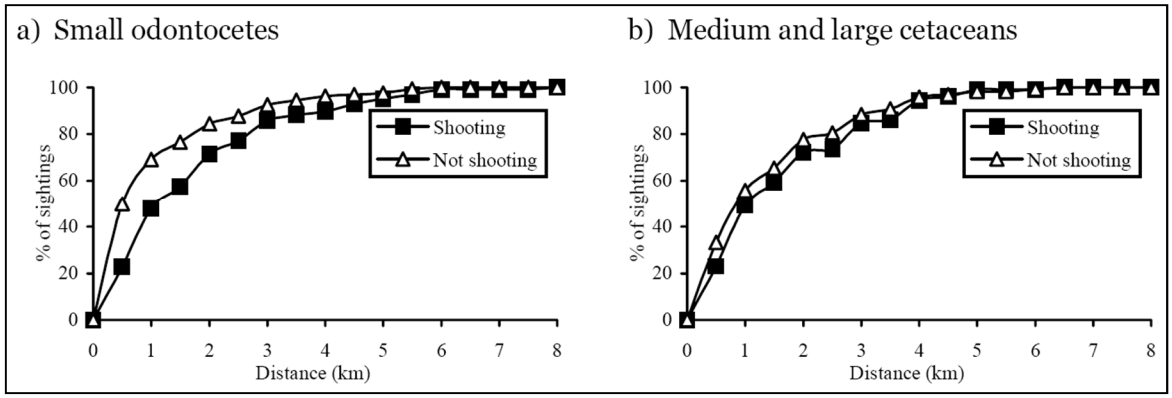
Gordon *et al.* (2004) considered the potential for TTS and concluded that the threshold was ~195 dB re 1 µPa SPL_{rms}(~ 210 SPL_{peak}) This is consistent with the review and calculations contained with Richardson and Moulton (2006), who considered the TTS threshold to be SPL_{rms} 192–202 dB re 1 µPa and reasonably consistent with the value presented by DEWHA (2008b) of SPL_{rms} 186 dB re 1 µPa.

Based on the more recent NOAA final guidance on underwater acoustic thresholds for onset of PTS and TTS (NMFS 2016) and the CMST modelling outputs, PTS effects on MF and HF cetaceans could occur out to maximum horizontal ranges of 50 m (MF) and 800 m (HF), respectively, from the 4,120 cui array (**Table 5.7**). Based on the application of the TTS threshold criteria of 224 dB SPL_{peak} (MF) and 196 dB SPL_{peak} (HF), TTS effects could occur in MF and HF cetaceans out to maximum horizontal ranges in the order of 100 and 2,000 m, respectively. However, as pointed out above, these impairment effects on both MF and HF cetaceans are unlikely to occur given the control and mitigation measures that are routinely implemented for marine seismic surveys in Australian waters, in compliance with EPBC Policy Statement 2.1 (i.e. use of MFOs; observation, low-power and shutdown zones; soft starts etc.).

Behavioural

There is little systematic data on the behavioural response of toothed whales to seismic surveys. Richardson *et al.* (1995) reported that sperm whales appeared to react by moving away from surveys and ceasing to call even at great distances from a survey. However, in a 2003 study (Jochens and Biggs 2003), two controlled exposure experiments were carried out (including one with three simultaneously tagged whales) to monitor the response of sperm whales to seismic source. The whales were exposed to a maximum received level of 148 dB re 1µPa. There was no indication that the whales showed horizontal avoidance of the seismic vessel nor was there any detected change in feeding rates of the tagged sperm whales.

Smaller toothed cetaceans have less sensitive hearing in the low frequency range of airgun array noise (10–300 Hz), and seismic operators sometimes observe dolphins and other small toothed whales near operating airgun arrays. However, there is a component of seismic pulses in the higher spectrum, and in general, most toothed whales do show limited avoidance of operating seismic vessels. Goold (1996) studied the effects of 3D seismic surveys on common dolphins (*Delphinus delphis*) in the Irish Sea. The results indicated that there was a local displacement of dolphins around the seismic operation. This observation is consistent with data compiled by Stone (2003) from marine mammal observers aboard seismic vessels in the North Sea that showed small, toothed whale species moved away from operating airguns (**Figure 5.3**).



Source: Stone (2003)

Figure 5.1 – Proportion of marine mammal sightings during seismic surveys

Based on the application of NMFS criterion for possible behavioural responses in all whales of 160 dB re 1 µPa SPL_{rms} (~ 175 SPL_{peak}; Table 5.4), potential behavioural effects to MF and HF cetaceans could occur at horizontal ranges up to 20 km of the 4,120 cui array proposed for use during surveys within the NWSR North operational area.

Summary

MF cetaceans, including beaked and sperm whales, are more relevant to species that may be encountered within the NWSR operational area. For these species, TTS may be experienced to a distance of <100 m from the source, while PTS may be experienced less than 50 m from the source. These distances are well inside the shutdown zones. With the implementation of proposed mitigation (i.e. use of MFOs; observation, low-power and shutdown zones; soft starts etc.), seismic noise may result in no more than behavioural responses in toothed whales such as sperm and beaked whales and the impacts are therefore considered to be minimal, ALARP and acceptable.

5.1.5.13 Baleen Whales

Baleen whales are low frequency (LF) cetaceans and include species such as humpback whales and pygmy blue whales which may be present within the operational area. Baleen whales produce a rich and complex range of underwater sounds ranging from about 12 Hz to 8 kHz, but with the most common frequencies below 1 kHz (McCauley 1994). Combined with studies of their hearing structures suggests that their hearing is also best adapted for low frequency sound (McCauley 1994, Richardson *et al.* 1995).

Mortality/potential mortal injury

There are no defined noise exposure criteria for mortality and potential mortal injury impacts in LF cetaceans. These effects are extremely unlikely to occur as received sound levels of sufficient magnitude to cause mortality/potential mortal injury may only occur at extremely close range (i.e. <10 m) to an operating acoustic source. This scenario is extremely unlikely to occur given the control and mitigation measures that are routinely implemented for marine seismic surveys in Australian waters, in compliance with EPBC Policy Statement 2.1 (i.e. use of MFOs; observation, low-power and shutdown zones; soft starts etc.).

Impairment

Physical damage to the auditory system of cetaceans may occur at levels of ~230–240 dB re 1µPa (SPL_{pk}; Gausland 2000), which is equivalent to a distance of a few metres from the energy source. However, based on the more conservative NOAA final guidance on underwater acoustic thresholds for onset of PTS (219 dB re 1µPa (SPL_{pk}) and TTS (213 dB re 1µPa SPL_{pk} ; NMFS 2016) and the CMST modelling outputs, PTS effects on LF cetaceans could occur out to a maximum horizontal range of 100 m from the 4,120 cui array (**Table 5.7**). Based on the application of the TTS threshold criteria of 213 dB SPL_{peak}, TTS effects could occur in LF cetaceans out to a maximum range in the order of 225 m.

Behavioural

The level of noise at which a behavioural response is elicited varies between species and even between individuals within a species (Richardson *et al.* 1995). Stone (2003) suggested that different groups of cetaceans adopt different strategies for responding to acoustic disturbance from seismic surveys, with baleen and killer whales displaying localised avoidance, pilot whales showing few effects and sperm whales showing no observed effects.

A comprehensive study carried out by McCauley *et al.* (2000) monitored the effects of seismic survey noise on humpback whales in the Exmouth Gulf region of WA. The following conclusions were drawn from this research:

- only localised avoidance was seen by migrating whales during the seismic operation, indicating that the 'risk factor' associated with the seismic survey was confined to a comparatively short period and small range displacement;

- coupled with the fact that humpback whales were seen to be actively utilising the 'sound shadow' near the surface, it was unlikely that animals were exposed to physiological risk unless at very short range from a large airgun array, perhaps of the order of a few hundred metres; and
- upper levels of noise at 1.5 km from the seismic survey array are in the order of 182 dB re 1µPa (SPL_{peak}), which is still well below the source levels of the highest components of humpback whale song (192 dB re 1µPa (SPL_{peak}). Thus, at 1.5 km the received airgun signal is still well within the range which humpback whales would be expected to cope with physiologically, since it would be difficult to argue that humpback whale song can cause physiological problems to the animals (McCauley *et al.* 2000).

McCauley *et al.* (2000) found that migrating humpback whales showed a general avoidance of an operating seismic source at 157–164 dB re 1µPa SPL_{rms}. Recent research from the analysis of the BRAHSS data has found similar results, where significant responses were observed within 3 km of an operating source and received levels were greater than 140 dB re 1 μPa^2 (SEL; Dunlop *et al.*, 2017). However, it is important to note the desktop research of data collected states that these limits "*do not represent a threshold, of response, but that responses were more likely to occur within these bounds than outside of them*". Responses were highly variable – some groups did not respond, some groups responded outside this (Dunlop *et al.*, 2017). Resting pods in key habitats (i.e. off Camden Sound with calves) showed avoidance at somewhat lower levels, specifically avoidance of 140 dB re 1µPa rms and a mean stand-off range at 143 dB re 1µPa rms. This equates to an SEL of ~130 dB re 1 μPa^2 and a ~30 km radius from the 4,120 cui source. The acquisition area is more than 450 km from recognised resting and calving BIA and so impacts will be negligible.

With regards to avoidance behaviour, it is known that baleen whales will avoid operating seismic vessels, and the distance over which the avoidance occurs seems to be highly variable. 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.

Based on the application of NMFS criterion for possible behavioural responses in all whales of 160 dB re 1 µPa SPL_{rms} (~ 175 SPL_{peak}; **Table 5.4**), potential behavioural effects to LF cetaceans such as humpback and pygmy blue whales, will be limited to distances up to 20 km of the 4,120 cui array proposed for use during surveys within the NWSR North operational area.

5.1.5.14 Cetacean Mitigation Measures

Humpback whales

The humpback calving and breeding BIA off the Kimberley coastline is more than 450 km from the operational area and so will not be discussed further in the EP. The recognised migration BIA is more than 40 km from the acquisition area at which point received levels will be less than SPL_{peak} 160 dB re 1 µPa and SEL 130 dB re 1 μPa^2.s and below levels that may result in behavioural changes.

As indicated in studies undertaken by Jenner *et al.* (2001) and Double *et al.* (2012), humpback whales (including calves) were generally limited to shallow waters close to the coast with very few (if any) venturing into deeper waters. This is reflected within the BIA as presented by the DoE NCVA (DoE 2015b). However, there is a very low likelihood of encountering whales in the operational area, and so EPBC Policy 2.1 Part A Standard Management Procedures are considered acceptable.

Pygmy blue whales

The pygmy blue whale 'known to occur' distribution (as presented in the pygmy blue management plan (DoE 2015a) and migration corridor, are overlapped by the operational area. With a potential disturbance radius of 40 km around the source, even in the narrowest section of the BIA there will still be considerable room (30 km) for the individuals to pass by the seismic vessel and still be within the identified migration BIA. Any disturbance would be limited to minor deviations around the seismic source and limited to the individuals in that immediate area. Travelling at average speeds (~ 75 km/day) in the operational area, it is reasonable to conclude an individual may experience noise above behavioural threshold levels for only a 12-hour period.

Double *et al.* (2014) acknowledged that in WA, pygmy blue whales migrate through an "*area that contains the majority of Australia's gas resources and in which production and development is ongoing". Whilst anthropogenic noise may alter blue whale behaviour, it is unlikely to pose a conservation risk unless it causes population level consequences such as changes in growth, reproduction and survival of individuals. Elevated ambient noise has been responsible for abandonment or avoidance of critical habitat by a number of cetacean species. Critical habitat includes habitat used to meet essential life cycle requirements such as foraging and breeding.*"

TGS conducted an assessment of whether the activity could result in significant impacts on pygmy blue whales (listed as Endangered and Migratory under the EPBC Act) using the Department of Environment's Matters of National Environmental Significance (NES) guidelines (DoE 2013b). The DoE NES guidelines (DoE 2013b) list the significant impact criteria for Endangered and Migratory species as:

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- *lead to a long-term decrease in the size of a population*
- *reduce the area of occupancy of the species*
- *fragment an existing population into two or more populations*
- *adversely affect habitat critical to the survival of a species*
- *disrupt the breeding cycle of a population*
- *modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline*
- *result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat*
- *introduce disease that may cause the species to decline, or*
- *interfere with the recovery of the species.*

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- *substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species*
- *result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or*
- *seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.*

There is no "real chance or possibility" that the NWSR North MC MSS will result in any significant impact outcomes for pygmy blue whales, based on the significant impact criteria for Endangered or Migratory species identified above, particularly with the application of proposed mitigation measures

Interrogation of sightings data from earlier TGS surveys in the region indicates that increased numbers of pygmy blue whales were present outside the identified migration BIA: specifically, in the area extending to the northwest of the narrowing portion of the BIA as indicated with the white line in the Figure below. For the purposes of this EP and implementation of controls, this will now be known as the BIA.

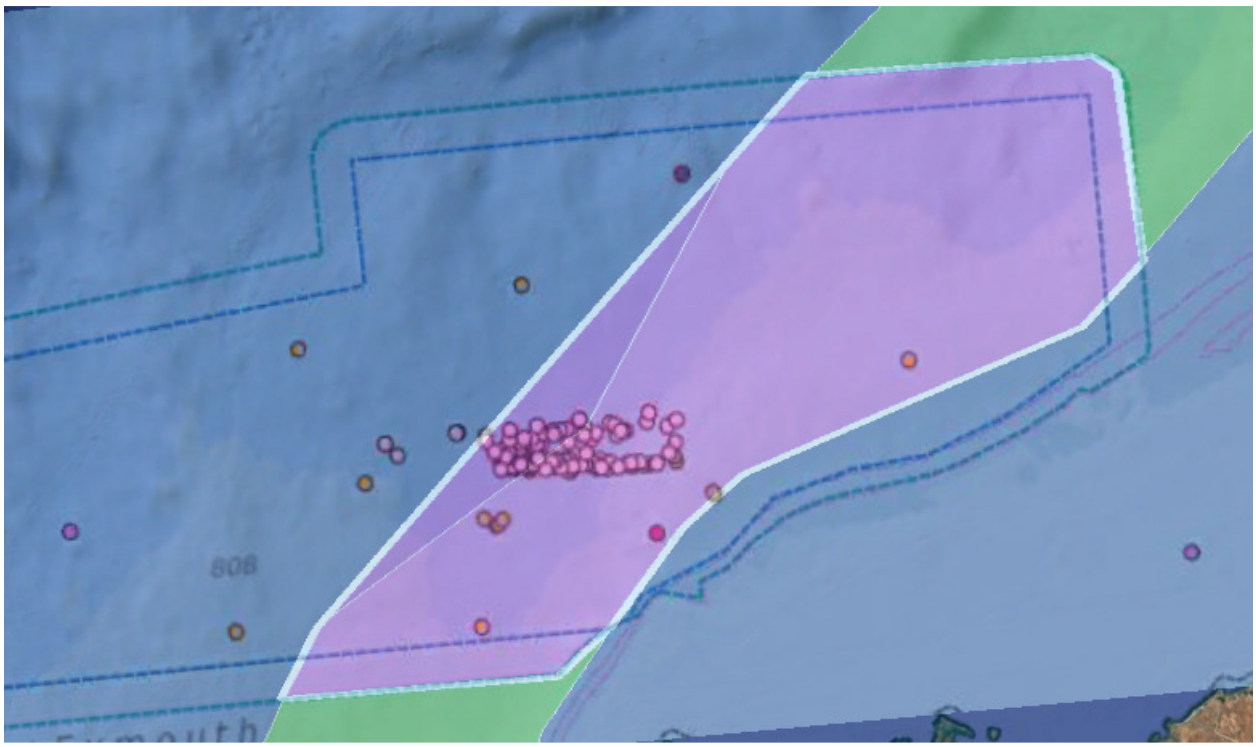


Figure 5.2 – Pygmy Blue Whale Exclusion Area

Green shading– recognised pygmy blue whale BIA; Purple shading– exclusion area incorporating BIA and area of increased sightings to the northwest; Dots – sightings of pygmy blue whales and unidentified cetaceans; Blue lines – NWSR North operational area

Consequently, TGS will take a precautionary approach and increase the physical limits of the exclusion zone to encompass the area of known increased numbers.

The Conservation Management Plan for the Blue Whale (CoA 2015) states "the long-term recovery objective for blue whales is to minimise anthropogenic threats to allow for their conservation status to improve so that they can be removed from the EPBC Act threatened species list". They recognise that this is unlikely in the short term and so have set interim objectives including "Anthropogenic threats are demonstrably minimised." This objective shall be tested by Target 4–1: *Robust and adaptive management regimes leading to a reduction in anthropogenic threats to Australian blue whales are in place*. TGS have developed robust adaptive management measures to ensure impacts from anthropogenic noise (seismic acquisition) to any cetaceans are minimised.

Sperm whales

Sperm whales (toothed whales) and have a higher hearing frequency than baleen whales and so it is thought that the impacts from seismic surveys may be less. This is reflected in the higher NMFS (2016) threshold criteria of SPL_{peak} 230 dB re 1 µPa for PTS and SPL_{peak} 224 dB re 1 µPa for TTS. Based in these higher threshold, it is likely that the generic behavioural threshold of SPL_{rms} 160 dB re 1 µPa (NMFS 2013) is very conservative. This is supported by Stone (2003) who observed that sperm whales showed no observed effects to acoustic disturbance from seismic surveys, while LF Baleen whales did.

The operational area and surrounding waters do not overlap any known critical habitat or designated BIAs for sperm whales, with the North-west Report Card (DEWHA 2012d) only indicating that sperm whales may be found around areas of upwelling and canyons on the continental shelf. Canyons of the Abyssal Plain and Scott Plateau which may therefore support increased numbers are outside the operational area. As such, it is expected that only low numbers of this species may be present within the operational area.

As sperm whales are gregarious and generally found in large pods (up to 50: SPRAT website accessed 2018), it is unlikely that all individuals will be diving at the same time and as such they will be visible to observers (MFOs). Furthermore, they are easily distinguishable from other species. As such, although they are deep divers, it is unlikely that, except for a transiting single male, they will not be identified (as per other cetacean species). Even

to a single transiting male, with the implementation of soft starts, the impacts will be minimal and not affect the species at a population level.

As the operational area does not overlap any identified critical habitat or BIA, control and mitigation measures to be implemented for humpback and pygmy blue whales, including adaptive management measures, will ensure that any potential impacts and risks are ALARP and acceptable. If it is believed that sperm whales may be in the area (pre-survey research, observation etc) then to account for possible longer dive times of the species, pre-watch periods will be increased

5.1.5.15 Simultaneous Operations and Cumulative Impacts

The cumulative impacts from seismic impulses within the marine environment are difficult to quantify because the acquisition of seismic data requires the temporary creation of sound/pressure waves that dissipate and soon disappear when the sound energy source is stopped. Unlike other activities that can result in the creation of contaminants and noxious materials (e.g. drill cuttings), there is no bioaccumulation of sound/pressure within the food chain. Nonetheless, there may be a temporary additive effect if sounds from one activity coincide and overlap spatially and temporally with another concurrent activity (e.g. masking). However, this "added sound" will disappear once one of the sound-generating sources stop or travel out of the area of concern.

Identification of Simultaneous Operations

The NOPSEMA website provides an adequate overview of proposed seismic surveys that may occur in the near future. As this EP covers an extensive area over a two-year period, it is difficult to determine what surveys may be proximal to the operational area, and thus what the potential cumulative effects could be from simultaneous operations. Prior to commencement of an NWSR North MC MSS, TGS will check the NOPSEMA website to determine if any further seismic surveys may potentially occur within or adjacent to the operational area. TGS will consult with other geophysical companies operating in Australian waters, and/or titleholders of petroleum titles adjacent to the operational area, to ascertain if there are other seismic surveys proposed for areas adjacent to the survey area over the same time period.

Assessment of Potential Cumulative Impacts

It is possible that other MSS may occur simultaneously in the vicinity of a survey being conducted within the NWSR North MC operational area. Note that TGS will not undertake simultaneous surveys, but may undertake more than one survey in the operational area within the 2-year life of the EP. These could result in cumulative impacts on matters of NES, such as whales, turtles and whale sharks.

With proposed mitigation in place, it is anticipated that any impacts to whales will be limited to behavioural only. Even if a survey is undertaken in the narrowest section of the pygmy blue whale migration BIA (being 75 km wide), with a 40 km radius anticipated based on behavioural threshold limits, individuals will have the ability to swim around the source and still stay within the BIA. It is anticipated that an individual pygmy blue whale would take between 6-7 days to transit the operational area overlapped by the migration BIA and between 9-10 days to transit the operational area in its entirety. It is highly unlikely that TGS would undertake surveys immediately after each other that could potentially affect the same migrating individual. However, during the identified migration period, TGS will commit to not undertaking another survey within 10 days of completing an earlier survey, thus limiting the potential for individuals to be affected by more than one survey during its migration (this is in addition to exclusion periods in the identified peak period). Although tranisiting whales may then pass through the same area on the reverse migration journey or in the next season (2nd year of EP), it would be many months later at which point any potential impacts would have recovered. As such, it is evaluated that the impacts from consecutive surveys will be minimal, ALARP and acceptable.

Based on available scientific evidence, fish that experienced TTS after exposure to seismic acoustic source discharges had normal hearing levels recovered within 18–24 hours (Popper *et al.* 2014). As outlined previously, larger fauna and mobile species will likely swim away from a sound source, thus minimising exposure and any risk of significant adverse impacts. Received sound levels may result in minor behavioural changes or temporary displacement only at an individual level.

Overlapping sail lines during a survey will only occur as a result of the requirement to 'infill' a line because acquisition was stopped due to either technical problems or shutdowns due to megafauna. The infill of lines is a standard operational procedure and will only incur a minor overlap of the line as the vessel realigns itself. Without infill activity, seismic surveys would be incomplete, the data often rendered worthless and client contract requirements not fulfilled. If a vessel had ceased operations in an area for a time, it would generally be hours before the infill activities could re-commence as (at the very least) the vessel needs time to turn around and commence soft start procedures. TGS cannot commit to a minimum timeframe associated with returning to undertake infill activities, but it is anticipated that it will be at least three hours before the return would occur.

The NMFS recognised that there is a "resetting" of SEL_{cum} to 0 after 12 hours of non-exposure (Stadler and Woodbury, 2009 as cited in Halverson *et al.* 2012). This "resetting" was specific for recovery from temporary effects to the hearing of exposed fish, not barotrauma. Popper *et al.* (2014) indicate that hearing levels of fish with TTS recovered within 18–24 hours. Studies done by Casper *et al.* (2012; 2013) looked at recovery in salmon from barotrauma (injury as opposed to TTS) as a result of being exposed to SEL_{cum} 217 dB, and identified that injuries decreased significantly between 2 and 5 days after exposure, but with no significant difference in the number of injuries between 5 and 10 days. Furthermore Casper *et al.* (2012), state the data support the hypothesis that one or two mild injuries resulting from pile driving exposure are unlikely to affect the survival of the exposed animals. As a survey vessel is constantly moving and the seismic array is an impulsive rather than continuous noise, it is reasonable to assume that recovery from TTS will occur in a shorter timeframe and so a period of 24 hours would be an acceptable 'resetting' period. It must also be noted that within the operational area, there are no habitats that can support site-attached fish species, with the closest being ~ 6 km away.

With the proposed control measures in place—i.e. no acquisition in waters shallower than 200 m; use of smaller sources for soft starts in water depths less than 200 m to ensure received levels directly below the source are less than 220 dB SPL_{peak} and that the reduced operational area is more than 6 km from any raised topographical feature, received levels will be below threshold levels that may result in TTS (being SPL_{peak} 205 dB) as reported by Popper *et al.* (2014). Based on available scientific evidence, fish that experienced TTS after exposure to seismic airguns had normal hearing levels recovered within 18–24 hours (Popper *et al.* 2014).

Simultaneous surveys

In the event that the timing of any proposed seismic survey overlaps a planned TGS survey in the NWSR North operational area, the titleholders and survey vessels will communicate with each other to ensure a minimum separation distance of 50 km is maintained between them during full seismic acquisition. This will minimise underwater noise interference that may affect seismic data quality, as well reducing the likelihood of potential cumulative impacts on marine fauna.

TGS will commit to not undertaking a 3D survey within two weeks of another survey over the same area. Based on anticipated received SEL, and proposed mitigation, a two week hiatus is considered more than sufficient to allow recovery, particularly for site-attached or sedentary sensitivities and values. Furthermore, TGS commit to only using one survey vessel at a time and undertaking no more than 25,000km^2 of surveys over the two-year life of the EP, thus further reducing the potential for cumulative impacts on marine fauna.

5.1.5.16 Potential Impacts to Australian Marine Parks and KEFs

Table 5.16 - Overview of main characteristics for KEF and AMP within or adjacent to the NWSR North MC MSS Operational Area

Sensitivity	Main characteristics (not exhaustive)	Assessment
Key Ecological Feature		
Exmouth Plateau	Important sea-floor feature that modifies the flow of deep waters.	Minimum waters depths over the Plateau are ~920 m and too deep to support site-attached species. Area is not a recognised aggregation area for cetaceans or other pelagic species. Regardless, with proposed mitigation measures, impacts to marine fauna are considered minimal and likely to be no more than behavioural responses.
Continental Slope Demersal Fish Communities	High levels of endemism. Supports demersal fish.	Minimum water depths of this KEF which is recognised for demersal species, overlapped by the operational area is ~220 m and likely too deep to support site-attached species. Regardless, based on predicted received levels vertically below the source, will be below those purported to induce mortality/potential mortal injury or recoverable injury to fish. Behavioural impacts may be experienced. The acquisition area overlaps ~ 230 km^2 of the KEF which covers an area of 33,182 km^2 which equates to only 0.7%. With proposed mitigation including soft start procedures, impacts to demersal fish species or other marine fauna are considered minimal.
Glomar Shoal	• high biological diversity and high localised productivity • important habitat for commercial and recreational fish species	The KEF is not overlapped by the acquisition area. At the closest point, the boundary of the acquisition area is located ~35 km from the boundary of this KEF at which point received levels (SPLpk < 167 dB re 1 µPa; SEL <137 dB re 1 μPa^2.s) will be below those that may result in injury, TTS or behavioural impacts.
The ancient coastline at 125 m depth contour	Unique seafloor feature with ecological properties of regional significance. Supports: • biologically important habitats • Invertebrates • may support migrating species • localised upwelling and enhanced biological productivity.	This KEF is not overlapped by the full-fold acquisition area. At the closest point, the boundary of the acquisition area is located ~4 km from the boundary of the KEF. Based on predicted received levels vertically below the source and out to 2 km. SEL at the seabed within the KEF (which is in deeper waters and 4 km away) will be below those purported to induce mortality/potential mortal injury, recoverable injury or TTS in fish or invertebrates. Effects to larvae and plankton are limited to the waters within a few hundred metres of the sound source. With proposed mitigation including soft start procedures and use of MFOs, impacts to marine fauna are considered minimal and limited to behavioural responses.
Marine Park		
Argo-Rowley Terrace AMP	• Important foraging areas for migratory seabirds and the endangered loggerhead turtle • Important area for sharks, which are found in abundance around the Rowley Shoals relative to other areas in the 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 • Provides protection for many seafloor features and continental slope • Examples of the communities and seafloor habitats of the Northwest Transition and Timor	The proposed IUCN Category II zone which covers deeper waters (>3,000 m and includes the Abyssal Plain and Scott Plateau and associated KEF) is ~ 100 km from the operational area at which point received levels will be well below that may cause injury, impairment or behavioural responses in marine fauna, including cetaceans. Due to the nature of diesel, impacts from a diesel spill are anticipated to be minimal. Minimum waters depths within the IUCN Category VI overlapped by the operational area are 1,700 m and not associated with any marine fauna BIA and not recognised for supporting site attached species. At these depths no discernible or lasting impacts to deep-water benthic communities, or the sea floor features that support them, are expected. Demersal fish communities associated with the shallower waters (225-500 m and 750-1,000 m) are more than 80 km from the edge of the acquisition area and so unlikely to be impacted by seismic generated noise. Waters supporting foraging birds and turtles are associated with the shallower waters closer to the Rowley Shoals and so more than 100 km from the acquisition area. As such, due to the depth of waters overlapped by the acquisition area and distances from waters supporting recognised species, impacts are considered minimal and acceptable. As seismic acquisition is not a permanent activity as the vessel is moving through an area and the effects from noise cease as soon as the array is at distance or turned off, then by its very nature, the activity will not break the continuous connectivity between Mermaid Reef Marine National Nature Reserve and reefs of the Western Australian Rowley Shoals Marine Park and the deeper waters of the region. KEF and their values are more than 100 km away. As there are no site-attached species, and with proposed mitigation to account for marine fauna (soft starts, MFO), acquisition will have minimal impact on sensitivities within this area.

Sensitivity	Main characteristics (not exhaustive)	Assessment

	Province provincial bioregions
	• Two KEF:
	  • the canyons linking the Argo Abyssal Plain with the Scott Plateau
	  • Mermaid Reef and the Commonwealth waters surrounding Rowley
		By implementing this EP and the controls and mitigation measures within it, impacts to the environment, including the values, sensitivities and management principles of the Argo-Rowley Terrace AMP, are considered ALARP and acceptable and will ensure that activities are not inconsistent with relevant IUCN principles, namely: the biological diversity and other natural values will be protected and maintained in the long term and will ensure the ecologically sustainable use of the AMP. If Management Plans come into force during the life of this EP, TGS will comply with the requirements of the plan including not undertaking seismic surveys within an area that is classed IUCN 1a, II or IV.

