DAVROS MULTICLIENT 3D MARINE SEISMIC SURVEY

ENVIRONMENT PLAN: PUBLIC SUMMARY

CGG Services (Australia) Pty Ltd

Revision 2

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Table of Contents

1. INTRODUCTION 1
1.1. ASSESSMENT 1
1.2. COORDINATES OF THE PROPOSED ACTIVITY 3
1.3. LOCATION OF THE ACTIVITY 4

2. DESCRIPTION OF THE RECEIVING ENVIRONMENT 5
2.1. REGIONAL SETTING 5
2.1.1. Climate and Meteorology 5
2.1.2. Oceanography 5
2.2. PHYSICAL ENVIRONMENT 6
2.2.1. Geomorphology and Sedimentology 6
2.3. Biological Environment 7
2.3.1. Productivity and Plankton Communities 7
2.3.2. Biological Communities 7
2.3.3. Protected Marine Fauna 8
2.4. Socio-Economic Environment 12
2.4.1. Commercial Fisheries 12
2.4.2. Recreational Fisheries 18
2.4.3. Petroleum Exploration 18
2.4.4. Commercial Shipping 19
2.4.5. Tourism and Recreation 19
2.4.6. Cultural Heritage 19
2.4.7. National Heritage 19
2.4.8. Marine Parks and Reserves 19
2.4.9. Other Protected Areas 20
2.4.10. Defence Activities 20

3. DESCRIPTION OF THE ACTIVITY 21
4. DETAILS OF ENVIRONMENTAL IMPACTS AND RISKS 23
4.1. Key Risk Assessment Methodology 23
4.2. Identification of Risks and Impacts 25
4.2.1. Environmental Aspects 25
4.2.2. Environmental Impacts 26
4.3. Assessment of Impacts and Risks 26
4.3.1. DISTURBANCE TO MARINE FAUNA 27
4.3.2. DISTURBANCE TO BENTHIC HABITATS 42
4.3.3. REDUCED AIR QUALITY FROM ATMOSPHERIC EMISSIONS 43
4.3.4. INTRODUCTION OF INVASIVE MARINE SPECIES 43
4.3.5. MARINE POLLUTION FROM ROUTINE DISCHARGES 45
4.3.6. MARINE POLLUTION FROM ACCIDENTAL DISCHARGES 47
4.3.7. DISTURBANCE TO SOCIAL AND COMMUNITY VALUES 55
4.3.8. Summary of environment risk assessment for the Davros MC3D survey 57
4.4. Implementation Strategy 60
4.4.1. Environmental Management Framework 60
4.4.2. Management Strategies 61
4.4.3. ALARP Demonstration 61
4.4.4. Demonstration of Acceptability 64

5. SUMMARY OF THE CONTROL MEASURES FOR THE ACTIVITY 66
6. SUMMARY OF THE ARRANGEMENTS FOR ONGOING MONITORING OF THE TITLEHOLDERS ENVIRONMENTAL PERFORMANCE 76

7. SUMMARY OF THE RESPONSE ARRANGEMENTS IN THE OIL POLLUTION EMERGENCY PLAN 77
7.1. Oil Spill Emergency Plan 77
7.2. Vessel SOPEP 77
7.3. Emergency Response Arrangements 77
7.3.1. Commonwealth Waters 78
7.3.2. State Waters 78
7.3.3. Type I Operational Monitoring 78
7.3.4. Type II Scientific Monitoring 79
7.3.5. Reporting 80
8. DETAILS OF CONSULTATION ALREADY UNDERTAKEN, AND PLANS FOR ONGOING CONSULTATION 81
8.1. Consultation Plan 81
8.2. Details of Consultation undertaken 81
8.3. Phase 2 – Ongoing Consultation and Phase 3 – Post Survey Notification 82
8.4. Merits of the Stakeholder Objections and Claims 82
9. DETAILS OF THE TITLEHOLDERS NOMINATED PERSON FOR THE ACTIVITY 87

LIST OF FIGURES

Figure 1.1- Location map – Davros MC3D marine seismic survey 4
Figure 2.1– Humpback whale migratory routes past the survey area. 10
Figure 2.2 - Tracks obtained in 2009 from 17 satellite-tagged humpback whales 10
Figure 2.3 - Demersal scalefish fisheries of the Pilbara region of Western Australia. Areas 1 to 6 14
Figure 2.4 - Distribution of P. maxima oysters in WA 15
Figure 2.5 - The Pearl Oyster Fishery fishing zones in WA 16
Figure 2.6 - Principal fishing areas for the Pearl Oyster Fishery and distribution of Pearl Oysters abundance 16
Figure 2.7 - Area fished in the North West Slope Trawl Fishery, 2011–12 17
Figure 3.1 - Shallow water zone around the Montebello Islands 22
Figure 4.1 - Key steps used for risk assessment 23
Figure 4.2 - Risk related decision support framework 62

LIST OF TABLES

Table 1.1 - Davros MC3D MSS area – boundary coordinates 3
Table 4.1 - Definitions for qualitative assessment of likelihood and environmental effects 24
Table 4.2 - Generic environmental risk assessment matrix 25
Table 4.3 - Summary of environment risk assessment for the Davros MC3D survey 58
Table 4.4 - Decision making tools and protocols 62
Table 4.5 - Hierarchy of Controls 64
Table 4.6 - Acceptability test 64
Table 5.1 - Summary of the control and mitigation and management measures for key aspects of the Davros MC3D MSS 66
Table 5.2 - Assessment of the additional control measures for ‘Medium’ Residual Risk Level 75

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1. INTRODUCTION

The geophysical company CGG Multiclient and New Ventures (CGG) proposes to acquire a multi-client three-dimensional (MC3D) marine seismic survey (MSS) off the North West Shelf (NWS) offshore from Western Australia (WA). The Davros MC3D MSS will comprise of acquisition of approximately (~) 11,056 km^2 of 3D seismic data, in Exploration Permits Exploration Permits W13-10, W13-11, W13-12, W13-13, W14-14, W14-20, WA-001-P, WA-191-P, WA-192-P, WA-202-P, WA-208-P, WA-209-P, WA-323-P, WA-330-P, WA-356-P, WA-452-P, WA-457-P, WA-458-P, WA-467-P, Retention Leases WA-007-R, WA-038-R, WA-045-R, WA-046-R, WA-047-R, WA-048-R, WA-052-R and Production Licences WA-003-L OI-L WA-008-L, WA-014-L, WA-015-L, WA-020-L, WA-026-L, WA-027-L, WA-041-L, WA-054-L, and adjacent open acreage areas.

This summary of the Environment Plan (EP) for the CGG Davros MC3D marine seismic survey (MSS), which will be acquired in the Carnarvon Basin offshore from Western Australia (WA), has been submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA), to comply with Regulations 11(3) and 11(4) of the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009.

