

THREE BEARS MC3D MARINE SEISMIC SURVEY ENVIRONMENT PLAN: PUBLIC SUMMARY

This summary of the Environment Plan for the TGS Three Bears MC3D marine seismic survey, which will be acquired in the Carnarvon Basin on the North West Shelf offshore from Western Australia (WA), has been submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA), to comply with sub-regulations 11(7) and 11(8) of the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009.

INTRODUCTION

The geophysical company TGS proposes to undertake a multi-client, three-dimensional (3D) marine seismic survey (Three Bears MC3D MSS), in the Carnarvon Basin on the North West Shelf offshore from WA (**Figure 1**). The Three Bears MC3D MSS will be comprised of approximately 465 square kilometres (km²) of 3D seismic acquisition in Exploration Permits WA-205-P, WA-450-P, Retention Lease Area WA-42-R, Release Area W12-08 and adjacent open acreage areas.

COORDINATES OF THE PROPOSED ACTIVITY

Boundary coordinates for the survey area (see **Figure 1**) are provided in **Table 1** below.

Table 1: Three Bears MC3D MSS survey area

Latitude (S)			Longitude (E)		
Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
20	29	55.306	114	30	04.765
20	29	55.303	114	40	04.742
20	41	06.558	114	40	04.727
20	41	06.626	114	35	04.737
20	47	34.397	114	35	04.729
20	47	34.171	114	30	04.742

Datum: GDA94

At the closest point, the Three Bears MC3D survey area is situated at a minimum distance of ~69 km to the west of Barrow Island, and ~81 km west of the Montebello Islands (**Figure 1**).

The Three Bears MC3D survey will take place on the upper continental slope and water depths in the survey area range from ~490 to 945 m, with shallowest water depths situated along the eastern boundary of the survey area and the deepest depths along the northern boundary (**Figure 2**).

Figure 1: Location map – Three Bears Multi Client 3D marine seismic survey

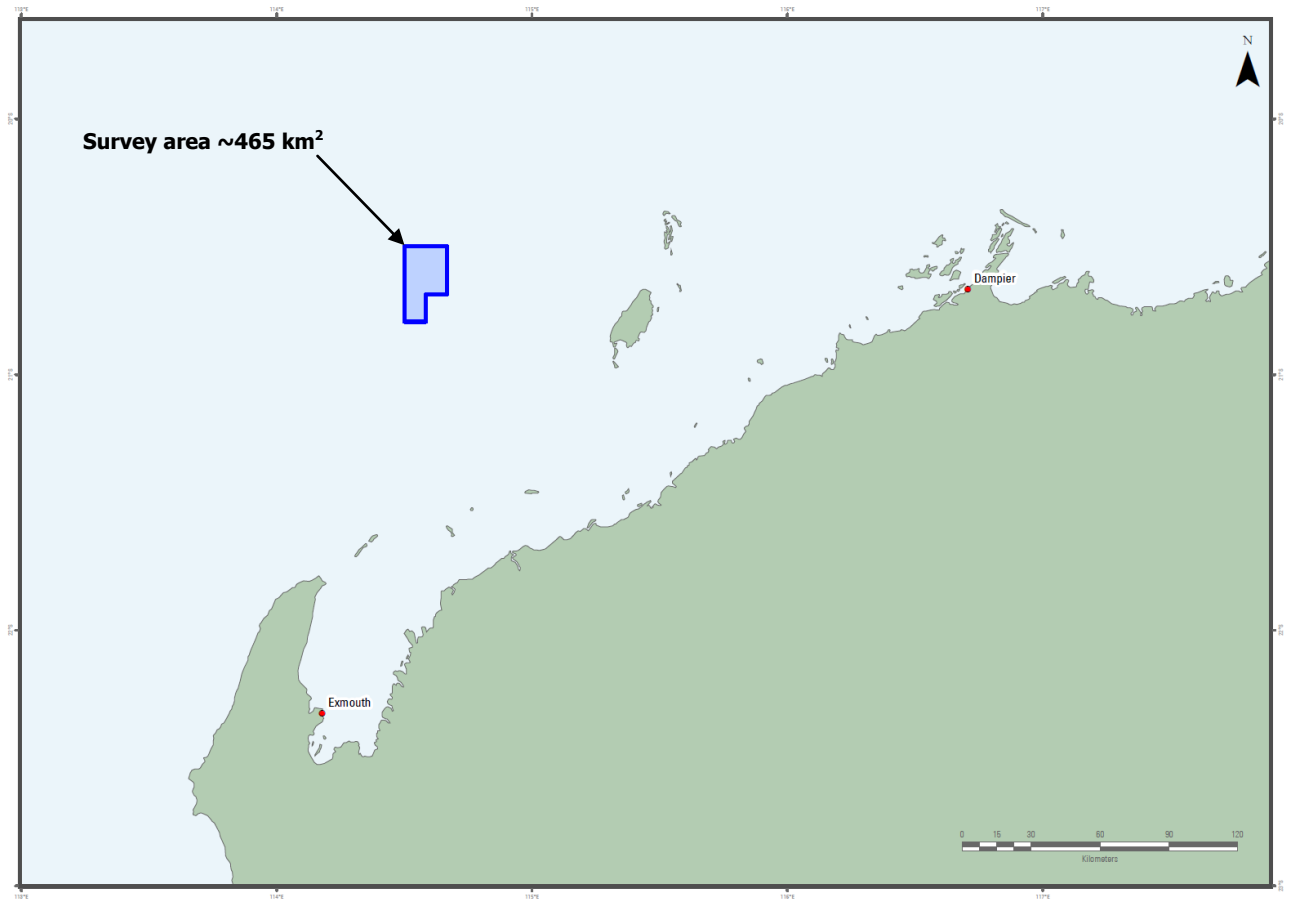
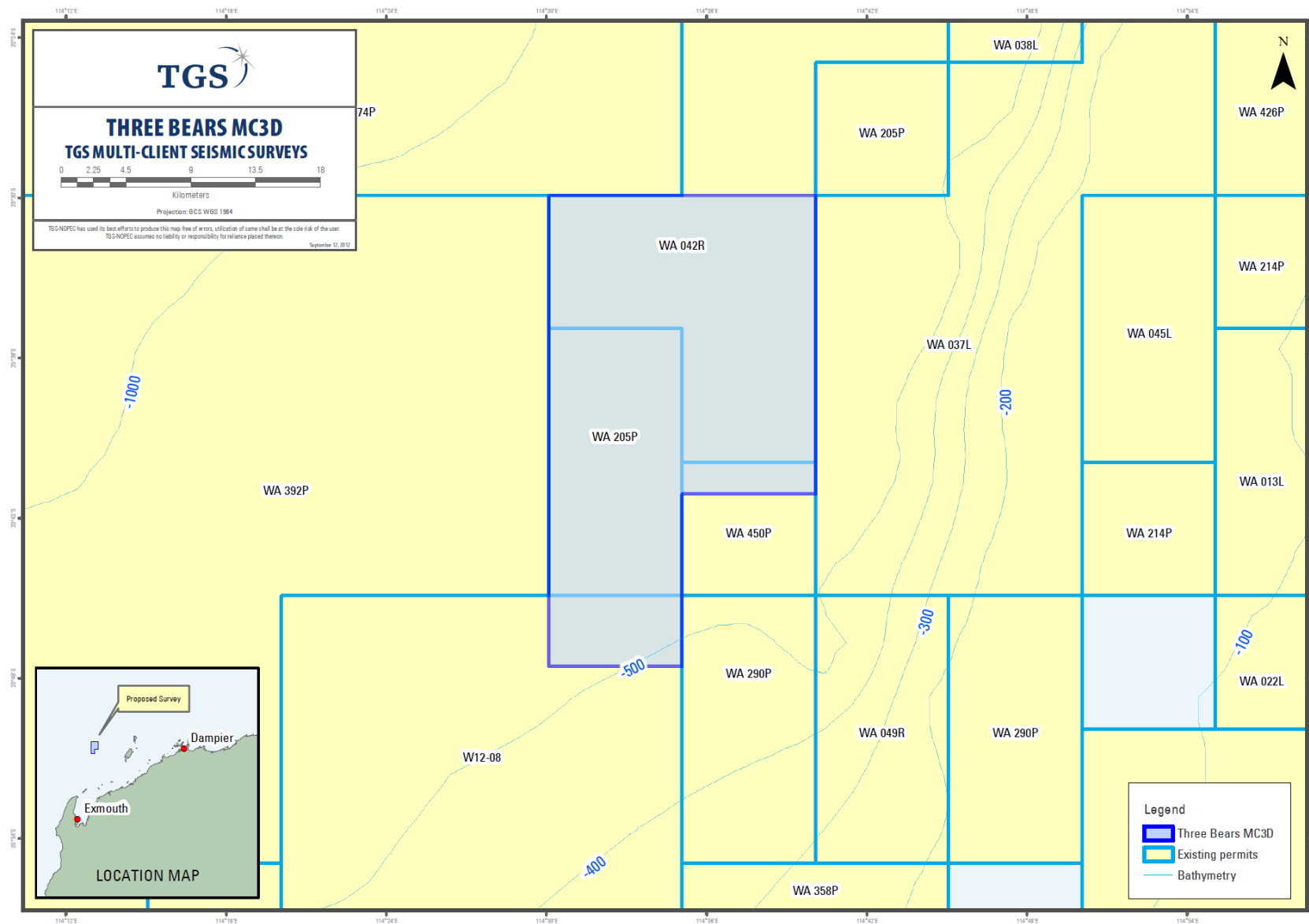