Montebello AMP	• Foraging areas adjacent to important breeding areas for migratory seabirds • Foraging areas for vulnerable and migratory whale sharks • Foraging areas and adjacent to important nesting sites for marine turtles • Includes part of the migratory pathway of the protected humpback whale • The Reserve includes shallow shelf environments with depths ranging from 15m to 150m and provides protection for shelf and slope habitats, as well as pinnacle and terrace seafloor features • Examples of the seafloor habitats and communities of the Northwest Shelf Province provincial bioregions as well as the Pilbara (offshore) meso-scale bioregion • One key heritage feature for the region: Wreck of the 'Trial' • One key ecological feature for the region: ancient coastline (a unique seafloor feature that provides areas of enhanced biological productivity) is represented in this reserve	The MAMP is not overlapped by the acquisition area. At the closest point, the boundary of the full-fold acquisition area and the operational buffer are located ~22 km from the boundary of this AMP at which point received levels will be SEL <148 dB re 1 µPa^2.s / SPL_{pk} <173 dB re 1 µPa. At this distance a diesel spill is not anticipated to enter the AMP (spill radius of 19 km) • Impacts to avifauna have been assessed and although the wedge-tailed foraging/breeding area overlaps the acquisition area, it is outside the AMP. Regardless, the assessment indicated that although birds may be affected slightly by seismic sounds, the impacts are not expected to be significant to individual birds or their populations. • Impacts to whale sharks have been assessed and indicate that with the implementation of controls such as soft-starts, observation zones and use of MFO, potential effects will be limited to short-term behavioural responses, possibly including avoidance of the operating acoustic source. It is highly unlikely that the underwater noise emissions from the acoustic source would cause any pathological effects (lethal and sub-lethal injuries). • Impacts to sea turtles have been assessed and indicate that with the implementation of controls such as soft-starts, behavioural response or avoidance behaviour that may still be expressed would be localised to a few individuals that may travel or rest directly under the source. • Impacts to Humpback whales have been assessed and indicate that with the implementation of controls such as soft-starts, observation zones and use of MFO, and adaptive management measures, impacts would be limited to behavioural response or avoidance behaviour and not be significant to individuals or their populations. • Impacts to benthic habitats potentially supporting sensitivities have been assessed and indicates that with water depth limits and the large distance between the source and habitats within the AMP, impacts to sensitive marine habitats are reduced and acceptable. • The Ancient coastline at 125 m depth contour KEF has only a minor overlap of the AMP (~0.04%), is not overlapped by the operational area and is located at depths ~125m. Subsequently with the implementation of control measures, the impact from noise is anticipated to be ALARP and acceptable. • The wreck 'Trial' is located outside the operational area. Impacts to divers has been assessed. Due to the distance of the acquisition area from the AMP, received levels are anticipated to be below threshold levels and so impacts will be minimal and acceptable. By implementing this EP and the controls and mitigation measures within it, impacts to the environment, including the values, sensitivities and management principles of the MAMP, are considered ALARP and acceptable and will ensure that activities are not inconsistent with relevant IUCN principles, namely: the biological diversity and other natural values will be protected and maintained in the long term and will ensure the ecologically sustainable use of the AMP. If Management Plans come into force during the life of this EP, TGS will comply with the requirements of the plan including not undertaking seismic surveys within an area that is classed IUCN 1a, II or IV.

5.1.5.17 Sound Source Verification

based on the current minimum depth of the acquisition area (200 m; minimum 150 m for operational buffer) and minimum distance to 50 m contour around raised topographic features (16 km from acquisition area; 6 km from operational buffer), TGS have assessed that SSV is not required.

Summary of Environmental Impact Assessment		
Potential Environmental Impact	**Environmental Values and Sensitivities Affected**	**Decision Type**
Direct acoustic disturbance to sensitive receptors (i.e. marine fauna): • Pathological impacts (lethal and sub-lethal injuries) - immediate and delayed mortality and physiological effects to nearby marine organisms • Physiological impacts - permanent or temporary hearing loss • Behavioural impacts - disruptions to feeding, mating, breeding or nursery activities of marine fauna	Marine fauna • Planktonic organisms • Benthic invertebrates • Fish • Elasmobranchs • Marine reptiles • Avifauna • Dugongs • Toothed whales • Baleen whales	B
Indirect acoustic disturbance to commercial fisheries - altered behaviour or breeding patterns of commercially-targeted marine species in such a way that commercial or recreational fishing activities are compromised	Commercial or recreational fisheries	
Indirect acoustic disturbance to heritage and conservation values of a sensitive location	Heritage or Conservation Areas: KEFs, BIAs, AMPs	

Residual Risk Assessment				
Potential Environmental Impact		**Consequence**	**Likelihood**	**Residual Risk**
Direct acoustic disturbance to sensitive receptors (i.e. marine fauna): • Pathological impacts (lethal and sub-lethal injuries) - immediate and delayed mortality and physiological effects to nearby marine organisms • Physiological impacts - permanent or temporary hearing loss • Behavioural impacts - disruptions to feeding, mating, breeding or nursery activities of marine fauna	Plankton	Minor	Unlikely	Medium
	Benthic invertebrates	Slight	Highly Unlikely	Low
	Fish	Minor	Unlikely	Medium
	Elasmobranchs	Slight	Highly Unlikely	Low
	Marine reptiles			
	Avifauna			
	Whale sharks			
	Toothed whales	Minor	Unlikely	Medium
	Baleen whales			
Indirect acoustic disturbance to commercial fisheries - altered behaviour or breeding patterns of commercially-targeted marine species in such a way that commercial or recreational fishing activities are compromised	Commercial or recreational fisheries	Minor	Unlikely	Medium
Indirect acoustic disturbance to heritage and conservation values of a sensitive location	Exmouth Plateau	Slight	Highly Unlikely	Low
	Ancient coastline at 125 m depth contour			
	Continental Slope Demersal Fish Communities			
	Glomar Shoal			

	Argo-Rowley Terrace AMP			
	Montebello AMP			

Summary of Control Measures

Operation of the seismic source[2] at all times during the survey will implement soft start procedures (gradual increase of power over 30 minutes)

- The first stage will involve activating the smallest volume element in the array.
- Subsequent stages will involve doubling the number of active elements at the start of each stage.
- All stages should be of approximately equal time duration.
- The total duration of the soft-start should be at least 30 minutes, no longer than 40 minutes or as specified in applicable regulatory requirements.

As there will generally be one stage in which doubling the number of elements is not possible (due to the number of elements in the full array not being, for example, 8, 16 or 32), it is preferable to make this stage the last one of the soft-start sequence (as opposed to adjusting the increments of other stages or placing a lower increment early in the soft-start sequence).

Operation of the seismic source within the operational area at all times will comply with EPBC Policy 2.1 Part A and certain Part B elements:

- Pre start-up visual observations (at least 30 minutes)
- precaution zones (Observation zone: 3+ km; Low power zone: 2 km; Shut-down zone: 500 m)
- Night-time and low visibility procedures.

One (1) dedicated Marine Fauna Observer (MFO) on the survey vessel for duration of the survey

Pygmy blue whales specific

Operation of the seismic source **within the 'known to occur' distribution** during the **peak** periods (this includes migration BIA as identified in the NCVA) in:

- **15 May** - **30 July** and **15 October** - **30 December**

must comply with the following EPBC Act Policy Statement 2.1 Part B Additional Management Procedure:

- application of increased precaution zones (Observation zone: >3 km; Shut-down zone: 2 km).
- application of an increased Pre Start-up Visual Observation of 45 minutes, rather than 30 minutes.
- Limiting initiation of soft start procedures to conditions that allow visual inspection of the precaution zone.

If the observed density of whales in the area is higher than expected from pre-survey research (i.e. three or more whale-instigated shut-downs/power-downs occur within preceding 24 hours), then:

- all night-time operations shall cease in this location.
- at this point, if less than three whale-instigated shut-downs/shut-downs occurred within the preceding 24 hours, night-time operations can re-commence in this location, as per EPBC Act Policy Statement 2.1 Part B.

after three days in which night-time operations ceased, it is reasonable to presume that the likelihood of encountering whales has increased (as per EPBC Act Policy Statement 2.1 Part B.6) and therefore TGS shall:

- undertake a dynamic risk assessment to determine if further mitigation is required (e.g. moving location or ceasing operations), and;
- contact the DoE for their advice.

Pygmy blue whales specific

The seismic source will not be operated in the following location:

- The pygmy blue whale migration BIA (as identified in the DOEE NCVA website); and
- the area directly to the northwest of the narrowest portion of the BIA to a line extending from 19°42'50.26"S; 113°53'55.68"E to 17°46'36.64"S; 116° 3'58.17"E

between the following peak migration dates:

- 15 May to 15 July
- 1 November to 15 December

Adaptive Management Measures for In-field Operations

Notwithstanding EPS # 33;

If the observed density of marine fauna in the area is higher than expected from pre-survey research (i.e. three or more shut-downs of the same species group; e.g. 3 or more whale shut downs, or 3 or more whale shark shut downs or 3 or more marine turtle shut downs) occur within 24 hours*), then:

- soft start procedures will be limited to conditions with good visibility.
- increased precaution zones (Observation zone >3 km; Shut-down zone 2 km) will be applied.
- pre Start-up Visual Observation will be increased to 45 minutes.
- all night-time operations shall cease in this location.

At this point, if less than three power-downs, shut-downs or sightings in the precaution zone occurred within the preceding 24 hours, standard management measures and night-time operations can re-commence in this location, as per EPBC Act Policy Statement 2.1 Part A.
Adaptive Management Measures for In-Field Operations If one (1) or more power-down, shut-down or sighting in the precaution zone is experienced each day for three (3) consecutive days (for the same species group), it is reasonable to presume that this is indicating trend and so the likelihood of encountering whales, whale sharks, or marine turtles has increased (as per EPBC Act Policy Statement 2.1 Part B.6), and as such TGS shall: • undertake a dynamic risk assessment to determine if further mitigation is required (e.g. additional MFO, moving location or ceasing operations), and; contact the DoE for their advice.
Sperm Whales – Pre-survey planning • If, based on pre-survey planning (which includes reviewing available information on whale sightings in the proposed survey area), it is believed sperm whales may be present in the survey area, then pre-watch periods will be increased to 45 minutes.
Detailed reports of all marine fauna sightings (cetaceans, whale sharks, turtles, dugong etc) and interactions will be recorded and reported, via the Annual Report (if relevant) and post-survey Environmental Performance Report.
Survey vessel personnel (marine and seismic) provided with pre-survey induction on EPBC Act Policy Statement 2.1 requirements and protected fauna.
• Only appropriately experienced MFOs (as determined by a review of their CVs) will be contracted to undertake the NWSR North MC MSS. • MFOs will have been trained and/or experienced in whale identification and behaviour, distance estimation, and be capable of making accurate identifications and observations of whales in Australian waters. • MFOs will ensure that requirements of Policy 2.1 and this EP (in relation to fauna observations) are implemented appropriately
Detailed reports of all marine fauna sightings (cetaceans, whale sharks, marine reptiles, dugong) and interactions will be recorded and reported and all cetacean sightings will be recorded using the Cetacean Sightings Application (CSA - Version 3 - BETA) or similar
• Vessels will not undertake full seismic acquisition activities within 50 km of another vessel that is also acquiring data. • TGS shall search the NOPSEMA website and consult with geophysical companies and/or titleholders to determine the presence of other seismic operations overlapping the operational area.
Prior to individual surveys, TGS will undertake pre-survey planning that will review and consider new information Pre-survey research (e.g. desktop review of best available, updated scientific data, evaluation of any suitable additional controls) to determine likelihood of encountering whales, to inform on-going improvement and assess if increased precaution zones or other adaptive management measures are required to be implemented to ensure impacts are ALARP and acceptable.
The largest sound source that TGS will use for any survey within the operational area will have a capacity no greater than 4,120 cui, which will produce an equivalent 0-peak SPL of no higher than 260.2 dB re 1µPa (at 1 m).
TGS will not undertake a 3D seismic survey less than 2 weeks after a survey has been undertaken over the same area.
TGS will not undertake another survey within 10 days of completing an earlier survey during the pygmy blue whale migration periods.
For all 3D surveys the racetrack method must be used.
The seismic array will not be discharged at full power in: • waters depths shallower than 200 m; or • outside the full fold acquisition area;
The seismic source will not be discharged during soft starts any closer than 5 km laterally beyond the 50 m depth contour around topographical features (e.g. shoals).
• Streamers will not be towed in water depths below 20 m chart depth. • Streamers must be more than 10 m from seabed
No more than one (1) TGS multi-client surveys will be undertaken at one time within the operational area.
• No more than 25,000 km^2 of surveys will be undertaken over the 2-year life of the EP
All spatial data sets sourced from authorative datasets, such as Commonwealth of Australia Government websites and provided to operating vessels by TGS. Spatial boundaries and exclusion zones will be:

• Entered into the survey vessel navigation systems on board for both seismic navigators and bridge personnel. • Included in the pre-survey induction. • All copy maps / charts will have such zones highlighted and discussed during the start-up briefing. • Seismic observers will confirm seismic acquisition lines entered into the integrated navigation system (INS) are not located within exclusion zones or outside of the operational area: o start of line and end of line location are located only within acquisition area. • Prior to commencing soft start procedures Seismic Observers will once again check that the start of line and end of line location are located only within acquisition area. • SEA will confirm the acoustic source is not located within exclusion zones or outside of the operational area prior to commencement of the acoustic source array. • Seismic observers will confirm seismic acquisition lines entered into the integrated navigation system are not located within exclusion zones or outside of the operational area: • start of line and end of line location are located only within acquisition area. Before each affected line commences, Client Representative confirm first and last shot point (including soft start location) are in the correct location and outside of exclusion zones and correct source capacity is selected for water depth.
TGS will ensure that received sound levels at the seabed are no greater than 220 dB re 1µPa (SPL_{peak}) during soft starts in water depths <200 m. Accordingly, the total source capacity will not exceed: • 3,060 cui in water depths between 150 m and 120 m; • 2,680 cui in water depths between 120 m and 100 m; • 1,940 cui array for water depths from 100 m to 70 m; and • 1,420 cui array for water depths from 70 m to 50 m.
TGS will not undertake a second survey that overlaps a previous survey in waters less than 250 m within the 2-year life of the EP

5.1.6 DISCHARGE OF BILGE WATER, SEWAGE AND FOOD WASTES (PUTRESCIBLES)

Description of Risk
During surveys in the operational area, the survey and support vessel will routinely discharge (on a daily basis) relatively small volumes of sewage and food wastes to the ocean in accordance with the requirements of the MARPOL 73/78 Convention (as implemented in Commonwealth waters by the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*. Additionally, the survey and support vessel may need to discharge bilge water during the survey. Routine discharges of bilge water, sewage and food wastes from the survey vessel and support vessel may cause a localised reduction in water quality.

Potential Environmental Impacts
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 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. Bilge tanks receive fluids from many parts of the vessel. Bilge water can contain water, oil, detergents, solvents, chemicals, particles and other liquids, solids or chemicals. Treatment of bilge water will be conducted using an oily water separator. However, if not treated prior to discharge there would be potential for a negligible and localised increase in nutrient concentrations. The potential impact from routine discharges of bilge water, treated or untreated sewage, and food wastes is expected to be negligible.

Summary of Environmental Impact Assessment				
Potential Environmental Impact		**Environmental Values and Sensitivities Affected**		**Decision Type**
Localised eutrophication of the water column		Marine habitats		A
Residual Risk Assessment				
Potential Environmental Impact		**Consequence**	**Likelihood**	**Residual Risk**
Localised eutrophication of the water column	Marine habitats	Slight	Highly Unlikely	Low
	Conservation and heritage values			

Summary of Control Measures
Sewage discharges from vessels must comply with the relevant requirements of: • MARPOL Annex IV Prevention of Pollution by Sewage from Ships • *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 vessels must comply with the relevant requirements of: • MARPOL Annex V Prevention of Pollution by Garbage from Ships • *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* - Section 26F • Marine Order 95 (Marine pollution prevention - garbage) 2013 Marine Notice 2017/4 MARPOL Annex V Discharges.
Bilge water discharges (machinery space bilges) must comply with the relevant requirements of: • MARPOL Annex I Regulations for the Prevention of Pollution by Oil Protection of the Sea (Prevention of Pollution from Ships) Act 1983 –Part II, Section 9.

Incineration of any oil sludge on board or disposal of any oil sludge/slops in port must comply with relevant the requirements of:

- MARPOL Annex I – Regulations for the Prevention of Pollution by Oil
- *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* – Part II, Section 12
- Marine Order 91 (Marine pollution prevention – oil) 2014

Marine Notice 09/2015 Guidance document for the recording operations in the Oil Record Book Part I.

5.1.7 REDUCED AIR QUALITY FROM ATMOSPHERIC EMISSIONS

Description of Risk

Atmospheric emissions from the proposed survey include greenhouse gas (GHG), NOx (nitrogen oxide), SOx (sulphur oxide), CO (carbon monoxide) and particulate matter (dark smoke) emissions from:

- Use of survey and support vessel main engines for propulsion.
- Use of survey and support vessel main and emergency power generation equipment.
- Use of aviation fuel for transport of personnel via helicopters.
- Use of marine diesel by the survey vessel(s) workboat.
- Incineration of oily sludge aboard the survey vessel(s).

Potential Environmental Impacts

Potential environmental effects from these atmospheric emissions are a contribution to GHG emissions (albeit very minor) that may potentially influence climate change, and a localised reduction in air quality. Atmospheric emissions generated during the survey will result in a localised, temporary reduction in air quality. Incineration of oily sludge is not expected to generate any significant atmospheric emissions, due to the infrequent nature of the activity and the small volumes of material being burnt during each disposal episode

Summary of Environmental Impact Assessment

Potential Environmental Impact	Environmental Values and Sensitivities Affected	Decision Type
Localised reduction in air quality from greenhouse gas emissions	Atmospheric environment	A

Residual Risk Assessment

Potential Environmental Impact		Consequence	Likelihood	Residual Risk
Localised reduction in air quality from greenhouse gas emissions	Atmospheric environment	Slight	Highly Unlikely	Low

Summary of Control Measures

Regarding atmospheric emissions, survey operations will adhere to relevant requirements of:

- MARPOL 73/78 Annex VI (as implemented in Commonwealth waters by the Commonwealth Protection of the Sea (Prevention of Pollution from Ships) Act 1983 (PSPPS Act);
- *Maritime Legislation Amendment (Prevention of Air Pollution from Ships) Act 2007;* and

Marine Orders Part 97 (Marine pollution prevention - air pollution) 2013.

5.2 UNPLANNED ACTIVITIES (ACCIDENTS / INCIDENTS)

5.2.1 COLLISION BETWEEN VESSELS / TOWED ARRAY AND MARINE FAUNA

Description of Risk
The survey and support vessels may present a potential physical hazard (e.g. animal displacement or vessel strike) to marine fauna including cetaceans, turtles, sea snakes, whale sharks and dugongs. Additionally, the tail buoys that are attached to the end of seismic streamers can represent an entanglement risk for turtles
Potential Environmental Impacts
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. Marine seismic surveys usually involve the use of two or more vessels travelling at slow speed (~ 4-5 knots) along defined paths. The timing and location of surveys within the operational area may coincide with sensitive periods such as humpback whale, blue whale and whale shark migrations and turtles internesting periods. Given the susceptibility of cetaceans, turtles and whale sharks to vessel strike, only potential impacts on these have been considered. Other fauna such as birds, fish and sea snakes are likely to avoid vessels operating in the area and so are considered at low risk of potential strike. **Cetaceans** The likelihood of vessel/whale collision being lethal is influenced by vessel speed; the greater the speed at impact, the greater the risk of mortality (Laist *et al.* 2001, Jensen and Silber 2003). During seismic data acquisition, the survey vessel will be moving at a speed of ~4 knots. According to the data of Vanderlaan and Taggart (2007), it is estimated that the risk of a vessel-whale collision resulting in lethal outcome is less than 10% at a speed of 4 knots. Vessel/whale collisions at this speed are uncommon and, based on reported data contained in the US National Ocean and Atmospheric Administration database (Jensen and Silber 2003) there are only two known instances of collisions when the vessel was travelling at less than 6 knots, both of these were from whale watching vessels that were deliberately placed amongst whales. **Turtles** Marine turtles on the sea surface or in shallow coastal waters have been observed to avoid approaching vessels by typically moving away from the vessels track (Hazel *et al.* 2007).Hazel *et al.* (2007) suggests this observed avoidance behaviour is based primarily on visual cues (although these authors acknowledge that vessel noise is within range of turtle hearing) and the success of this behaviour in avoiding a vessel strike is largely dependent on the speed of the approaching vessel (rather than vessel type) and the prevailing water clarity. Turtle entrapment with streamer tail buoys can lead to mortalities (Ketos Ecology 2007, 2009). This has been an issue particularly for marine seismic surveys off the west coast of Africa. In recent years, geophysical acquisition companies and seismic contractors have been designing and implementing "turtle guards" – modifications to the tail buoys that minimise the potential for turtle entrapment. More recently, developments in the design of tail buoys has resulted in tail buoys that do not represent a turtle entrapment threat. An example of these tail buoys is the PartnerPlast 900L which are designed to skim along the surface with just a single chain extending beneath the surface. The survey vessel to be used for surveys within the NWSR North MSS operational area shall either be fitted tail buoys or turtle guards to prevent entrapment. The operational area does not overlap any recognised BIA and is ~ 20 km from the outer boundary of the Flatback turtles internesting buffer BIA. It has been established that this is an overly-conservative BIA in the WA populations and that the majority of internesting flatback turtles will be between the island and mainland,

or only within 10 km of an island. Consequently, no exclusion is required for the flatback turtle internesting buffer in WA, or for any other turtle species.

Whale Sharks

Although the whale shark's skin is thicker and tougher than any other shark species, the species may be behaviourally vulnerable to boat strike. They spend a significant amount of their time close to the surface of the water (DEH 2005a; Norman 1999) and several sharks bear scars that have probably been caused by boat contact (DEH 2005a).

The DPaW have developed a code of conduct for commercial vessels engaged in whale shark watching to minimise the risk of disturbance to normal whale shark behaviour and boat strike. These measures have been used to develop minimum requirements for vessels within the NWSR North MC MSS.

Given the slow operating speed of the survey and support vessels (unless in an emergency) and the low likelihood of large numbers of animals being present, the potential for vessel strike to impact significantly on cetacean, whale shark or turtle populations in the operational area is assessed to be low.

Vessel-marine fauna interaction procedures will be prepared to ensure any interactions between the support vessel and cetaceans, whale sharks and turtles are managed in accordance with Part 8 of the EPBC Regulations 2000, and with guidelines from the Commonwealth Government (DEH 2005b). These procedures, in the form of an action flowchart, will be distributed to the support vessel Masters, and the crew will be made aware of these requirements at induction prior to commencement of surveys within the operational area.

Summary of Environmental Impact Assessment			
Potential Environmental Impact		**Environmental Values and Sensitivities Affected**	**Decision Type**
Injury/fatality to protected marine fauna		Marine Fauna: cetaceans, marine turtles, dugongs & whale sharks	A
Residual Risk Assessment			
Potential Environmental Impact		**Consequence**	**Likelihood**	**Residual Risk**
Injury/fatality to protected marine fauna	Cetaceans	Minor	Remote	Low
	Marine Turtles			
	Whale sharks			
Summary of Control Measures			
TGS will adhere to the OPGGS Environment Regulations requirements for reportable incidents.			
Operations of the survey and chase vessel will be in accordance with Marine Notice 15/2016: Minimising the risk of ships colliding with cetaceans.			
The survey will use streamers designed to reduce entanglement risks to marine fauna.			

5.2.2 VESSEL GROUNDING, ANCHORING AND EQUIPMENT DRAGGING OR LOSS

Description of Risk
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.
Potential Environmental Impacts
The potential and significance of impacts caused by vessel grounding, anchoring or loss of equipment is in part dependent on the type of receiving environment. Soft sediment benthic areas relatively devoid of sensitive habitats and consisting of sandy /silt substrate or mud is the predominant benthic receiving environment within, and adjacent to much of the operational area. Exceptions to this are the many shoals, banks, reefs and pinnacles throughout the NWMR and NMR. No seismic acquisition shall occur in waters <200 m. Defence also made it known that unexploded ordnances may be present on and in the sea floor where activities may be undertaken, and so there is the risk of detonation. Due to the depths and method of surveys, this risk has been assessed as low. 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 are fitted with pressure-activated, self-inflating buoys that are designed to bring the equipment to the surface if lost accidentally during a survey. As the equipment sinks it passes a certain water depth at which point the buoys inflate and bring the equipment back to the surface where it can be retrieved by the seismic or support vessels Dragging of the streamer along the seabed may result in localised physical disturbance of substrates, benthic habitats and communities. Steamers will be towed at a depth that will not allow them to be closer than 10 m from the seabed. The operational area is limited to waters deeper than 150 m. Various petroleum infrastructure such as platforms and floating production storage offload (FPSO) units are present within the operational area. Steaming too close to an emergent structure could result in streamer entanglement, damage or loss. Vessels and associated equipment, including deployed streamers, will not enter a petroleum safety zones (PSZ) around any emergent petroleum infrastructure as provided for in Chapter 6, Part 6.6 of the OPGGSA.As per Section 668 of the OPGGSA, PSZ are usually 500 m. **Anchoring** The size of the anchor and chain and the frequency of anchoring will affect any potential damage. The majority of the benthos in the operational area is sand/mud/silt. Anchoring in these habitats typically cause minimal disruption to the soft sediment and, given the widely distributed benthic flora and fauna found within these areas, would have a minimal to negligible impact to the benthic communities. Anchoring over shoals or reefs may impact more sensitive environments supporting coral communities. Anchoring is not a planned activity for the NWSR North MC MSS and would only occur in emergency circumstances. Vessels are fitted with highly sophisticated position fixing equipment and all measures will be taken to avoid areas of sensitive habitats such as corals, seagrasses and macroalgal beds. **Vessel Grounding** Vessel impact and grounding has the potential to damage living resources, cause fracturing, reef rock displacement, and sediment disturbance. These are caused by vessel contact with the ocean bottom, by prop wash and cable dragging during attempts by operators and/or salvagers to re-float the vessels, and by subsequent movement of destabilised substrates (Gittings *et al.* 1993). Vessel grounding also has the potential to result in the loss of containment of hydrocarbons such as fuels and oils from vessels that may also adversely affect aquatic marine life.

The potential for the survey and support vessel to become grounded while working within the operational area is unlikely due to the absence of shallow waters (<20 m water depth) and lack of shoals, reefs or other raised topographic features. Vessels are equipped with up-to-date navigation equipment, GPS and charts, thus the chances of running aground are unlikely.

Whilst the vessels are in transit to/from a survey area there is the possibility of grounding in shallow waters in the vicinity of coastal islands. However, the scope of this EP does not cover transfer of the survey or support vessels to and from the survey area.

Summary of Environmental Impact Assessment			
Potential Environmental Impact		**Environmental Values and Sensitivities Affected**	**Decision Type**
Localised physical damage from: • Vessel grounding • Deployment/retrieval of anchors • Equipment dragging or loss		Benthic habitats	A
Residual Risk Assessment			
Potential Environmental Impact		**Consequence**	**Likelihood**	**Residual Risk**
Localised physical damage from vessel grounding	Benthic habitats	Minor	Highly Unlikely	Low
Localised physical damage from deployment/retrieval of anchors		Slight	Highly Unlikely	
Localised physical damage from equipment dragging or loss		Slight	Unlikely	

Summary of Control Measures
TGS will adhere to the *Navigation Act of 2012*, particularly regarding the use of approved navigation systems.
TGS will adhere to industry standards and best practice regarding streamers used in surveys.
Anchoring will not occur within the operational area except in the event of an emergency.
Surveys will comply with relevant requirements of Marine Order 32 (Cargo handling equipment) 2016 for lifting activities.

5.2.3 ACCIDENTAL RELEASE OF HAZARDOUS OR NON-HAZARDOUS MATERIALS

Description of Risk
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.

Potential Environmental Impacts
Hazardous Materials These materials have the potential to adversely impact the marine environment if accidentally released in significant quantities. The potential effects include a reduction in water quality and toxic effects on marine flora and fauna. Chemicals e.g. solvents and detergents will typically be stored in small containers of 5-25 L 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. Some spills may occur when small containers of chemicals are being used in open areas, where there is a risk of some entering the sea if spilled. The realistic worst-case volume would be 25 L. **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.

Summary of Environmental Impact Assessment			
Potential Environmental Impact		**Environmental Values and Sensitivities Affected**	**Decision Type**
Localised, temporary reduction in water quality		• Marine fauna Benthic habitats	A

Residual Risk Assessment				
Potential Environmental Impact		**Consequence**	**Likelihood**	**Residual Risk**
Localised, temporary reduction in water quality	Marine fauna Benthic habitats	Slight	Highly Unlikely	Low

Summary of Control Measures
Handling of hazardous and non-hazardous wastes aboard the survey and support vessels will comply with relevant requirements of: • MARPOL Annex III • MARPOL Annex V • *Protection of the Sea (Prevention of Pollution from Ships) Act* • Marine Order 94 (Marine pollution prevention – packaged harmful substances) 2014 • Marine Order 95 (Marine pollution prevention – garbage) 2013 Marine Notice 2017/4
Survey vessels will have SOPEPs in place that are compliant with the relevant requirements of: • Regulation 37 of MARPOL Annex I Marine Order 91 (Marine pollution prevention — oil) 2014
All hazardous substances (as defined in the International Maritime Dangerous Goods Code) will have Material Safety Data Sheets (MSDS) that are readily available on board.
TGS will ensure that all vessels carry and store spill kits as required in the vessel's SOPEP.

5.2.4 HYDROCARBON RELEASE CAUSED BY TOPSIDES (VESSEL) LOSS OF CONTAINMENT

Description of Risk
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.

Potential Environmental Impacts
Hydrocarbons which may be stored on deck (or within below deck storage) on the survey and support vessel may include lubricating oils or hydraulic fluids. The size of potential spills to deck of these substances are likely to be between 50 and 200 L (0.05 m^3 and 0.2 m^3) 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. Volumes of hydrocarbons greater than 200 L (0.2 m^3) such as main engine lubricating oils, waste engine oil and hydraulic fluid would normally be stored below decks in designated storage tanks and do not represent a direct hazard for deck spills unless smaller volumes are being used on deck directly from a container. 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. **Credible spill scenario** Containment measures (i.e. bunds, containment lips, or absorbent booming) will be applied to the storage of drums or containers that are present on deck to prevent direct discharge to the marine environment. In the event of an accidental spill or leaking container, it is most likely that spilled material will be contained aboard (e.g. via use of scupper plugs) and recovered with minimal risk of material entering the marine environment through overboard drains or scuppers. For a spill on deck to result in a release to the marine environment, there would need to be an un-confined spill which was subsequently allowed to flow overboard and since use of oils or other chemicals on deck would usually be confined within areas with deck combing or bunds, this is highly unlikely to occur. 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 usually contained within a bund or drip tray under the equipment mounted on deck. A burst hydraulic hose on an extended crane could potentially result in hydraulic fluid being sprayed in a fine jet out over the water however, this would only result in a small volume (less than 1 L to approximately 25 L) before the problem was noticed, equipment shut down and the leak stopped.

Summary of Environmental Impact Assessment			
Potential Environmental Impact	**Environmental Values and Sensitivities Affected**		**Decision Type**
Localised, temporary reduction in water quality due to hydrocarbon contamination	Marine fauna Benthic habitats		A
Residual Risk Assessment			
Potential Environmental Impact	**Consequence**	**Likelihood**	**Residual Risk**
Localised, temporary reduction in water quality due to hydrocarbon contamination	Marine fauna Benthic habitats	Slight	Unlikely	Low

Summary of Control Measures
Hydrocarbon storage on deck of the survey vessel must be designed and maintained to contain and prevent deck spills entering the marine environment.
Equipment located on deck utilising hydrocarbons will be stored safely to reduce risk of loss of hydrocarbon containment to the marine environment.