The commencement date of the Davros MC3D MSS is yet to be finalised, CGG plans to commence the Davros MC3D MS survey no earlier than Q2 2014, however this is subject to availability of the survey vessel for conducting the survey, client data requirements, fair sea state conditions suitable for marine seismic acquisition, and granting of approvals from the appropriate government bodies. The Davros MC3D MSS is expected to extend for a total duration of ~9 months and this period is for acquisition of the entire survey program, but may be conducted in phases depending on weather and vessel availability.

1.1. ASSESSMENT

The EPBC Act is administered by the Department of Environment (DoE). The EPBC Act protects matters of national environmental significance (NES) in relation to Commonwealth actions and actions on (or impacting upon) Commonwealth land or waters.

Prior to 28 February 2014, petroleum and greenhouse gas activities in Commonwealth waters that were likely to impact on matters of NES were subject to regulation under both the OPGGS Act and the EPBC Act. As part of the Commonwealth's Governments strategy for streamlining of offshore petroleum environmental approvals, from 28 February 2014 (when the amended OPGGS (Environment) Regulations commenced), NOPSEMA is now the sole regulator of environmental approvals for offshore petroleum activities in Commonwealth waters. Therefore, the EPBC referral process will not be applicable to this project and NOPSEMA has the role to assess whether matters of NES are potentially being impacted upon.

CGG will apply the requirements of the Australian Commonwealth Government Guidelines: *EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales*, and will also continue to utilise marine fauna observers (MFO) to ensure effective implementation of Part A Standard Management Procedures and gathering of accurate sightings data. In addition Part B Additional Management Procedures will be implemented during migration periods of sensitive marine species.

The Davros MC3D MSS was referred to the DoE on 10 December 2013 (EPBC Reference Number 2013/7092) and was assessed as "not a controlled action if undertaken in a particular manner" – i.e. the action, as proposed, did not require approval under the EPBC Act. The following conditions have been incorporated into this EP:

1. Part A, Standard Management Procedures of the *EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales* (September 2008), using the 2 km low power zone, must be implemented during all **seismic operations** to minimise impacts to **whales**.

2. The following additional management measures, as identified in Part B of *the EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales* (September 2008), must be implemented to minimise impacts to Humpback Whales (*Megaptera novaeangliae*).
    a. From **1 June to 30 November**: two dedicated **Marine Fauna Observers (MFOs)** must be onboard the seismic vessel during **seismic operations**; and at least one **MFO** must be observing for Humpback Whales during **daylight hours**.
    b. If the survey is required to **power down** 3 or more times per **day** for 3 consecutive days as a result of sighting Humpback Whales, then the **seismic operations** must not be undertaken thereafter at **night-time** or during **low visibility** conditions. **Seismic operations** cannot resume at **night-time** or during **low visibility** conditions until there has been a 24-hour period, which included **seismic operations** during good visibility conditions, during which no power downs have occurred for Humpback Whale sightings.
3. The following management measures must be implemented during all **seismic operations** during the period from 1 August to 31 October to minimise impacts to the Whale Shark (*Rhincodon typus*).
    a. At least one of the MFOs identified in particular manner 2(a) must be observing for Whale Sharks, in addition to observing for Humpback Whales, during **daylight hours**.
    b. If Whale Sharks are observed within 500 m of the seismic source, Part A, Standard Management Procedures of the *EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales* (September 2008), using the 500 m observation, low power and shutdown zone, must be implemented in the same manner as for **whales**.
4. **Seismic operations** must not occur within the 'Biologically Important Areas' for the Green Turtle (*Chelonia mydas*), Hawksbill Turtle (*Eretmochelys imbricata*) and Loggerhead Turtle (*Caretta caretta*), during the peak nesting period for these species between **1 October to 28 February.**
5. **Seismic operations** must not occur within the 'Biologically Important Area' for the Flatback Turtle (*Natator depressus*) during the peak nesting period between **1 December and 31 January.**
6. To minimise potential cumulative impacts to Humpback Whales, during the period from **1 June to 30 November**, a buffer distance of at least 50 kilometres must be maintained between the survey vessel that is conducting **Seismic Operations** for this action and the survey vessel that is conducting **Seismic Operations** for the Stag 4D and Reindeer 3D Multi-Azimuth Marine Seismic Survey (EPBC 2013/7080).

The survey will be carried out in accordance with the specific temporal and spatial restrictions on acquisition, and with all other particular manner conditions specified in the Decision Instrument, Particular Manner Conditions (EPBC 2013/7092).

1.2. COORDINATES OF THE PROPOSED ACTIVITY

Boundary coordinates for the ~11,056 km^2 survey area (see **Figure 1.1**) are as follows.

Table 1.1 - Davros MC3D MSS area – boundary coordinates

Latitude (S)	Longitude (E)	Latitude (S)	Longitude (E)	Latitude (S)	Longitude (E)
Decimal Degrees	Decimal Degrees	Decimal Degrees	Decimal Degrees	Decimal Degrees	Decimal Degrees
-19.83201	116.00132	-20.33657	115.60277	-20.29286	115.49575
-19.83201	116.25131	-20.33645	115.60263	-20.29319	115.49381
-19.74867	116.25132	-20.33526	115.60107	-20.29359	115.49188
-19.74867	116.33465	-20.33412	115.59947	-20.29406	115.48996
-19.66534	116.33465	-20.33304	115.59783	-20.29459	115.48807
-19.66534	116.50131	-20.33201	115.59614	-20.29519	115.48620
-19.58201	116.50131	-20.33105	115.59441	-20.29586	115.48435
-19.58200	116.75131	-20.33015	115.59265	-20.29658	115.48253
-19.58200	116.83464	-20.32931	115.59085	-20.29738	115.48074
-19.58200	116.91798	-20.32854	115.58902	-20.29823	115.47898
-19.49867	116.83465	-20.32784	115.58716	-20.29915	115.47726
-19.49867	116.75131	-20.32720	115.58527	-20.29972	115.47627
-19.33200	116.75131	-20.32702	115.58467	-20.30239	115.47007
-19.33200	116.50131	-20.32662	115.58336	-20.30298	115.46915
-19.08200	116.50131	-20.32612	115.58142	-20.30382	115.46761
-19.08200	116.91798	-20.32569	115.57947	-20.30471	115.46610
-19.16534	116.91798	-20.32543	115.57809	-20.30565	115.46463
-19.16502	117.08433	-20.32539	115.57791	-20.30669	115.46297
-19.24867	117.08464	-20.32538	115.57780	-20.30779	115.46136
-19.49867	117.08465	-20.32532	115.57750	-20.30894	115.45979
-19.49867	117.00131	-20.32503	115.57552	-20.31015	115.45827
-19.58200	117.00131	-20.32480	115.57353	-20.31141	115.45680
-19.58200	116.91798	-20.32465	115.57153	-20.31272	115.45538
-19.66533	116.91798	-20.32457	115.56953	-20.31408	115.45401
-19.66533	116.83464	-20.32342	115.56817	-20.31549	115.45270
-19.74867	116.83464	-20.32231	115.56677	-20.31695	115.45144
-19.74867	116.75131	-20.32128	115.56537	-20.31844	115.45024
-19.83200	116.75131	-20.32014	115.56373	-20.31998	115.44911
-19.83200	116.66798	-20.31908	115.56209	-20.32156	115.44803
-19.99866	116.66798	-20.31825	115.56070	-20.32317	115.44702
-19.99866	116.58464	-20.31401	115.55749	-20.32482	115.44607
-20.08200	116.58464	-20.30776	115.55099	-20.32650	115.44519
-20.40542	116.26343	-20.30268	115.54344	-20.32821	115.44437
-20.38532	116.00134	-20.29891	115.53507	-20.32995	115.44363
-20.38158	115.95327	-20.29799	115.53262	-20.33202	115.44284
-20.35569	115.62500	-20.29687	115.52863	-20.33202	115.41797
-20.35522	115.61919	-20.29578	115.52643	-20.33202	115.08464
-20.35014	115.61465	-20.29429	115.52149	-20.24869	115.08466
-20.34876	115.61379	-20.29335	115.51716	-20.24869	115.16799
-20.34727	115.61279	-20.29305	115.51380	-20.16536	115.16798
-20.34581	115.61174	-20.29298	115.51346	-20.16536	115.25131
-20.34439	115.61063	-20.29270	115.51151	-19.99869	115.25132
-20.34301	115.60947	-20.29247	115.50955	-19.99868	115.41798
-20.34293	115.60940	-20.29232	115.50758	-19.91535	115.41799
-20.34166	115.60825	-20.29224	115.50560	-19.91535	115.58465
-20.34036	115.60699	-20.29223	115.50362	-19.91535	115.83465
-20.33948	115.60608	-20.29228	115.50165	-19.83201	115.83465
-20.33900	115.60559	-20.29241	115.49968	-19.83201	115.91798
-20.33770	115.60414	-20.29260	115.49771		