Figure 2: Three Bears MC3D MSS area, with bathymetry and permit areas



DESCRIPTION OF THE PROPOSED ACTIVITY

The Three Bears MC3D MSS is scheduled to occur in early to mid-October 2012 and is expected to be of approximately 22 days duration.

Timing of commencement is dependent on fair sea state conditions suitable for marine seismic acquisition, the availability of the survey vessel for conducting the survey, and granting of approvals from the appropriate government bodies.

During the proposed activities, the survey vessel will traverse a series of pre-determined sail lines within the survey area at a speed of approximately 8-9 km/hr. As the vessel travels along the survey lines, a series of noise pulses (every 8-10 seconds) will be directed down through the water column and seabed. The released sound is attenuated and reflected at geological boundaries and the reflected signals are detected using sensitive microphones arranged along a number of hydrophone cables (streamers) towed behind the survey vessel. The reflected sound is then processed to provide information about the structure and composition of geological formations below the seabed in an attempt to identify hydrocarbon reservoirs.

The seismic array will comprise of a maximum of 14 solid streamers, with a maximum length of 6 km. Streamer spacing will be 100 m, and line spacing will be 750 m. The source (airgun array) tow depth will be 6 m (+/- 1 m) and the streamer tow depth will be 9 m (+/- 1 m). The operating pressure for the airgun array will be approximately 2,000 psi. The airgun array will consist of two sub-arrays, each with a maximum volume of approximately 4,000 cui. These sub-arrays will be fired alternately, with a shotpoint interval of 18.75 m vertical distance. The source produces sound pulses (within a few metres in the order of 265-275 dB re 1 μ Pa sound pressure level – SPL) at frequencies extending up to approximately 100 Hz. These sound pulses decrease to levels in the order of 201 dB re 1 μ Pa (SPL) within 1 km of the source and approximately 181 dB re 1 μ Pa (SPL) within 10 km, dependent on the sound propagation characteristics of the area.

TGS proposes to conduct the Three Bears MC3D MSS using a purpose-built seismic survey vessel—the *Ramform Sterling*, which is owned by PGS Falcon AS and operated by the PGS Geophysical AS. The vessel has all necessary certification/registration and is fully compliant with all relevant MARPOL and SOLAS convention requirements for a vessel of its size and purpose. The *Ramform Sterling* has an implemented and tested Shipboard Oil Pollution Emergency Plan (SOPEP), in accordance with Regulation 37 of Annex I of MARPOL 73/78.

The *Ramform Sterling* will travel within the survey area at an average speed of 4.5 knots (approximately 8.3 km per hour).

A support vessel, the *Pacific Crest*, will accompany the seismic survey vessel to maintain a safe distance between the survey array and other vessels, and to manage interactions with shipping and fishing activities, if required. The support vessel will also re-supply the survey vessel with fuel and other logistical supplies. The support vessel will have a crew of approximately nine personnel. This support vessel is not required to have a SOPEP, as it is less than 400 tons gross tonnage.

The *Ramform Sterling* does not routinely refuel at sea, as the vessel has an endurance of 4-5 months. Consequently, during the proposed Three Bears MC3D survey, no at sea refuelling will be undertaken—the vessel will start the survey with a full load of fuel following a port call prior to survey commencement.