SOPEP drills will be undertaken as per the seismic vessel standard operating procedure and compliant with the relevant requirements of: • MARPOL Annex I (Regulation 15) OPGGS Environment Regulations.
In the event of a hydrocarbon spill from topside containment loss, TGS will implement spill monitoring and reporting procedures in accordance with relevant requirements of: • This EP's OPEP and vessel's SOPEP • MARPOL Annex I • *Protection of the Sea (Prevention of Pollution from Ships) Act* • Marine Order 91 OPGGS Environment Regulations.

5.2.5 HYDROCARBON RELEASE CAUSED BY TRANSFER SPILL OR VESSEL COLLISION BETWEEN SURVEY VESSEL AND SUPPORT VESSEL OR THIRD-PARTY VESSEL

Description of Risk
The hazards associated with fuel and oil spills during the NWSR North MC 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.
Potential Environmental Impacts
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. As the amount of diesel that could be spilled through a refuelling accident is less than that involved in a vessel collision, modelling results for a vessel collision only are presented and used to determine the zone of potential impact (ZPI). **Assessment of Likelihood** In an ERA, the likelihood component of the assessment is a function of the event occurring and subsequently affecting a sensitive resource (i.e. having an impact). For a hydrocarbon spill, the likelihood is a combination of: • the probability of a spill occurring, and the volume of that spill at source (primary risk); and • the probability of a spill reaching a sensitive part of the environment (secondary risk). According to DNV (2011), frequency of spills exceeding 1tn (per year) can be broken down into eight different accident types. Of all possible accident types, annual spill frequencies are dominated by transfer (19.9%), drift grounding (21.6%) and powered grounding (19.1%), whilst the spill frequency for vessel collisions is 11.6%. Therefore, transfer spills have a much greater potential to cause large spills than do vessel collisions. 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. Based on a review of the Australian Transport Safety Bureau's marine safety database there are no recorded instances of collisions, grounding or sinking of a seismic vessel or its support vessels in Australian waters in at least the last 30 years. Although there is commercial fishery and shipping activity in some areas of the operational area, a collision between the survey vessel(s) and another vessel unconnected with the activity is unlikely, given the comprehensive control and mitigation measures in place to manage the risk of vessel collisions. However, a possibility remains of a collision occurring between the survey vessel(s) and the support vessel during occasions when the vessels are manoeuvring close to each other. It has been assessed as unlikely that the survey or support vessels grounding within the operational area, and the absence of emergent features (noting a 500 m exclusion zone will be implemented around petroleum infrastructure and activities are limited to deep waters). **Spill Modelling** The following spill scenarios were assessed:

- 3 m^3 instantaneous surface discharge of MGO as a result of a refuelling incident
- 220 m^3 surface discharge of MGO over a six-hour period resulting from a vessel collision.

The ZPI as a result of 3 m^3 refuelling incident was much smaller than that of the 220 m^3 spill and ranged from a ~14 km to 18 km. As no refuelling will occur within 25 km from emergent land, the remainder of this section focuses on the impacts associated with the larger spill.

Sensitivities that may be Affected

Table 5.17 - Summary of sensitivities that may be impacted based on ADIOS modelling

Emergent Features or Sensitive Receptors	Distance from Operational Area	Values and Sensitivities	overlapped ZPI 19 km
Montebello AMP	Multiple Use Zone 20 km away	• Foraging areas adjacent to important breeding areas for migratory seabirds • Foraging areas for vulnerable and migratory whale sharks • Foraging areas and adjacent to important nesting sites for marine turtles • Shallow shelf environments with depths ranging from 15 metres to 150 m	NO
Argo-Rowley Terrace AMP	Marine National Park Zone >90 km away	• The reserve provides protection for the communities and habitats of the deeper offshore waters of the region in depth ranges from 220 metres to over 5000 metres • The reserve provides protection for many seafloor features including aprons and fans, canyons, continental rise, knolls/abyssal hills and the terrace and continental slope • Examples of the communities and seafloor habitats of the Northwest Transition and Timor Province provincial bioregions • KEF - the canyons linking the Argo Abyssal Plain with the Scott Plateau (unique seafloor feature with enhanced productivity and feeding aggregations of species)	NO
	Multiple Use Zone – Overlaps	• Important foraging areas for migratory seabirds and the endangered loggerhead turtle • Important area for sharks, which are found in abundance around the Rowley Shoals relative to other areas in the region • The reserve provides connectivity between the existing Mermaid Reef Marine National Nature Reserve and reefs of the Western Australian Rowley Shoals Marine Park and the deeper waters of the region	**YES (13.2%)**
Glomar Shoal – KEF	24 km away	• High biological diversity and high localised productivity • Important fishing grounds	NO
125 m isobath – KEF	1 km at closest point	• Contribute to higher diversity and enhanced species richness • Facilitate increased availability of nutrients off the Pilbara • Enhanced productivity may attract larger marine life such as whale sharks and large pelagic fish • Humpback whales migrate along the ancient coastline	**YES**
Exmouth Plateau - KEF	Overlaps	Contributes to upwelling of deeper water nutrients	**YES**
Continental Slope Demersal Fish Communities – KEF	Overlaps	Rich assemblage of ~500 fish species and high endemicity	**YES**

Due to the distance of the operational area from emergent lands, there is no risk of impact to benthic habitats and communities associated with intertidal, shallow subtidal or shoreline habitats.

Protected marine fauna at risk within or adjacent to the operational area as a result of a 220 m^3 release of marine diesel includes:

- cetaceans;
- whale sharks;
- turtles;
- sea snakes; and

- seabirds.

Social aspects such as commercial fishing, recreational fishing or marine-based tourism may be effected.

Assessment of Consequences

Entrained hydrocarbons may pose different risks to habitats and fauna compared to a surface slick. Due to this dilution of entrained oil in the water column compared to a surface slick, toxic impacts are likely to be less. Entrainment associated with diesel will generally be limited to the top few metres of the water column (depending on conditions). Consequently, benthic environments in deeper waters are not affected.

As diesel is less viscous or sticky when compared to black oils, the diesel tends to penetrate porous sediments quickly but also tends to be washed off quickly by waves and tidal flushing. Diesel oil is readily and completely degraded by naturally occurring microbes in approximately two months (NOAA 2012). No shorelines are at risk from surface diesel slicks or entrained hydrocarbons.

A summary of the sensitive receptors found in this potential area, and the potential impacts of both surface slicks and entrained oil, are outlined below**.** Although the amount of entrained oil to be generated is minimal and so its effects negligible, an overview is provided.

Table 5.18 - Summary of sensitive receptors

Receptor	Potential Exposure	Potential Impacts
Marine Fauna		
Cetaceans	Marine mammals are highly mobile and anecdotal evidence indicates whales and dolphins may be able to detect and avoid surface slicks. <u>EPBC listed species</u> 27 cetacean species were identified by the EPBC Protected Matters search as potentially occurring in the operational area. Of these, four are listed as threatened <u>BIA</u> The operational area overlaps the BIA (migration north and south) for the pygmy blue whale. Planning will be undertaken to try and avoid these peak sensitive periods, but it is possible that activities will overlap. Pygmy blue whales may feed opportunistically during the migration.	Marine mammals that have direct physical contact with surface slicks and entrained oil from surface fouling or through ingestion of hydrocarbons and/or inhalation of toxic vapours may experience irritation of sensitive membranes such as the eyes, mouth, digestive and respiratory tracts and organs, impairment of the immune system or neurological damage (Etkins 1997).Marine mammals are generally able to metabolise and excrete limited amounts of hydrocarbons, but acute or chronic exposure poses greater toxicological risks (Grant and Ross 2002). Such impacts may include changes in behaviour and reduced activity, including inflammation of the mucous membranes, lung congestion, pneumonia, liver disorders, and neurological damage (Geraci and St. Aubin 1990). Surfacing within a hydrocarbon slick may lead to a toxic level of exposure. However, cetaceans have a thickened epidermis that greatly reduces the likelihood of hydrocarbon toxicity from skin contact with oiled waters (Geraci 1990; O'Shea and Aguilar 2001). For surface oil, inhalation of vapours at the water's surface and ingestion of hydrocarbons during feeding (in particular, surface skimming baleen whales) are more likely pathways of exposure (National Marine Fisheries Service 2008). The concentration of entrained hydrocarbons will be less in comparison to surface slicks due to the effects of dilution with sea water and inability for some hydrocarbon residues to entrain. This behaviour of entrained diesel combined with a thick epidermis layer means cetaceans are unlikely to be affected greatly from skin contact with entrained hydrocarbons. Chronic ingestion of subtoxic quantities of oil may have subtle effects which would only become apparent through long-term monitoring. The transfer of petroleum hydrocarbons through the mother's milk to sucking young is another way oil affects dolphins. <u>Pygmy blue whales</u> Pygmy blue whales that are feeding opportunistically during migration may be exposed to surface slicks or entrained oil. <u>Humpback whales</u> Individual Humpback whales migrating north and south may be exposed to surface diesel slicks but it is highly unlikely given the operational area is more than 40 km from the identified BIA. <u>Dolphins</u> Snubfin, humpback and bottlenose dolphins will mostly be in shallow waters outside the operational area. Individuals may be present

		Humpback and pygmy blue whales are pelagic gulp feeders and therefore are unlikely to ingest large quantities of surface hydrocarbons, although they may be prone to ingesting smaller amounts of entrained oil. However, the amount of entrained oil potential consumed during feeding is likely to be low. Dolphins are toothed whales which feed on fish and squid and spend much of their time in waters close to shore. Low numbers of humpback and pygmy blue whales and dolphins may encounter surface slicks and entrained oil. The potential consequences of contact are minor (as assessed above). The potential impacts of surface slicks and entrained oil on these species is considered to be low.
Marine reptiles	<u>EPBC listed species</u> Five migratory turtle species were identified by the EPBC Protected Matters search as potentially occurring in the operational area. All of these species are listed as threatened. Two species of sea snake (short-nosed and leaf-scaled sea snake) are listed as critically endangered. Given the survey water depths are greater than 200 m and distance offshore from the mainland mostly >120 km, and not near islands that support them, it is unlikely that sea snakes will be encountered in large numbers. <u>BIA</u> The operational area does not overlap any turtle BIA. The ZPI overlaps the 60 km flatback internesting BIA by ~ 10 km at its closest point. The nesting season for turtles is most commonly the summer months.	Marine turtles are vulnerable to the effects of hydrocarbon spills at all life stages (eggs, post hatchlings, juveniles and adults) whilst in the water or onshore (NOAA 2010a). Contact with hydrocarbons can have lethal or sub-lethal physical or toxic effects or impair mobility. Marine turtles are in frequent contact with the sea surface and they may also feed at or below the water surface or rest at the surface. This frequent contact with the sea surface or oils entrained in the upper surfaces and a lack of avoidance behaviour makes turtles susceptible to coating with spilled hydrocarbons and inhalation of toxic hydrocarbon vapours. The main pathways for hydrocarbon exposure include ingestion and inhalation of vapours. Turtles are particularly prone to ingestion of surface oil, especially where it forms solid masses such as tar balls. Hydrocarbons ingested by a turtle do not pass rapidly through its digestive tract; it may be retained for several days, increasing internal contact and the likelihood that toxic compounds will be absorbed. The risk of gut impaction also increases for turtles that have ingested oil. Marine turtles' diving behaviour also puts them at risk. They rapidly inhale a large volume of air before diving and continually resurface over time, therefore turtles in an oil spill would experience both extended physical exposure to the oil and prolonged exposure to hydrocarbon vapours. Hatchlings are particularly prone to surface slicks as they have little mobility and are unable to change direction in response to a spill. They also spend a greater proportion of time on the sea surface than adults. Hatchlings coated with oil residue may have reduced mobility, rendering them more vulnerable to predation, in addition to the toxic impacts described above (NOAA 2010). Entrained oil presents fewer impacts to turtles. While skin contact with entrained oil may occur, the entrained hydrocarbons will be at lower concentrations, due to dilution with water in the water column, and thus reducing the toxicity. Smaller quantities of hydrocarbons may be ingested, but concentrations, and resulting toxicity, will be less than surface oil. Further, the impacts of inhaling hydrocarbon vapours are not applicable to entrained oil
		The consequences of marine turtles encountering a surface slick may be severe. However, the operational area is in deeper offshore waters >150 m depth, and more than 68 km from beaches and recognised turtle nesting areas. Hydrocarbons will not reach nesting beaches areas and would not remain in a toxic state for long; the numbers of animals to be contacted and affected would be minimal and not significant at a population level.
		Sea snakes may experience sub-lethal impacts (as described above) and in extreme cases, there may be lethal impacts.
Seabirds	<u>EPBC listed species</u> 14 seabird species were identified by the EPBC Protected Matters search as potentially occurring in the operational area <u>BIA</u> The operational area is adjacent to BIA for three species but with only minor overlaps to two spp.	Seabirds are particularly vulnerable to surface hydrocarbons. As most fish survive beneath floating slicks, they will continue to attract foraging seabirds, which typically do not exhibit avoidance behaviour. Physical contact with surface slicks can result in plumage fouling resulting in hypothermia; decreased buoyancy and potential to drown, inability to fly or feed, anaemia, pneumonia and irritation of eyes, skin, nasal cavities and mouths (AMSA 2012). Smothering of feathers can also lead to excessive preening, diverting time away from other behaviours leading to starvation and dehydration. Preening of oiled feathers will also result in to ingestion of hydrocarbons and the associated impacts of toxicity and potential illness. The impacts of surface oil on seabirds can be severe. The operational area overlaps BIA (foraging and breeding) for a number of species of seabird. Therefore, significant impacts could occur to seabirds of these species foraging in the area of surface slicks. T The effects of entrained oil on seabirds are less severe than those posed by surface slicks. Significant impacts could occur for those species that plunge feed below the surface where the birds, and the fish they are feeding on, would be exposed to entrained oil.

		Given the operational area overlaps the BIA (foraging, foraging and breeding) for only 2 seabird species, any birds foraging in the area of surface slicks would be exposed to potentially significant impacts from surface oil, and to a lesser extent, entrained oil. However, given the rapid breakdown of the hydrocarbons, impacts are not expected to be significant at a population level, although they would be increased if a large spill coincided with a period when birds were provisioning young.
Sharks and bony fish	<u>EPBC listed species</u> Seven threatened species, and nine migratory species of sharks and rays were identified by the EPBC Protected Matters search as potentially occurring in the operational area, as well as a range of syngnathid fish species. <u>BIA</u> The operational area overlaps the migratory BIA (foraging) for the whale shark	Since fish and sharks do not generally break the sea surface and surface diesel slicks are expected to have dispersed with ~2% remaining within 18 and 24 hours, impacts are expected to be minimal. Whale sharks often feed on dense aggregations of prey (e.g. krill, bait fish) close to the sea surface (Colman 1997) and could therefore come into contact with surface diesel slicks. The BIA for the migration route of whale sharks overlaps the operational survey area and consequently individuals may be present. Hydrocarbon droplets can physically affect sharks and fish exposed for an extended duration (weeks to months). Smothering through coating of gills can lead to the lethal and sub-lethal effects of reduced oxygen exchange, and coating of body surfaces may lead to increased incidence of irritation and infection. Fish may also ingest hydrocarbon droplets or contaminated food leading to reduced growth, and hydrocarbon tainting of their flesh, making them unfit for human consumption. There is potential for localised mortality of fish eggs and larva due to reduced water quality and toxicity. Effects will be greatest in the upper 10 m of the water column and areas close to the spill source where hydrocarbon concentrations are likely to be highest.
		Due to the low probability of contact with surface oil, the impact of surface oil on sharks and fish will be negligible. Although entrained hydrocarbons can have negative impacts on fish and fish eggs/larvae, considering the volume of entrained hydrocarbons potentially encountered the low persistence of diesel and the large extent of suitable marine habitat, the impact on populations is considered low.
Crustaceans	All substrates and habitats. Most at risk in shallow waters.	Crustaceans are less at risk of being affected by an oil spill as the diesel fuel would form a surface slick and routes of exposure to organisms living in the water column or on the ocean floor would be limited. However, these animals can be affected in some circumstances when oil spills enter shallow or confined waters. There are increased risks to some species and life stages in shallow near shore waters such as seagrass and mangrove habitats. These foreshores are believed to function as essential feeding and "nursery" breeding grounds for many crustaceans. Given that the operational area is more than 60 km from shallow water environments, it is unlikely crustaceans will be impacted.
Plankton	The elevated concentrations of dissolved aromatic hydrocarbons associated with surface diesel slicks would likely be acutely toxic to pelagic organisms present in surface waters in the area of a major diesel spill. The elevated concentrations of dissolved aromatic hydrocarbons associated with surface diesel slicks would likely be acutely toxic to pelagic organisms present in surface waters in the area of a major diesel spill.	
Marine habitats		
Sandy beaches	Sandy beaches have a relatively low biodiversity although they do provide important habitats for nesting turtle, breeding and foraging seabirds, and shorebirds. They also provide habitat for polychaetes, molluscs, marine crustaceans, semi-terrestrial crustaceans and insects. There is no potential for shoreline accumulation of hydrocarbons	Surface hydrocarbons may accumulate on sandy beaches, impacting the area by physically smothering the habitat. This may have sub-lethal or lethal impacts on intertidal macrofauna/infauna. Stranded oil may have toxic effects on invertebrates with knock on impacts on the shorebirds that forage upon them. As hydrocarbons disperse, the intertidal communities would be expected to recover. The sandy beaches on NWMR islands are active nesting locations for numerous species of turtles, but particularly the hawksbill and green turtles. Oiling of gravid adult females or hatchlings in near-shore waters or while traversing inter-tidal or high tide shoreline areas is potentially possible. Given turtles nest above the high-water mark, however, buried eggs are unlikely to be directly exposed to any hydrocarbons (NOAA 2010b).The impact of entrained oil on sandy beaches is negligible.
		The majority of NWMR islands supporting nesting beaches are at least 60 km from a possible spill location (e.g. Montebello Islands) and so will not be impacted by the hydrocarbons.
Intertidal or submerged coral reefs, banks and pinnacles	Rankin Bank and Glomar Shoal are within the ZPI for a spill, but are completely submerged and more than 10 m form the surface and so unlikely to be affected. No other shoals, banks or	Physical coating by surface slicks and exposure to water soluble hydrocarbon fractions (toxic effects) may cause sub-lethal or lethal impacts to certain sensitive biota, particularly, sessile coral species. The most vulnerable coral colonies to direct contact with surface slicks would be those close to the shoreline or periodically exposed at spring low tides (NOAA 2010b) such the tidally exposed reef flat habitat that and shallow lagoon and outer reef slope coral habitats of Imperieuse Island. Impacts to corals will depend on species' tolerance as well as exposure concentrations and length of exposure.
		Surface hydrocarbons may make contact with intertidal reefs should reef features become emergent, for example during low tide.

	pinnacles are in the region.	Impacts of contact with surface oil can include impaired feeding, fertilisation, larval settlement and metamorphosis, larval and tissue death and decreased growth rates (Villanueva *et al.* 2008). Surface oil also has the potential to impact reef fauna (turtles, sea birds) as outlined above. Below a depth of 3-4 m, coral colonies associated with submerged reefs would be separated from surface slicks by the overlying waters. Thus, the likelihood of surface oil contacting submerged reefs and shoals is low. Physical effects from entrained oil have the potential to coat contacted coral reefs. The phenomena of smothering of exposed coral surfaces or polyps by oil spills has only been reported where very large oil spill quantities, or very sticky oil slicks, have been encountered. Response to hydrocarbon exposure can include impaired feeding, fertilisation, larval settlement and metamorphosis, larval and tissue death and decreased growth rates (Villanueva *et al.* 2008).There may be increased mortality of early life stages, particularly in coral larvae as the reproductive life stages of corals are reported to be more susceptible to hydrocarbon toxicity (Negri and Heyward 2000). Submerged reefs may be subject to contact with dispersed hydrocarbon droplets (entrained oil) introduced into the water column by wave action on surface slicks (NOAA 2010b).
		Rankin Bank and Glomar Shoal are within the ZPI for a spill, but are completely submerged and more than 10 m form the surface and so unlikely to be affected. No other shoals, banks or pinnacles are in the region. Below a depth of 3-4 m, coral colonies associated with submerged reefs would be separated from surface slicks by the overlying waters. Thus, the likelihood of surface oil contacting submerged reefs, shoals or pinnacles is low. As such, any impacts to intertidal or submerged reefs are not likely to be significant. While entrained hydrocarbons can have negative impacts on intertidal and subtidal reefs, given the distance between the potential spill locations and the closest reefs, no impact is anticipated. As such, the impact of entrained oil on reef communities is considered negligible.
Seagrasses and Macroalgae	Seagrasses are predominantly found in State waters, the majority in depths of up to 10 limited seagrass patches are found in or adjacent to the operational area. Macroalgae occurs predominantly in the intertidal and shallow sub-tidal waters on hard substrates throughout the islands.	Seagrasses and macroalgae could be vulnerable to oil slicks when exposed at low tide and also by providing a barrier to sunlight required for photosynthesis. Seagrass patches associated with the shallow reef habitats may also be exposed to entrained hydrocarbons and exhibit toxicity effects. Seagrass and macroalgae could be vulnerable to hydrocarbons. No areas within the ZPI that could potentially be impacted have been identified.
Sponges	Limited to hard substrate mostly in waters >10 known to occur in Rowley Shoals and Little Turtle Island. High sponge biodiversity on many shoals and banks within the NWMR.	Small particles and emulsions (generally associated with 'heavier' oils) may be ingested or block the feeding mechanisms of invertebrates such as oysters, starfish, sponges and corals. These particles also may have toxic components, so the effects can be physical, chemical or both. Sponges are not expected to be affected by oil spills as they are found in submerged waters, usually at depths greater than 10m.
Socio-economic		
Commercial fisheries	The operational area overlaps a number of commercial fisheries. There could be both direct and indirect impacts on these fisheries in the unlikely event of a large diesel spill occurring within the operational areas. The operational area overlaps the MoU 74 Box, but the majority of fishing occurs closer to the islands inside an exclusion zone	Surface hydrocarbons will have negligible impacts on fish (see 'Fish' above) but exclusion zones surrounding a spill can directly impact fisheries by restricting access for fishermen, leading to financial losses. Other impacts can occur via oiling of vessel hulls, trap gear (traps, buoys, lines) and trawl gear and divers (POMF) if the equipment is deployed or retrieved through surface slicks. Entrained hydrocarbons can have toxic effects on fish and fish spawning (as outlined in 'Sharks and bony fish' above) reducing catch rates and rendering fish unsafe for consumption, leading to financial losses. Crustaceans such as prawns are not anticipated to be impacted directly.
		Entrained oil may reduce catch rates and impact on the quality of the fish caught, rendering them unfit for human consumption. The effects could be medium to long-term and given the length of the fishing seasons for some of the fisheries potentially affected, the impacts are considered to be moderate.

Shipping	There are several commercial shipping routes that overlap the operational area, with a moderate to high frequency of vessel traffic	Exclusion zones surrounding a spill will reduce access for vessels. Some vessels would have to take large detours leading to potential delays. As several shipping routes overlap operational area, potential impacts to commercial shipping could be low to moderate.
Petroleum industry	The operational area overlaps several FPSO and platforms.	Exclusion zones surrounding a spill may impact vessels trying to access petroleum infrastructure. Some vessels would have to take large detours leading to potential delays. Surface diesel itself would not affect the infrastructure.
Marine tourism and recreation	Rowley Shoals, including Mermaid Reef (within 25 km exclusion).	Exclusion zones surrounding spills could reduce access for recreational fishing and snorkelling/diving on emergent and intertidal reefs. Stranding of oil on sandy beaches or the impacts on reefs (described above) may impact some tourism activities. Within the NWMR tourism is prevalent around Broome and to a lesser degree around towns along the Kimberley coast and at the Rowley Shoals due to their remote locations. Eighty Mile Beach is a popular tourism destination as are some of the waters just off the coastline. However, as the operational area and buffer is more than 180 km from the coastline at its nearest point, tourism activities will not be affected. Some diving charter and fishing vessels venture to the Glomar Shoal, and if a spill was to reach these areas, tourism may be affected. Impacts are anticipated to be minimal and with no shoreline accumulation. No contact shall occur with emergent land. Diving and fishing charter vessels may be affected, but with the warm waters and high evaporation rates, minimal impacts will occur. Recreational fishing is popular both off beaches and vessels. Vessels may experience exclusion zones, and fish may be tainted as outlined above.
AMP and KEFs	Argo Rowley Tce AMP Montebello AMP 4 x KEFs	The modelling suggests that the furthest a diesel spill may travel is 19 km and hence may overlap 2 x AMP and 4 x KEFs. As KEF and AMP are in commonwealth waters, benthic communities are unlikely to be affected by a diesel spill. Values and sensitivities in all these locations are referenced within this table under the specific topics (i.e. cetaceans, fish). No other AMP, KEP or marine reserves are anticipated to be impacted by a hydrocarbon spill due to their distance from the operational area. Consequently, although all areas are considered matters of NES, no significant impacts from surface oil or entrained oil on their sensitivities and values are expected to occur.

Overall, the impact of surface and/or entrained hydrocarbons on protected areas is considered low: the nature of diesel in the marine environment is highly evaporative and dispersive and is not expected to persist for more than 24 hours.

TGS shall ensure that activities that overlap or may affect a KEF or AMP will not result in unacceptable impacts to the values associated with the KEF or AMP, and will have regard to the Marine Bioregional Plans for the NWMR (DSEWPAC 2012a) and relevant IUCN principles. By implementing this EP and the controls and mitigation measures within it, adverse impacts to the environment, recognised values and sensitivities within each KEF or AMP are considered ALARP and acceptable and will not be inconsistent with relevant IUCN principles or management plan goals for 'Australian Marine Parks'.

Summary of Environmental Impact Assessment		
Potential Environmental Impact	**Environmental Values and Sensitivities Affected**	**Decision Type**
• Toxic effects on marine fauna & communities • Localised and temporary reduction in water quality • Interactions with other maritime users Disturbance to key sensitivities and values of protected areas	• Marine Fauna: cetaceans, marine turtles & whale sharks • Marine habitats and biological communities • Commercial & recreational fisheries • Shipping industry Petroleum industry	B

Residual Risk Assessment				
Potential Environmental Impact		**Consequence**	**Likelihood**	**Residual Risk**
	Cetaceans	Minor	Highly Unlikely	Low
	Marine reptiles	Minor		Low

Residual Risk Assessment				
Potential Environmental Impact		**Consequence**	**Likelihood**	**Residual Risk**
Toxic effects on marine fauna & communities	Seabirds	Moderate		Medium
	Sharks and bony fish	Slight		Low
	Crustaceans			
	Plankton	Moderate		Medium
Localised and temporary reduction in water quality	Sandy beaches	Minor	Highly Unlikely	Low
	Intertidal or submerged coral reefs, banks and pinnacles	Minor		
	Seagrasses and macroalgae	Minor		
	Sponges	Slight		
	Mangroves	Minor		
Interactions with other maritime users	Commercial fisheries	Moderate	Highly Unlikely	Low
	Shipping industry	Minor		
	Petroleum industry	Slight		
	Marine tourism and recreation	Minor		
Disturbance to key sensitivities and values of protected areas	Argo-Rowley Terrace AMP	Minor		
	Montebello AMP	Minor		

Summary of Control Measures
Refuelling at sea will be in accordance with relevant legislation, industry standards and best practice and the TGS and vessel owner's standard operating procedures.
TGS will ensure compliance with Section 571(2) of the OPGGS Act, which requires titleholders to maintain financial assurance.
TGS will ensure that survey vessels use diesel fuel with low volatile characteristics and are less persistent in the marine environment.
In the event of a diesel spill to sea from transfer spill or vessel collision, the primary response strategy will be in accordance with relevant legislation, industry standards and best practice, this EP's OPEP and the vessel's SOPEP.
In the event of a diesel spill to sea, TGS will implement spill monitoring and reporting procedures in accordance with relevant requirements of: • MARPOL Annex I • *Protection of the Sea (Prevention of Pollution from Ships) Act* • Marine Order 91 OPGGS Environment Regulations.
Regarding oil spill contingency and emergency response arrangements, TGS will consult with all relevant persons during pre-survey planning and in the event of a major diesel spill.

6 IMPLEMENTATION STRATEGY

Any seismic survey carried out under the NWSR South MC MSS EP will be in accordance with the NOPSEMA-accepted EP, applicable legislation and under the framework of the TGS Environment Policy and HSE Management System. To ensure TGS's environmental management standards and performance outcomes are achieved, all contractors will be required to comply with all relevant TGS's HSE systems/policies and standards. A series of work instructions, procedures and plans will be used for surveys undertaken within the operational area to ensure that appropriate management measures are applied, and identified environmental impacts and risks are continually reduced to ALARP.

6.1 ONGOING MONITORING

Environmental performance of all proposed surveys within the 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 (including TGS's environmental management framework) 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: 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 individual survey, by the Survey Environmental Advisor (SEA) via mechanisms such as audits and inspections.
- An inspection(s) of the vessels will be carried out before or during each individual survey of the activity to ensure that procedures and equipment for managing routine discharges and emissions are in place to ensure compliance with the EP*.
- An inspection(s) of the vessels will be carried out annually or with every new contractor (whichever is more frequent) to ensure that contractor HSE management systems are in accordance with all relevant requirements of TGS's environmental management framework and HSE management system.
- 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).

Any non-conformances shall be reported, tracked and closed-out.

The collection of data from audits, inspections and response tests 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, including the implementation strategy, upon completion of each individual survey 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.

6.1.1 PRE-SURVEY PLANNING

At least six weeks prior to individual surveys, TGS shall undertake pre-survey planning that will review and consider the following at a minimum:

- Stakeholder engagement:
  - Review fisheries licence area that overlaps the proposed survey area
- Changes to all relevant legislation or regulatory guidelines.
- Seismic source modelling to determine ideal and compliant acoustic array volume to be used.
- Confirm timings since previous surveys in the area/overlapped to ensure:
- Undertake calculations to track size of surveys to ensure that no more than 25,000km^2 shall be surveyed over the 2-year life of the EP
- Existing information in relation to any component of the receiving environment described in Chapter 2 (including BIA's).
- Consultation with the WA Department of Parks and Wildlife on permitted research within or adjacent to the survey area.
- Australian Marine Park (AMP) status (including any changes in status) and relevant IUCN principles.
- Overlap with specific charter and dive operators and if SIMOPS will be required.
- Information from previous surveys, including but not limited to:
  - Marine fauna migration routes and frequency of sightings.
  - Species of cetaceans sighted.
  - Avoidance of multiple surveys undertaken in same area in less than one month apart.
  - Potential for cumulative impacts from past or proposed surveys, if known.
- Check NOPSEMA website and with other seismic and O&G companies.
- New issues and or concerns raised by stakeholders.
- Changes to commercial fishery license areas, fishery status, current fishing effort and licence holders overlapping the OA based on:
  - Current status reports of the fisheries and aquatic resources.
  - Current list of license holders extracts from the Fisheries Public Register.
  - Information provided directly by fishers, the DoF and AFMA through the stakeholder consultation process.
    - Fishing locations
    - Spawning areas
- Potential military activities.
- Newly-available scientific literature.