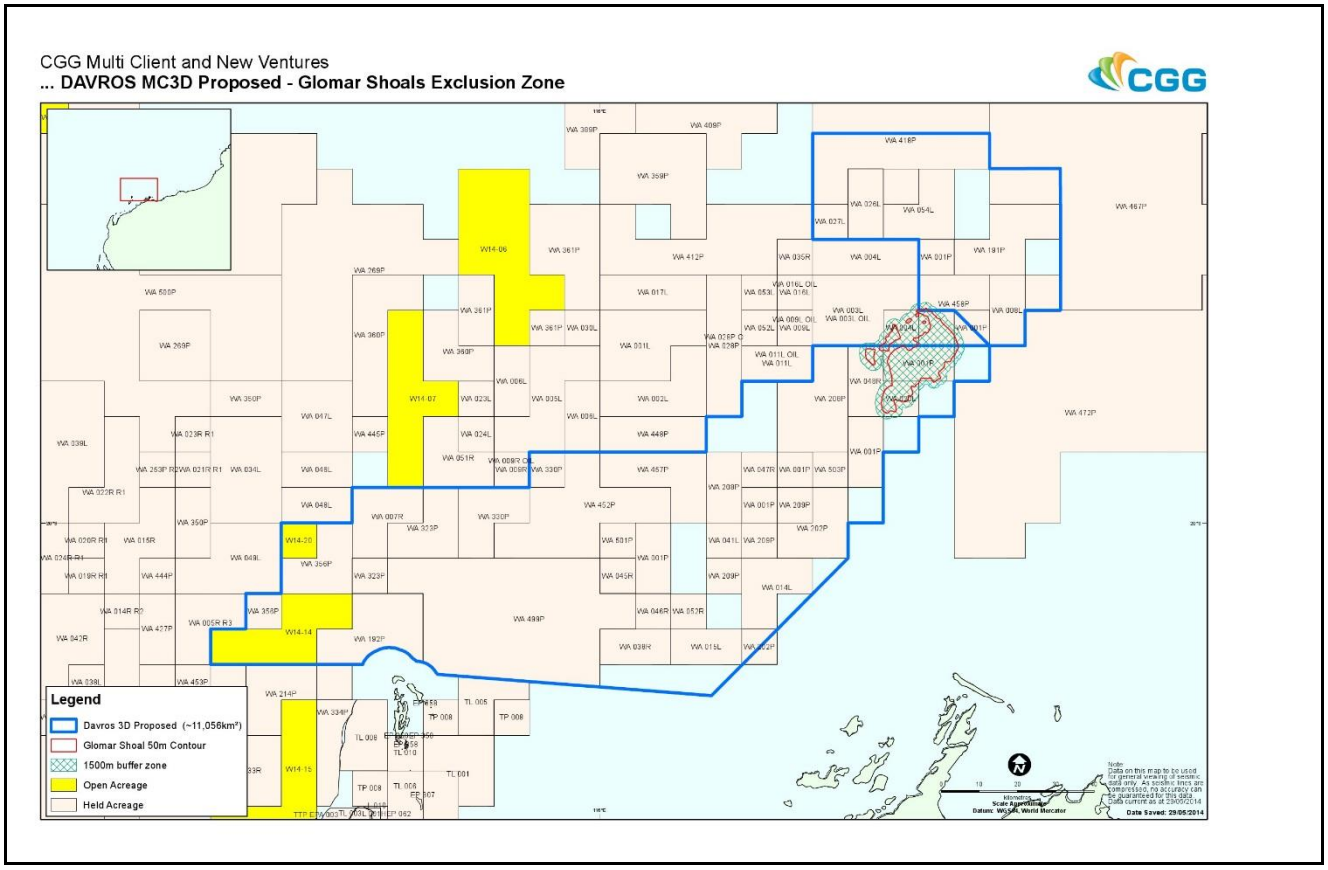
Datum: WGS84

1.3. LOCATION OF THE ACTIVITY

The Davros MC3D survey area is located ~52 km northwest of Dampier and the north-eastern corner of the survey area is located ~212 km northwest of Port Hedland. Legendre Island in the Dampier Archipelago is ~40 km to the east of the survey area. The southwest margin is located ~6 km north of Trimouille Island (in the Montebello Island group) and ~38 km north of Barrow Island. The Argo Rowley Commonwealth Marine Reserve is located ~147 km to the north of the survey area. The Glomar Shoals are within the northern section of the survey area. The survey area overlaps the multiple use zone (MUZ) of the Montebello Commonwealth Marine Reserve.

Water depths across the survey area range from ~20 m to ~300 m, with the deepest water depths situated in the northeast section of the survey area, correlating with the Ancient Coastline feature at the 125 m depth contour.

Figure 1.1- Location map – Davros MC3D marine seismic survey



2. DESCRIPTION OF THE RECEIVING ENVIRONMENT

In accordance with Regulation 13(2) of the Environment Regulations, a description of the existing environment that may potentially be affected by planned and unplanned activities relating to the Davros MC3D MSS survey area is presented in this section. It includes a description of relevant natural, cultural and socio-economic aspects of the environment, as well as details of relevant values and sensitivities.