DESCRIPTION OF THE RECEIVING ENVIRONMENT

The survey area for the proposed Three Bears MC3D survey is located in the Carnarvon Basin on the North West Shelf (NWS), approximately 150 km west of Dampier (**Figure 1**). The NWS is scattered with islands, the largest of which is Barrow Island.

Physical Environment

The Pilbara Region is characterised by two seasons: summer (September–April) and winter (May–August). The southern portion of the NWS region, including Barrow Island, is characterised by an arid, subtropical climate. In summer, mean daily temperatures range between 20°C and 34°C. During winter, mean daily temperatures range between 17°C and 26°C. Relative humidity at Barrow Island ranges from 61% in the winter months (September) to 70% in the summer (February).

Meteorological records from Barrow Island are detailed and are likely to be indicative for the region. Given its position in relation to the survey area, meteorological conditions on Barrow Island are considered to provide a good proxy for conditions likely to be encountered in the survey area further offshore. Rainfall on Barrow Island varies significantly each year and is dependent on rain-bearing low-pressure systems, thunderstorm activity, and the passage of tropical cyclones (which generally occur from November to April). Average annual rainfall at Barrow Island is 306 mm with most rain (85%) occurring between January and July. The mean ambient wind speed around Barrow Island during summer is 6.6 m/s, and the maximum summer wind speed is 16.2 m/s. The dominant wind directions during summer are from the south-west and west. During winter, winds approach from the east, south, and south-west and have a mean speed of 5.8 m/s and a maximum speed of 19.4 m/s.

An average of five tropical cyclones per year occur in the Pilbara Region, with an average of two per year passing through the Barrow Island area. According to the Bureau of Meteorology, the Australian tropical cyclone season runs from 1 November to 30 April, with cyclones most common between December and March. Tropical cyclones are unpredictable in occurrence, intensity, and behaviour and can generate extreme seas and swell. Large increases in precipitation are associated with cyclones, and the Bureau of Meteorology reports that rainfall totals greater than 100 mm are common with tropical lows that move over land.

In the deep waters of the survey area, water temperatures at depths greater than 500 m range from a summer peak of approximately 10°C to a winter low of about 4°C. The mean temperature for depths between 200 and 250 m is approximately 10°C. Surface water temperatures offshore range between approximately 20°C in winter and 31°C in summer. Water circulation in the region is influenced by the southward-flowing Leeuwin Current and the Indonesian Throughflow. Currents in the survey area are principally driven by semidiurnal tidal forcing. The direction of tidal currents is a flood flow towards the south-west and an ebb flow towards the north-east. Local winds can influence water circulation, more so in the upper 200 m of the water column. Maximum current speeds in upper regions of the water column (surface to 100 m deep) near the survey area are predicted to range from 0.33 to 0.8 m/s in non-cyclonic conditions and may occasionally approach 1.1 m/s under extreme storm conditions.

The region typically experiences a persistent winter swell of around 2 m, generated by low-pressure systems in southern latitudes. During winter, strong easterly winds can also generate 2 m seas. Both swell and seas tend to be smaller during summer. Astronomical tides on the NWS are semidiurnal and generally quite large, ranging from 0.95 m near Exmouth to more than 3 m on the inner shelf near Broome. Maximum spring tide amplitudes range from just over 2 m at Exmouth, 2.5 m at Onslow, 4.5 m at Dampier, to nearly 6 m at Port Hedland.

The continental slope (the scarp), extends from 300 m to 1,200 m water depth and is divided into an upper, middle and lower slope based on distinctive changes in the seabed gradient and morphology. At the base of the scarp, maximum seabed slopes of up to 80° can be found. Average slopes in the upper scarp are 4° to 5°, while the average slope of the middle and lower scarp is more benign (2° to 5°).

Biological Environment

The deepwater habitats of the survey area are generally depauperate and typical of the low abundance, richness and diversity observed in other deep areas of the NWS. However, there are areas of increased infaunal abundance in deeper water depths, as evidenced by areas of heavily bioturbated sediments, indicating an active infaunal assemblage (see below). Benthic surveys conducted in depths ranging from 212 m to more than 1,300 m, showed that no epifauna (i.e. fauna living on the seabed) were recorded from the majority of samples (63%) and infauna, where present, were in low abundance, with low richness and diversity. Surveys conducted in the scarp region found that the soft sediment in the area was often marked by burrow holes made by unidentified organisms (thought to be small fish or crustaceans); these soft sediments supported some benthic life, including solitary sea pens, holothurians, and hydroids. Soft corals were present and were found to be most abundant at depths between approximately 550 and 700 m, with Alcyonian soft corals being the most common taxa identified. At these sites, the soft corals were found in mixed communities with bryozoans, sponges, and hydroids.

Small pelagic fish are believed to comprise a significant proportion of the fish biomass throughout the region, feeding on pelagic phytoplankton and zooplankton and providing a food source for a wide variety of predators including large pelagic fish, sharks, seabirds, and marine mammals. Fish species of the inner shelf include lizardfish, goatfish, trevally, angelfish, and tuskfish. Large pelagic fish (such as tuna, deep lizardfish, deep goatfish, ponyfish, deep threadfin bream, adult trevally, billfish, mackerel, swordfish, and marlin) are also found in the region, mainly in water depths of 100 to 200 m, and occasionally on the continental shelf. The region also contains a rich variety of chondrichthyan fish (sharks, skates and rays), which occupy a broad range of shallow and deepwater habitats, as well as being distributed throughout the water column.

The NWS region is associated with important populations of demersal fish species, including commercial species such as snappers, emperors, and groupers, which are distributed across a number of distinct depth ranges, specifically areas of the upper slope (225–500 m water depth) and mid slope (750–1,000 m water depth). More than 508 fish species have been identified on the slope in this area, of which 64 species are endemic.

Protected Marine Fauna

A review of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) database (Protected Matters search tool) held by the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) was conducted for a polygon encompassing the survey area. From the Protected Matters search, it is apparent that eight listed Threatened species may occur, or relate to, the survey area:

1. the southern giant petrel;
2. the blue whale;
3. the humpback whale;
4. the loggerhead turtle;
5. the green turtle;
6. the leatherback turtle;
7. the hawksbill turtle; and
8. the flatback turtle

The survey area for the proposed Three Bears MC3D MSS 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 (TECs) in the vicinity of the survey area.