If new information regarding the receiving environment relevant to the NWSR North MC MSS is present, then an internal risk assessment will be conducted.

6.2 OIL POLLUTION EMERGENCY PLAN

The OPEP for seismic surveys undertaken within the NWSR South MC MSS operational area comprises:

- Survey or support vessel(s) > 400T SOPEP - deals with spills which are either contained on the vessel or which can be dealt with from / by the vessel.
- Survey or support vessel(s) < 400T spill management plan - deals with spills which are either contained on the vessel or which can be dealt with from / by the vessel.

- National Plan for Maritime Environmental Emergencies (NATPLAN): 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 (AMSA 2014).
- WA State Emergency Management Plan for Marine Oil Pollution (WestPlan-MOP) and Department of Transport (DoT) Oil Spill Contingency Plan (OSCP) - deals with spills from the vessels which affect WA State waters.

6.2.1 DRILLS AND TRAINING

A drill test of the oil spill emergency response arrangements (OPEP) will be conducted during the mobilisation phase prior to commencement of operations of the survey (unless a vessel is moving immediately to/from a separate survey undertaken under this EP) and at least annually. If a vessel is moving directly from a survey undertaken under another TGS EP within the same regions (e.g. NWSR South EP or Canning-Northern Carnarvon EP which have similar testing arrangements), then drills can involve a desk-top test only. As vessels, the majority of personnel and environmental context will be similar in this situation, it is reasonable to conclude that response arrangements were tested when first 'introduced' even if under a separate EP, and so compliant with Regulation (8C)(a).

Support vessel SOPEP/spill management plans will also be tested during the mobilisation phase as part of the OPEP. As required under 14(8C)(b), response arrangements shall be tested if they are significantly amended. 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.

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.

Implementation and testing of the survey vessel(s) SOPEP/spill management plan, plus adherence to the additional spill response and reporting measures, will enable TGS to demonstrate that environmental risks from fuel and oil spills during the proposed survey have been reduced to ALARP.

6.2.2 INITIAL ACTIONS

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 WA DoT).

6.2.3 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 2014a). 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).

6.2.4 STATE WATERS

If surface slicks appear likely to enter WA State waters then subsequent actions will be determined in consultation with the WA DoT under WestPlan–MOP and the their OSCP. The WA DoT are the designated Hazard Management Agency (HMA) for oil spills from vessels within the WA State jurisdiction.

6.2.5 WA STATE ARRANGEMENTS AND DOT ROLE IN MARINE OIL SPILL RESPONSE

The WA DoT response network is comprised of two spate units:

- Maritime Environmental Emergency Response (MEER)
- State Response Team (SRT)

6.2.6 TYPE I OPERATIONAL MONITORING

In the event of an accidental event that resulted 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 (if this plan is activated). In addition, provisions for real-time oil spill monitoring may be undertaken by a third part provider (e.g. RPS-APASA or AMSA) if required. Specific monitoring / data requirements are:

- estimation of sea state;
- estimation of wind direction and speed;
- locating and characterising any surface diesel slicks;
- GPS tracking;
- manual or computer predictions (e.g., using ADIOS2 or real-time oil spill monitoring undertaken by third party provider) of movement of surface slicks; and
- GIS mapping.

This Type I monitoring will be restricted to daylight hours only, when surface slicks will be visible from the vessel. The information gathered from this monitoring will be passed on to AMSA, via the POLREP form, but also via ongoing SITREP reports following the initial spill notification to RCC Australia. This information will be used to inform the requirement for Type II scientific monitoring

6.2.7 TYPE II SCIENTIFIC MONITORING

As a result of the operational area being more than 60 km from any emergent land or shallow waters, spill modelling indicates that hydrocarbons from a diesel spill will not impact any emergent land or enter the waters of Mermaid Reef AMP or Rowley Shoals Marine Park. Regardless, 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 as required. This scientific monitoring will have a focus on relevant environmental and social values and sensitive receptors. Once determined sensitive receptors may be impacted, TGS will commission the scientific monitoring program immediately, but no greater than 2 hours.

Relevant stakeholders may include, but not be limited to, the following:

- Combat Agency (WA DoT);
- WA Environmental Protection Authority (EPA);
- WA Conservation and Parks Commission (CPC);
- WA Department of Parks and Wildlife (DPaW);
- Department of Environment (DoE);
- NOPSEMA;
- appropriate marine research and monitoring organisations, such as:
    - WA Marine Science Institution (WAMSI);
    - Australian Institute of Marine Science (AIMS);
    - UWA Oceans Institute; and
    - environmental consultancy companies with appropriate expertise and experience in hydrocarbon spill monitoring
- marine contractors able to provide appropriate vessels for inshore/shallow water; and
- key marine users in protected areas.

The scientific monitoring program will be developed to ensure that it is sufficient to inform any remediation activities, particularly with respect to shoreline environments, and that is meets the monitoring guidelines and methodologies described in the following best practice guidance documents:

- AMSA Oil Spill Monitoring Handbook (AMSA 2003a); and
- Oil Spill Monitoring Background Paper (AMSA 2003b).

6.3 ENVIRONMENT PLAN REVISION AND RESUBMISSION

As required under Regulation 17 of the Environment Regulations, TGS will submit a revision of this EP to NOPSEMA if any of the following criteria are met:

- The commencement of any new activity, or any significant modification, change, or new stage of an existing activity, not provided for in this EP.
- The occurrence of any:
    - significant new environmental impact or risk;
    - series of new environmental impacts or risks;
    - significant increase in an existing environmental impact or risk;
    - series of increases in existing environmental impacts or risks; and
- Any significant change to the receiving physical, biological or socio-economic environment within, or immediately adjacent to, the operational area.
- The identification of any:
    - KEF not already described in this EP;
    - threatened species of cetacean, marine reptile, sharks and ray-finned fish and seabirds not already described in this EP; and
    - critical habitat/BIA for threatened species not already described in this EP, which has spatial overlap with the operational area.
- Internal risk assessment results during pre-survey planning suggest that the residual risk ranking for any part of the activity, has increased

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.

6.3.1 RISK ASSESSMENT PROCESS

An internal risk assessment will be carried out if:

- non-conformances suggest that specified mitigation measures no longer adequately ensure that the activity is managed to ALARP; or
- new developments in the scientific understanding of impacts and risks suggest that risks and impact are no longer acceptable; or
- on receipt of any stakeholder claim or concern received before or during the activity; or
- there are changes to scope.

7 REPORTING ARRANGEMENTS

The following reporting arrangements are in place:

- MFO Final Report on the conduct of the survey, and any marine fauna sightings/interactions (including any whale-instigated shut-downs of the acoustic source) will be provided to DoEE.
- An annual report to NOPSEMA that will comprise a review of achievement of the EPO and EPS for that year to determine if they have been met.
- Reporting of environmental incidents to NOPSEMA, according to the requirements of Regulation 26(4) of the Environment Regulations, and in accordance with NOPSEMA guidance on notification and reporting of environmental incidents
- NOPSEMA will be notified of all recordable environmental incidents, according to the requirements of Regulation 26B, as soon as practicable but not later than 15 days after the end of the calendar month.
- Any oil pollution incidents in WA State waters will be reported immediately to the WA Department of Transport Oil Spill Response Coordination (OSRC)
- Any oil pollution incidents in Commonwealth waters will be reported to AMSA
- Any oil pollution incidents in port will be reported immediately to the relevant port authority

8 STAKEHOLDER CONSULTATION

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

- Phase 1: Preparatory Consultation:
  - Stakeholders notified of the proposed NWSR North MC MSS operational area.
  - Updates on changes
- Phase 2: Pre-survey Consultation:
  - Stakeholders notified of individual surveys, including location within the NWSR North 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:
  - Includes complying with requests from stakeholders for notification of the completion of individual surveys.

8.1.1 CONSULTATION – SEPTEMBER 2014 TO 15 DECEMBER 2016

Stakeholder consultation for the NWSR North EP began in 2014 when it was part of a much larger operational area. However, due to the operational area changing numerous times much of the earlier stakeholder records, such as those associated with the Northern Territory, are no longer relevant to the current operational area covered under this EP.

8.1.2 CONSULTATION – MAY 2017

The following stakeholders, including fisheries bodies and organisations and State and Commonwealth Government departments, were informed of the proposed environment plan, via letters and emails sent out on the 12th May 2017:

- Entities or individuals currently holding licences for the following WA State-managed commercial fisheries:
    - Mackerel Managed Fishery (MMF)
    - Northern Demersal Scalefish Managed Fishery (NDSF)
    - Pilbara Demersal Scalefish Fishery (PDSF)
        - Pilbara Fish Trawl Interim Managed Fishery (PFTIMF)
        - Pilbara Trap Managed Fishery (PTMF)
        - Pilbara Line Fishery (PLF)
    - Pearl Oyster Managed Fishery (POMF)
    - West Coast Deep Sea Crab (Interim) Managed Fishery (WCDSCF)
- Australian Fisheries Management Authority (AFMA)
- Australian Fisheries Management Authority (AFMA)
- Australian Southern Bluefin Tuna Industry Association (ASBTIA)
- Broome Fishing Club (BFC)
- Commonwealth Fisheries Association (CFA)
- IOTC Secretariat
- Mary Island Fishing Club (Derby)
- MG Kailis Group
- Northern Wildcatch Seafood Australia (NWSA)
- Paspaley Pearls
- Pearl Producers Association (PPA)
- Recfishwest
- WA Department of Fisheries (DoF)
- WA Fishing Industry Council (WAFIC)
- WestMore Seafoods
- Airservices Australia
- Australian Border Force (ABF)
- Australian Hydrographic Service (AHS)
- Australian Maritime Safety Authority (AMSA) – Nautical Assessment Officer
- Australian Maritime Safety Authority (AMSA) -
- Australian Maritime Safety Authority (AMSA)
- Cape Conservation Group
- Centre for Whale Research
- Commonwealth Department of the Environment - Marine Reserves Branch (DoE-AMPB)
- Department of Parks and Wildlife (DPaw)
- Directorate of Property Acquisition, Mining and Native Title
- IFAW Oceania
- Ningaloo Coast World Heritage Advisory Committee
- Strategic Border Command (SBC)
- WA Department of Parks and Wildlife
- WA Department of Mines and Petroleum (DMP)
- WA Department Transport (DoT)

The following stakeholders were deemed no longer relevant as the activities would not affect their interest or activities and so received a letter informing them as such:

- Entities or individuals currently holding licences for the following WA State-managed commercial fisheries:

    - North Coast Prawn Managed Fishery (NCPMF)
        - Broome Prawn Management Fishery (BPMF)
        - Nickol Bay Prawn Managed Fishery (NBPMF)
        - Kimberley Prawn Managed Fishery (KPMF)
        - Onslow Prawn Managed Fishery (OPMF)
    - Shark Bay Fisheries (SBF)
        - Shark Bay Prawn Fishery (SBPF)
        - Shark Bay Scallop Fishery (SBSF)
    - Entities or individuals currently holding licences for the following NT State-managed commercial fisheries:
        - Aquarium Fish / Display licence
        - Coastal Line Fishery Licence
        - Demersal Fishery Licence
        - Mud Crab Fishery Licence
        - Offshore Net & Line Fishery Licence
        - Spanish Mackerel Fishery Licence
        - Timor Reef Fishery Licence
- Other NT organisations:
    - A Raptis & Sons
    - Amateur Fishermens Association NT (AFANT) (N only)
    - Austral Fisheries
    - Australian Longline Pty Ltd
    - Northern Prawn Fishery (Qld) Trawl Association Inc.
    - Northern Territory Guided Fishing Industry Association
    - Northern Territory Seafood Council (NTSC)
    - Northern Territory Trawler Owners Association
    - NPF Industry Pty Ltd
    - NT Department of Mines and Energy
    - NT Department of Primary Industry and Fisheries
    - NT DoT
    - Tiwi Land Council
    - Tuna West Indian Ocean Tuna Association
    - WA Seafood Exporters
    - Western Australian Northern Trawl Owners Association (WANTOA)

As outlined in the AFMA website, the following fishing industry associations, along with AFMA, have been contacted in regard to the proposed survey:

- Commonwealth Fisheries Association (CFA)
- WAFIC
- AFMA
- Australian Southern Bluefin Tuna Industry Association (ASBTIA)
- North West Slope Trawl (NWST)
- Western Deepwater Trawl Fishery (WDTF)
- Western Tuna and Billfish Fishery (WTBF)
- Southern Bluefin Tuna Fishery (SBFTF);
- Western Skipjack Fishery (WSF)

8.1.3 CONSULTATION – AUGUST 2017

In August 2017 an update was to provided to stakeholders with an opportunity to provide comments prior to the EP being re-submitted, as well as advise them of additional information regarding recent changes to

the proposed EP. Between May and August, meetings with relevant fishers and fisheries bodies were undertaken or offered. The following stakeholders were contacted:

- Mackerel Managed Fishery (MMF)
- Northern Demersal Scalefish Managed Fishery (NDSF)
- Pilbara Demersal Scalefish Fishery (PDSF)
    - Pilbara Fish Trawl Interim Managed Fishery (PFTIMF)
    - Pilbara Trap Managed Fishery (PTMF)
    - Pilbara Line Fishery (PLF)
- Pearl Oyster Managed Fishery (POMF)
- West Coast Deep Sea Crab (Interim) Managed Fishery (WCDSCF)
- Australian Fisheries Management Authority (AFMA)
- Australian Fisheries Management Authority (AFMA)
- Australian Southern Bluefin Tuna Industry Association (ASBTIA)
- Broome Fishing Club (BFC)
- Commonwealth Fisheries Association (CFA)
- IOTC Secretariat
- Mary Island Fishing Club (Derby)
- MG Kailis Group
- Northern Wildcatch Seafood Australia (NWSA)
- Paspaley Pearls
- Pearl Producers Association (PPA)
- Recfishwest
- WA Department of Fisheries (DoF)
- WA Fishing Industry Council (WAFIC)
- WestMore Seafoods
- Airservices Australia
- Australian Border Force (ABF)
- Australian Hydrographic Service (AHS)
- Australian Maritime Safety Authority (AMSA) – Nautical Assessment Officer
- Australian Maritime Safety Authority (AMSA)
- Cape Conservation Group
- Centre for Whale Research
- Commonwealth Department of the Environment - Marine Reserves Branch (DoE-AMPB)
- Department of Parks and Wildlife (DPaw)
- Directorate of Property Acquisition, Mining and Native Title
- IFAW Oceania
- Ningaloo Coast World Heritage Advisory Committee
- Strategic Border Command (SBC)
- WA Department of Mines and Petroleum (DMP)
- WA Department Transport (DoT)

8.1.4 CONSULTATION – DECEMBER 2017

As a result of reducing the operational area again, an update was sent to all relevant entities as outlined above with the exception of the following who received a no longer-relevant stakeholder update letter:

- Northern Wildcatch Seafood Australia (NWSA)
- Paspaley Pearls
- Pearl Producers Association (PPA)
- Mary Island Fishing Club
- Broome Fishing Club
- Northern Demersal Fishery (NDSF) licence holders

8.1.5 CONSULTATION – JANUARY 2018

To assist with the evaluation of potential impacts from seismic operations on recreational diving activities, in January 2018, seven dive companies were contacted by phone regarding whether they undertook charters to Rankin Bank or Glomar Shoals. All companies stated that charters did not occur at these locations as they were too far out and their activities were limited to shallower and closer waters such as Ningaloo Reef and Dampier Archipelago.

8.2 PHASE 2 - PRE-SURVEY CONSULTATION

TGS are mindful of identifying new stakeholders and of affording as long a notification period as possible in relation to proposed surveys. As such, as far in advance as possible, TGS shall notify relevant stakeholders of a potential survey that may affect their interests or activities.

Consequently, as soon as a survey is considered likely to occur, TGS will notify relevant stakeholders with the information that is available: at a minimum the likely timeframe and possible location of the survey. This will give stakeholders an opportunity to identify a narrowed timeframe and location than that previously supplied as part of the EP notification and the greater NWSR North operational area. Stakeholders will again be offered the opportunity for face-to face meetings. As more details become available, TGS shall supply updates to relevant stakeholders. The result is that information may be supplied to stakeholders as part of a staged process.

Stakeholders will receive information as soon as an approximate location, duration and timeframe is known, but no less than 6 weeks prior to the survey. Furthermore, no less than 1 week prior to the commencement of the survey, all remaining details will be provided.

Consequently, it is anticipated that no less than 1 week prior to commencing any survey within the NWSR North MC MSS operational area, TGS will have contacted relevant stakeholders to provide information for the proposed activity, including:

- The size, location and geographical coordinates for the survey
- The timing and duration
- Parameters for the towed seismic array (airgun array and streamer spread),
- Details of the survey and support vessels
- Overview of potential risks and impacts
- Proximity to any dive sites if going within the 40-m depth contour
- An offer of a 3-day Lookahead Plan to all relevant stakeholders
- Contact details of where to submit a concern

At any point during this notification process, stakeholders will have a further opportunity to raise with TGS any specific concerns or issues regarding the proposed survey.

8.3 PHASE 3 – ONGOING CONSULTATION

Consultation with relevant stakeholders will be ongoing while the NWSR South MC MSS EP is valid. TGS will comply with requests by stakeholders for additional information and requests for updates during individual surveys undertaken within the NWSR South MC MSS operational area. Significant changes to scope will trigger a revision of the EP.

As required under sub regulation 16(b), TGS shall assess the merits of any new claims or objections made by a relevant stakeholder whereby they believe the activity may have adverse impacts upon their interest or activities. TGS shall finalise the assessment of merit of any claim or objection received during a survey

within 1 week of receipt and undertake any resulting management of change actions as soon as practicable, but preferably within that week timeframe.

If the claim has merit, where appropriate, TGS shall modify management of the activity and notify the relevant stakeholder. If the outcome of the assessment of merit of a claim or objection received during a survey suggests that impacts and risks are new or significantly increased (if the residual risk ranking has changed) then this will trigger a revision to the EP given that under subregulation 8(1) it is an offence for a titleholder to continue if a new impact or risk, or increase in the impact or risk, is not provided for in the EP in force. Notification to stakeholders of significant new or increased risks will be issued prior to submission of the revised EP as part of a new consultation process for the revised EP.

8.3.1 REGULAR UPDATES

TGS shall ensure that approximately every six (6) months all stakeholders have been provided with an update of activities associated with the NWSR North EP, including completed surveys and potential new locations for surveys (if known). As part of this process, TGS shall check that identified stakeholders are still relevant and correct, and also identify new stakeholders (via organisational bodies such as AFMA, AMSA, DoF, lessons learnt etc.). This action will ensure that stakeholders have a greater opportunity to identify areas of concern, and minimise the chances of being 'surprised' if a shorter timeframe for notification occurs as a result of a survey being finalised with minimum lead-in time. Stakeholders will be offered the opportunity for face-to-face meetings. Updates may be a stand-alone notice or part of a notification associated with a survey.

8.3.2 ARBITRATION

Based on stakeholder feedback from commercial fishery bodies such as DoF and WAFIC, there is concern that there is no formal, arbitrated mechanism for stakeholder feedback to influence the scope or timing of the surveys. To this end TGS have committed to meeting with DoF (and other parties if requested) on a quarterly basis to discuss any objections from commercial fishers, evidence provided, assessment of claims, and outcomes.

8.4 PHASE 4 – POST SURVEY NOTIFICATION

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

Table 8.1 - Stakeholder feedback and TGS' assessment - 16 December 2016 to 30 April 2017

No.	Stakeholder	Stakeholder Feedback	TGS Assessment on Feedback and Response
1 – Department of Fisheries (DoF)			

1	**DoF**	No response received from DoF	16/12/2016 – TGS contacted DoF:
			• TGS introduced NWSR North EP and explained reason for contacting as Dr XX details were passed on to TGS by Mr XX of Northern Wildcatch Seafood Australia in order to discuss the Northern Demersal Fishery, the status of goldband snapper and red emperor (and other indicator species in their fishery) and the risks associated with seismic activity during spawning.
			• TGS explained the purpose of large scale strategic EP's:
			  • Minimise the uncertainty associated with getting approvals from NOPSEMA in a timely manner.
			• Explained challenges:
			  • implementing appropriate control measures to minimise impacts to commercial fishers for a survey that could potentially occur anywhere in the operational area at any time.
			  • Understandably, this is a point of concern for many fishers and as such we are trying to gather as much information as possible to determine where and when exclusion zones may need to be applied.
			• TGS are very willing to consider exclusion zones as they do have genuine concerns for the environment and stakeholders, but I am sure you appreciate that we are potentially discussing very large areas for much of the year (NDSF may not be the only exclusions we have to consider) and so it is potentially very restrictive.
			• Added to this, some fishers prefer that we avoid the active fishing areas to minimise scaring fish away which extends into months beyond the spawning period and so further restricts periods when seismic acquisition may occur.
			• I would appreciate the chance to talk with you about the status of the fishery and DoF's view of the impacts of seismic on spawning and its potential effects on stocks.
			• In previous communications some years ago, the DoF acknowledged that although spawning periods were known for many species, the actual locations where this occurred was not; is this still the case?
			• Also, if it is preferred that spawning be avoided, are there more sensitive periods within those identified below as provided by DoF in 2013:
			  • Goldband Snapper – January to April inclusive
			  • Red Emperor – January, March and October
			• TGS informed DoF if they could take the time to discuss these issues, it would be greatly appreciated. And a contact number was provided.

No.	Stakeholder	Stakeholder Feedback	TGS Assessment on Feedback and Response
		17/01/2017 – DoF advised TGS: • Advised TGS – Dr XX is on leave until the 2nd Feb 2017. 23/01/2017 DoF: • Agreed and suggested to send through the dates when TGS are ready.	23/01/2017 – TGS responded to DoF: • Thanked DoF for the update on Dr XX. • Expressed that TGS are still keen to maintain regular meetings with DoF. • TGS are meeting today to discuss the first possible survey under the recently accepted NWSR South EP. • As soon as the details are finalised TGS will inform DoF. • TGS would like to meet with DoF to kick off the regular meetings once the notices to fishermen go out.
		19/1/2017 – DoF– auto reply: Thank you for your email. I am currently out of the office until 2 Feb 2017. I will only be responding to email infrequently.	19/1/2017 – TGS contacted DoF • TGS requested an opportunity to discuss the Northern Demersal Fishery stocks and potential impacts from seismic surveys. • TGS requested Dr XX to provide further information, or discussion.

		24/01/2017 - DoF responded to TGS:
		• DoF suggested 1:00 – 2:00 at our offices on the 1st Feb 2017.
			23/01/2017 – TGS responded to DoF:
			• Informed DoF that a survey under NWSR South EP may not occur until late March/early April.
			• TGS would like to catch up soon to discuss the proposed survey, and the NWSR North EP currently under assessment and fisheries licence holder feedback.
			• TGS suggested the following dates:
			  ▪ Tuesday 31 Jan
			  ▪ Wed 1 Feb
			  ▪ Thurs 2 Feb
			  ▪ Wed 15 Feb
			  ▪ Thurs 16 Feb
			  ▪ Fri 17 Feb
			• TGS stated their preference is the earlier dates, but they will fit in with DoF availability.
			
			24/01/2017 – TGS responded to DoF
			• Confirmed TGS will attend meeting at DoF office on Feb 1st at 1pm.
			• Agenda proposed:
			  ▪ Proposed upcoming survey under NWSR South EP
			  ▪ Feedback to date on NWSR North EP
			  ▪ General discussion on seismic noise and DoF perspectives.
			• Requested DoF send TGS the meeting request

		No response received from DoF	21/02/2017 – TGS contacted DoF: • TGS requested DOF time to discuss fishery stocks in relation to the Northern Demersal Fishery?

No.	Stakeholder	Stakeholder Feedback	TGS Assessment on Feedback and Response
			• TGS informed DoF they are prepared to consider temporal and/or physical exclusion to minimise any potential impact from seismic on commercial fish spawning, but as spawning appears to be generalised over a very large area, and the periods are also quite extended, this obviously is not ideal. • TGS understand that other seismic companies have implemented exclusion periods and zones, but these are generally for much smaller and specific surveys. • TGS requested DoF provide further information and clarity of spawning periods and locations and likely impact from seismic activities on spawning and commercial fish populations. • TGS also requested DoF to advise if they cannot assist.
		22/02/2017 – DoF responded to TGS: • DoF stated that they look forward to having regular catch ups with TGS. • DoF confirmed the dot points accurately reflect the meeting discussion. • DoF informed TGS before the reports from the workshop are published, the Department will now be request the following from titleholders: ▪ In December 2016, the Department facilitated a risk assessment workshop examining the potential impacts of seismic air gun surveys on finfish and invertebrates. ▪ The outcomes from this workshop are currently being finalised, and will be published by the end of June 2017. ▪ In the interim, and in line with the preliminary assessment undertaken at the workshop, the Department formally objects to any seismic surveys being undertaken in waters less than 50m in depth. ▪ This objection is based on scientific evidence in published papers that relate to unacceptable impacts to sessile and mobile invertebrates and finfish stocks. ▪ The Department expects that titleholders will undertake their own impact assessments relevant to finfish and invertebrates in WA for seismic survey activities.	02/02/2017 – TGS responded to DoF – Post-meeting response: • TGS thanked DoF for taking time to meet, stating that it was a productive and a good open discussion. ▪ TGS provided DoF with a copy of the maps brought along to the meeting. ○ TGS summarised the meeting and provided DoF with the main discussion points; • Outlined to DoF that a survey (NWSR17) may be starting in March/April 2017 under the recently-accepted NWSR South EP: • *Provided map of possible survey area* • *Confirmed that this is a 2D survey only* • *Maximum sound source likely ~ 4120 cu.in, though may possibly end up being ~ 3620 cui (a single source, made up of four sub-arrays, or source strings)* • *Minimum depth of ~ 150 m only, although vessels may undertake line turns in shallower waters.* • *Anticipated timeframe is ~ 60 days* • *Density of shots is anticipated to be ~ 40/ line km (ie Shotpoint Interval is 25m).* • *Only 5 fishery management areas are overlapped being:* • *Mackerel Managed Fishery* • *Onslow Prawns* • *Pearl Oyster Management Fishery* • *Pilbara line and trap fisheries.* • *Due to depth limits, the survey is unlikely to affect Prawns or POMF fishery.* • *The survey lines only overlap the outer limits of Pilbara line and trap by ~ 8 km and so unlikely to affect that fishery* • *Mackerel Managed Fishery is overlapped and DoF indicated that Jimmy Money was heading further north and so could be affected by the survey. TGS confirmed they would provide details ASAP to Jimmy and indicated that as this is a 2D survey, there is flexibility in the lines*

No.	Stakeholder	Stakeholder Feedback	TGS Assessment on Feedback and Response
		▪ The Department also expects that key spawning times for major species published in the Department's guidance statement(1) are also considered in the impact assessment. ▪ This includes referring to published scientific literature around spawning locations/ preferred habitats and species behaviour for finfish indicator species(2) and key invertebrates species. ▪ During the consultation process, sufficient information should be provided to the Department to allow an informed assessment of planned activities and possible consequences to fish stocks, including the assessment of known and potential impacts to fish stocks based on the scientific literature. ▪ This information may also need to be provided to WAFIC and fishers if requested during consultation. ▪ 1- *Guidance statement on undertaking seismic surveys in Western Australian waters* http://www.fish.wa.gov.au/Documents/occasional_publications/fop112.pdf ▪ 2- Resource *Assessment Framework (RAF) for Finfish Resources in Western Australia* http://www.fish.wa.gov.au/documents/occasional_publications/fop085.pdf • DoF informed TGS they are providing this information, so TGS is aware in advance of what the Department will be requesting. 22/02/2017 – DoF responded to TGS: • Thanked TGS for the update regarding the NWSR17 2D survey. • Informed TGS if they need anything from Fisheries regarding the **EP North** resubmission please feel free to touch base.	*and so happy to discuss coordinating in order to try and avoid where Mr XX is fishing.* • *TGS confirmed they are very keen to work with fishermen to avoid sensitive periods/locations. DoF again confirmed that although the spawning periods for many species was known, locations were not and they potentially cover very large areas. It is easier to avoid species such as prawns and pearl oysters that have specific timings and locations. TGS are in talks with prawn fishers and NTSC regarding avoiding sensitive locations.* • *The NWSR17 survey is a continuation of a survey undertaken in 2016 to the north that was originally part of the Canning-Northern Carnarvon (CNC) EP. This EP has since expired and the CNC area is now contained within the NWSR North EP which is currently being assessed by NOPSEMA.* • *TGS are looking at undertaking a regional 2D survey and hence require the large operational areas – this is the main focus for TGS. However, 3D surveys are possible.* • *DoF suggested it may be worth better educating stakeholders on 2D survey techniques and whether it may be possible to supply general information to WAFIC to present in their regular newsletters to its members.* • NWSR North is currently being assessed by NOPSEMA: • DoF are aware that the NWSA/NDSF have objections about the survey and requested TGS discuss the matter of spawning with Dr XXX. As per note above, DoF confirmed that spawning locations can cover large regions and that DOF may not be able to provide more details (although if anyone could he would be the most likely). • DoF briefly discussed the risk assessment Workshop that was undertaken on 07-Dec-2016 regarding the effects of seismic on fisheries stocks. • 2D and 3D were considered to have similar impacts as it was assessed on sound source size, but then segregated out depending on density of shots. • DoF have strong concerns over any surveys in waters < 50 m and indicated that at this stage, they were pleased with TGS' limit of 150 m • Results of the risk assessment should be available during the middle of the year. • Confirmed that regular meetings will occur with DoF (~ every 3-4 months) and that they would be informed of objections or claims from fishermen and how TGS have dealt with such claims. This ensures a level of accountability for TGS.