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

2.1. REGIONAL SETTING

The Davros MC3D survey area lies entirely in Commonwealth marine waters in the Northwest Shelf Province of the NWMR. The Northwest Province is located offshore between North West Cape and Cape Bougainville and represents the distribution patterns of marine life in the NWMR at a broad scale encompassing much of the area more commonly known as the North West Shelf (NWS).

The NWMR is divided into three large scale ecological systems based on the influence of primary ecological drivers such as the influence of ocean currents, seafloor features and eco-physical processes. The Davros MC3D survey area lies entirely in the Pilbara system. Within the large scale ecological systems of the NWMR, smaller sub-systems have also been identified. These sub-systems reflect changes in physical and/or biological characteristics that differentiate the (area) sub-system from adjoining areas.

2.1.1. Climate and Meteorology

The NWS is subject to an arid (mainly summer rain) subtropical climate with tropical cyclone activity from November to April. The summer and winter seasons fall into the periods September-March and May-June, respectively. Winters are characterised by clear skies, fine weather and predominantly strong east to southeast winds and infrequent rain. Summer winds are more variable, but west to southwest predominate. Weather is largely controlled by the seasonal oscillation of an anti-cyclonic belt. Three to four cyclones per year can be expected, primarily in the December to March period, though cyclones have been recorded as late as June.

The Northwest Shelf Province (NSP) extends across both State and Commonwealth waters and is located in a transitional climatic region between the dry tropics to the south and the humid tropics to the north. The Pilbara Region is characterised by summer daily temperatures ranging between 20^{o}C and 34^{o}C. During winter, mean daily temperatures range between 17^{o}C and 26^{o}C.

The Northwest or West Monsoons prevail from December to March and are associated with prominent cloud, rain and thunderstorm activity. Annual rainfall is typically low and highly variable. Most intense falls occur during the first half of the ‘wet’ season, where Barrow Island receives an average 320 mm per annum from 25.6 rain days. The region has a very high cyclone incidence and these may occur between December and April.

During the summer months (October–March) the prevailing winds are from the southwest, west and northwest, bringing with them warm, humid air. The southern region of the NWS is characterised by a more arid, subtropical climate. The peak wind speeds are in the range of 15–25 knots but tend to average less than 10 knots. The winter wind (June–August) is characterised by moderate to strong east northeast to southeast winds. These winds result from high-pressure systems which ridge across the Pilbara in winter. April–May and September are the transitional periods when winds are lighter and more variable.

2.1.2. Oceanography

The NWMR is influenced by a complex system of ocean currents that change between seasons and between years, which generally results in the surface waters being warm, nutrient-poor, and of low salinity. The Davros

MC3D survey area is located on the inner continental shelf of the NWS in water depths ranging from ~20 m to ~300 m (see **Figure 1.1**). The deepest water depths are situated in the northwest section of the survey area, correlating with the Ancient Coastline feature at the 125 m depth contour.

The regional oceanography of the NSP bioregion is dominated by the movement of surface currents derived from waters of the Indonesian Throughflow (ITF). Throughflow waters are circulated through the NWMR by branches of the South Equatorial and Eastern Gyral Currents. During winter, when the southern flow of the ITF is greatest, it dominates the water column. During summer when the ITF is weaker, strong winds from the southwest cause intermittent reversals of the currents, which may be associated with occasional weak upwellings of colder, deeper water onto the shelf. The Ningaloo Current is also thought to intrude into the southern part of this bioregion during summer, flowing towards the north as far as Barrow Island.

The region typically receives a persistent swell of around 2m, generated by low-pressure systems in southern latitudes during winter. Although strong easterly winds can also generate 2 m seas. Both swell and seas tend to be smaller during summer. Mean swell heights are low at around 0.4 to 0.6 m in all months of the year. Sea directions run roughly parallel to prevailing wind directions. Hence, in summer, seas typically approach from the west and southwest, while in winter, seas typically approach from the south and east. Mean sea wave heights of less than 1 m with peak heights of less than 2 m are experienced in all months of the year.

Tides are semi-diurnal with a diurnal inequality and are extremely strong. The tidal amplitude is magnified in the NWS area with tidal ranges of 6 m along the Pilbara coast and tides of up to 10 m along the Kimberley coast. Tidal currents mid-shelf attain average speeds of 0.25 knots during neap tides and up to 0.5 knots during spring tides. The mean surface current speeds during the transitional months of April–May are estimated to be of the order of 0.3 m/s.

Ocean currents are semi-diurnal, flowing across the local bathymetry in a southwest/northeast direction parallel to the Pilbara coastline. Swells are predominately from the southwest to west but wind generated waves can develop from any direction, reflecting the regional wind regime in place at the time.

Tropical cyclones generate waves propagating out in a radial direction from the storm centre, and generate swells from any direction, with wave heights between 0.5 and 9.0 m. In the open ocean, sustained winds result in wind-forced currents of approximately 3% of the wind speed. The predicted frequency of swells exceeding 2 m is less than 5%.

2.2. PHYSICAL ENVIRONMENT

2.2.1. Geomorphology and Sedimentology

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

2.2.1.1. Bathymetry

Water depths in most of the survey area range from ~20 m to ~300 m, with the deepest water depths situated in the northwest and the shallowest water depths situated in the southwest corner of the survey area (see **Figure 1.1**). The survey area overlaps two Key Ecological Features (KEF), the 125 m ancient coastline (believed to be an important migratory pathway for cetaceans and other pelagic species such as the whale shark) and the Glomar Shoals (appears to be a particularly important site for fish species within the bioregion.

2.2.1.2. Sedimentology

Sediment differentiation within the NSP occurs on a north-south gradient. South of Broome, sediment texture is relatively homogenous and dominated by sands, with a small proportion of gravels. Mud increases slightly within 100 km of the coast and within 100 km of the shelf break but is mostly absent from areas in between.

There are a number of reefs, islands and shoals in the Pilbara system of the NWMR adjacent to or within the vicinity of the Davros MC3D survey area:

- The Montebello Islands are located ~6 km (Trimouille Island) to the southwest of the southern boundary of the survey area in State waters.
- The Dampier Archipelago is located ~29 km (Rosemary Island) to the east of the eastern boundary of the survey area in State waters.
- Barrow Island is located ~38 km to the south of the southern boundary of the survey area in State waters.
- The Lowendal Islands are located ~32 km to the southeast of the southern boundary of the survey area in State waters.
- Glomar Shoals are located within the northern section of the Davros MC3D survey area.

2.3. BIOLOGICAL ENVIRONMENT

2.3.1. Productivity and Plankton Communities

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

Most of the NWMR species are tropical and are also found in other parts of the Indian and western Pacific oceans. The NWMR contains more coastal and shelf fish species than anywhere else off the Western Australian coast, particularly in the Kimberley and NWS and is home to globally significant populations of internationally threatened species. The NWMR supports internationally important breeding and feeding grounds for a number of threatened and migratory marine species that transit through the bioregion, including humpback whales, which mate and give birth in the waters off the Kimberley coast. Significant turtle rookeries are found on coastal beaches and offshore islands and the surrounding waters provide important resting and internesting (i.e. in between egg laying periods) habitats.