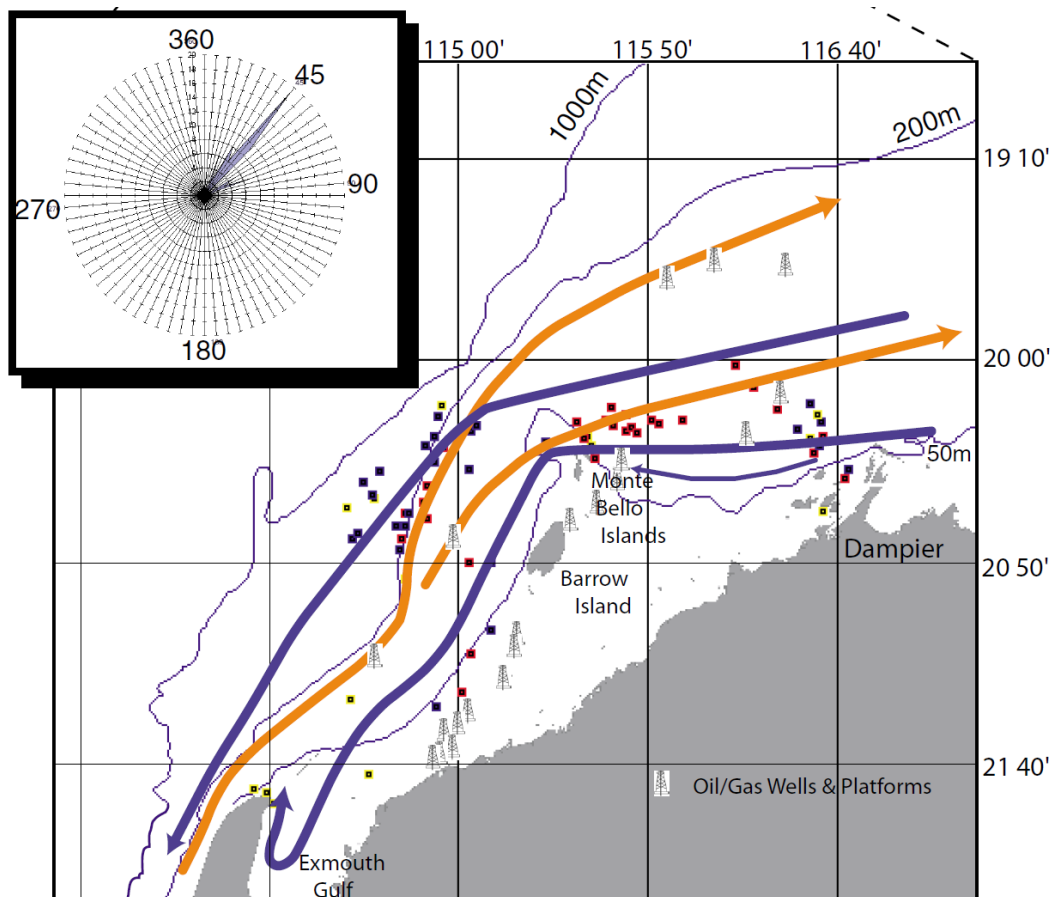
Whales and Dolphins

The EPBC Act database lists 23 cetacean species that may occur in, and adjacent to, the survey area of the Three Bears MC3D MSS, all of which are protected under the Act; one of which is also classified as Endangered, one as Vulnerable and six as Migratory species.

The humpback whale is the most commonly sighted whale in north WA waters. The species has been observed seasonally to complete their northern migration in the Camden Sound area of the west Kimberley, after feeding in Antarctic waters during the summer months. It is likely that the whales follow a predictable

migratory path and migrate both north and south within the continental shelf boundary (200 m bathymetry) (**Figure 3**). However, on the southbound migration it is likely that most individuals, and particularly cow/calf pairs, will stay closer to the coast than the northern migratory path. This is confirmed by recent satellite tracking of southbound female humpback whales in the Kimberley region.

Figure 3: Humpback whale migratory routes past the survey area



The Three Bears MC3D survey is scheduled to occur in early to mid-October 2012, which overlaps the end of the southbound migration of humpback whales in the North-west (NW) Cape to Port Hedland region. As the survey area (water depth range ~490 to 945 m) is located in the deep waters of the upper continental slope of the NWS, it is unlikely that humpback whales will be encountered during the survey, particularly as cow/calf pairs tend to move south in water depths less than 200 m.

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

The survey area does not include any known blue whale feeding, breeding or resting areas. In the NWMR pygmy blue whales migrate along the 500 m to 1,000 m depth contour on the edge of the slope, and are likely to be feeding on ephemeral krill aggregations. The northward component of this migration takes place from May to mid-August, with a peak in July-August, and the southward component occurs from late October to November-December, with a few isolated individuals moving south in January. The migration appears to be centred on the 500 m depth contour. Consequently, it is possible that blue whales will be

encountered during the survey, given the proposed period of acquisition (early to mid-October) and the water depth range (~490 to 945 m) in the survey area. However, the survey period is unlikely to overlap the peak of the southward migration of pygmy blue whales in the region.

Offshore waters of the NWMR once supported substantial populations of sperm whales. The presence of sperm whales as evidenced by 19th Century whaling industry data suggests occasional bursts in production, which may be associated with variations in slope (such as canyon heads) and may support species at a number of trophic levels. The deep waters above the gully/saddle on the inner edge of the Exmouth Plateau are thought to be important for sperm whales which may feed in the region (based on the 19th Century whaling industry data). The reasons for this aggregation are not known. Other cetaceans are also believed to use north flowing currents through the deep gully/saddle to assist in their northward migration, similar the northward flowing offshoot of the Eastern Gyral Current.

There are no known breeding, calving or feeding grounds for any listed threatened or migratory whale species within, or in the immediate vicinity of the Three Bears MC3D survey area.

Marine Reptiles

Five marine turtle species may occur in the survey area - green turtle, leatherback turtle, hawksbill turtle, loggerhead, and flatback turtle. Green turtles feed on macroalgae and are by far the most common turtle seen in nearshore waters. Loggerhead turtles are carnivorous, feeding mainly on molluscs and crustaceans. Hawksbill turtles feed mainly on sponges and are more often found in deeper waters of the NWMR. Green, flatback and loggerhead turtles all breed from September to March, while the hawksbill turtle breeds from July to March. The reefal habitats in the photic zone are key feeding habitats for green and hawksbill turtles.