No.	Stakeholder	Stakeholder Feedback	TGS Assessment on Feedback and Response
			• TGS thanked DoF and suggested the next meeting in a few months or sooner if there's something we need to share. • TGS informed DoF they are expecting response from NOPSEMA regarding TGS NWSR North EP under assessment on 09-Feb, and likely there'll be an RFI or another OMR they will have to respond to. ▪ https://www.nopsema.gov.au/environmental-management/activity-status-and-summaries/details/353 22/02/2017 – TGS responded to DoF: • TGS appreciated DoF passing on the information, it is very helpful. • *TGS informed DoF that the planning for the pending NWSR17 2D survey has been delayed – in the first bullet-point from the previous email stated operations should commence in "March/April". It is now known to be more like "early April" - perhaps the first week of that month.* • TGS 'EP North' has come back from NOPSEMA, with an Opportunity to Modify and Resubmit, our second OMR – TGS has until 10-April in which to respond. • TGS confirmed they will be in touch in due course re another TGS/DOF Meeting.
		28/02/2017 – DoF responded to TGS: • DoF provided some references to assist TGS with some of the information requested. ▪ The ESD report has the spawning information. ▪ The other two papers are about habitats and catch history which can help pinpoint areas where red emperor and goldband snapper are more likely to reside. • DoF advised TGS to let them know if TGS need me to hunt around for more information • DoF informed TGS that they have a dedicated library (open to the public) for fisheries related information including scientific journals, TGS is more than welcome to spend some time there • DoF provided the location of the library • DoF provided a link to the FRDC website - http://www.fish.gov.au/ 28/02/2017 – DoF responded to TGS: • DoF searched the Library catalogue for items that might be of use to you and have attached the results (23 items).	28/02/2017 – TGS contacted DoF • TGS requested DoF help with regards to the NWSR North resubmission. • TGS are trying to work out some logical temporal and physical exclusion periods, for the Northern and Pilbara Demersal Scalefish sector. • TGS has an extract from a DoF guidance document that provides spawning timings, but some are contradictory to other information, particularly for the target species of Goldband snapper and red emperors. • TGS queried if DoF has a 'recent' document that provides more information on spawning periods? • TGS acknowledged that we have discussed previously that although timings are known, spawning locations are not, but if DoF has anything at all on the subject it would be appreciated.

No.	Stakeholder	Stakeholder Feedback	TGS Assessment on Feedback and Response
		• DoF informed TGS that the search wasn't restricted too much (i.e., both L. sebae and P. multidens; not just spawning references). • DoF informed TGS that if any of these are of use to you let me know and I'll see what we can do. • Some we can send to you (our publications), but for others you may have to visit the Library. • DoF previously provided the Library's address. • DoF informed TGS the opening times	

		21/3/2017 – DoF responded to TGS via phone conversation.
		• DoF explained that Dr XX is not a seismic or acoustic specialist, he is a tropical fin fish research scientist.
		  • He will not provide titleholders with acoustic / seismic impact advice.
		  • DOF will provide a response informing industry of his position.
			21/3/2017 – TGS emailed DoF:
			• TGS requested help and or advice from DoF.
			• TGS have been trying to get hold of Dr XX for some time and he doesn't answer emails.
			• TGS called DoF and DoF said he was only contactable via email.
			• TGS have a feeling he does not want to be involved and NWSA has nominated him as a contact person without his prior consent.
			• TGS asked DoF if this is the case?
			• TGS acknowledged that DoF probably won't be able to supply much more info than what is already in the public domain and that no one knows where the fish actually spawn,
			• TGS informed DoF that the stakeholder is extremely reluctant to meet and discuss potential exclusion zones until we have spoken to Dr XXX and preferably have him in the meeting.
			• TGS requested confirmation from DoF regarding Dr XX involvement, TGS can let NWSA know and hopefully move forward.
			• If/when TGS meet the fishers, would yourself or another DoF party be available to join in the meetings?

		21/3/2017 – DoF to TGS: DoF re-sent the reference list to TGS.	21/3/2017 – TGS called DoF • TGS called DoF to request information regarding NDSF. • DoF informed TGS they had already provided Scope with a reference list and will re-send the information. 21/3/2017 – TGS responded to DoF TGS thanked DoF for the reference list.
2 – Northern Demersal Scalefish Fishery (NDSF) - Northern Wild Catch Seafood Australia (NWSA)			
2	NWSA	11/01/2017 – NWSA responded to TGS: • Requested TGS advise NWSA when they have received the further information from Dr XXX in the research section of DOFWA.	16/01/2017 - TGS responded to NWSA: • To date we have not had any response from Dr XX, but now that the Christmas period is over, they will try again. • DoF reception will not provide a phone number, TGS is relying on email.

No.	Stakeholder	Stakeholder Feedback	TGS Assessment on Feedback and Response
		• NWSA will be happy to discuss further once the further information is to hand.	• TGS will be in touch with NWSA once they have contacted and discussed the fishery status with Dr XX.

		27/2/2017 – NWSA responded to TGS:
		NWSA informed TGS:
		• The entire b zone is critical to our operation.
		• 10 years ago, our fishery had no zones in a north / south sense.
		• These zones (A,B, and C were)introduced as a management tool by DOFWA.
		• In essence Zone B is the continental shelf or "crust ", with our best catches made between **70 and 150 metres**.
		• it is where we catch 90 % of our fish.
		• When there is no seismic activity in b zone, our catches are extraordinarily good.
		• When there is seismic activity in B zone our catches will decline by 50 %.
		• Our company NWSA, has invested very heavily in this fishery, we own 70 % of the fishery, we work very cohesively with DOFWA in a management sense.
		• Your repeated seismic activity in our fishery is, in my view our greatest problem.
		• Im happy to be involved in discussions with a view to stopping you guys from repeatedly bombarding our fishery with 2d and 3d seismic year after year after year in Zone B.
			27/02/2017 – TGS contacted NWSA:
			• TGS informed NWSA the email address being used was incorrect:
			• TGS provided NWSA with email chain of communication that NWSA did not receive, that being:
			  ▪ 21/2/2017 – TGS to DOF
			  ▪ 19/1/2017 – TGS to DOF
			  ▪ 16/12/2016 – TGS to DOF (see **Table 8.1**)
			• TGS informed NWSA that DoF informed TGS the only way to contact Dr XX is via email.
			• For this reason, TGS has not formally responded to your letter of objections as TGS have been trying to seek further information.
			• TGS is still keen to meet with NWSA and sit down with some maps and discuss the areas and times you would like TGS to avoid.
			• TGS know that a suitable compromise and outcome can be established that will keep all parties happy.
			• TGS queried if NWSA is available any time in the near future to meet?

			27/02/2017 – TGS contacted NWSA:
			• TGS provided NWSA with an update to the NWSR North EP:
			  ▪ TGS still trying to pin down fishers and fishery management bodies to determine sensitive areas.
			  ▪ TGS understand that your preferred fishing location is Zone B in Area 2 as indicated in the figure below.
			  ▪ Your most productive months are Nov – Feb inclusive.
			  ▪ TGS queried if there is a particular section in Zone B that is preferred, or the whole thing.
			  ▪ NWSA mentioned they would provide information on your main area of concern – TGS requested this?
			• TGS asked NWSA to meet with so we can sit down with a map, discuss the 5 year program and ascertain the exact areas of concern?

No.	Stakeholder	Stakeholder Feedback	TGS Assessment on Feedback and Response
		01/03/2017 – NWSA responded to TGS: • NWSA informed TGS that he is happy for XXX to represent his views on this one. • There is no need to meet us both and I will more than likely be at sea. • XX has a comprehensive knowledge of the grounds, spawning times and issues that we have. • DOFWA should in my view be present and Dr XXX should be their representative. • WAFIC have to date been completely inept and incompetent. • If XX and DOF decide it is imperative to have me attend, then I will try to be available to give an insight into what actually happens to catch rates in the areas you are shooting.	28/02/2017 – TGS contacted NWSA • TGS advised NWSA they would like to meet with you both to discuss potential seismic exclusion zones or periods to be carried forward into the NWSR North Environment Plan. • TGS would like the opportunity to provide an overview of their strategy for the next 5 years and how this can work in with the fishing industry. • TGS advised NWSA that it would be preferable to meet with NWSA at the same time to discuss the preference in avoiding spawning or fishing periods, or a combination thereof, but if needed, we are happy to have separate meetings with you both. • TGS asked NWSA availability for next week or the one after? • TGS advised NWSA that Roland is happy to travel to wherever is convenient for yourselves. • TGS suggested to NWSA, as offered previously, if they would like DoF or WAFIC to attend the meeting, we can look at their availability too.
		14/03/2017 - NWSA responded to TGS: • NWSA thanked TGS for the email. • Informed TGS they are happy to meet in person or by telephone to discuss the issues but it seems to me it would be useful first for us to understand the information obtained by you from DOF and what impact that has on the EP from your perspective. Are you able to do so? • For the sake of completeness, we continue to object for the reasons expressed in our email dated 14 December 2016.	1/3/2017 – TGS responded to NWSA: • TGS thanked NWSA for the email and conformation that you are happy for XXX to be your representative. • TGS will wait to hear from XXX regarding times to meet. 1/3/2017 – TGS responded to NWSA: • TGS informed NWSA of best contacts for correspondence •
		No response received from NWSA	23/03/2017 – TGS contacted NWSA: • TGS informed NWSA they have been unsuccessful in meeting or talking with Dr XXX although they are still trying. • Regardless, and as stated in previous emails, TGS would like to meet and discuss the issues with you in person and potential control measures including exclusion periods. • Further meetings can always be undertaken if we subsequently meet with Dr XXX. • TGS informed NWSA that TGS is very willing to fly and meet you at a time and location of your choosing. • We acknowledge your objections from correspondence in December 2016 and hope that by meeting shortly, we will discuss and address your concerns. • TGS requested NWSA inform TGS of their earliest convenience a suitable meeting time and location.

No.	Stakeholder	Stakeholder Feedback	TGS Assessment on Feedback and Response
		28/04/2017 – NWSA responded to TGS: ▪ Apologised for the delay in responding. ▪ NWSA informed TGS of the following: ○ Whilst happy to keep an open dialogue on our objections to this survey we are not sure that meeting will advance matters at all in relation to our objections unless and until we know the response to the objections we have made. ○ We have made very detailed submissions in relation to our objections and the control measures we believe are required. We have also provided information to enable you to have a dialogue with DOFWA about the fishery, spawning periods and the risks. To date we have only received a response that in essence suggests interaction between NT and WA fisheries makes life difficult for the seismic acquirer. We don't see that as an appropriate response. ○ If you are prepared to agree the control measures we have requested in our detailed submission we are sure a sensible dialogue can be held. Absent that it seems to us we have no idea what you intend to do to reduce the risks we have identified to ALARP and discussions are not likely to be fruitful.	05/04/2017 – TGS contacted NWSA • introductory email: ○ Informed NWSA: ▪ Role at TGS - Operations Manager and based in Perth. ▪ Have now spoken to three different people requesting a meeting with NWSA. ▪ Note, to date we have still not heard back from Dr XXX. ▪ Though my role is more related to operations and the actual acquisition and vessel planning – hence I am very keen to know and discuss your fishing zones and possible exclusion zones and periods. ▪ PROVIDED MOBILE NUMBER
3 – Northern Prawn Fishery (NPF) – Northern Prawn Fishing Industry (NPFI)			
3	**NPF**	28/02/2017 – NPFI responded to TGS: ▪ NPFI thanked TGS for the email and the opportunity continue dialogue on this EP. ▪ NPFI requested from TGS (to assist them to identify impacts) a shape file of the area which includes depth contours. ▪ Informed TGS XXX included in the email response.	27/02/2017 – TGS contacted NPFI and WA Seafoods : • Informed NPFI: ○ TGS are still looking at progressing the basin-wide EP in the NT and off the WA north west coast and are very keen to ascertain which areas you would like avoided and when. ○ If we have this information, we can then assess the feasibility of avoiding them spatially and/or temporally. Bear in mind, that none of their surveys will occur in waters shallower than 150 m. ○ Are you able to either meet and discuss in detail or provide some further information for us?

No.	Stakeholder	Stakeholder Feedback	TGS Assessment on Feedback and Response
			○ TGS are keen to meet and sit down with some maps and discuss the program and areas of sensitivity to the prawning industry.
		No response received from NPFI	02/03/2017 - TGS contacted NPFI: • TGS informed NPFI: • Scope Resources will email the requested GIS data. ○ Consultant is going on leave tomorrow for 2 weeks, in future please liaise directly with Vanessa and Roland (TGS) (both ccd to this email chain) for any further information you need and to then organise a meeting to discuss potential exclusion periods?
		02/03/2017 – NPFI responded to TGS: Confirmed receipt of GIS files and informed TGS they will review next week. Informed TGS they will need to continue our discussion on cost recovery for our time in assessing these impacts.	02/03/2017 – TGS contacted NPFI: • Provided NPFI with current GIS shape files for TGS NWSR North EP operational area. ○ 1 – TGS NWSR North EP - Operational Area. ○ 2 - Bathymetry contours for the operational area overlapping the Northern Prawn Fishery license area
4 – Northern Prawn Fishery (NPF) – WA Seafoods			
4	NPF (WA Seafoods)	No response received from WA Seafoods	19/01/2017 – TGS contacted WA Seafoods (WAS): • TGS thanked WA Seafoods for making time to meet face-to-face in December • TGS will be reviewing WA Seafoods concerns in more detail. • TGS provided WA Seafoods with the main points discussed during the December meeting: • WAS concerns are the effects of noise on prawns. • Believes it is clear there is a lack of scientific support based on Conoco Philips meetings where only 1 report was cited. JE assured him there was a lot of research and that the results varied. • WAS would like TGS to avoid the JBG during fishery periods as outlined by NPF, but mostly the latter period. JBG important area and there are specific locations that are favoured in the SW cornier of the Gulf. • WAS confirmed they were aligned with NPF. • WAS concerns was that in the future seismic companies would target Gulf of Carpentaria as this is the main fishing grounds that support the fishery. • WAS indicated that his fishers have stated they are pulling up dead nautilus shells south of Scott Reef in about 250 m waters. • WAS is not sure what is causing this and has not checked whether a survey had gone through the area. He will ask his skippers to report back on these things and will pass info on to JE.

No.	Stakeholder	Stakeholder Feedback	TGS Assessment on Feedback and Response
			• WAS confirmed in the NW that the favoured grounds were in waters over 200 m deep. JE outlined that based on acoustic modelling that impacts are anticipated to be minimal and not result in deaths. As such, JP main concern is the JBG. • JE assured WAS that TGS are willing to consider exclusion zones based on fact and evidence and that the JBG could be looked at for these. • JE outlined the consultation process with 6-monthly updates and requests for info and also outlined the process so that TGS are accountable and must respond to claims. TGS requested WA Seafoods to **confirm the preferred time and location for an exclusion zone in the JBG**.
		30/01/2017 – WA Seafoods responded to TGS: Informed TGS they are currently in Europe until 12th January and will try to have a look.	30/01/2017 – TGS contacted WA Seafoods: • TGS queried if WA Seafoods has reviewed the meeting summary and has any further comments? • TGS requested the dates and locations WA Seafoods wants avoided so we can write this into the environment plan? 30/01/2017 – TGS responded to WA Seafoods: Apologised for disturbing John and not to worry about responding until they get back from overseas.
		No response received from WA Seafoods	21/02/2017 – TGS contacted WA Seafoods: • TGS queried WA Seafoods if they have had a chance to review the meeting summary and to provide the location and dates you would like TGS to consider avoiding?
5 – Northern Territory Seafood Council (NTSC)			
5	**NTSC**	No response received from NTSC.	05/12/2016 – TGS contacted NTSC: • Forwarded a stakeholder update letter for NWSR North EP. • EP risk assessment is still being revised to reflect modelling results and TGS' recent decision to limit seismic acquisition to waters deeper than 50 m. • However we believed it is important to get this information to you before Roland's upcoming visit on the 13th December. • The data on acoustic levels and commitments are unlikely to change. • It is important that the NTSC is aware that an Environment Plan is a living document and subject to change as a result of continuous improvement and new information that comes to hand. • As such, if the NTSC can provide definitive information for temporal or physical exclusions, this evidence will be assessed and surveys may be modified accordingly. • If NTSC require further clarification on any of the data provided, to contact TGS.
		No response received from NTSC.	12/12/2016 – TGS contacted NTSC:

No.	Stakeholder	Stakeholder Feedback	TGS Assessment on Feedback and Response
			• TGS confirming face-to-face meeting with NTSC – at NTSC Office (Esplanade) –at 3 or 3:15pm.
		No response received from NTSC.	23/12/2016 – TGS contacted NTSC: • TGS apologised for delay in responding to NTSC. • TGS forwarded meeting minutes • Please do acknowledge if all ok, if not please highlight to me areas/comments you think need correction or editing etc. • Regarding the '*Process Document*' I make mention of in the Minutes in Item (5), we did some time ago send through the attached (see pdf file), which I believe is too high a level to what you're seeking? • Can you please confirm – is there too much information within same re noise impacts – would you want less, or even no mention, within the TGS Process Doc, which I will work on in January, once we're both back from Leave periods.
		6/02/2017 – NTSC responded to TGS: • NTSC thanked TGS for following up. • NTSC informed TGS the earliest they will be able to look at the documents provided is the week beginning 20th February 2017.	23/01/2017 - TGS contacted NTSC: • TGS resent the email sent to NTSC on 23/12/2017.
		No response received from NTSC.	15/2/2017 – TGS contacted NTSC: • TGS raised past discussion item a document describing seismic surveys and the TGS approach to the basin-wide 5-year Environment Plan, a document that was non-technical and, hopefully, short/concise. • TGS forwarded a **DRAFT** of the first iteration. • TGS sought clarification from NTSC – requesting if this was the type of document they were seeking? • TGS would appreciate feedback or comments you may have on this, good/bad or items that you think are not covered enough or are, conversely, covered too much. • Please do feel free to edit via Track Changes and send back to us, if you believe it necessary. • As you can see, we are still very keen to get to know more specifics regarding sensitive periods and locations/areas, so that we can do our utmost to consider them and then work with you and your members towards avoiding same if at all possible. • If you have any Meetings or members gatherings coming up I would be very keen to tie in another visit with such an event, thereby having an opportunity to talk further about TGS' plans, going forward, with you and your members. 15/02/2017 – Read Receipt Received

No.	Stakeholder	Stakeholder Feedback	TGS Assessment on Feedback and Response
		No response received from NTSC.	03/03/2017 – TGS contacted NTSC: • TGS queried if NTSC had reviewed the information sent on 15th February 2017 and sent it through to their members? • TGS are still seeking precise information on prime fishing locations and periods so that we can develop control measures and possible exclusion zones within our 'EP North' Environment Plan. • • Are you able to please supply some information on this? • • If not, could you please let us know immediately and perhaps tell us who could provide such information. *** • If we have concrete advice, we are willing to commit to physical and/or temporal exclusions. • Attached (second Word.doc) is a small overview of the Northern Territory Fisheries that we may impact and proposed controls. • TGS are also willing to discuss other control measures such as placing limitations of how many surveys are undertaken throughout a season; how large an area a survey may cover during periods (e.g. no more than, say, 40% of a fishery management area); and future consultation processes to ensure any objections or concerns are heard and actioned with third party involvement. • We would ask that this information be passed onto your members so that they may understand that we are very keen to work with them. • We understand you are very busy, but would appreciate being able to move forward with these discussions in the very near future. • Additionally, I can be up in Darwin late next week (Thu/Fri 9/10-March) – perhaps you would rather set aside some time for a face-to-face Meeting? • Absolutely no problem for us, in fact it is preferred, if your schedule can accommodate?
		No response received from NTSC.	10/03/2017 –TGS contacted NTSC: • called a couple of hours ago and left a message. • Would really appreciate a call back or an email Reply, as I'd like to meet this coming Thu afternoon, 16-March. • If that doesn't suit, could you pitch an alternative day, please?

Table 8.2 - Stakeholder feedback and TGS' assessment - May to August 2017

Stakeholder	Stakeholder Feedback	TGS Assessment on Feedback and Response
DoEE Marine Reserves Branch	15-5-2017 DoE requested information regarding when TGS would require a response by.	TGS informed DoE they we were planning to re-submit the NWSR North EP to NOPSEMA by 9th June 2017 and to ensure we take your interests into account, it would be appreciated if responses could be received by the 2nd June 2017.
AHS	15-5-2017 The Australian Hydrographic Service (AHS) acknowledged that the email has been received by the AHS.	No response required from TGS.
	Thanks for the update. Please advise of any activities preferably three weeks prior to commencement.	18-May-2017 - TGS will adhere to the requests of the AHS and has included in the EP a more conservative notification period of 6 weeks.
Austral Fisheries - Southern Fleet Operations	12-5-2017 Out of office response received: *I am currently on leave until Monday 15th May.* *Please direct any Austral Fisheries matters to Martin Exel at mexel@australfisheries.com.au or Theo Verios at tverios@australfisheries.com.au* *Please direct any COLTO matters to Richard Ball, at contact@colto.org*	n/a
Northern Wildcatch Seafood Australia (NWSA) -	24/5/2017 NWSA informed TGS that they will follow up with Dr XXX. NWSA confirmed the timing restrictions are those set out in my submission to you dated 14 December 2016 Appendix O. NWSA claims that the changes to the EP you refer to do nothing to address the risks and issues we have raised nor reduce them to ALARP. It does not appear to have been addressed at all. NWSA objection remains.	12/5/17 TGS advised NWSA that they will provide the NWSR North EP fisheries acoustic risk assessment once it is completed. Informed NWSA: • TGS and Scope Resources have tried to contact Dr XXX on multiple occasions, via phone and email and no response has been received to date. • TGS is considering NWSA's request received on 16 December 2016 and is currently examining the NDSF zones and the NWSR North operational area and the feasibility of inclusion of a spatial and / or temporal exclusion into the NWSR North EP. • TGS requested NWSA clarify the timing restrictions requested as there is a contradiction in months quoted from yourself (14 December 2016) and Grant Barker (24 March 2016). Please provide clarity on the Zone B timing exclusions you are seeking. • TGS have made significant changes to the EP, and therefore are providing an update regarding recent changes in the size and shape of the proposed operational area, as well as an additional information on the proposed activities (Attachment). • This revision will ensure greater efficiency in the management of uncertainties associated with environmental approvals and timelines for future seismic surveys.
	n/a	30/6/17 TGS reviewed the Department of Fisheries and Western Australian Marine Research Laboratories (WAMRL) published literature for this fishery: See **Appendix P.** • Fletcher, W.J. and Santoro, K. (eds). (2015). • DoF, 2008

<table>
<tr><th>Stakeholder</th><th>Stakeholder Feedback</th><th>TGS Assessment on Feedback and Response</th></tr>
<tr><td></td><td></td><td>

Newman, et al., 2008.
Marriott et al., 2013.

From the scientific literature TGS has incorporated the following information regarding the NDSF into the TGS NWSR North EP:

NDSF aquatic zone fished - inshore (shelf) demersal, 20-250 m isobath.
Main species landed by this fishery are red emperor and goldband snapper.
Kimberley spawning season:

Red emperor:
Spawning season - October to March
Goldband snapper:
Spawning season - January to April
Multiple spawners within a multiple male: multiple female spawning system.

<table>
<tr><td>Zone A</td><td>• Zone A is an inshore developmental area.
• The proposed acquisition operational area does NOT overlap NDSF Zone A (se
• Lower catch in Zone A and C combined (151 tonnes in 2014).
• Exploratory TACs are set for Zone A due to a likely lower sustainable catch.
• Zone A effort expended in 2014 – 153 standard fishing days (SFDs) – 75% SFD</td></tr>
<tr><td>Zone B</td><td>• Zone B comprises the area with most of the historical fishing activity.
• The proposed operational area overlaps ·44 % of NDSF Zone B.
• Majority of NDSF catch is from Zone B (960 tonnes in 2014).
• Catch water depth data coincides with majority of catch within NDSF Zone B.
o Goldband snapper catches in 80-150m water depths.
o Red emperor catches in 60-120 m water depths.
• Actively fished during the identified spawning season, although the total take
• Zone A effort expended in 2014 – 986 SFDs.</td></tr>
<tr><td>Zone C</td><td>• Zone C is an offshore deep slope developmental area representing waters dee
• Exploratory TACs are set for Zone C due to a likely lower sustainable catch.
• The effort expended in Zone C in 2014 was 8 SFD's.</td></tr>
</table>
From the analysis of the controls identified by NWSA and the scientific literature review, TGS proposes to implement the following mitigation controls and exclusions in an effort to reduce potential impacts to indicator species in the NDSF during the spawning season:

No 3D surveys will be conducted within the NDSF Zone B during the period 1st January to 30th April inclusive, and from 1st to 31st October (see Table 1 below).
Outside of this temporal restriction, the maximum area that can be acquired as part of a single 3D survey in Zone B of the fishery is 5,000 km^2.
In the event that new research regarding the timing and area of spawning of key target species (e.g. red emperor) is identified, acquisition plans will be reviewed in line with EP Section 6.9.1 - Risk Assessment Process and EPS #21.

</td></tr>
</table>

<table>
<tr><th>Stakeholder</th><th>Stakeholder Feedback</th><th>TGS Assessment on Feedback and Response</th></tr>
<tr><td></td><td></td><td>
Table 1 –Spatial and temporal exclusions for the NDSF Zones A to C within the TGS NWSR North EP
<table>
<tr><th rowspan="2">NDSF Zone</th><th colspan="12">Month</th></tr>
<tr><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sept</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>A</td><td colspan="12"></td></tr>
<tr><td>B</td><td>×</td><td>×</td><td>×</td><td>×</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>×</td><td>✓</td><td>✓</td></tr>
<tr><td>C</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
</table>
× = No seismic acquisition
✓ = Seismic acquisition can be undertaken

Avoidance of the spawning period identified by NWSA for both indicator species substantially reduces potential impacts to goldband snapper and red emperor breeding stock of the NDSF. The additional control of limiting survey area sizes in NDSF fishing Zone B to no greater than 5,000 km2 will further reduce potential impacts by ensuring potential surveys do not overlap more than 7% of the NDSF at any one time, where the highest capture of stock is taken in the fishery. TGS believe that with the implementation of these controls potential impacts and risks to the NDSF fishery is considered acceptable.
Additionally, TGS will implement the following for all zones within the NDSF that overlap the NWSR North operational area to further reduce potential impacts to the NDSF:

No more than 25,000 km2 of 3D and 25,000 line km of 2D will be acquired within a 12 month period, for the two year lifespan of the EP.
No more than two TGS multi-client surveys will be undertaken at one time within the operational area.
TGS will consider the implementation of reasonable temporal or physical exclusion zones, or other control measures, if (EPS 21):
appropriate evidence is provided such as peer-reviewed literature or applicable historical catch data; and
a robust risk assessment has been undertaken; and
It is assessed that without the implementation of further measures, the activity will not be ALARP.

As soon as TGS believe an individual survey will occur, as much information as possible will be supplied to relevant stakeholders, particularly commercial fisheries, as detailed in the EP consultation plan and at a minimum will include location, timing and maximum source size.
Final notification with confirmed details (i.e. vessel contact details, detailed timings and specific survey line location) will be supplied no later than 2 weeks prior to the commencement of the survey.
A 3 day look ahead can be issued to stakeholders (as requested) so that recipients are aware of upcoming survey vessel locations and activities within the vicinity of their interests.
</td></tr>
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Stakeholder	Stakeholder Feedback	TGS Assessment on Feedback and Response
		TGS believes with the implementation of these controls, potential impacts and risks to the spawning and breeding stock of the NDSF have been reduced to ALARP. TGS are committed to working with all stakeholders in understanding any concerns and working towards a mutually acceptable solution. TGS would still like to meet with you to discuss this further so we can begin working towards an outcome that will allow both industries to conduct their activities under their respective licensing arrangements.

	5/7/2017
	NWSA responded with the following queries:
	I understood from the EP Summary the intent was to acquire 2D and 3D seismic. Your email appears to:
	• confine table 1 to 3D surveys suggesting 2D surveys will still be conducted during spawning seasons;
	  ○ outside of the table 1 temporal restriction the maximum 5,000 km2 area that can be acquired as part of a single survey in Zone B of the fishery is confined to 3D surveys leaving 2D surveys unrestricted.
	NWSA sought clarifation regarding their interpretation of the email and whether this is the intent?
	NWSA advised TGS that they accept that there has been an absence of meaningful discussion. Pending clarification our objection remains.
		21/7/17
		TGS, thanked NWSA for pointing out the error.
		In response to NWSA queries:
		• confine table 1 to 3D surveys suggesting 2D surveys will still be conducted during spawning seasons;
		In the email response below Bullet point 1 (above Table 1) should read:
		• *No **2D or 3D** surveys will be conducted within the NDSF Zone B during the period 1st January to 30th April inclusive, and from 1st to 31st October (see **Table 1** below).*
		• outside of the table 1 temporal restriction the maximum 5,000 km2 area that can be acquired as part of a single survey in Zone B of the fishery is confined to 3D surveys leaving 2D surveys unrestricted.
		  ○ No this is not correct, 2D surveys are definitely not unrestricted.
		  ○ The EP contains additional operational commitments that restrict the number of surveys acquired and the amount of km2 that can be acquired over a 12 month period under the NWSR North EP:
		  ▪ No more than 25,000 km2 of 3D and 25,000 line km of 2D will be acquired within a 12 month period, for the two year lifespan of the EP.
		  ▪ No more than two TGS multi-client surveys will be undertaken at one time within the operational area.
		  ▪ Survey vessels will not undertake full seismic acquisition activities within 50 km of another vessel that is also acquiring data.
		  ▪ TGS will not undertake a 3D seismic survey less than two weeks after a survey has been undertaken over the same area.
		  ○ Additionally, it is important to note that Zone B of the NDSF fishery accounts for ~6% of the total area of the NWSR North Operational Area.
		TGS believes with the implementation of these control measures, potential impacts and risks to the spawning and breeding stock of the NDSF have been reduced to ALARP and as such we look forward to NDSF confirming, by way of Reply email, that the above measures are considered acceptable. We will then ensure that these communications are included in the EP, before it is re-submitted to the Regulator for assessment.

West Coast Deep Sea Crustacean	12-5-2017 Mr XXX thanked TGS for keeping them updated and informed TGS they they are fishing further south.	18-May-2017 - TGS Thanked Mr XXX for the update on their fishing locations. TGS requested If your fishing area moves further north could you please inform us. In the meantime I'll still keep you on the notification list as you previously requested.