The offshore waters of the NWMR are oligotrophic and planktonic abundances are likely to be low, is characterised by high species diversity but relatively low endemicity. Bentho-pelagic fish (those that occur in water depths of ~200–1,000 m) are a vital link in the trophic systems of the NWMR. As they migrate vertically between the pelagic and benthic (seafloor) systems they consume nutrients and aid the transfer of the nutrients between the two systems. Other processes also transfer nutrients from pelagic systems to benthic systems. For example, many deep water benthic communities are either attached to the seafloor or have limited ranges and are heavily reliant upon nutrients in the form of detritus falling through the water column into the benthic environment.

2.3.2. Biological Communities

The sandy substrates on the shelf within this bioregion are thought to support low density benthic communities of bryozoans, molluscs and echinoids. Sponge communities are also sparsely distributed on the shelf, but are found only in areas of hard substrate. The region between Dampier and Port Hedland has been described as a hotspot for sponge biodiversity. This biodiversity may reflect the tendency of sponge larvae to settle out of the water column very quickly, resulting in minimal larval exchange and high population differentiation between sponge communities. Other benthic and demersal species in this bioregion include sea cucumbers, urchins, prawns and squid. The benthic and pelagic fish communities of the NSP are strongly depth-related, indicative

of a close association between fish communities and benthic habitats. The fish communities are also highly diverse and a number of fish biodiversity hotspots have been identified between Port Hedland and North West Cape.

The Glomar Shoals appear to be a particularly important site for fish species within the bioregion, this is because of increased biological productivity associated with localised upwelling at this location. A number of commercial fish species are caught in high numbers in this area, including Rankin cod, brownstripe snapper, red emperor, crimson snapper and the frypan bream.

The system supports large prawn and crab populations, generally in inshore areas, along with pearl oysters. Other species known within the system include turtles, dugongs and whales (humpback whales aggregate in Exmouth Gulf during their southern migration and pass through the system on their way to and from breeding grounds in the Kimberley.

Sandy beaches provide important habitat for turtle nesting, particularly at Barrow Island, the Montebello Islands, Lowendal Islands, the Dampier Archipelago and the Ningaloo Coast. Between November and March, adult female turtles will lay eggs on the beach above the high tide mark; later in this period hatchlings will emerge from the nests and make their way to the water. Adult females will often wait in near shore water before coming up onto the beach, and may revisit the beach a number of times before exiting onto the beach and laying her eggs.

Mangroves are recognised significant habitats as they are productive coastal forest systems, providing habitat and shelter for birds, fish and other marine species and are important nursery sites for juvenile fish, lobsters and prawns. Significant areas of mangrove are found on the western side of the Cape Range Peninsula (Mangrove Bay), Exmouth Gulf (largely on the southern and eastern shores) and in extensive stretches along many creeks and watercourses of the mainland coast heading north towards Broome. They are also found on the Montebello and Lowendal Islands, along the south-eastern and southern shores of Barrow Island and in sheltered pockets on the offshore islands of the Dampier Archipelago.

2.3.3. Protected Marine Fauna

A review of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) database (Protected Matters search tool) held by the DoE was conducted for the survey area polygon described by the boundary coordinates provided in **Table 1.1**, with the application of a 1 km buffer zone.

The 10 listed Threatened species that may occur, or relate to, the survey area:

1. the southern giant petrel;
2. the blue whale;
3. the humpback whale;
4. the short-nosed sea snake;
5. the loggerhead turtle;
6. the green turtle;
7. the leatherback turtle;
8. the hawksbill turtle;
9. the flatback turtle; and
10. the whale shark.

As indicated by the Protected Matters search the Davros MC3D survey area overlaps two Key Ecological Features (KEF).

1. The Glomar Shoals; and
2. The Ancient Coastline at 125 m Depth Contour.

There are a number of Biologically Important Areas (BIA) (e.g. breeding, nesting, foraging areas) for EPBC Act-listed species of marine fauna that are in the vicinity of the Davros MC3D survey area. The BIA with ranges overlapping the survey area include:

- migration area (north and south) for the humpback whale and pygmy blue whale;
- foraging areas and high density foraging areas for the whale shark;
- foraging, mating, nesting and internesting buffer for the flatback turtle;
- foraging and internesting areas for the green turtle;
- foraging, nesting & internesting areas for the hawksbill turtle and loggerhead turtle; and
- breeding areas for the wedge-tailed shearwater, roseate tern and fairy tern

2.3.3.1. Cetaceans

The EPBC Act database lists 25 cetacean species that may occur in, and adjacent to, the survey area of the Davros MC3D MSS, all of which are protected under the Act; one of which is also classified as Endangered, one as Vulnerable and eight as Migratory. The blue whale is listed as Endangered and Migratory and the humpback whale is listed as Vulnerable and Migratory.

The humpback whale is the most commonly sighted whale in northern Western Australian 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) (see **Figure 2.1**). 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 (see **Figure 2.2**).

The population that winters off Western Australia is known as the Group IV population. Its migration in the region is characterised by three distinct directional phases:

- Northbound phase - starts April, peaks July and tapers off by August. Around the Barrow Island/Montebello Islands area, northerly migrating humpback whale numbers peak during late July/early August, and may extend north to the continental shelf edge at 130 km offshore, generally out to the 200 m depth contour.
- Transitional phase (peak numbers expected at this time) - between late August and early September.
- Southbound phase – usually occurring between late August and early September, although smaller numbers may occur until November (this phase of migration is segmented by 2–3 week delay in appearance of peak numbers of cow/calf pods after the main migratory body has passed). Southerly migration in this area is contracted in a narrower band than the northerly migration route, generally occurring closer to the coast in waters less than 100 m deep (see **Figure 2.1**).

The timing of the proposed Davros MC3D MSS has not yet been determined but is expected to extend for an acquisition duration of ~9 months, and possibly conducted in phases. Therefore, it is possible that the survey will coincide with the migration period (north and/or south) for humpback whales.

Figure 2.1– Humpback whale migratory routes past the survey area.