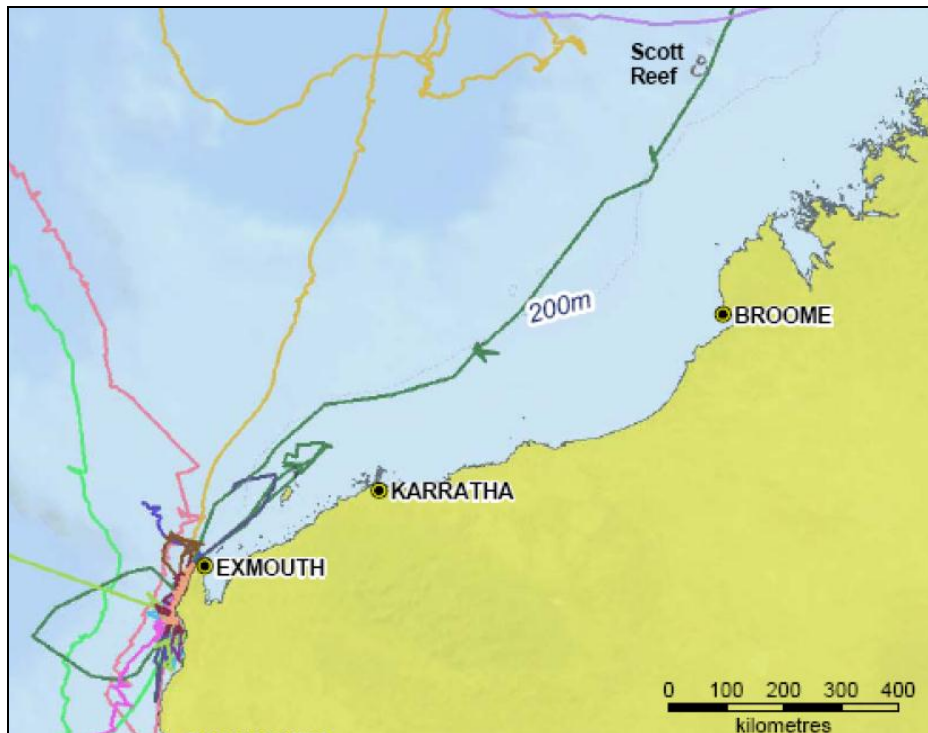
The leatherback turtle is a pelagic feeder, found in tropical, subtropical and temperate waters throughout the world. Nesting is mainly confined to tropical beaches although some nesting occurs on subtropical beaches. No major nesting has been recorded in Australia, although scattered isolated nesting (1-3 nests per annum) occurs in southern Queensland and the Northern Territory. It is unlikely to be encountered within the survey area and adjacent waters.

Recent Position Tracking Terminal (PTT) observations of flatback turtles have recorded their presence in the Exmouth Plateau sub-system. Overall, is unlikely that significant numbers of marine turtles will be encountered during the seismic acquisition throughout most of the survey area, given the water depths and lack of shallow submerged features.

Sharks and Ray-finned Fishes

The whale shark is listed as Vulnerable and Migratory under the EPBC Act. Although there are no records of the whale shark's presence in the survey area there have been sightings in the region, and they are known to occur in both tropical and temperate waters and are normally oceanic and cosmopolitan in their distribution. The tracks of two whale sharks tagged at Ningaloo Reef in 2005 passed the vicinity of the Three Bears MC3D survey area (see **Figure 4**). It is possible that they may be encountered during the proposed survey.

Figure 4: Whale shark tracks off the NW Cape from 2005-2008



Seabirds

Based on the results of two survey cruises and other unpublished records, 18 species of seabirds have been recorded over North-West Shelf (NWS) waters. These included a number of species of petrel, shearwater, tropicbird, frigatebird, booby and tern, as well as the silver gull. Of these, eight species occur year round and the remaining 10 are seasonal visitors. From these surveys, it was noted that seabird distributions in tropical waters were generally patchy except near islands. Apache commissions annual surveys of the avifauna around its operating facilities on the NWS, resulting in a significant amount of data for the area around the Barrow, Lowendal and Montebello islands groups, ~70-80 km to the east of the Three Bears MC3D survey area. In 2006, 40 species of seabirds were recorded around the Lowendal Islands (89 recorded in total). Seventy species of seabird have been recorded at the Montebello Islands and 112 species at Barrow Island. In and around the Exmouth Gulf and further offshore, there is less quantitative data available.

Socio-Economic Environment

Commercial Fisheries

A number of commercial fisheries occur in the waters of the NWS, including areas within the survey area for the proposed Three Bears MC3D survey. These fisheries include the:

- Commonwealth Managed Fisheries: North West Slope Trawl Fishery, Western Tuna and Billfish Fishery, Southern Bluefin Tuna Fishery, Western Skipjack Tuna Fishery, and Western Deepwater Trawl Fishery.
- State Managed Fisheries: Northern Demersal Scalefish (Pilbara Region), North Coast Shark Fishery.