Stakeholder	Stakeholder Feedback	TGS Assessment on Feedback and Response
Fishery - LICENSEE	Read receipt received.	n/a
	12 Aug 2017 Mr XXX thanked TGS for the notification and informed TGS that the notification was good reading and they are south of the operational area.	21 Aug 2017 TGS responded and thanked Mr XXX for the update top their fishing location, which is outside of the operational area.
Western Australian Fishing Industry Council (WAFIC)	12/5/17 WAFIC Informed TGS that they do not have time today to look at the 14 pages of detailed information in the attachment above. WAFIC expressed concerns regarding stakeholder fatigue: • Information overload which is completely inappropriate for the commercial fishing section. • Stakeholder fatigue prevents relevant stakeholders from making comment. • They don't have the time after fishing for days (or in WAFIC case with a full-time job here) to read, analysis and assess the information provided. • Concerned that titleholders can say they have "consulted, updated and informed" potentially affected parties to NOPSEMA, but the reality is, with information overload, that it hasn't occurred. • WAFIC requested a one-page executive summary being part of the Scope / TGS process please? WAFIC believes this would be a significant leap forward in improving stakeholder relationships and ensuring the information gets through. Parties who wish to read the micro-detail can do so.	31/5/2017 TGS addressed the merits of WAFIC claims and informed WAFIC: • Concerns raised will be included in the re-submission of the TGS NWSR North EP to NOPSEMA. • TGS acknowledged stakeholders may be experiencing consultation fatigue • Thanked WAFIC for the suggestion of including a summary page. TGS will incorporate a summary into future consultation letters in an effort to help reduce consultation fatigue for fisheries licence holders. • Please find attached a summary of the latest NWSR North Stakeholder Consultation Update letter sent out in May 2017, as per your request. • TGS reiterated to WAFIC - it is important to note that under the Regulations provision of the summary alone would not be considered as providing "sufficient information" to stakeholders. o Regulation 11A(2) (Division 2.2A) of the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009, clearly states "For the purpose of the consultation, the titleholder must give each relevant person sufficient information to allow the relevant person to make an informed assessment of the possible consequences of the activity on the functions, interests or activities of the relevant person". Therefore, TGS strongly advises all relevant stakeholders to read the summary page in conjunction with the consultation update letter.
Australian Maritime Safety Authority (AMSA) - Nautical Advice	12/5/17 AMSA requested a copy of the latest ESRI ArcGIS shapefile for the TGS' NWSR North multi-client MSS area. AMSA confirmed receipt of the GIS files.	12/5/17 TGS forwarded TGS NWSR North GIS files to AMSA.
	18/5/17 AMSA provide TGS with the following information: • Traffic plot (showing AIS data from April 2017), providing a very generic overview of traffic patterns through the proposed survey area. • Due to the large expanse of the proposed survey, varying levels of traffic concentrations will be encountered throughout the course of the survey.	29/5/17 • TGS confirmed receipt of the TGS confirm receipt of the April 2017 AIS traffic plot and advised AMSA the advice will be forwarded on to the vessel Master. • TGS will also ensure that the vessel Master is aware of AMSA's advice regarding varying levels of traffic concentrations likely to be encountered throughout the operational area and that there may be considerable speed difference between commercial shipping and the survey vessel whilst conducting survey operations. • TGS will ensure caution is exercised throughout the operational area and exceptional communications are maintained with commercial shipping.

Stakeholder	Stakeholder Feedback	TGS Assessment on Feedback and Response
	• Such a broad survey area incurs broad nautical advice which dilutes the importance of nautical safety advice for specific areas. • It is noted that prior to commencing any survey within the proposed North West Shelf Renaissance North survey area, TGS – NOPEC Geophysical Company Pty Ltd (TGS) will provide AMSA with detailed information for the proposed activity. • At this point AMSA will have a further opportunity to raise any specific concerns or issues regarding the proposed survey. AMSA appreciates TGS' agreement to such regular consultation during the validity of the EP. • Given the length of tow, any support vessels, in cooperation with the survey vessel, will need to be active and maintain exceptional communications with all commercial shipping in the survey area noting there will be a considerable speed difference between commercial shipping and the survey vessel whilst the latter is conducting operations. • Seismic vessels must display appropriate day shapes, lights, streamers and reflective tail buoys, to indicate the vessel is towing and is therefore restricted in her ability to manoeuvre. Visual and radar watches must be maintained on the bridge at all times. • Please have the survey vessel notify AMSA's Joint Rescue Coordination Centre (JRCC) through rccaus@amsa.gov.au (Phone: 1800 641 792 or +61 2 6230 6811) for radio-navigation warnings 24-48 hours before operations commence. • AMSA's JRCC will require the survey vessel's details (including vessel name, callsign and Maritime Mobile Service Identity (MMSI)), satellite communications details (including INMARSAT-C and satellite telephone), area of operation, requested clearance from other vessels and need to be advised when operations start and end. • The Australian Hydrographic Service must be contacted through hydro.ntm@defence.gov.au no less than four working weeks before operations commence for the promulgation of related Notices To Mariners (NTM). AMSA welcomes further communication on the NWSR North multi-client marine seismic survey activities.	• TGS will adhere to AMSA safety advice and all vessels operating under the NWSR North Environment Plan will display appropriate day shapes, lights, streamers and reflective tail buoys, to indicate the vessel is towing and is therefore restricted in her ability to manoeuvre and visual and radar watches will be maintained on the bridge at all times. • TGS will adhere to the request to notify AMSA's Joint Rescue Coordination Centre (JRCC) a minimum of 48 hours before operations commence • AHS will be contacted no less than four working weeks before operations commence. Advised AMSA if they have any further questions regarding TGS' NWSR North EP, please feel free to contact us at Scope Resources.

Stakeholder	Stakeholder Feedback	TGS Assessment on Feedback and Response
	15-Aug-2017. AMSA provide TGS with the following information: • Traffic plot (showing AIS data from June 2017), providing a very generic overview of traffic patterns through the proposed survey area. Noting TGS provided AMSA with GIS shape files of the survey area (Rev7) • AMSA notes the changes to the survey area. • Due to the large expanse of the proposed survey, varying levels of traffic concentrations will be encountered throughout the course of the survey. • Such a broad survey area incurs broad nautical advice which dilutes the importance of nautical safety advice for specific areas. • It is noted that prior to commencing any survey within the proposed North West Shelf Renaissance North survey area, TGS – NOPEC Geophysical Company Pty Ltd (TGS) will provide AMSA with detailed information for the proposed activity. • At this point AMSA will have a further opportunity to raise any specific concerns or issues regarding the proposed survey. AMSA appreciates TGS' agreement to such regular consultation during the validity of the EP. • Given the length of tow, any support vessels, in cooperation with the survey vessel, will need to be active and maintain exceptional communications with all commercial shipping in the survey area noting there will be a considerable speed difference between commercial shipping and the survey vessel whilst the latter is conducting operations. • Seismic vessels must display appropriate day shapes, lights, streamers and reflective tail buoys, to indicate the vessel is towing and is therefore restricted in her ability to manoeuvre. Visual and radar watches must be maintained on the bridge at all times. • Please have the survey vessel notify AMSA's Joint Rescue Coordination Centre (JRCC) through rccaus@amsa.gov.au (Phone: 1800 641 792 or +61 2 6230 6811) for radio-navigation warnings 24-48 hours before operations commence. • AMSA's JRCC will require the survey vessel's details (including vessel name, callsign and Maritime Mobile	29-May-2017 • TGS confirmed receipt of the TGS confirm receipt of the June 2017 AIS traffic plot and advised AMSA the advice will be forwarded on to the vessel Master. • TGS will also ensure that the vessel Master is aware of AMSA's advice regarding varying levels of traffic concentrations likely to be encountered throughout the operational area and that there may be considerable speed difference between commercial shipping and the survey vessel whilst conducting survey operations. • TGS will ensure caution is exercised throughout the operational area and exceptional communications are maintained with commercial shipping. • TGS will adhere to AMSA safety advice and all vessels operating under the NWSR North Environment Plan will display appropriate day shapes, lights, streamers and reflective tail buoys, to indicate the vessel is towing and is therefore restricted in her ability to manoeuvre and visual and radar watches will be maintained on the bridge at all times. • TGS will adhere to the request to notify AMSA's Joint Rescue Coordination Centre (JRCC) a minimum of 48 hours before operations commence • AHS will be contacted no less than four working weeks before operations commence. Advised AMSA if they have any further questions regarding TGS' NWSR North EP, please feel free to contact us at Scope Resources.

Stakeholder	Stakeholder Feedback	TGS Assessment on Feedback and Response
	Service Identity (MMSI)), satellite communications details (including INMARSAT-C and satellite telephone), area of operation, requested clearance from other vessels and need to be advised when operations start and end. • The Australian Hydrographic Service must be contacted through hydro.ntm@defence.gov.au no less than four working weeks before operations commence for the promulgation of related Notices To Mariners (NTM). AMSA welcomes further communication on the NWSR North multi-client marine seismic survey activities.	
NT Department of Primary Industry and Fisheries	12-5-2017 NT Department of Primary Industry and Fisheries (NT DPI) thanked TGS for contacting the Northern Territory Department of Primary Industry and Resources and informed TGS of the following: • Your email will be forwarded to the appropriate area for a response during government business hours. • In the meantime, the NT Government website, https://nt.gov.au/ may help you with your enquiry, enter your search term into the search box, or alternatively the following links may assist: ○ Due diligence requests for livestock property sales https://nt.gov.au/industry/agriculture/livestock/due-diligence-requests-for-livestock-property-sales ○ Due diligence relating to a search enquiry for a parcel of land https://landresources.nt.gov.au/rangelands/information-requests/due-diligence ○ Regional offices and research farms https://dpir.nt.gov.au/contacts ○ Laboratory services including water testing https://dpif.nt.gov.au/services-and-courses/laboratory-services ○ Working with DPIR https://dpir.nt.gov.au/about ○ Applying for NT Government jobs http://www.careers.nt.gov.au/Pages/default.aspx ○ Department of Primary Industry and Resources Northern Territory Government dpir.nt.gov.au nt.gov.au	No response required from TGS.
NT DoT	NT DoT Thanked TGS for the correspondence. NT DoT advised TGS that due to the high volume of enquires the	No response required from TGS..

Stakeholder	Stakeholder Feedback	TGS Assessment on Feedback and Response
	Marine Safety Branch receives, a response if required may take up to five working days. For any urgent enquiries, you can contact the Marine Safety office on (08) 89 24 7100 to speak to a Customer Service Representative. Or if you need information in relation to the National Regulator – Australian Maritime Safety Authority (AMSA) follow link www.amsa.gov.au or for more information on our services visit our website at www.nt.gov.au Office hours are Monday to Friday between 8.00AM – 4.00 PM.	
WA Department of Mines and Petroleum (DMP)	16 May 2017 DMP Thanked TGS for keeping them informed of the proposed North West Shelf Renaissance North MC MSS in Commonwealth waters adjacent to the WA coast. DMP acknowledges the alterations to the operational area as specified in the document dated 11 May 2017. DMP also notes that this activity will be assessed under the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS(E)R) by the National Offshore Safety and Environmental Management Authority (NOPSEMA). No further information is required at this stage.	No response required from TGS.
	28 Aug 2017 Department of Mines, Industry, Regulation and Safety (DMIRS) acknowledged receipt of the notification. DMIRS informed TGS they reviewed the notification and do not require any further information at this stage. DMIRS noted the following changes to the survey parameters from that supplied to the department in February, March 2016, October and December 2016: • No data acquisition in water depths shallower than 150 m • EP will be valid for two years (Reduced from 5 years). • Surveys will be restricted to a maximum of 25,000 km2 of 3D acquisition and 25,000 line kms of 2D per year. DMIRS requested TGS provide DMIRS with a pre-start notification confirming the start date of the proposed activity and a cessation notification to inform DMP upon completion of the activity. DMIRS notes that this activity will be assessed under the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA).	31 Aug 2017 – TGS responded to DMIRS confirming their request for pre-start and cessation notification, and acknowledged no further information is required at this stage.
Southern Trading	thanked TGS for the email and confirmed Thank you for your email.	This email is to confirm our discussion regarding stakeholder consultation and notifications in the meeting on 13th March 2017. In the discussion you made comment that Southern Trading Pty Ltd do not wish to be engaged by Scope Resources, or our Clients, for projects located north of Exmouth, North West Cape.

Stakeholder	Stakeholder Feedback	TGS Assessment on Feedback and Response
	I confirm to you that we have no interest in receiving seismic survey advices for any surveys being conducted north of Exmouth. You may wish to contact Chaceon P/L to advise as appropriate.	Scope Resources, and our Clients, would like to proceed with this approach and as such seek your agreement to do so. Further, Scope Resources would like to make it clear that, if you are in agreement, we will use your response to this email in future submissions of Environment Plans (or revisions of) so that NOPSEMA are aware of our agreed engagement plan. Can you please confirm that Southern Trading Pty Ltd do not want to be contacted by Scope Resources, or our Clients, for seismic related projects that are being planned in waters north of Exmouth, Western Australia, and that this agreement will remain in place until Scope Resources are advised by Southern Trading Pty Ltd. If you have other fishing colleagues that you think may benefit from the above or similar approach, we would be very happy to hear from them. Thank you for your time and we hope that this protocol will make ongoing consultation less burdensome for all.
Chaceon	Chaceon responded and confirmed – Yes	This email is to confirm our discussion regarding stakeholder consultation and notifications via telephone on 7 March 2017. In the discussion you made comment that Chaceon do not wish to be engaged by Scope Resources, or our Clients, for projects located north of Exmouth, North West Cape. Scope Resources, and our Clients, would like to proceed with this approach and as such seek your agreement to do so. Further, Scope Resources would like to make it clear that, if you are in agreement, we will use your response to this email in future submissions of Environment Plans (or revisions of) so that NOPSEMA are aware of our agreed engagement plan. Can you please confirm that Chaceon do not want to be contacted by Scope Resources, or our Clients, for seismic related projects that are being planned in waters north of Exmouth, Western Australia, and that this agreement will remain in place until Scope Resources are advised by Chaceon. If you have other fishing colleagues that you think may benefit from the above or similar approach, we would be very happy to hear from them. Thank you for your time and we hope that this protocol will make ongoing consultation less burdensome for all.
DPIRD	**See Table 8-5**	

Table 8.3 – Stakeholder Meetings – May to August 2017

Stakeholder	Date	Stakeholder Feedback	TGS Assessment on Feedback and Response
Department of Fisheries (DoF)	22/May/ 2017	9/5/17 – Scope and TGS met with Department of Fisheries. DOF queried the level of uncertainty what we don't know about the level of impacts, acknowledging that mortality doesn't seem to be the issue with fishers, the issue is behavioural impacts for fishermen. Considering the lack of science in WA, is / will TGS be contributing to research, providing research opportunities, or conducting baseline surveys before, after, during acquisition to further increase our body of knowledge. HK explained this is being done quite well by petroleum companies for inshore dredging projects. DoF raised concerns and potential issues with strategic EP. DoF informed TGS they will respond officially to the stakeholder update letter via email. DOF explained his role in the DoF seismic environment impact assessment and seismic guidance statement, realistically, they hope to have a draft ready for public comment by the end of the year. DOF - was pleased with the discussion and there is a potential to work with WAFIC to develop recommendations into the DoF seismic guidelines - such as seismic survey 'no go' areas or 'no go' timing (e.g. key species spawning times or high intensity fishing periods) . 19/5/17 - DoF formal response received, see **Table 8.2**.	9/5/17 – Scope and TGS met with DOF. TGS and DoF Discussed strategic EP's, history, and where we are at now. TGS explained the recent changes to the NWSR North EP. TGS Explained the MultiClient business model, differences in 2D & 3D seismic survey. TGS explained the latest work undertaken in assessing a 'likely credible representative' survey within a fishers licence area. This will be put forward to fishers during face-to-face meetings with the intent to trigger more meaningful discussions on where fishing 'hot spots' and non-fishing areas are within respective licence areas. 15/5/17 TGS provided DoF with web-links, followed by 4 YouTube videos which show aspects of the seismic acquisition (depicted are 3D, multi-streamer, vessels) offshore. https://www.seismicsurvey.com.au/ http://www.soundandmarinelife.org./ Here's the four YouTube videos; https://www.youtube.com/watch?v=FN8IAb0rG9A&list=PL0mBuRj4lpcN1Wmv5hcYMURIWB03puns3&index=3 Life onboard a seismic vessel (vessel: WG Amundsen); https://www.youtube.com/watch?v=9OY4mcbcI1E&list=PL0mBuRj4lpcN1Wmv5hcYMURIWB03puns3&index=5 TGS seismic video offshore; https://www.youtube.com/watch?v=YNkJqJ2VAkQ&t=38s CGG seismic offshore video (vessel: Veritas Viking) https://www.youtube.com/watch?v=vI72nW5T4N4 14/6/2017 - Called and requested meeting with DoF and Dr XXX. 27/6/2017 - Called no answer. TGS will contact again for regular updates and pre-survey consultation.
INDIVIDUAL LICENSEE	22/May/ 2017	No response regarding meeting request received to date.	22/5/17 - Called left voicemail message to contact Scope Resources. 22/5/17 - Sent follow up email requesting a face-to-face meeting with TGS and Scope Resources. 31/5/17 - Called left voicemail message to contact Scope Resources. 26/6/17 - Called and spoke to Jimmy, he will be in Perth around the 18/19th July - Scope to contact him closer to this date to arrange a meeting time. 14/7/2017 - Called and left voicemail message to contact Scope Resources. 24/7/2017 - Send SMS - Seeking Fat Marine availability for a meeting in Exmouth. 27/7/2017 - Send SMS - Following up on meeting availability in Exmouth. 01/08/2017 - Send SMS - Following up on meeting availability in Exmouth. 2/08/2017 - Called and left message to contact for meeting availability.

Stakeholder	Date	Stakeholder Feedback	TGS Assessment on Feedback and Response
			TGS will contact again for regular updates and pre-survey consultation.
MG Kailis Group	22/May/ 2017	No response regarding meeting request received to date.	22/5/17 - Called no answer. 22/5/17 - Sent follow up email requesting a face-to-face meeting with TGS and Scope Resources. 31/5/17 - Called left voicemail message to contact Scope Resources. Daryl returned call. Confirmed email address and re-sent consultation letter and meeting request to MG Kailis c/o Daryl Elmer. 27/6/2017 - Called and left voicemail message to contact Scope Resources. 21/7/2017 - Called and left voicemail message to contact Scope Resources. TGS will contact again for regular updates and pre-survey consultation.
INDIVIDUAL LICENSEE	22/May/ 2017	No response regarding meeting request received to date.	22/5/17 - Called, no answer. 22/5/17 - Sent follow up email requesting a face-to-face meeting with TGS and Scope Resources. 31/5/17 - Called left voicemail message to contact Scope Resources. 27/6/2017 - Called left voicemail message to contact Scope Resources. 21/7/2017 - Called and left voicemail message to contact Scope Resources. 21/7/2107 - Franky called back - explained he is the accountant and doesn't know much about the fishing, but will pass on the message to the manager. Franky also explained that he passed on the original email requesting a meeting to the manager. TGS will contact again for regular updates and pre-survey consultation.
Northern Wildcatch Seafood Australia (NWSA)	22/May/ 2017	22/5/17 - . informed TGS that he does not want to talk about the seismic EP's. XXXX is now NWSA spokesperson and he will be dealing with this from here on.	22/5/17 - Called and requested meeting. 27/6/2017 - See previous SH feedback- did not call. 21/7/2017 - See previous SH feedback- did not call.
Northern Wildcatch Seafood Australia (NWSA)	23/May/ 2017	No response regarding meeting requested received to date. 24/5/2017 - response received from NWSA see **Table 8.2**.	23/3/17 - TGS Rang, and they Will pass on my message, re wishing to meet. Agreed if I don't hear by tomorrow, I'd call again Mon 4/4/17 - TGS Rang, I will call again in morning. 5/4/17 - TGS Rang, to meet and for GM to either call or email me back. 23/5/17 - Called office, requested to organise a stakeholder meeting for the TGS NWSR North EP, in regard to their response letter. Reception was hesitant and informed Scope that they have been instructed not to give out mobile contact. Informed her that we have been trying to get hold of xxx for 3 months. Under the Regulations, we are required to assess the merits of NWSA claims, which we will do. If NWSA does not return this call or the email sent last week then we will not attempt to contact him for a meeting again. Reception said they will pass the message on. 27/6/2017 - See previous communications - did not call. 27/6/2017 - See previous communications - did not call.

Stakeholder	Date	Stakeholder Feedback	TGS Assessment on Feedback and Response
			TGS will contact again for regular updates and pre-survey consultation.
Ocean Wild Tuna	22/May/ 2017	31/5/17 – No further action as stakeholder declined the offer of a face-to-face meeting due to no fishing effort in operational area.	22/5/17 - Sent follow up email requesting a face-to-face meeting with TGS and Scope Resources. 31/5/17 –xxx confirmed they are not currently fishing north of Kalbarri at the moment, as such there is no need to meet. Jenny requested to remain on notification list and if their fishing area changes in the future they will notify TGS. TGS will contact again for regular updates and pre-survey consultation.
OLD BROWN DOG PTY LTD	22/May/ 2017	22/5/17 - No further action as stakeholder declined the offer of a face-to-face meeting.	22/5/17 - He is too busy and doesn't have time to meet. Said *"we'll wait and sort it out on the water on the day*". "*Don't expect us to move our gear if your coming through*". Informed xxx if he changes his mind and would like to meet to contact Scope. TGS will contact again for regular updates and pre-survey consultation.
Pearl Producers Association (PPA)	22/May/ 2017	31/5/17 – Meeting to be held after 13/6/17.	22/5/17 - Called went to message bank, but message bank full and could not record any more messages. Sent follow up email requesting a face-to-face meeting with TGS and Scope Resources. 31/5/17 - Called and spoke to XXX, he is currently travelling and will be available to meet the week beginning 13/6/17. Scope to call Aaron to arrange a time closer to this date. 27/6/17 - called and spoke to XXX - he is available next week, then he is away for a week, said to send through meeting request and we can go from there. 19/7/2017 - called and spoke to XXX, re-organise meeting for next week and requested to send through email confirmation. Email request sent. 25/7/2017 - called and left message to contact to arrange a meeting time. TGS will contact again for regular updates and pre-survey consultation.
RNR FISHERIES PTY LTD	22/May/ 2017	No response to date.	22/5/17 - Called no option to leave voice mail. 22/5/17 - Sent follow up email requesting a face-to-face meeting with TGS and Scope Resources. 31/5/17 - Called no answer and no option to leave voice mail. 27/6/17 - Called no answer and no option to leave voice mail. 21/7/2017 - Called and left voicemail message to contact Scope Resources. TGS will contact again for regular updates and pre-survey consultation.
Western Australian Fishing Industry Council (WAFIC)	23/May/ 2017	n/a	23/5/17 - WAFIC was not happy with the latest mail out - 14 pages. WAFIC doesn't have time to read this, and fishers won't have the time to read either. Explained this is a requirement from NOPSEMA – "provide sufficient, relevant information so a stakeholder can make an informed assessment". WAFIC suggested inclusion of an Executive summary, highlighting page numbers or fact sheet highlighting the main points and changes in the letter.

Stakeholder	Date	Stakeholder Feedback	TGS Assessment on Feedback and Response
	1/Jun/2017	n/a	1/6/2017 TGS sent through a meeting agenda / discussion topic to WAFIC for the meeting scheduled in the afternoon.
	1/Jun/2017	Discussion topics: What TGS is doing differently listed changes in the last letter sent to WAFIC, plus discussed 25,000 km2 operational restriction of 2D and 3D per year for 2 years. TGS confirmed that this will most likely not exceed 15,000 km per year 1. WAFIC suggested this is conveyed to stakeholders. Previous feedback resulted in inclusion of all fisheries maps. Discussed WAFIC feedback regarding summary table: WAFIC acknowledged the quick response from TGS in providing the summary. WAFIC informed TGS the letter is too long and fishers will not have time to read them. TGS informed WAFIC that the letter was long due to the requirement by NOPSEMA to ensure that relevant persons are provided will 'sufficient' information so that they can assess the impact on their interests / activities. 2. WAFIC suggested TGS provide stakeholders with a Fact sheet along with a summary (if required) and a complete letter. VB informed WAFIC that stakeholder consultation meetings are being conducted now and stakeholder responses will be included in the final re-submission to NOPSEMA. Stakeholders are not responding to requests, if they don't respond then we cannot establish 'rules of engagement' or 'protocols of operation' with them. 3. WAFIC explained that the no response is likely because stakeholders are 'fatigued'. • WAFIC informed TGS of the following: o MMF – fish out to 100 m water depth, beyond this no interactions. o ASBTIA – potential stakeholder for this project as operational area overlaps the spawning grounds. TGS has received confirmation from ASBTIA that they do not want to be included in consultation for this project.	1/6/2017 - meeting with WAFIC, TGS and Scope Resources. 5. TGS agree and will incorporate this into future consultation letters / updates. 6. TGS agree and will include a summary 'fact sheet' in future consultation letters / updates. 7. TGS agree, however, fishers need to understand that titleholders are still required to adhere to the OPGGS Act. 8. TGS to answer WAFIC 9. TGS agree and will provide reference links in future consultation letters / updates.

Stakeholder	Date	Stakeholder Feedback	TGS Assessment on Feedback and Response
		○ Shark Fishery – northern Shark Fishery is still closed. ○ Western Shark Fishery – trial runs every year, no fishing since 2008. ○ WDWTF – fish from 200 – 700 m water depths. ○ WTBF – fish from 300 – 500 m water depths, TGS has confirmed with WTBF they are not currently fishing within op area, but want to remain on the consultation notification list. In the information provided it states that there are levels that may cause injury to fish. If fish are injured then they become more susceptible to shark predation. Does the EP assess the impacts on fisheries if their potential catch is injured and susceptible to shark predation? 4. WAFIC acknowledged that TGS provided references in the latest mail out, but would like TGS to provide the online links to the references, TGS will include this request in the next mail out if the information is available online. Which WA State fisheries do WAFIC represent? WAFIC – all WA State fisheries, and North West Slope Trawl, Western Deepwater Trawl Commonwealth fisheries Are there any that are not represented? WAFIC – No, some are also represented by Fisheries associations, e.g. PPA. Is there a means for licence holders to request meetings with titleholders through WAFIC? WAFIC explained the 'fee for service' available. **<u>Additional discussion:</u>** 1. WAFIC requested from TGS how can a fishing vessel become a chase boat? 2. Is there a way to develop a 'good standing agreement' between fishers (chase boat) and the geophysical company? 3. What's acceptable? Is there specific classifications of vessels or preferences for vessel type, size, and equipment on board?	

<table>
<tr><th>Stakeholder</th><th>Date</th><th>Stakeholder Feedback</th><th>TGS Assessment on Feedback and Response</th></tr>
<tr><td></td><td>27/Jun/2017</td><td>n/a</td><td>27/6/2017 - did not call as met with WAFIC on 1/6/2017.
21/7/2017 - did not call as met with WAFIC on 1/6/2017.

TGS will contact again for regular updates and pre-survey consultation.</td></tr>
<tr><td></td><td>4/Jun/2017</td><td>n/a</td><td>4/6/17
TGS sent WAFIC a summary of the meeting items discussed.</td></tr>
<tr><td></td><td>17-Aug-2017</td><td>n/a</td><td>17-Aug-2017
TGS sent WAFIC a response to concerns / queries raised during meeting held on 1/6/17.
TGS informed WAFIC:
• TGS appreciates WAFIC making time to meet and discuss the concerns and issues of commercial fisheries licence holders, and to discuss the additional changes TGS has made to the proposed EP operational area and the precautionary and conservative control measures implemented.

• TGS acknowledges that WAFIC does not have time to review the entire NWSR North EP sections, therefore in the table below we have identified relevant EP sections which can be supplied to WAFIC upon request.

Responses to WAFIC's queries / questions raised are tabulated below (Table 1):

<table>
<tr><th>WAFIC query</th><th>TGS Response</th></tr>
<tr><td>Does the EP assess the impacts on fisheries if their potential catch is injured and susceptible to shark predation?</td><td>The EP risk assessment does not specifically include an assessment of injured fish and potential shark predation due to the lack of scientific information. If WAFIC knows of any scientific papers or studies being conducted, please forward the information to TGS so that it can be assessed and incorporate into the fisheries risk assessment.
The EP does however include an impact and risk assessments on fish and commercial fisheries, including:
• Disruption to commercial fisheries (EP Acoustic Risk Assessment available for review upon request):
o Spatial analysis – overlap with fisheries licence areas.
o Stakeholder feedback assessment.
o Operational restrictions:
▪ From the spatial analysis TGS have implemented additional operational restrictions, for example as a result of the spatial analysis assessment and consultation with NDSF the following additional controls have been implemented:</td></tr>
</table>
</td></tr>
</table>

Stakeholder	Date	Stakeholder Feedback	TGS Assessment on Feedback and Response
			• NDSF: o no 2D or 3D surveys will be conducted in Zone B of the NDSF during the period 1st January to 30th April inclusive; o outside of this temporal restriction, the maximum area that can be acquired as part of a single 3D survey in Zone B of the fishery is 5,000 km^2; and o in the event that reliable information regarding the timing and area of spawning of key target species (e.g. red emperor) is identified, acquisition plans will be reviewed in line with **Section 8** of this EP. • Impacts to fish (**EP Acoustic Risk Assessment available for review upon request**): o Mortality. ▪ Site-attached species. ▪ Shoals. o Impairment. o Behaviour. o Catch rates. • Additionally, an assessment of potential control measures to reduce impacts to fish has also been undertaken (**EP Assessment available for review upon request**): The NWSR North EP implements mitigation strategies for noise from the Western Australian Department of Fisheries guidance note on undertaking seismic surveys[1]: The following will be implemented: • 'Soft Starts" for all discharges of the acoustic source. • Avoid restricting movement of fish away from the source of seismic sounds. TGS has liaised with stakeholders and implemented spatial and temporal operational restrictions based on sensitive spawning located and times identified by fisheries licence holders through the consultation process. Therefore, with the proposed precautionary controls and mitigation procedures implemented, TGS believes that impacts and risks to

[1] Department of Fisheries. 2013. *Guidance Statement on Undertaking Seismic Surveys in Western Australian Waters*. Fisheries Occasional Publication No. 112, 2013. Government of Western Australia. Department of Fisheries.