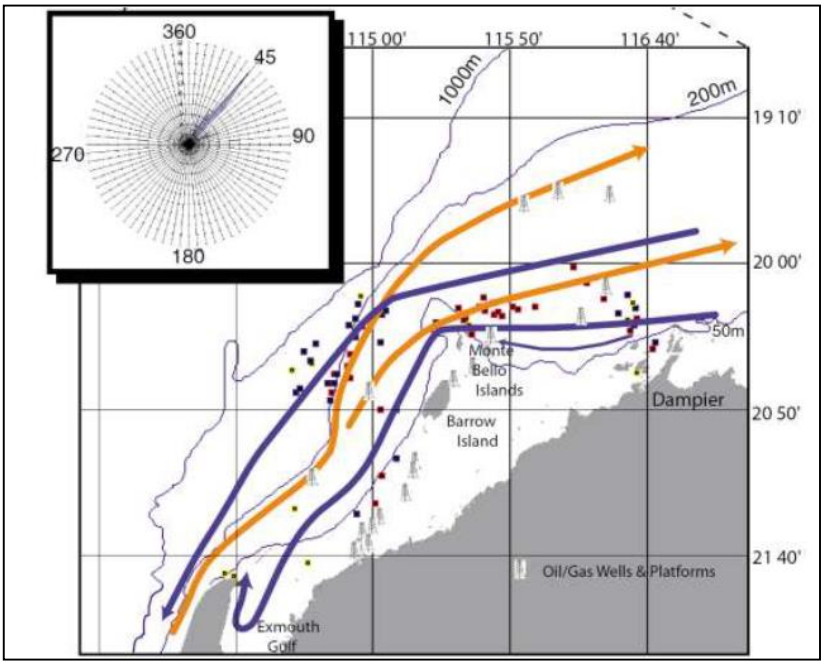
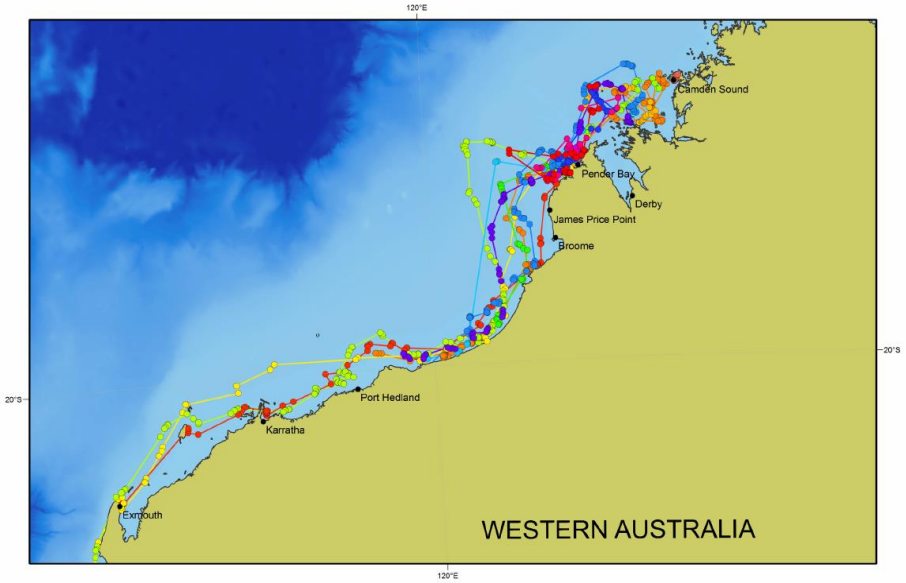


Figure 2.2 - Tracks obtained in 2009 from 17 satellite-tagged humpback whales



Other rare species of whale include the blue whale, which may be present in, or adjacent to, the Davros MC3D survey area as indicated from the EPBC Act database search. The blue whale is rarely present in large numbers outside recognised aggregation areas. Blue whales are believed to calve in tropical waters in winter and births peak in May to June, however the exact breeding grounds of this species are unknown.

In the NWMR, pygmy blue whales (*Balaenoptera musculus brevicauda*) migrate along the 500 m to 1,000 m depth contour on the edge of the slope, and are likely to be feeding on ephemeral krill aggregations. The northbound component of this migration takes place from May to mid-August, with a peak in July–August, and the southbound 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. The northern

boundary of the Davros MC3D survey area is approximately 30 km south of the BIA for pygmy blue whales and the southeastern boundary is approximately 60 km east of the BIA for pygmy blue whales. Although it is possible that pygmy blue whales will be encountered during the Davros MC3D survey it is unlikely that significant numbers of individuals will be encountered due to the water depths in the survey area (~20 m to ~300 m). The majority of animals will be moving north/south in water depths of ~500 m and offshore of the survey area.

The NSP supports several resident populations of common bottlenose dolphins and Indo-Pacific humpback dolphins including around the Montebello Islands and in the bays of the Dampier Peninsula. Roebuck Bay supports a significant population of Australian snubfin dolphins and waters around Browse Island support the highest diversity of cetacean species in Western Australia including large numbers of oceanic dolphins.

2.3.3.2. Dugong

Dugong are a listed Migratory species under the EPBC Act and are protected under Schedule 4 of the WA Wildlife Conservation Act. Dugong occur in Exmouth Gulf, around Barrow Island, in and adjacent to Ningaloo Reef, the Lowendal Islands, Montebello Islands and Shark Bay. They are also known to inhabit coastal waters close to Broome and along the Kimberley coast. It is possible that dugongs may be encountered in the southern portion of the survey area.

2.3.3.3. Marine Reptiles

The PMST identified five species that may occur within or in the waters surrounding the Davros MC3D survey area and include, green, hawksbill and flatback turtles (all listed as Vulnerable and Migratory) and loggerhead turtles (listed as Endangered, and Migratory). The Dampier Archipelago, the Montebello Islands and the Lowendal Islands have been identified as regionally significant rookeries for the hawksbill, green and flatback turtles, and to a lesser extent the loggerhead turtle. The green turtle is common around Barrow Island, while identified rookeries for the flatback turtle include Barrow Island and more north-easterly beaches including those at Cape Thouin, which is located to the east of the Dampier Archipelago.

2.3.3.4. Sharks and Ray-finned Fishes

The whale shark is listed as Vulnerable and Migratory under the EPBC Act and is also classified as Vulnerable on the World Conservation Union's Red List of Threatened Species

There is a general lack of knowledge on many aspects of whale shark biology, including definitive migration patterns. In WA, they are known to aggregate in the reef front waters of Ningaloo Reef from March to July, and northward of the Ningaloo Marine Park along the 200m isobath from July to November, each year with the highest frequency of sightings occurring in April. Whale shark presence coincides with the coral mass spawning period, when there is an abundance of food (krill, planktonic larvae and schools of bait fish) in the waters adjacent to the reef. Estimates of the size of the population participating in the Ningaloo aggregation are between 300 and 500 individuals.

The Davros MC3D survey area does not represent any critically important areas (migration, feeding, breeding areas) for the whale shark. A BIA (foraging area) for the whale shark overlaps the Davros MC3D survey area. Therefore, it is possible that whale sharks will be encountered during the proposed survey although significant numbers of individuals are unlikely.

Other EPBC Act protected marine species that may occur within the survey area include 30 species of pipefishes and five species of seahorses (Family Syngnathidae).

2.3.3.5. Sea Snakes

There are 17 protected species of sea snakes listed as marine species under the EPBC Act that may occur within or adjacent to the survey area. The short-nosed sea snake is also listed as Critically Endangered under the EPBC Act and may be present in the survey area as it has been identified as being present in the region. The olive sea snake is a common inhabitant of the waters around Barrow Island. Given the water depths within

the survey area (~20 m to ~300 m) and proximity to the Montebello Islands (~6 km) it is possible that sea snakes will be encountered during the Davros MC3D MSS.