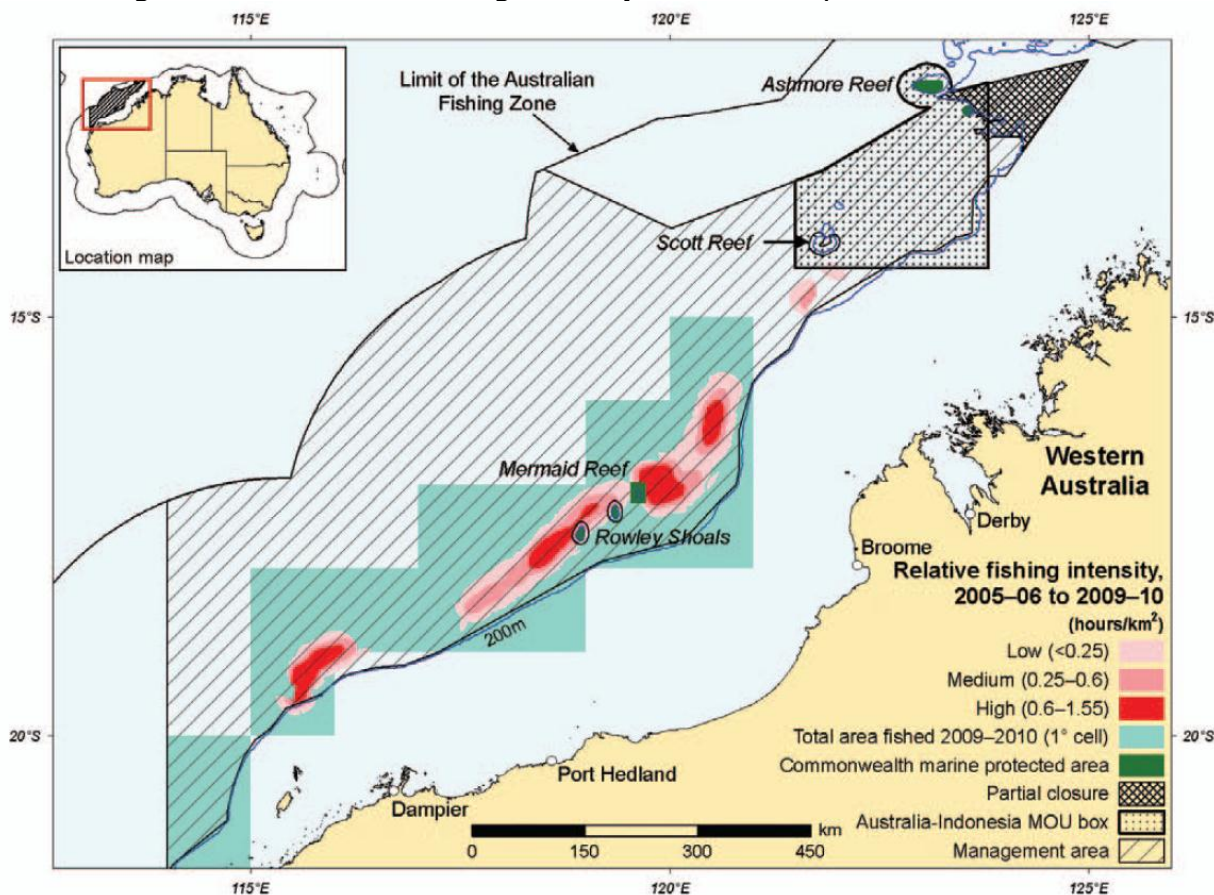
The Commonwealth fisheries are managed by the Australian Fisheries Management Authority (AFMA). Of the five fisheries managed by AFMA listed above, only the North West Slope Trawl Fishery (NWSTF) is active in the deeper continental slope waters off the NWS.

The NWSTF operates off north-western Australia from 114°E to 125°E, roughly between the 200 m isobath and the outer boundary of the Australian Fishing Zone. The NWSTF has traditionally targeted scampi and

deepwater prawns. However, in recent years, Australian scampi has been the main target of the fishery. Demersal trawl gear is used in the NWSTF. Fishing for scampi occurs over soft, muddy sediments or sandy habitats, typically at depths of 350–600 m on the continental slope. Two vessels were active in the fishery in 2009–10, with Australian scampi being the main target. In the past, vessels based in the Northern Prawn Fishery have fished opportunistically in the NWSTF, but this has not been the case in the past three years. Recent effort in the fishery has been dominated by a small number of vessels based in WA.

Whilst the Three Bears MC3D survey area overlaps a small part of the south-western area fished by the two vessels operating in the NWSTF in 2009–2010 (see **Figure 5**), it is apparent that most of the effort and catch within the fishery occurs in upper slope waters (350–600 m) to the north-east of the survey area—especially to the south-west and north-east of the Rowley Shoals.

Figure 5: Relative fishing intensity in the NWSTF, 2005–06 to 2009–10



Petroleum Exploration and Production

Petroleum exploration and production, including seismic surveys and the drilling of exploration wells, is an ongoing activity within the permit areas WA-205-P, WA-450-P, retention lease area WA-42-R and adjacent areas. The Three Bears MC3D survey area is located ~10 km to the west of the Gorgon gas field. The survey area overlaps the southern tip of the Clio gas field, originally discovered by Chevron in 2006. There is no existing petroleum production infrastructure in the survey area and surrounding waters.

To date, only one exploration wells have been drilled in the area covered Three Bears MC3D survey polygon: the Euryale-1 well, drilled by WAPET in 1999.

Shipping

Although there are no defined shipping lanes in the NW Cape region, clear shipping routes emerge when Australian Ship Reporting System (AUSREP) data is analysed. Under the *Navigation Act 1912*

(Commonwealth), all vessels operating in Australian waters are required to report their location on a daily basis to the Rescue Coordination Centre (RCC Australia). AUSREP is an integral part of the Maritime Search and Rescue (SAR) system in Australia, and is operated by the AMSA through the RCC Australia.

Data obtained from the Australian Marine Spatial Information System (AMSYS) for 2006-2007 indicates a clear north-south shipping route running parallel to the Cape Range Peninsula and then heading north from west of the NW Cape—this is the shipping route between the Australian west coast and Lombok Strait. In 1999-2000, about 657 vessels used this route. Another shipping route parallels the coast between the NW Cape and the port of Dampier, with significantly fewer vessels using this on an annual basis (less than 150 annually). AMSA (Nautical Advice) have advised that the major shipping routes in the area are situated to the south-east and west of the Three Bears MC3D survey area. AMSA advice is that vessel traffic will be encountered to the south-east of the survey area travelling along the Montebello-Tryal Rocks recommended track to and from NW Cape / Exmouth. Some traffic will be encountered to the west of the survey area travelling from NW Cape / Exmouth to Indonesia.

Tourism

Due to the water depths the survey area, and distance to coastal areas of the Pilbara, there are no recreational activities (such as recreational fishing and marine-based tourism) undertaken in the area.

Cultural Heritage

There are no known indigenous cultural heritage values or issues for the waters and seabed within and immediately adjacent to the Three Bears MC3D survey area. Similarly, there are no current or pending Native Title Determinations for the waters and seabed within and immediately adjacent to the survey area.

There are no known historic shipwreck sites within or immediately adjacent to the Three Bears MC3D survey area.

National Heritage

There are no places listed on the Commonwealth Heritage List or the Register of National Estate within or adjacent to the Three Bears MC3D survey area.

Marine Parks and Reserves

The closest marine protected areas to the Three Bears MC3D survey area are the Montebello/Barrow Islands Marine Conservation Reserves, which are located in WA State waters ~65 km to the east.

The Commonwealth Government has finalised its proposal to gazette the Montebello Commonwealth Marine Reserve, north-west of Barrow Island. The proposed marine reserve covers over an area of approximately 3,413 km², in waters depths ranging from approximately 15 m to 150 m.