Stakeholder	Date	Stakeholder Feedback	TGS Assessment on Feedback and Response	
				commercial fisheries and target fish species is considered acceptable and has been reduced to ALARP.
			How can a fishing vessel become a chase boat?	The challenge for TGS' involvement, due to not owning/operating seismic vessels, is that we do not select the Chaseboat - this is done by the Seismic contractor. TGS can recommend the use of a certain Chaseboat provider company, or, in this instance, recommend the use of a specific fishing vessel which would then need to meet the seismic contractors own offshore/marine prequalification criteria requirements. Thus, the Seismic Contractor company would later end up chartering and in a formal charter-party Agreement with the fishing vessel owner/operator.
			Is there a way to develop a 'good standing agreement' between fishers (chase boat) and the geophysical company?	Yes, a Good Standing Agreement ought to be possible, between Seismic Contractor and fishing vessel owner/operator. Though in the survey planning stages (many months prior to acquisition) TGS could find out, from the Seismic Contractor, what the minimum standards are for working with their seismic vessel in Chaseboat capacity. Perhaps it is worth considering certain Seismic Contractors being contacted by certain fishing vessel owners/operators – with a view to finding out the requirements? If these are identified now/soon, before a survey is imminent, then it gives the fishing vessel owner/operator time to see if this is even viable – perhaps the standard(s) required are simply not feasible or beyond the capabilities of the fishing vessel(s).
			What's an acceptable (vessel type)?	I believe many fishing vessels ought to be suitable – a search for the specs of vessels offered by the various Australian chaseboat providers will reveal sizes/types. Examples provided
			Is there specific classifications of vessels or preferences for vessel type, size, and equipment on board?	Equipment requirements are fairly easy to remedy – certainly such items as ARPA radar (and possibly a backup/secondary radar) and twin engines can put one vessel ahead of another, if there's a selection process being undertaken. Endurance offshore can be a factor, with luck she can either endure 5 weeks offshore without replenishment (though I don't think many Chaseboats can) and, if not, only has to depart the Mother Ship <u>once</u> in a 5-week swing. Ie *if* she has to return to port weekly or bi-weekly, then that's a lot of time away and not protecting the towed seismic spread. Of more importance is having a **Safety Management System** in place – ie having a Planned Maintenance System, having Procedures

Stakeholder	Date	Stakeholder Feedback	TGS Assessment on Feedback and Response
			in place for key activities, a means of Reporting Unsafe Conditions, Near Misses, Incidents etc. Refuelling, personnel transfer, cyclone avoidance, garbage management, blackout procedures. Emergency Response procedure. The list goes on. It is possible that certain fishing vessels would be able to tick the required physical/vessel/equipment requirements, easily. But to tick the Safety Management System box could potentially be challenging, as the fishing industry may not be as high a profile as the oil and gas industry when it comes to such matters. In an effort to increase transparency between our two industries and also encouraged by NOPSEMA, TGS will provided WAFIC with extracts from the TGS NWSR North EP, which are relevant to your concerns and issues raised (**EP Acoustic Risk Assessment available for review upon request**). TGS appreciates that WAFIC is time short, however, TGS believes that it is in WAFIC's best interest to review the risk assessment sections relevant to its fisheries members in order to gain an appreciation of the effort TGS has taken to assess and reduce potential impacts and risks to commercial fisheries and the target fish species, and the additional mitigations incorporated to address specific fisheries licence holders concerns.
WestMore Seafoods	22/May/ 2017	No response to date.	22/5/17 - Called and spoke to reception, they said xxx is very busy and we'd have better luck sending him a direct email. 22/5/17 - Sent follow up email requesting a face-to-face meeting with TGS and Scope Resources. 27/6/2017 - See previous communications - did not call. 21/7/2017 - Called and left voicemail message to contact Scope Resources. TGS will contact again for regular updates and pre-survey consultation.

Table 8.4 - Stakeholder feedback and TGS' assessment – December 2017 and January 2018

Stakeholder	Stakeholder Feedback	TGS Assessment on Feedback and Response
AFMA	14/12/2018 While AFMA has no comments to make on the revised environment plan we wish to continue to continue to be consulted on future information releases on this this project. If it has not already happened, I would draw your attention to the need to consult with the West Australian fishing industry through WAFIC and any other relevant state based industry associations.	TGS recognise the AFMA and the advice. No objections to assess nor response required. 26/2/2018 – TGS thanked AFMA and confirmed that WAFIC and DPIRD had been contacted and that they would continue to consult with AFMA.
AMSA	12/12/2017 Requested shape files or latitudes and longitudes 20/12/2017 Requested shape files or latitudes and longitudes. Would like to generate maps prior to Christmas break 8/1/2018 Attached updated historical AIS traffic plot of the revised survey area. Previous advice provided by AMSA on 15 August 2017 remain extant	20/12/2017 -Assured AMSA that the shape files would be sent through as soon as the polygon was finalised. Clarified that the EP would not be resubmitted until January and activities would not be imminent 22/12/2017 – latest GIS data for Rev 13 polygon provided to AMSA. 26/2/2018 – responded to AMSA with thanks and acknowledge that previous advice still stands
CCG	10/1/2018 Provided new email addresses for contact. While the size and duration of the survey has been reduced, CCG still hold concerns about the potential impacts, both immediate and cumulative to marine animals. For this reason, we recommend that TGS give strong consideration to: – the use of survey methods that are shown to reduce these impacts, for example marine fibrosis. – the expansion of noise monitoring using PAM or similar devices – and aerial visual monitoring devices such as drones or Swift, an unmanned aerial vehicle invented by UWA that is capable of flying 5 times longer than a drone. These technologies would increase the accuracy over existing industry standards which rely heavily on trained MFOs and good weather conditions. Real-time knowledge of cetacean presence in association with the implementation of avoidance measurements would increase the effectiveness of these measures.	21/1/2018 – TGS apologised for the delay is response and stated that they were still working through CCG's response and would revert back soon. 26/2/2018 – TGS assessed the feasibility of using drones or UAV and determined it was not feasible nor required based on control measures already in place. This assessment has been included in the EP. The use of PAM has already been assessed in the EP and will not utilised. Marine vibroseis has been reviewed previously based on CCG response to another EP and discounted as a feasible alternative as it is still in development stage and not yet suitable for commercial applications. These techniques were assessed and outlined in the response to CCG. TGS acknowledged the alternate email address and welcome future discussions with CCG.
DPIRD	**See Table 8.5**	
WAFIC	11/12/2017 Requested maps showing fisheries overalys	12/12/2017 – acknowledged WAFIC's request and that the maps would be supplied shortly. 20/12/2018 – TGS let WAFIC know that there had been a minor change to the OA and once finalised, maps would be provided.

Stakeholder	Stakeholder Feedback	TGS Assessment on Feedback and Response
	22/2/2018 – WAFIC queried the status of the EP 22/2/2018 – WAFIC wanted to know if there had been any further boundary changes, when the surveys were planned to commence and what responses, if any, TGS had from commercial fishers.	22/12/2017 – Final fishery overlay maps supplied to WAFIC along with offer to meet and discuss if they wished. 22/2/2018 – TGS responded stating that the EP was to be resubmitted by 2/3/2018 26/2/2018 – TGS confirmed no further changes had occurred and supplied a copy of the December update again. TGS supplied a zoomed in map to show where the boundary followed the 200 m contour. Confirmed that likely no surveys for at least 4 months, but if that changes TGS will let WAFIC and other stakeholders know. Confirmed no responses from fisheries apart from AFMA with a standard response to contact WAFIC. Confirmed that some fisheries had received 'no longer relevant' letters including NDSF, PPA and Paspaley and there had been no response
January 2018 – Dive Company Feedback regarding whether tours were undertaken at Glomar Shoal or Rankin Bank (Phone call only)		
Pilbara Dive and Tours	No answer. Left message	No assessment on feedback required
Exmouth Diving Centre	No tours offered at Glomar or Rankin, only around Dampier Archipelago	
Dive Ningaloo	No tours offered – they do not know where Glomar or Rankin are	
Ningaloo Reef Dive and Snorkel	No tours offered. Generally, tours only inside Ningaloo reef	
Diving Frontiers and Charters	No tours offered. Vessel will not go that far out to sea	
Mackerel Islands	No tours offered – they do not know where Glomar or Rankin are	
Ningaloo Whalesharks	No tours offered. Only local to Exmouth & Ningaloo reef	

Table 8.5 – DoF/ DPIRD Feedback May 2017 – May 2018

Stakeholder Feedback	TGS Assessment on Feedback and Response
12-5-2017 The Department informed TGS that they will provide comments on the amended proposal within the next couple of weeks.	18/5/2017 - TGS responded to DoF and thanked them for keeping TGS informed and If there's any information they need regarding this project, to contact Scope Resources.
Read receipt received.	No response required from TGS.
19/5/17 DOF thanked TGS for the consultation package provided on 12 May 2017 in relation to the revised NW Shelf Renaissance North Multi-client Marine Seismic Survey. The Department considers itself a 'relevant person' and has provided feedback on an earlier version of this proposal on 21 July 2016. With respect to the current revision, the Department provides the following comments. The Department appreciates the various changes made to the previous proposal and acknowledges the effort of TGS in attempting to address its concerns. However, as discussed during our meeting on 9 May 2017, the Department objects to large-scale seismic survey proposals for which details on the spatial and temporal extent of activities with potential impacts are not explicitly defined – as these proposals lack the information required to allow the Department to make an informed assessment of the possible consequences. The two main reasons for maintaining this position: • Fish and fishers are affected by environmental, social and economic drivers, which can result in significant changes in the fishing industry over relatively short timeframes. Therefore, the Department generally reserves the right to review/update its comments if the proposed activities have not commenced within 6 months and objects to proposed activities with the potential to impact on aquatic resources and/or the industry and for which commencement is uncertain and may exceed 6 months. • The proposed seismic survey includes activities associated with relatively localised 3D seismic surveys for which the Department considers the development of individual environmental plans to be appropriate and required. Due to the potential for repeated disturbance of organisms in the survey area over an extended period of time, 3D surveys generally have a significant potential of causing impacts on, or behavioural responses in, aquatic organisms and, hence, are likely to affect fishers when conducted in certain areas within the proposed survey envelope. Details such as the proposed commencement, duration and spatial extent of 3D surveys are therefore crucial in assessing the potential consequences of its associated seismic activities on aquatic resources and fishers. It is the Department's understanding that if an informed assessment of potential impacts cannot be made in relation to a particular activity, it cannot be covered by an environment plan – i.e.:	4/8/17 TGS thanked DOF for the response. TGS understands the Department's concern in providing advice for activities which commencement is uncertain or may exceed 6 months. However, as discussed with the Department and noted in the August 2016 correspondence, TGS propose to contact stakeholders, including the Department and fisheries licence holders, on a regular basis (approximately every 6 months) throughout the life of the EP. This will afford further opportunities for TGS to understand upcoming fishing activities and potential physical or temporal sensitivities for that next six month period, while providing the Department and fisheries licence holders the opportunity to raise any concerns or objections. Additionally, the pre-survey planning EP commitment requires TGS to review and consider the following at a minimum: EP Section 6.1.1 - Pre-survey planning At least six weeks prior to individual surveys, TGS shall undertake pre-survey planning that will review and consider the following at a minimum • Stakeholder engagement: • Review fisheries overlapping proposed survey area and initiate agreements. • Changes to all relevant legislation or regulatory guidelines. • Seismic source modelling to determine ideal acoustic array volume to be used. • Existing information in relation to any component of the receiving environment described in Chapter 2 (including BIA's). • Consultation with the WA Department of Parks and Wildlife on permitted research within or adjacent to the survey area. • Commonwealth Marine Reserve (AMP) status (including any changes in status) and relevant IUCN principles. • Overlap with specific charter and dive operators and if SIMOPS will be required. • Information from previous surveys, including but not limited to: • Marine fauna migration routes and frequency of sightings. • Avoidance of multiple surveys undertaken in same area in less than one month apart. • Potential for cumulative impacts from past or proposed surveys, if known. • New issues and or concerns raised by stakeholders. • Changes to commercial fishery license areas, fishery status, current fishing effort and licence holders overlapping the OA based on: • Current status reports of the fisheries and aquatic resources. • Current list of license holders extracts from the Fisheries Public Register.

○ Under regulation 11A (Division 2.2A) of the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009*, a titleholder "… must give each relevant person sufficient information to allow the relevant person to make an informed assessment of the possible consequences of the activity on the functions, interests or activities of the relevant person." The Department's position is that an informed assessment of the possible consequences of the activity on the functions, interests or activities of the Department, fishers and other stakeholders cannot be made without having been provided with adequate detail, particularly the spatial extent, commencement date and duration of each 3D survey to be covered by the Environment Plan in question. ○ As an Environment Plan is required (under regulation 16, Division 2.3) to contain: (i) a summary of each response made by a relevant person; (ii) an assessment of the merits of any objection or claim about adverse impacts; and (iii) a statement of the titleholder's response or proposed response to each objection or claim, the Department concludes that 3D surveys need to be fully defined; assessed for potential impacts by all relevant persons; and each objection/claim about adverse impacts associated with these surveys to be considered by the titleholder *before* the relevant Environment Plan can be submitted to NOPSEMA in accordance with the regulations as set out under Division 2.2A and Division 2.3. It is our understanding, therefore, that activities with potential impacts (particularly 3D surveys) require to be defined in sufficient detail for consultation with relevant persons to be effective and for the formal arbitrated mechanism (to ensure the concerns of relevant persons are taken into account) is maintained. In view of the above, the Department formally objects to the current NW Shelf Renaissance North Multi-client Marine Seismic Survey proposal by TGS and requests that this position is communicated to the regulator (NOPSEMA). The Department remains committed to provide targeted, detailed advice and comment on seismic survey proposals for which activities are more clearly defined. 11-Aug-2017 – Read receipt received.	• Information provided directly by fishers, the DoF and AFMA through the stakeholder consultation process. ○ Fishing locations ○ Spawning areas • Potential military activities. • Newly-available scientific literature. If new information regarding the receiving environment relevant to the NWSR North MC MSS is present, then an internal risk assessment will be conducted as described in Section 6.9.1. If sighting data is available from previous TGS surveys or other sources, or new information regarding whale migration periods is available, the information will be used in planning the timing of individual surveys within the operational area and the level of mitigation to be implemented (e.g. Policy 2.1 Part B or adaptive management measures). Based on feedback, TGS may be able to modify surveys to avoid sensitivities. Furthermore, as soon as TGS believe a survey may be a reality, information regarding the proposed survey will be sent to all stakeholders with further opportunity for claims or objections to be raised. As required under the Environmental Regulations and outlined within the EP, TGS shall assess the merits of any new claims or objections made by a relevant stakeholder, regardless of when they are made. If the claim has merit, where appropriate TGS shall modify management of the activity. This process for regular consultation and assessment of claims or objections, is outlined within the EP and therefore auditable by NOPSEMA. As such, there is a formal arbitrated mechanism for stakeholder feedback. However, as previously discussed with the Department, TGS propose to meet with the Department of Fisheries on a regular basis throughout the life of the EP to discuss and report on any relevant stakeholder feedback, the process of assessment undertaken, and any proposed modifications as a result of stakeholder concerns. With these proposed commitments in place it is hoped that the Department has more confidence that TGS shall appropriately assess all claim and objections related to the activity throughout the two-year life of the EP. Additionally, TGS would like to request from the Department information regarding spawning areas and times for the key species fished in the Northern Demersal Scalefish Fishery (NDSF), this being Goldband snapper and Red emperor. NDSF has advised TGS that these are the key indicator species for the NDSF. Unfortunately, NDSF has been unavailable for a face-to-face meeting to discuss the concerns of the NDSF, as has Dr xxx, whom xxx nominated as being an "authority on the fishery, the relevant species and finfish generally with a particular focus on tropical species". Nevertheless, we would still like to request a meeting with Dr xxx. Any additional information regarding spawning timing and / or sensitive spawning areas for the key indicator species of the NDSF fishery will help inform TGS when implementing additional management controls and operational commitments in the EP. It would be good to have some clarity on this before continuing discussions with Northern Wildcatch. Please note that, as required under the Environment Regulations, all consultation must be included within the submitted EP and as such NOPSEMA will be made aware of the Departments stance in relation to the NWSR North MC MSS EP. Similarly, all impacts and any objections or claims raised by stakeholders will be included within the EP.
10-8-2017	n/a

Fisheries responded to TGS request and has noted the request for further information on spawning areas and times in the region and is in the process of developing advice informed by recent research. DoF will forward Scope Resources a copy once finalised.	
Read receipt received.	n/a
23-Aug-2017 the Department of Primary Industries and Regional Development Fisheries Division (Fisheries) responded to TGS notification update and provided feedback: Fisheries appreciates the various changes made to the proposal and acknowledges TGS' effort in attempting to address its concerns. The proposed increase in the minimum depth surveyed (from 100 m to 150 m) and the reduction in the duration of the EP (from 5 years to 2 years) are two significant changes that go some way to address some of Fisheries' major concerns. However, Fisheries generally objects to 'strategic' EP's, i.e. EP's that typically are in place for two or more years and cover very large areas and 3D surveys that are poorly defined in terms of survey area location (within the project envelope), start date and duration. Strategic EPs increase risks to fisheries and aquatic resources and reduce the capacity of Fisheries to make an informed assessment of the potential consequences and ensure proponents are provided with project-specific and up-to-date advice. In this case, Fisheries is expected to be able to make an informed assessment of the possible consequences of the 'worst case' survey within the proposed project envelope of 500,000+ km^2, given a brief summary of the proposed survey activities. The following is noted: • 3D seismic activities will be capped at 25,000 km^2 per year – allowing a number of 3D surveys covering a total of 50,000 km^2 in the two years of the plan. The way the document is worded appears to allow for two surveys of 25,000 km^2 each to be conducted 'back to back' – i.e. one at the end of the first year and the second at the start of the second year – and covering immediately adjacent ground. • No information is provided on the duration. In order to get a sense of the potential duration of a 25,000 km^2 3D seismic survey, Fisheries assumed an area 250 x 100 km with acquisition lines 500 m apart and a vessel speed of 4 knots which led to 500 lines of 100 km in length being sailed in ~281 days. Assuming 5% extra for steaming time (between lines): ~ 296 days. Two surveys of 25,000 km^2 may therefore take 592 days to complete or 19.5 months. According to this calculation it will be possible for a 50,000 km^2 area to be impacted by seismic activities for 19.5 consecutive months (or, if not consecutive, within a 24 month timeframe). Fisheries notes that surveys of this spatial and temporal scale are inappropriate in waters off Western Australia where available information on (even) key species is	TGS met with DPRID on 18/9/2017 to discuss the response received: Thank you for taking the time to meet with us to discuss the Departments response to the TGS NWSR-North stakeholder update letter sent on 11th August 2017. For ease of response, we have included a table showing the queries from the Departments in the left hand column and TGS comments in the right hand column in the table below. Please don't hesitate to contact me if you have any queries. Additionally, below is a summary of the discussion points and action items for your reference: Please feel free to add any additional information or comments. 1. TGS - raised changes to the EP operation area and reduction in operating water depths, minimum depth is now 200m (previously 150m). 2. DoF - Raised concerns with threshold used in the EP and they advised use of McCauley 185 dB SPL (rms) from the 2003 caged snapper studies. a) TGS explained this reference is assessed in the EP, however, TGS do not agree and it is not applicable. TGS explained to DoF this experiment was undertaken on caged fish and this is not representative of pelagic / demersal species that may be encountered within the operational area. b) DOF then raised, that this threshold then should be applicable for site attached species. c) TGS explained that the EP contains conservative controls for site attached species and is based on acoustic modelling. d) Please see attached EP excerpt relevant for the Department – impacts and risk assessment for 1-Interactions with Fisheries and 2-Acoustic noise. e) McCauley et al. (2003) reference on caged fish has been considered in the NWSR-North EP risk and impacts assessment. 3. TGS explained the commitment for SSV - changes to vertical verification being undertaken first. a) DoF queried if SSV results will be submitted to NOPSEMA and how soon after the field verification is completed the results will be known. • JASCO advised TGS that preliminary SSV results (vertical) can be provided within 12-15 days of the logger retrieval. b) TGS informed DoF the results are not given to NOPSEMA, however they will be provided in an inspection for compliance, or if the 220 dB SPL is exceeded and triggers a non-compliance to the EP commitment not to exceed this level- then this will be reported to NOPSEMA. 4. DoF requested better bathymetry map for their assessment. **a) TGS can provide a bathy map - 50 - 100 m bathymetry increments.** ▪ **Attached along with this email.**

typically incomplete. Without accurate data on key ecological characteristics such as spawning grounds, spawning times and the distribution of key habitats, 3D seismic surveys at such massive spatial and temporal scales have a markedly increased risk of, inadvertently, causing a significant adverse effect on aquatic resources and/or fisheries by potentially enveloping a number of key habitats or fishing grounds over an extended period of time (e.g. over entire fishing seasons, spawning periods, etc.). Fisheries is of the view that the precautionary principle should steer proponents towards smaller seismic survey areas and shorter durations (with appropriate intervals between surveys conducted in the same broader area) in order to ensure that risks and potential impacts are ALARP and acceptable.

- No information is provided on the timing of a survey other than it occurring within 2 years of acceptance of the EP. Within this timeframe the status of key aquatic resources may change considerably due to changes in both environmental events/conditions and anthropogenic pressure. This makes determining (or restricting) the potential consequences of seismic activities, in the context of cumulative impacts, extremely difficult.
- No information is provided on proposed 3D survey boundaries, i.e. the location of the 3D survey areas within the envelope (or the shape of the survey areas). It may be appreciated by the proponent that it would take a considerable amount of effort on Fisheries' behalf to come up with a worst case survey (shape and timing), which would be required in order to assess the possible consequences of the proposed activities as covered by this EP. It should, evidently, not be the responsibility of Fisheries to determine the worst possible case, only to go through the exercise again at every new revision of the EP.
- No information is provided on cumulative impacts. One or more other proponents may imminently be submitting strategic EPs covering seismic activities in an area with a large amount of overlap with the NWSR North MC MSS area. It is impossible for Fisheries (or any other stakeholder) to make an informed assessment of the possible consequences of seismic activities covered by numerous strategic EPs in the face of so much uncertainty and plasticity and over time periods extending over multiple years.

Fisheries appreciates the commercial value of having strategic EP's accepted by NOPSEMA, but wishes to make the case that there appears to be no benefit to the State if strategic EP's are accepted – certainly not when compared to an alternative regulatory environment that requires EP's to be developed for each individual well-defined 3D survey. Fisheries poses that the main principle of any EIA and environmental approval process is to ensure that credible and defensible decisions are made about the environmental impacts of proposed (social use) activities or

b) TGS offered providing DoF GIS shape files of the operational area to assist with their assessment:

- **Attached along with this email.**

5. DoF raised concerns with cumulative risk assessment and queried how this will be done for strategic EP's when multiple strategic Ep's could potentially be operating at one time.
    a) TGS explained the pre-survey planning process and how operators communicate about potential adjacent surveys.
    b) TGS informed DOF - TGS will provide cumulative EP risk assessment section in the reply to DOF's recent stakeholder submission.
    c) DoF informed TGS that XXX provided DoF with the relevant EP acoustic risk assessment section, which made DoF's assessment easier. DoF could see the risk assessment process had been undertaken properly and the final estimates of % overlap, interactions estimate and residual risk ratings were considered acceptable by DOF.
    d) TGS informed DoF that they could provide the EP risk assessment.
        - Attached along with this email.
    e) DoF raised concerns as the EP submission date is very soon, TGS explained the consultation is ongoing, and will continue throughout the validity of the EP.
6. DoF raised plankton paper - DOF believe it should be considered, it is new science - in our backyard and from a well-known scientist and should be treated as such.
    1. TGS disagree, RR raised concerns from IAGC review of the paper and DoF agreed that the experiment should be repeated.
    2. Please see table below response regarding the McCauley et al. (2017) reference.
7. DoF informed TGS of a new information source online - Fish cube.
    a) this will also contain information regarding fisheries undertaking or being granted Marine Stewardship Council (MSC) - Certified Sustainable Seafood.
8. TGS explained the Multi-client data acquisition procedures - hypothetical examples of how data is acquired and examples of how data is marketed and sold.
    a) DoF presented TGS with the outcomes of the fisheries risk/hazard assessment tables from seismic industry risk assessment - they will be published in the coming months.

1. TGS informed the Department in the previous response letter: TGS proposes to contact stakeholders, including the Department and fisheries licence holders, on a regular basis (approximately every 6 months) throughout the life of the EP. This will afford further opportunities for TGS to understand upcoming fishing activities and potential physical or temporal sensitivities for that next six month period, while providing the Department and fisheries licence holders the opportunity to raise any concerns or objections.

This is same approach which has been accepted by NOSPEMA in TGS' NWSR-South MC MSS EP.

2. Yes, this is correct.

Although, the letter also states:

However, the maximum size of an individual 3D survey, for example, is more likely to be 15,000 km2 or less.

developments (e.g. Prideaux and Prideaux 2016). It is difficult to see how this outcome can be ensured for strategic EPs. Fisheries understands that there may be mitigating management responses in place to address some of the above concerns, such as the requirement for any identified "new or increased environmental risks" triggering the submission of a proposed revision of the EP under the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009*. However, in practice, the onus will largely be on Fisheries and other stakeholders to identify a change in the risk profile of the various EPs in place at any one time in any one area and to communicate that position to the relevant operators and the regulator. The expectation that stakeholders should bear this responsibility may be reasonable in relation to well-defined survey-specific projects but not with respect to strategic EPs, which appear to have no other benefit other than delivering a commercial advantage to the proponent over competitors. Finally, and in relation to the information provided in Appendix 2 (which in the information package is presented as 'the EP Excerpt containing the plankton risk assessment'), the document does not appear to provide even a qualitative assessment of the potential impacts on aquatic resources, fisheries or the ecosystem posed by the proposed activities and informed by the 2017 McCauley et al. paper and the CSIRO modelling study. For example: • The assessment fails to mention that the significant impacts on zooplankton as reported by McCauley et al. (2017) occurred at intensities ≥178 dB re 1 µPa PK-PK and, instead, uses 207 dB re 1 µPa (SPL peak) without explanation. • The assessment fails to give an assessment as to how far from the source (4120 cui) this sound intensity is expected to be achieved, noting that the smaller array modelled by CSIRO (3000-3200 cui) was estimated to achieve this level at 2.5 km from the source • The assessment fails to give an indication of the scale and duration of the impact on zooplankton populations and availability in the survey area. Such an assessment would require the proponent to scale up the results of the CSIRO modelling, given that the CSIRO study assumed a survey area of only 2,900 km^2 with a duration of just 43 days while the proposed EP covers seismic activity occurring in two blocks of 25,000 km^2 each for 19.5 months (based on 'worst case' figures as set out above). Presumably this may result in significant reduced availability of zooplankton over two areas somewhat smaller than 25,000 km^2 for almost 10 months each. • The assessment fails to outline what the potential consequences are of this scale of impact to aquatic resources and fisheries, especially when the 3D surveys are conducted at the worst possible time at the worst possible location within the project envelope. • The assessment fails to investigate the risk of impact to ecosystem function and integrity, given that the plausible cause of mortality in invertebrate zooplankton as suggested by McCauley et al. (2017) may also occur in	TGS understands that the Department will assess if the proposed activities potential impacts and risks on commercial fisheries based on the worst-case scenario. However, TGS believes that it is not the responsibility of the Department to undertake an assessment. TGS will provide the Department with the complete acoustic and interaction with fisheries risks and impacts assessment, whereby a range of 'credible survey area sizes' are spatially assessed with the overlap of the survey area with fisheries license area zones. 3. Correct – duration has not been provided as this information is not available – it is completely dependent upon towed spread (particularly streamer configuration). More streamers with broader/wider separations between them results in a reduced survey time. Different seismic companies and the different vessels within them can/do have different towing capacities and different vessel survey operating speeds. However as discussed TGS believe the assessment undertaken by the Department is not representative of a typical survey within the operational controls in place for min km2 of acquisition, TGS predict over a rolling twelve month period under the NWSR-North EP, 25,000 km2 3D survey duration could be completed in approximately 7 months. 4. TGS requested additional consultation meetings with stakeholders and fisheries scientists to determine timing and location of key indicator species spawning. With the exception of Northern Wildcatch Seafood Australia, no additional information has been received. TGS has used available scientific information and information provided from discussions with WAFIC to develop and implement spatial and temporal buffers for commercial fisheries licence areas. TGS welcomes further discussions with stakeholders and the Department to better define spatial and temporal exclusions and restrictions implemented. This was expressed to stakeholders in the latest updated letter: "Similarly, to assist TGS with planning future surveys so that physical interactions will be minimised, if you know of locations or times that are particularly sensitive to your operations, this information would be greatly appreciated – rest assured that any such information will be treated as highly confidential. Also, if you would like to receive survey updates directly, please identify how often we should send updates and the correct contact information for future liaisons. This will ensure timely notification prior to any survey activities commencing in the area". Commitments currently proposed in the TGS NWSR-North EP Such as: • NDSF: o No 2D or 3D surveys will be conducted in Zone B of the NDSF during the period 1st January to 30th April inclusive; o outside of this temporal restriction, the maximum area that can be acquired as part of a single 3D survey in Zone B of the fishery is 5,000 km2; and o in the event that reliable regarding the timing and area of spawning of key target species (e.g. red emperor) is identified, acquisition plans will be reviewed in line with Section 8 of this EP. • PFTIMF:

similarly vulnerable epifaunal/infaunal taxa with presumably longer-lasting effects. • The assessment also fails to take into consideration cumulative impacts, e.g. due to other 3D surveys in the area. On the basis of the above, and unless all concerns can be appropriately addressed by the proponent, Fisheries objects to the proposed NW Shelf Renaissance North Multi-client Marine Seismic Survey. P.S. Fisheries aims to provide proponents of seismic surveys with contemporary guidance on its concerns and how these concerns may be addressed in the EP. Fisheries is developing a draft Guidance Statement for this purpose that is expected to be subject to stakeholder consultation in 4-6 months' time. In the meantime, Fisheries will provide proponents with 'interim guidance' as to the information it expects from proponents in order to allow it to "make an informed assessment of the possible consequences of the activity on its functions, interests or activities". This is a 'working document' that will be updated from time to time. A summary of the current draft is provided below FYI. New information requirements Fisheries expects proponents of seismic surveys to demonstrate that: 1. An informed assessment has been conducted of the risks and potential impacts associated with the proposed activities on potentially affected fisheries and aquatic resources; and 2. Appropriate impact management and risk control measures will be in place (where necessary) to ensure residual impacts will not only be as low as reasonably practicable (ALARP) but also acceptable. In relation to the first point, the risk assessment should clearly define: • the proposed acquisition parameters and other relevant operational details, e.g. array capacity (volume), array dimensions and tow depth, air gun pressure, hydrophone streamer dimensions and tow depth range and estimated array pulse strength; • the proposed commencement, duration and spatial extent of the survey activities; • 3D surveys only: the predicted sound exposure levels at the seabed for that part of the survey area that is in waters <250 m depth and, additionally, for any other parts of the survey area that overlap fishing zones where benthic invertebrates and/or demersal fish may be targeted. This may take the form of a map of the relevant parts of the seabed within the seismic survey area with the predicted exposure levels overlaid. Useful thresholds may be emphasised for clarity; • the potential impacts of the proposed activities on fisheries and aquatic resources; • the risk level for each potential impact (including a rationale); and • the degree of rigour/certainty associated with the predicted impacts.	o there will be <5% overlap between any single 3D survey and Zone 2 of the fishery—i.e. the maximum 3D survey area for a single survey will be <3,000 km2. • PTMF: o there will be <5% overlap between any single 3D survey and Zone 2 of the fishery—i.e. the maximum 3D survey area for a single survey will be <3,000 km2. Additionally, individual surveys that are >10,000 km2 will be conducted in deep offshore water depths >200m and therefore outside of the active fishing areas within the MMF, NDSF PFTIMF and PFTMF fisheries. 7. The EP risk assessment has conducted with the assumption that an individual survey may occur in any season at any time within a 12 month period. The consultation period is ongoing for all EP's accepted by NOPSEMA. Stakeholders including Government Departments can at any time during the validity of the EP raise a concern if the perceived 'risk' of the activity on a receptor has increased This was expressed to stakeholders in the August 2017 updated letter: The Regulations require that TGS must consider any new concerns raised by stakeholders during the validity of the EP, and therefore stakeholders can review their position if new research or information becomes available. 8. Correct – exact individual survey location has not been provided - this is the intent of strategic EP's to allow for flexibility in planning surveys due, in part, to the limited availability of seismic survey vessels and seasonal restrictions in the area. 9. Please see the NWSR-North MC MSS EP Excerpt provided below in Appendix 1 = Section 0 - Simultaneous Operations and Cumulative Impacts. 10. TGS appreciates the view of the Department, however TGS refer the Department to the Regulator NOPSEMA who is responsible for the assessment and acceptance of strategic EP's, and has accepted 3 strategic EP's since 2014: TGS – Canning Basin MC MSS EP PGS – Outer Exmouth MC3D MSS EP TGS - NWSR-South MC MSS EP 11. Correct, this is the acceptable process under the OPGGS (Enviro) Regs and is defined in the EP as follows: If a significant new or increased impact or risk is identified as a result of an internal risk assessment described in Section 6.9.1 and it is not already appropriately covered under the EP, as required under sub regulation 17 (6), TGS shall submit a proposed revision to the EP. TGS shall determine at the time of the internal risk assessment, whether a risk or impact is considered 'significant' (i.e. has resulted in an increased residual risk ranking) based on information available at that time (e.g. reviewed scientific information, stakeholder claims or concerns). Notification to stakeholders of significant new or increased risks will be issued prior to submission of the revised EP as part of a new consultation process for the revised EP.