2.3.3.6. Seabirds and Migratory shorebirds

Four EPBC Act-listed species of seabird may occur in the survey area and surrounding waters: the southern giant petrel (listed as Migratory and Endangered), the lesser crested tern and roseate tern (listed as Migratory), and the osprey (Listed Marine Species). There are no BIA within or adjacent to the Davros MC3D survey area for the southern giant petrel or osprey and although some individuals might be encountered during the survey it is unlikely to be in significant numbers.

Studies suggest that Barrow Island is both a staging site (an area where migrating birds gather and feed before continuing on their migration) and an important non-breeding site for migratory shorebirds. Shorebirds are widely distributed around Barrow Island, which is an internationally significant site for six migratory shorebird species including ruddy turnstones, sanderling, red-necked stint, and grey-tailed tattler. Greater sand plover, and lesser sand plover and two non-migratory species – fairy tern and sooty oystercatcher.

The highest abundances of shorebirds occur on the south eastern and southern coasts of Barrow Island. Many of these species are protected under international treaties (e.g. Japan-Australia Migratory Bird Agreement [JAMBA], China-Australia Migratory Bird Agreement [CAMBA], Republic of Korea – Australia Migratory Bird Agreement [ROKAMBA], and Commonwealth and State Legislation, such as the EPBC ACT and the WA Wildlife Conservation Act.

Serrurier Island (~169 km to the south of the Davros MC3D survey area) and Airlie Island (~115 km to the south) are also important breeding areas for migratory birds including the little tern, Caspian tern, wedge-tailed shearwaters and ospreys.

BIA for the lesser crested and roseate tern is located on the Montebello Islands. There is also BIA for the wedge-tailed shearwater on the islands in the Montebello group.

2.4. SOCIO-ECONOMIC ENVIRONMENT

2.4.1. Commercial Fisheries

The principal commercial fisheries in the NWMR focus on tropical fin fish, particularly the high-value emperors, snappers and cods that are taken by the Northern Demersal trap fisheries. The typical catch is in the order of 3,000 tonnes annually, making these fisheries, at an estimated annual value of around $12 million, the most valuable fin fish sector in the state.

The NWMR has a number of small, limited-entry trawl fisheries for prawns, producing about 700 tonnes annually and valued at around $10 million. There are also significant fisheries for Spanish mackerel, barramundi/threadfin salmon and shark, and a developing fishery for blue swimmer crabs. However, the bioregion is increasingly coming under threat from international poaching, particularly for sharks. A number of fin fish activities, including offshore demersal line fishing and near-shore beach seining and gillnetting, also occur in the region.

State fisheries administered by the Department of Fisheries (DoF) that can operate in the proposed Davros MC3D survey area include the following:

- the Mackerel Managed Fishery (MMF)
- the North Coast Prawns Managed Fishery (NCPMF)
    - Nickol Bay Prawn Limited Entry Fishery (NBPR)
    - Onslow Prawn Limited Entry Fishery (ONPR)
- Pilbara Demersal Scalefish Managed fishery (PDSMF)
    - Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF)

    - Pilbara Trap Managed Fishery (PTMF)
    - Pilbara Line Fishery (PLF)
- the Pearl Oyster Managed Fishery (POMF);
- the Western Australian West Coast Deep Sea Crustacean Managed Fishery (WCDSCF);

Commercial fisheries managed by the Australian Fisheries Management Authority (AFMA) that can operate in the Davros MC3D MSS area include the following:

- the North West Slope Trawl Fishery (NWSTF)
- the Western Skipjack Fishery (WSF);
- the Western Tuna and Billfish Fishery (WTBF); and
- the Southern Bluefin Tuna Fishery (SBTF).

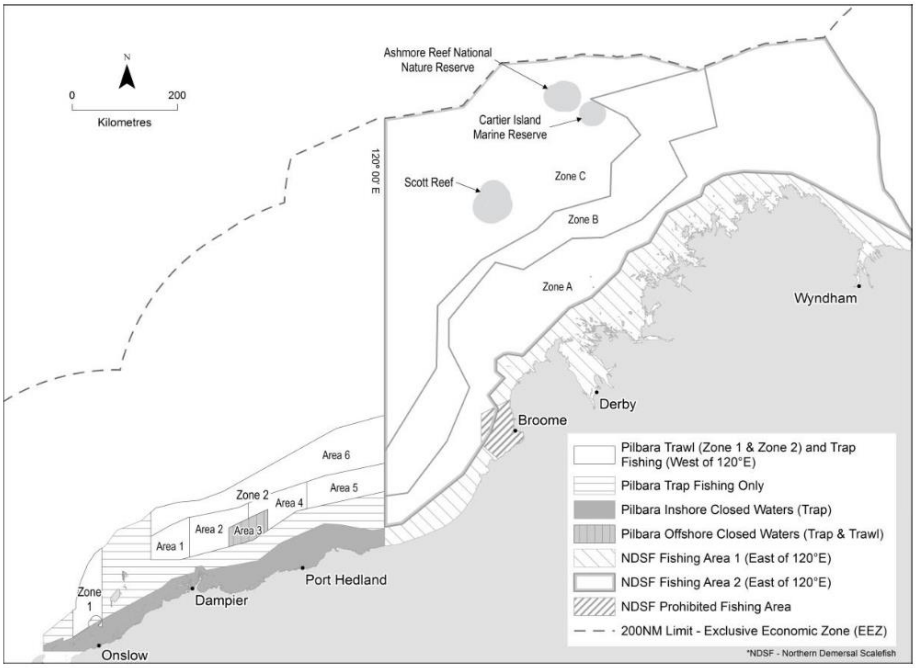
The MMF uses near-surface trolling gear from small vessels in coastal areas around reefs, shoals and headlands to target Spanish mackerel (*Scomberomorus commerson*). Jig fishing is also used to capture grey mackerel (*S. semifasciatus*), with other species from the genera *Scomberomorus, Grammatorcynus* and *Acanthocybium* also contributing to commercial catches. Permit holders may only fish for mackerel by trolling or handline. There are currently 49 licences in the fishery with 15, 15 and 19 licences in Areas 1, 2 and 3 (respectively) with the combined quota allocations being consolidated onto 14 boats operating within the fishery. The majority of catch is taken in Area 1, Kimberley and the reported catch for 2012 was 180.3 t. Catch from Area 2, Pilbara in 2012 was 88.0 t. Area 2 (Pilbara) of the fishery overlaps the Davros MC3D survey area and it is possible fishing operations will occur in the vicinity of the survey area.

The NBPR primarily targets banana prawns (*Penaeus merguiensis*). The NBMF incorporates the Nickol Bay, extended Nickol Bay, Depuch and De Grey size managed fishing grounds, which are confined to the coastal waters of the Pilbara. In 2012, the season extended from 15 March to 22 October with a total catch of 129 t of banana prawns. The northeast corner of the Davros MC3D survey area is located within the NBPMF. The fishing effort is primarily restricted to shallow coastal waters and it is unlikely there will be any interactions between the proposed survey and vessels fishing in the NBPMF.