The key ecological feature of the proposed reserve is the ancient coastline, which is a unique seabed feature that provides areas of enhanced biological productivity. The area acts as a foraging area for migratory seabirds and for marine turtles, and also includes part of the migratory pathway of the humpback whale. The proposed reserve includes shallow shelf environments and provides protection for shelf and slope habitats, as well as pinnacle and terrace seabed features.

Other Protected Areas

There are no listed World Heritage places or Ramsar Wetlands of International Importance in the Three Bears MC3D survey area or surrounding waters. The nearest World Heritage site to the survey area is the Ningaloo Coast World Heritage Area, which is located ~90 km south of the southern boundary of the survey area.

There are no listed Ramsar wetlands within, or adjacent to, the proposed Three Bears MC3D survey area.

Defence Activities

The Three Bears MC3D survey area does not overlap any defence training or military exercise areas.

MAJOR ENVIRONMENTAL HAZARDS AND CONTROLS

An Environmental Risk Assessment (ERA) has been undertaken to understand and manage the environmental risks associated with the Three Bears MC3D MSS to a level that minimises impacts on the environment and meets the objectives of the survey. The ERA methodology applied is consistent with the Australian/New Zealand Standard *AS/NZS ISO 31000:2009 Risk management, Handbook 203:2006 Environmental risk management – Principles and process*, and *Handbook 89-2012 Risk management – Guidelines on risk assessment techniques*.

The risk assessment has been undertaken to identify the sources of risk (aspects) and potential environmental impacts associated with the activity and to assign a level of significance or risk to each impact. This subsequently assists in prioritising mitigation measures to ensure that the environmental impacts are managed to As Low As Reasonably Practicable (ALARP).

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

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

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

- disturbance to marine fauna including marine mammals, marine turtles and fish;
- disturbance to marine habitats including seabed and benthic habitats;
- reduced air quality from atmospheric emissions as a result of operation of machinery and use of internal combustion engines;
- introduction of invasive marine species as a result of ballast water discharge and vessel biological fouling;
- marine pollution from routine discharges including sewage water, bilge water and other solid wastes;
- marine pollution from accidental discharges including hydrocarbon spills and hazardous materials;
- disturbance to social and community values due to interactions with commercial fishing vessels and shipping; and
- disturbance to heritage and conservation values due to operation of vessels within, or in the vicinity of, protected areas.

The environmental aspects of the Three Bears MC3D MSS that have the potential to cause significant environmental effects have been determined through an evaluation of the proposed activity, the surrounding environment including specific sensitivities and values, and legislative requirements. These environmental aspects are:

- accidental discharge of hazardous materials;
- accidental fuel and oil spills from the survey and support vessels; and
- vessel collisions, resulting in fuel and oil spills and/or damage to benthic habitats.

Implemented control measures documented in **Table 2** ensures that the environmental risks associated with these impacts are maintained at ALARP levels, while maintaining economic viability for the proposed activity. These control measures are taken into consideration in calculating the residual risk associated with the potential environmental impacts.

MANAGEMENT APPROACH

The design and execution of the proposed Three Bears MC3D MSS will be conducted under the framework of the TGS Environmental Policy, TGS Health, Safety and Environmental (HSE) Management System, and the survey vessel operator (PGS Geophysical) HSE&Q Management System. The seismic programme will be supported by a project-specific HSE Plan (that includes Emergency Response (ER) procedures), PGS's Emergency Response Procedures, and a TGS Emergency Preparedness Bridging Document (incorporated within the HSE Plan). To ensure TGS's environmental objectives and management standards are achieved, the survey vessel operator (PGS Geophysical) will be required to comply with all relevant requirements of TGS's HSE systems/policies and standards.

TGS and its seismic contractor (the survey vessel operator) will apply a tiered approach to optimising the environmental performance of the project and ensuring that its environmental standards and performance objectives are achieved. The approach involves identification of local and regional environmental sensitivities, prioritisation of risks, determination of appropriate practices and procedures to reduce those risks, and clear designation of roles and responsibilities for implementation.

Under the framework of the HSE and ER documentation discussed above, a series of procedures for vessel and seismic operations, and plans will be used for the Three Bears MC3D survey to ensure that appropriate management measures are applied as required to minimise the risk of environmental disturbance from operations. The work instructions, procedures and plans are documented within corporate systems/manuals developed by PGS, as well as documents written specifically for the proposed survey.

TGS is responsible for ensuring that the proposed Three Bears MC3D MSS is managed in accordance with the Implementation Strategy and the TGS HSE Management System.

Given the control measures that will be implemented for all environmental aspects of the survey, the risk of significant adverse environmental effects from the proposed Three Bears MC3D MSS has been assessed as low for all aspects, apart from discharge of hazardous materials, fuel and oil spills and vessel collisions, which have been assessed as medium.

The implementation of specific whale monitoring and encounter procedures will be used to minimise the potential for any adverse effects to whales. These procedures comply fully with the Australian Commonwealth Government Guidelines: *EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales* (September 2008).

Two dedicated, expert Marine Fauna Observers (MFOs) will be aboard the *Ramform Sterling* for duration of the Three Bears MC3D survey. The key role of the MFOs will be to visually monitor the waters around the survey vessel for the presence of cetaceans during daylight hours. The MFOs will be responsible for recording any cetacean sightings during the survey on the appropriate sightings forms, using the 'Cetacean Sightings Application' software provided by the Australian Marine Mammal Centre (AMMC) at the Australian Antarctic Division. Sighting records will be sent to the TGS Environmental Adviser by the Client Representative, and reported to the AMMC. The MFOs will also be responsible for ensuring that the interaction procedures are implemented and followed correctly during survey activities.

The survey will be conducted in water depths of ~490 to 945 m away from any shallow water habitat areas that may be important for turtle feeding. The survey area is located at least 69 km away from any beaches and adjacent shallow waters that are important for turtle nesting, hatching and breeding. The survey area is not located close to any locations important for seabird breeding.

The survey is unlikely to have any significant effects on benthic communities due to the water depths across the survey area (~490 to 945 m). Anchoring of the survey or support vessel will only occur in emergency circumstances and both vessels are fitted with highly sophisticated position fixing equipment. No at sea refuelling of the *Ramform Sterling* will take place during the Three Bears MC3D survey.