With respect to the second point, Fisheries expects to provide more guidance on what it deems to be 'acceptable impacts' when the Guidance Statement is released in the first quarter of 2018. In the interim, Fisheries expects titleholders to make that assessment based either on evidence (e.g. from relevant peer-reviewed research) or on the most conservative available information. Factors titleholders should consider in determining 'acceptable' levels of impact are: • the current status of key or indicator fish/invertebrates in the region[1]; • the proportion of the relevant population(s) (of each key/indicator species) that may potentially be affected – after taking into consideration: o management and risk control measures and o known seasonal aggregations, spawning/nursery grounds, key habitats and other relevant specifics[2] • other (cumulative) impacts on the status of key/indicator species. Footnotes: 1. Relevant information on the status of fisheries and aquatic resources is publically accessible in the Status reports of the fisheries and aquatic resources of WA 2015/16 at http://www.fish.wa.gov.au/Documents/sofar/status_reports_of_the_fisheries_and_aquatic_resources_2015-16.pdf and elsewhere on the Department's website and/or in the scientific literature. 2. Some relevant data regarding seasonal aggregations, important habitats and spawning/nursery grounds for some key species may be found in the various research and status reports available on the Fisheries' website, but it should be noted that not all information is currently collated and/or publically accessible. Fisheries expects proponents of seismic surveys to make reasonable attempts to seek out relevant information by liaising extensively with fishers, relevant researchers, WAFIC, Recfishwest and other stakeholders where appropriate. **Uncertainty – commitment to research** Fisheries encourages proponents of seismic surveys to commit to supporting research efforts investigating the impacts of seismic surveys in a local setting and/or to undertake validation monitoring to investigate the reliability of sound exposure predictions generated by modelling software in WA waters. Ultimately, increasing the knowledge base and reducing uncertainty is likely to reduce the environmental approval process and (costly) monitoring requirements. **Seismic activities in shallow waters** Seismic activities in shallow waters up to 100 m tend to have the greatest degree of overlap with fisheries and the highest risk of significant impacts on aquatic resources, according to the preliminary results of the 2016 seismic survey ERA workshop. Fisheries strongly encourages proponents to: • avoid, where possible, seismic activities in shallow waters <50 m depth; and	The strategic (Basinwide) EP is not undertaken/proposed in order to gain "commercial advantage" over competitors. The purpose of a broad scale approach for the EP submission to NOPSEMA is to manage the uncertainties associated with timelines for environmental approvals for MSS in Commonwealth waters. This occurs primarily as a result of the limited availability of suitable seismic survey vessels in the region and the complexities of dealing with other issues, including planning (e.g. client data schedule requirements), operational (e.g. cyclone season), and environmental factors (e.g. blue whale migration). 12. Attachment 2 of the information package sent to DoF on 11 August contains a qualitative and semi-quantitative assessment of the potential impacts to plankton, based on the findings of the McCauley et al. (2017) paper and of the subsequent CSIRO review and modelling study (Richardson et al. (2017). This information, as provided, has already been incorporated into the EP impact assessment (Section 5.1.5.4– Planktonic Organisms). The threshold impacts used for the impact assessment are taken from best available scientific data, this being Popper et al. (2014). Given the shortcomings and limitations of the McCauley et al. (2017) study, as identified and described in Richardson et al. (2017) and summarised in Attachment 2, the reported received level (≥178 dB re 1 µPa PK-PK) at which impacts on zooplankton were observed at a range of 1.1-1.2 km, cannot be regarded as a suitable alternative sound exposure guideline for plankton to replace the 207 dB re 1 µPa (SPL peak) of Popper et al. (2014). 13. TGS modelling indicates that received levels of ~180 dB re 1 µPa PK-PK may occur at distances of ~10 km from the source. Additionally, as discussed TGS are also undertaking in-field sound source verification (SSV) prior to the first survey under the NWSR-North or NWSR-South Environment Plans. The SSV is designed to verify the accuracy of the predicted received sound levels, process and formula for determining these levels, and of the appropriateness of the proposed separation distance from sensitive receptors, TGS will undertake an in-field horizontal and vertical SSV process during surveys within the NWSR North MC MSS operational area. This horizontal SSV will only take place if it has not already occurred during a survey conducted under the TGS NWSR South MC MSS EP (accepted 15/09/16). Please see the EP extract (Section 5.1.5.23) for more information regarding the proposed SSV proposed. 14. Richardson et al. (2017) estimated the spatial and temporal impact of seismic activity on zooplankton on the Northwest Shelf from a 2,900 km2 3D survey, considering the mortality estimates of McCauley et al. (2017) and accounting for typical growth rates, natural mortality rates, and the ocean circulation in the region. Simulations took account for the fact that the seismic source and associated impact radii for zooplankton will be constantly moving across the survey area, and will not return along a parallel line for several hours, during which time, the movement of zooplankton with currents will have introduced new zooplankton to the survey area, while any "holes" will move down current and also gradually become repopulated in non-impacted areas. As already described in the plankton impact assessment of the EP, simulations that included ocean circulation showed that the impact of the seismic survey on zooplankton biomass was greatest in the Survey Region (defined as the survey acquisition area with a 2.5 km impact zone around it) (22% of the zooplankton biomass was removed) and declines as one moves beyond it to the Survey Region + 15 km (14% of biomass removed), and the Survey Region + 150 km (2% of biomass removed).

- minimise the intensity of the seismic array as much as possible at all times, but particularly when conducting activities in waters <250m depth.

It should be noted that activities with a higher risk of impact require: (i) a higher degree of rigour (when predicting likely impacts); and (ii) consideration of appropriate management and risk control measures, in order to be considered 'acceptable' by Fisheries. In some cases, this may require the proponent to provide peer-reviewed research in support of its assumptions and/or to commit to implementing appropriate monitoring and management frameworks aimed at ensuring actual impacts do not exceed predictions.

Consideration of seismic impacts on zooplankton and benthic invertebrates

Fisheries expects proponents to assess the risk of impacts on potentially vulnerable invertebrates (both in the water column and associated with the benthos); changes to community structure; and flow-on effects to higher trophic levels.

Consultation with other stakeholders

Fisheries expects proponents to initiate and maintain ongoing consultation with the Western Australian Fishing Industry Council, Recfishwest, relevant representative bodies AND directly with licensees in the potentially affected fisheries (contact details of licensed fishers can be obtained through the Department's public register through the link provided below).

The postal addresses of all licenced fishers in the above fisheries can be requested by completing the application form for an extract from the Public Register here: http://www.fish.wa..au/Documents/commercial_fishing/r-1_application.pdf . Note that an application form needs to be submitted for each required extract individually (in this case each fishery). Each submission will be subject to a fee. You will receive the contact details for each licence holder in the fishery.

Biosecurity

Vessel, equipment and facility operators must take reasonable measures to minimise the risk of committing offences under the *Fish Resources Management Act 1994* and associated regulations related to transferring live non-endemic or noxious fish (including marine pests) into WA waters.

There are two ways to demonstrate commitment to the above. For vessels moving into WA waters from overseas or interstate (including WA-based support vessels servicing unmanned offshore facilities, Floating Production Storage and Offloading vessels and Mobile Offshore Drilling Units), there are two options:

1. Utilise the Department's biofouling risk assessment tool, Vessel Check (https://vesselcheck.fish.wa.gov.au) and complete the actions to manage any activity related vessels to a LOW / ACCEPTABLE risk rating, or
2. Actively use a biofouling management plan and record book that meets all requirements under the current edition of the International Maritime Organisation's *Guidelines for the Control and Management of Ships' Biofouling to Minimise the Transfer of Invasive Aquatic Species*.

For large offshore facilities including MODUs, CPFs and the like, management to ALARP is strongly recommended.

The major findings of the CSIRO study were that there was substantial impact of seismic activity on zooplankton populations on a local scale within or close to the survey area, however, on a regional scale the impacts were minimal and were not discernible over the entire Northwest Shelf Bioregion. Additionally, the study found that the time for the zooplankton biomass to recover to pre-seismic levels inside the survey area, and within 15 km of the area, was only three days following the completion of the survey. This relatively quick recovery was due to the fast growth rates of zooplankton, and the dispersal and mixing of zooplankton from both inside and outside of the impacted region (Richardson et al. 2017).

The plankton impact assessment section of the EP already includes a scaled up semi-quantitative analysis for a nominal 25,000 km2 3D survey, based on the application of the Popper et al. (2014) threshold criterion (survey area +230 m), and also using the impact distances as applied in the CSIRO modelling study (survey area + 2.5 km; and survey area + 15 km). As indicated above, TGS modelling indicates that received levels of ~180 dB re 1 µPa PK-PK may occur at distances of ~10 km from the 4,120 cui source, and so application of a 15 km impact range can be regarded as conservative.

It is important to note that whilst the EP contains an assessment on the 'worst-case scenario' of a 25,000 km2 proposed 3D individual survey within operational area, the maximum size of an individual 3D survey, for example, is more likely to be 15,000 km2 or less. As such, the likely duration of individual surveys would be considerably less than 10 months.

Even allowing for survey durations longer than the 36 days modelled in the CSIRO study, and an impact range of 15 km (average of 14 – 22% reduction in zooplankton biomass), the magnitude of impacts is still not expected to be significant at the spatial scale of a worst-case scenario' of a 25,000 km2, and impacts would still not be discernible at the regional scale where impacts to biomass in the Richardson et al. (2017) simulations were negligible.

Richardson et al. (2017) observed that zooplankton biomass generally showed a decline until Day 22 of the simulations, and then increased relatively until the end of the simulated survey on Day 36. This reflects the movement of water through the survey area and the recovery of the zooplankton biomass as it moves into non-impacted areas, which indicates that beyond a certain duration (i.e. ~22 days) seismic acquisition area and duration contributes less to changes in overall biomass in the region relative to natural mortality rates and rates of recovery.

It is well understood that large natural spatial and temporal variation occurs in phytoplankton and zooplankton biomass in the North-west Marine Region and other parts of the world, with populations varying significantly at spatial scales from hundreds of metres to hundreds of kilometres and temporal scales of hours, days, seasons and inter-annually, due to tidal and large scale currents, bathymetry, temperature, salinity, water chemistry parameters and other environmental factors. In a review of mortality estimates (Houde and Zastrow 1993) , the mean mortality rate for marine fish larvae was M = 0.24, a rate equivalent to a loss of 21.3% per day. McCauley et al. (2017) observed a natural mortality rate of 19% per day (which was applied as the natural mortality rate in Richardson et al. [2017]), while Tang et al. (2014) reported mortality rates of 11.6% (average minimum) to 59.8% (average maximum) in marine

Operators should also act to manage residual risk of vessels and facilities after arrival in or off WA waters. Even where risk is managed through the above measures before departure, it is possible that microscopic marine pests can subsequently settle. For example, this may occur if a vessel or facility fails to depart from overseas or interstate for WA within seven days of undertaking the reasonable measures. To address this residual risk the Department recommends that a follow-up marine pest inspection or survey using other means is conducted at least 75 days after departure for WA. Any equipment coming from overseas or interstate for this activity should also be either new, or thoroughly cleaned, then dried for at least 24 hours and inspected for marine pests before use in WA waters. The Department requests that the presence of any suspected marine pest or disease be reported within 24 hours by email (mailto:biosecurity@fish.wa.gov.au) or phone via the *FishWatch* 24 hour hotline on 1800 815 507. This includes any organism listed in the Western Australian Prevention List for Introduced Marine Pests (see: http://www.fish.wa.gov.au/Documents/biosecurity/epa_introduced_marine_pests.pdf), and any other non-endemic organism that demonstrates invasive characteristics. It is also important that this information is forwarded directly to all associated vessel operators. In summary: 1. Fisheries expects seismic survey EPs to adequately address the issues as set out above; and 2. Fisheries strongly encourages proponents to give all 'relevant persons' an opportunity to provide comment and advice once the proposed activities are refined and well-defined.	environments based on a review of available research, which highlights the huge naturally occurring variability that can occur in planktonic populations. These mortalities are only partly the result of predation, and non-predatory factors have been estimated to account for 25% to 33% of the total mortality among marine copepods on average (and higher in some instances) (Tang et al. 2014). 15. The EP risk assessment already contains an assessment of impacts to fish and fisheries, including an assessment of impacts and risks to fish spawning. 16. The potential spatial scale of zooplankton mortality indicated by the McCauley et al. (2017) study should be treated with some caution, based on the shortcomings and limitations of this experiment as identified and described in Richardson et al. (2017). An impact range of 1.1-1.2 km for mortality effects cannot be applied to "similarly vulnerable epifaunal/infaunal taxa", such as benthic invertebrates. The EP impact assessment section includes detailed assessments of the potential impacts and risks of seismic acquisition within the operational area to benthic crustaceans and molluscs (including pearl oyster). This impact assessment takes into account the findings of recent studies examining the potential effects of seismic airgun noise on crustaceans (Edmonds et al. 2016) and scallops (Day et al. 2016 ; Przeslawski et al. 2016). 17. The EP includes a comprehensive assessment of potential cumulative impacts that could result from simultaneous seismic acquisition within the operational area (Section 0), which includes a range of mitigation measures to ensure that cumulative impacts would be reduced to As Low as Reasonably Practicable (ALARP) and acceptable levels.
26/10/2017 DPIRD thanked TGS for the additional information received on 22 September 2017. They recognise that a lot of work had gone into the assessment, however requested to receive the information earlier so that better advice could be provided. Therefore, should the current version of the EP not be accepted by the Regulator and TGS decides to resubmit a revised version, Fisheries formally requests to be provided with sufficient information (see below) to allow it to make an informed assessment of the possible consequences of the proposed activities on its functions, interests and activities. Fisheries also requests to be provided with a period of 4-6 weeks to respond prior to resubmission. DPIRD again provided a copy of the draft guidance statement. This was assessed on 23-8-2018 (above) and not addressed again.	6/11/2017 TGS thanked DPIRD for feedback and information on the future Fisheries Guidance Statement. Stated TGS are not in a position to confirm the course of action if the EP is not accepted by NOPSEMA but confirmed they are committed to ongoing consultation and will confirm how they will proceed once the NOPSEMA assessment outcome is known. A response is anticipated around the 17th of November 2017 The comments in the email dated 26/10/2017 were discussed in meeting 4/4/2018 and TGS stated that they were addressed in updated EP assessment which was provided to DPIRD. TGS acknowledge the comments made by DPIRD. TGS believe all concerns have been appropriately addressed through subsequent correspondence and meetings with DPIRD and through the revision of the EP evaluation which was supplied to DPIRD for review and comments. See correspondence below dated 20/4/2018 and 24/4/2018. 2a. revised thresholds used in EP evaluation as supplied to DPIRD.

In addition to above comments and information, DPIRD responded to statements made by TGS to meeting minutes on 22/9/2017 (red text) and addressed earlier in this Table. 2a. DoF still had concerns with using 185 SPL rms as threshold level. Believed further assessment was required and needed to look at the potential for fish to leave an area as a result of fleeing the source and how this may affect the population or management unit or another appropriate spatial unit, particularly if this was to occur during spawning. Site attached species cannot flee and so the level may not be appropriate. The survey may potentially occur over the preferred habitat of the goldband snapper during spawning period and this does not appear to be assessed. 2c. Fisheries proposed that an appropriate approach would be to determine the maximum horizontal distance at which 185 dB (rms) is achieved and then propose a buffer to from an appropriate depth contour relevant to site-attached fish – eg 50-60 m. 5a. DoF has concerns re cumulative impacts from multiple surveys in a region and believes the acceptance of the EPs to be a form of deregulation. 5b. A cumulative risk assessment cannot be undertaken with the information available 5c.DoF had concerns that TGS' approach of calculating % of overlap with fisheries licence zones was too coarse and that better assessments could be conducted – as a minimal overlap with a licence zone can mean a significant overlap with current fishing grounds within the licence area. 6.1 DoF believe that the plankton paper is relevant and that it was published in a highly respected publication. However, agree that the results were different enough to make a repeat experiment worthwhile. 6.2 DoF provided information on accessing fishcube data which contains fisheries-specific spatial catch data for the period 2005-2016. It is an excellent tool and allow stakeholders to get a better idea of where fishing grounds are within much larger management envelopes.	2c. This has been addressed in the EPs and appropriate buffers identified. However, due to the reduction in the polygon, the survey is more than 6 km from waters and topographic features that may support site-attached species at which point received levels will be well below threshold levels for behavioural impacts. 5a. TGS acknowledges the Departments concerns, but cannot comment further as this is a process under the control of NOPSEMA. However, under the EP further controls are implemented including review of pre-survey information to ascertain if any aspects of the environment have changed or further info on fisheries etc is available. 5b A cumulative risk assessment section is available in the EP assessment section. This was provided to DPIRD for review. 5c. TGS acknowledge that the initial assessment may be too coarse. As such further information was gained through 'Fish Cube' which shows actual areas fished and this data was then used in the assessment. This approach was discussed with DPIRD in meeting 4/4/2018 and acceptable. 6.1 – Although TGS still believe the concerns raised by IAGC on the validity of the plankton paper and that the experiment required repeating, the paper has been referenced within the EP evaluation. 6.2 – TGS has accessed fishcube data and used it extensively within the EP evaluation.
9/1/2018 Feedback as a result of updated information sent to all stakeholders on 11/11/2018. The department welcomed the proposed reductions as they will markedly reduce the risk posed by the activities. However, the department is of the view that the risk assessment provided in 22 Sept 2017 does not fully address its concerns nor fully asses the relevant risks. For example: • It does not fully assess the risks to, and potential impacts on, demersal fish stocks. Survey area boundaries, timing and duration are not currently known, which means the assessment should assume a 'worst case' seismic survey. What is known is that the acquisition area partly overlaps the spatial distribution of a number of demersal fish stocks and the acquisition parameters are expected to result in exposure levels at the seabed that exceed TTS thresholds in Popper et al. 2014 for finfish (e.g. 186 dB SEL_{cum}). DPIRD reiterated that fish will either not disperse and so be impacted and this should be assessed. More reasonable would be they will disperse. In	21/1/2018 – TGS apologised for the delay is response and stated that they were still working through the departments letter and would revert back soon. TGS have completed the risk assessment and addressed DPIRD concerns. TGS apologise for the delay in response and acknowledge that the DPIRD have requested longer review periods in order to provide advice. However, based on the ongoing changes to the EP based on both NOPSEMA and DPIRD feedback, the risk assessment has only just been completed. To allow DPIRD 4 weeks minimum to review and comments would mean a further month delay in submission, and based on feedback from NOPSEMA, an extension in its resubmission would not be possible. The full risk assessment will be provided to DPIRD. Should DPIRD provide further evidence beyond that which has been evaluated that further physical or temporal exclusions are required to ensure that impacts to fisheries are not significantly increased beyond those which may be accounted for by natural mortality or environmental parameters, this will be assessed according to the risk assessment requirements in this EP.

this case it may be conservative to assume that this occurs at sound levels of ~162-168 dB re 1uPa2.s (~186-193 SPLpeak) as suggested by the findings of McCauley et al. (2003), The risk assessment should assess the risk associated with the effects of dispersion of fish out of the survey area at the scale of the relevant biological. A worst-case assessment should assume the survey will be conducted over the peak spawning season • It is not clear from the information provided that the potential impacts are assessed at the appropriate spatial scale. It is the Department's view that impacts should be assessed at the scale of a *biological stock* (as opposed to a larger scale such as the population, species distribution or bioregion). • Should – after considering the above – the risks to one or more biological stocks not be negligible then a cumulative impact assessment should be conducted to evaluate the sum of risks on a stock during the survey and a period of 12 months following cessation of seismic activities. • With respect to zooplankton, the Department is of the view that the risk of impacts on zooplankton (and flow-on effects on higher trophic levels) should be assessed based on the findings of McCauley et al. (2017) and the modelled results of Richardson et al. (2017).	TGS acknowledge the DPIRD comments and agree that demersal species may disperse and be subjected to behavioural impacts. As such TGS have altered the threshold levels for behavioural effects but based it on a lower (more conservative) level of 176 dB resulting in a 15 km area of potential influence. . The risk assessment assesses the risk associated with the effects of dispersion of fish out of the survey area at the scale of the relevant biological stocks assuming a survey area of 25,000 km2 with maximum overlap of the spatial distribution of the relevant fish stocks. Based on the supporting information on fisheries and fish species, including spawning locations and favoured depths and habitat types, it is assessed that the surveys will have limited impact on fish catches or spawning as a result of physical parameters and so temporal exclusions are not allowed. Information has been provided on the life characteristics and spawning ecology of the various indicator species and other main commercial species of the bioregion and, where appropriate, have been assessed at he biological stock level. Where information was not available, information from adjacent jurisdictions (Gascoyne and Kimberley) was utilised. As a result of the assessment which looked at current fishing levels and stock, it was concluded that the potential impacts from the proposed seismic surveys will be negligible on the biological stocks. As suggested by DPIRD, risk of impacts on zooplankton (and flow-on effects on higher trophic levels) have been assessed based on the findings of McCauley et al. (2017) and the modelled results of Richardson et al. (2017). It was evaluated that impacts would be limited and not affect species populations or biological stocks. 26/3/2018: TGS formally responded: As I am sure you are aware, the NWSR North Environment Plan has changed a great deal over the past 2.5 years, both in physical size and the assessments undertaken based on new information or requests. For this reason, NOPSEMA were unwilling to provide further extension in its submission and once the assessment was finalised it was required to be submitted immediately. Consequently, we could not provide DPIRD the full assessment 4 – 6 weeks prior to its resubmission, and for this we apologise. As pointed out on other occasions, consultation is ongoing and if the DPIRD still has major objections with the activity based on our latest assessments, we will be required to address your concerns. In our assessment of the impacts of the activity on fisheries, we provided greater detail and evaluation on the physical exclusion of commercial fishing activities, noise impacts on zooplankton, behavioural impacts and consequences on catchability and spawning fish. We concur that it is reasonable to assume that non- site attached fish species will move away from a seismic source and so provided greater evaluation on this. Please note that within the assessment, TGS elected to evaluate the potential behavioural impacts on fish based on the data presented by McCauley *et al.* (2000) being 161-168 dB SPL_{rms} (SPL_{peak} 176-183 dB). This equates to a potential zone of impact out to ~ 15 km. This is in contrast to information provided by DPIRD which suggested that levels as high as 186-193 SPL_{peak} could be used to inform evaluation of impacts to fisheries; equating to a potential zone of impact to only 6 km (utilising conservative TGS modelling). As such, this assessment provides a very conservative evaluation on the potential impacts to fish species. As requested, the risk assessment then assessed the risk associated with the effects of dispersion of fish out of the survey area at the scale of the relevant biological stocks (justification for stock scale is

	provided) assuming a survey area of 25,000 km^2 with maximum overlap and during peak spawning periods. Based on information on the ecology of each species, preferred depth locations (< 200 m) and habitat for fish (and spawning) it was determined that the activity would have negligible impact on biological stocks or catch rates. Subsequently, a cumulative impacts assessment is believed to be unnecessary. Please also note that risk of impacts on zooplankton has been assessed based on the findings of McCauley *et al.* (2017) and the modelled results of Richardson *et al.* (2017). The details will not be outlined here but are available in the full assessment attached. Provided for your information are the following risk assessment sections form the NWSR North Environment Plan: • Section 5.1.3 – Interaction with Fisheries, Diving, Shipping and Petroleum Service Vessels • Section 5.1.5 – Underwater Noise Emissions from Discharge of the Acoustic Array As a result of the survey being limited to waters deeper than 200 m; a greatly reduced operational area that now only overlaps a limited number of commercial fisheries; and that the majority of targeted species show a preference for shallower waters and habitats associated with raised topographic features etc., it has been assessed that the proposed NWSR North seismic surveys will have negligible impact of biological stocks or commercial fishing activities. A meeting was set up between TGS and DPIRD for 4/4/2018 to discuss the comments and updated risk assessment.
4/4/2018: Meeting between DPIRD and TGS Overview of changes provided as well as revised risk assessment based on previous DPIRD correspondence (including that dated 26/10/2017 and 9/1/2018). DPIRD confirmed they had not read the updated risk assessment before the meeting (it was subsequently learned it had been fire-walled) but were very pleased at the changes made and that at first glance it appeared that many of their concerns have been answered. DPIRD recommended TGS access fishcube data and use it in the evaluation.	TGS confirmed that Fishcube data had been requested and would be used in the assessment TGS sent follow up email outlining the significant changes in the EP including water limits of 200m and reduction in operational area.
20/4/2018: DPIRD provided response/ notes to the updated risk assessment. Much of the response contained information that was not a claim or objection, but notes only. These are not recorded in this table, but the full copy is available in Appendix T. 2. The expected exposure levels at the seabed directly underneath the survey vessel and horizontally exceed thresholds at which marine fauna (including fish and invertebrates) have been shown to be adversely affected. This includes behavioural responses which may affect stocks and fisheries operating in the area 3. The maximum spatial envelope and duration of the survey is considerable and does not appear to be justified/supported by a rationale anchored by clearly defined exploration targets and project-specific operational objectives 4. ERA workshop suggest proposed parameters to pose high risk to immobile invertebrates and demersal fish up to 250m, medium risk to these groups in waters >250m and mobile inverts at 100m and >250m. At these levels DPIRD expects key	23/4/2018 TGS provided responses to DPIRD within their email and requested another meeting to discuss if DPIRD were available. 2. An assessment of possible impacts on spawning success and commercial fisheries in the area has been presented in Section 5.1.5, particularly in Sections 5.1.5.7 to 5.1.5.9. Also found in the Risk Assessment (RA) section of the EP provided to DPIRD. 3. TGS provided a rationale behind the basin-wide approach 4. TGS outlined that various groups had been identified and assessed as presented in the risk assessment given to DPIRD. TGS requested whether the department had reviewed the assessment. TGS also requested if the department could provide more information on what was expected in the cumulative impacts assessment as a potentially huge undertaking. 5. TGS agreed and this is why the area was limited to waters >200m

species from each group to be identified and risks and impacts assessed, including cumulative impacts. 5. DPIRD stated that not all information discussed in previous point 4 was included but that they acknowledged that the proposed control measures of restricting seismic activity to waters >200m is likely to considerably reduce the risk to stocks of key target species. 6 DPIRD believe the flexibility built into EP with respect to timing and area covered is not supported and that surveys with well defines areas etc can enable the operator to accurately avoid critical windows or key habitats, particularly for in NW Australian waters where demersal fish have relatively small stock sizes. DPIRD listed possible control measures. DPIRD encourages all proponents to identify specific targets and tailor the survey to minimise impacts prior to submission to regulator for approval.	6. TGS states that the reasons for the flexibility were explained to DoF earlier and they were under the impression that the reasoning was understood and acceptable. TGS believe that even with a basin-wide EP, critical habitats and timings etc can still be identified and appropriate control measures implemented to minimise impacts, including NW indicator species. TGS again outlined its control measures such as limiting to 200 m depth, maximum survey size being 25,000 km and over 2 years and limiting source size. TGS outlined the multi-client model and how they are not limited to specific permits like titleholders are and as such need an EP with more general parameters over a larger area. TGS stated that they believed many of the statements within their response were very generic and not specific to the NWSR North risk assessment provided to the DPIRD and asked whether they had reviewed the risk assessment and still had concerns.
24/4/2018 DPIRD responded stating that the department had no capacity to engage in every minutae of every survey. Some comments were provided within the email chain as well as the following points: • DPIRD does not support strategic EPs for many reasons including those provided in Prideaux and Prideaux (2015). But mainly because acquisition parameters must be known and due to the difficulty in assessing cumulative impacts from two strategic EPs. But they acknowledge it is their positions and that it is up to the Regulator. • Notwithstanding the above point, **DPIRD acknowledge that by limiting the survey to >200m water there is a low risk of impact at the spatial resolution of biological stocks** • It was DPIRD view **that although the assessment provided was incomplete, providing a long list of comments on issues that , *in this particular case*, have little impact on the outcome, was not warranted**. Comments within the email as follows: 3. DPIRD was not interested in business models but was just clarifying that this was a strategic EP 4. None of the comments are particularly relevant as point 5 was included it explain that in this particular survey (because of the control measures) not all information was required. 6. DPIRD have requested any correspondence indicating their acceptance of strategic EPs be provided	1/5/2018 TGS acknowledge the DPIRDs stance on strategic EPs but believe they are workable documents built on a robust risk assessment process and contain much of the detail discussed by the DPIRD and as outlined in the Prideaux paper. TGS again stated that to minimise impacts to fishes and fishers, control measures have been introduced. TGS were satisfied to know the department can see the value in the changes in the EP and that in this instance there will be minimal impact at the spatial resolution of biological stocks and that no further information is requested. TGS understand that the department have competed their review and feedback and that TGS will not request further clarifications or information. TGS will keep the department informed. TGS will consult with the department further regarding past discussions regarding strategic EPs