CONSULTATION PLAN

Consultation with stakeholder groups concerning TGS's proposed Three Bears MC3D MSS has taken place, primarily within the commercial fishing industry, during the preparation of the Environment Plan, and prior to the commencement of the survey. The following organisations have been contacted and informed of the proposed operations:

- A Raptis and Sons
- Austral Fisheries Pty Ltd
- Australian Fisheries Management Authority (AFMA)
- Australian Hydrographic Service (AHS)
- Australian Maritime Safety Authority (AMSA)
- Border Protection Command (BPC)
- Centre for Whale Research (CWR)
- Commonwealth Fisheries Association (CFA)
- Department of Broadband, Communications and the Digital Economy (DBCDE)
- Department of Defence (Directorate of Property Acquisition, Mining and Native Title)
- Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC)
- Geoscience Australia (GA)
- MG Kailis
- National Native Title Tribunal (NNTT)
- Northern Fishing Companies Association (NFCA)
- Shark Bay Seafoods
- TunaWest
- WA Department of Fisheries (DoF)
- WA Department of Mines and Petroleum (DMP)
- WA Department of Transport
- WA Fishing Industry Council (WAFIC)
- WestMore Seafoods

Consultation with all of the stakeholders listed above, plus any others identified during the consultation process, will continue during and after the survey, if necessary.

Table 2: Summary of environmental risks and management approach for key aspects of the Three Bears MC3D MSS

Impact category	Potential impacts	Control and mitigation measures	Residual risk level
Disturbance to marine fauna	<p>Cetaceans - behavioural reactions (avoidance, diving, increased dive times)</p> <p>Disturbance to marine turtles, fish communities, and seabirds</p>	<ul style="list-style-type: none"> • Adherence to EPBC Act Policy Statement 2.1 and the following additional mitigation measures: <ul style="list-style-type: none"> ➢ precaution zones (observation zone: 3 km+; low power zone: 2 km; and shutdown zone: 500 m) ➢ two dedicated MFOs on survey vessel ➢ application of vessel-whale interaction procedures for non-acoustic energy source operations • Detailed reports of all cetacean sightings will be recorded using the DSEWPaC Cetacean Sightings Application • External lighting of vessels will be minimized to that required for navigation, vessel safety and safety of deck operations, except in the case of emergency • Survey will be conducted in water depths of ~490 to 945 m away from any shallow water habitat areas important for turtle feeding • Survey area is located at least 69 km away from any beaches and adjacent shallow waters important for turtle nesting, hatching and breeding • Survey area is not located close to any locations important for seabird breeding • Survey will not be operating over critical habitat for feeding, spawning, breeding or migrating fish populations 	Low
Disturbance to benthic habitats	Small localised disturbance to epibiota in event of loss of equipment	<ul style="list-style-type: none"> • Survey will be conducted in water depths of ~490 to 945 m away from any shallow water areas • No anchoring of the either survey or support vessel will take place during survey unless in an emergency • All reasonable efforts taken to retrieve lost equipment • Recording and reporting of all items lost overboard 	Low
Introduction of invasive marine species	Introduction and establishment of invasive marine species with consequent impacts on benthic communities, fisheries etc.	<ul style="list-style-type: none"> • Vessels required for the proposed activity will not discharge ballast water • Adherence the Australian Ballast Water Management Requirements, if necessary • Both the survey and support vessels will have all the necessary AQIS clearances to operate unrestricted anywhere in Australian waters 	Low
Marine pollution from routine discharges	Localised temporary decrease in ambient water quality from discharge of sewage, grey water, putrescible wastes and bilge water	<ul style="list-style-type: none"> • All sewage and putrescible wastes will be handled and disposed of in accordance with MARPOL Annex IV • Discharge of sewage and putrescibles waste will be of short duration with high dispersion and biodegradability • Sewage and putrescible wastes macerated where possible prior to disposal • All sewage and putrescible waste treatment systems and holding tanks are to be fully operational prior to survey commencement • Relevant discharge requirements for treated and untreated sewage are adhered to (>3 nm from land for treated sewage; >12 nm from land for untreated sewage) 	Low

Impact category	Potential impacts	Control and mitigation measures	Residual risk level
Marine pollution from accidental discharges	Acute toxicity effects on marine fauna, such as marine turtles, fishes and seabirds, from accidental discharges of hazardous materials	<ul style="list-style-type: none"> • Harmful Packaged Substances handled and disposed of in accordance with MARPOL Annex V • Garbage Management Plan in place detailing wastes generated and disposal requirements • No discharge of plastics or plastic products of any kind from vessels • All solid, liquid and hazardous wastes (other than sewage, grey water and putrescible wastes) will be incinerated or compacted (if possible) and stored in designated areas and sent ashore for recycling, disposal or treatment • Correct segregation of solid and hazardous wastes • Incinerators used are compliant with MARPOL and IMO requirements • All storage facilities and handling equipment will be in good working order and designed in such a way as to prevent and contain any spillage as far as practicable • Bilge water will be treated and disposed of in accordance with MARPOL Annex I 	Medium
	Acute toxicity effects on marine fauna from fuel and oil spills	<ul style="list-style-type: none"> • Survey and support vessels will comply with MARPOL Annex I requirements to prevent oil pollution (e.g. SOPEP implemented and tested for survey vessel) • Spill response bins/kits located in close proximity to hydrocarbon storage areas and replenished if required • Identified personnel trained in the use of the equipment • Hydrocarbons located above deck will be stored with some form of secondary containment to contain leaks or spills • No at sea refuelling will take place during the Three Bears MC3D survey 	Medium
Interaction with commercial fisheries and shipping activities	<p>Interference to commercial fishing vessels and shipping operating within or near the survey area and surrounding waters</p> <p>Potential direct and indirect noise impacts on target species</p> <p>Restriction of access to fishing grounds, loss or damage to fishing gear</p>	<ul style="list-style-type: none"> • Notification of activity details as required to relevant commercial fisheries management agencies, fishing industry bodies and individual companies • Consultation with AMSA prior to the survey commencing • Use of a support vessel to manage vessel interactions • Use of standard maritime safety procedures (Notice To Mariners (NTM) via the Australian Hydrographic Service; radio contact, display of appropriate navigational beacons and lights) • Compliance with AMSA administered marine safety regulations and marine notification requirements • Strict adherence to equipment handling and acquisition procedures • Fishermen and other mariners alerted of vessels presence and extent of towed array • Establishment of a vessel exclusion zone around the survey vessel • Where possible in-water equipment lost will be recovered • Detailed records of equipment lost overboard will be maintained 	Low

FURTHER DETAILS

For further information about the proposed TGS Three Bears MC3D MSS in the Carnarvon Basin on the North West Shelf offshore from Western Australia, please contact:

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