The ONPR targets western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus* spp.). The fleet is composed of trawlers up to 23 m in length. No commercial trawling occurred by the dedicated Onslow licenced fishing boats therefore, no landings of major penaeids or byproduct for the 2012 season were recorded. The 2012 fishing season extended from 13 April through to the 12 October. The Davros MC3D survey area is located within Area 3 of the ONPR area of operations, and interactions with fishing vessels during the survey may occur. However, no fishing occurred during the 2012 season and due to the fact that fishing effort is confined to the shallow coastal waters along the Pilbara coast, it is unlikely that there will be any overlap between the proposed survey activities in the survey area and vessels fishing in the ONPR.

The Pilbara Demersal Scalefish Fisheries include the Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF), Pilbara Trap Managed Fishery (PTMF), and the Pilbara Line Fishery (PLF). These fisheries collectively use a combination of vessels, effort allocations (time), gear limits, plus spatial zones (including extensive trawl closures) as management measures. Targeted species are tropical, demersal fish species (in order of gross tonnage) and are as follows; goldband snapper (*Pristipomoides\ multidens*), bluespotted emperor (*Lethrinus punctulatus*), red emperor (*L. sebae*), crimson snapper (*L. erythropterus*), saddletail snapper (*L. malabaricus*), Rankin cod (*Epinephelus multinotatus*), brownstripe snapper (*Lutjanus vitta*), rosy threadfin bream (*Nemipterus furcosus*), spangled emperor (*Lethrinus nebulosus*) and frypan snapper (*Argyrops spinifer*). 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. In 2012, ~13 vessels were operating in the PDSF.

Figure 2.3 - Demersal scalefish fisheries of the Pilbara region of Western Australia. Areas 1 to 6



The PFTIMF is situated in the Pilbara region in the north west of Australia. 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 (see **Figure 2.3**). A large amount of the fishery, primarily inshore areas, is closed to fishing. 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). There are 11 permits for the fishery in 2012, with the combined effort allocations being consolidated over time onto three full time vessels and the total commercial landings for the season was 1,312 t. The Davros MC3D survey area overlaps Zone 1 (which is closed to fishing) and Zone 2 (Area 1, 2 & 6) of the PFTIMF. Therefore, it is possible that vessels operating in the PFTIMF could operate in the vicinity of the survey area during the proposed activities.

The PTMF lies north of latitude 21°44'S and between longitudes 114°9.6'E and 120°00'E on the landward side of a boundary approximating the 200 m isobath and seaward of a line generally following the 30 m isobath (see **Figure 2.3**). There are 11 permits for the PTMF, with the combined effort allocations being consolidated over time onto three full time vessels that have no seasonal restrictions. The PTMF catch decreased from 459 t in 2011 to 416 t in 2012. Major species taken by the trap fishery in 2012 were red emperor, crimson snapper, blue-spotted emperor, Rankin cod, goldband snapper and spangled emperor. The Davros MC3D survey area is located almost entirely within the management regions of the PTMF. Therefore, it is possible that vessels operating in the PTMF could lay traps within or adjacent to the survey area during the proposed activities.

The PLF is managed under the *Prohibition on Fishing by Line from Fishing Boats (Pilbara Waters) Order, 2006*. Nine fishing boat licenses are exempted from this prohibition for any nominated 5-month block period within the year. The total annual catch of scalefish taken by the PLF is historically much lower than is taken by the trawl and trap fisheries. In 2012, the total annual catch for the line fishery was historically much lower than that taken annually by the trawl and trap fisheries, the total annual catch was approximately 77 t, which was lower than that taken in 2011, but within the target catch range of 50 - 115 t. In recent years (since ~2006), the line fishery catches have been dominated by ruby snapper and goldband snapper, typically accounting for more than 40% of the total annual catch. In 2012, line fishers reported operating for 328 days, compared with

376 days in 2011. The Davros MC3D survey area is located entirely in the PLF management area. Therefore, line fishing vessels may be encountered during the proposed activities.

The WA pearl oyster fishery is the only remaining significant wild-stock fishery for pearl oysters in the world. It is a quota-based, dive fishery, operating in shallow coastal waters along the NWS. The harvest method is drift diving, in which six to eight divers are attached to large outrigger booms on a vessel and towed slowly over the pearl oyster beds, harvesting legal sized oysters by hand as they are seen. The species targeted is the Indo-Pacific, silver-lipped pearl oyster (*Pinctada maxima*). The Western Australian pearling industry comprises three main components: the collection of pearl oysters from the wild; production of hatchery-reared pearl oysters; and grow-out of pearls on pearl farm leases. Quota limits are set for the take of pearl oysters from the wild to ensure the long-term sustainability of the resource. The Pearl oyster fishery targets *P. maxima* (silver lipped pearl oyster) in Western Australian (WA) waters from Exmouth to the Northern Territory 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 *Pt. fulcata*.

Pinctada 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 (see **Figure 2.4** and **Figure 2.5**). The Department of Fisheries (DoF), Ecologically Sustainability Development (ESD) Report for the Pearl Oyster Fishery in 2006, states that pearl oysters are known to occur in 0 to 50 metres off the coast of WA shown in **Figure 2.6**.

Figure 2.4 - Distribution of P. maxima oysters in WA

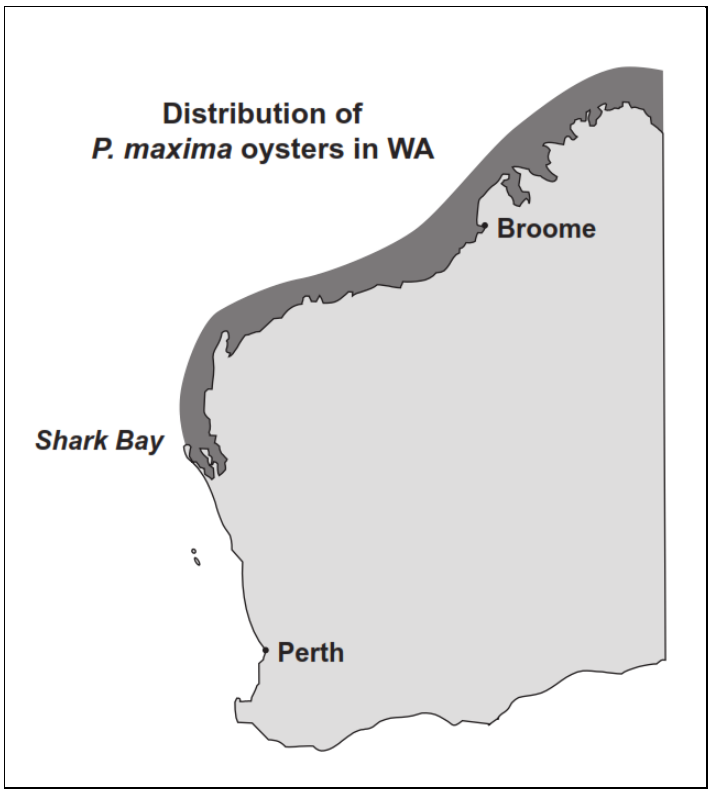


Figure 2.5 - The Pearl Oyster Fishery fishing zones in WA

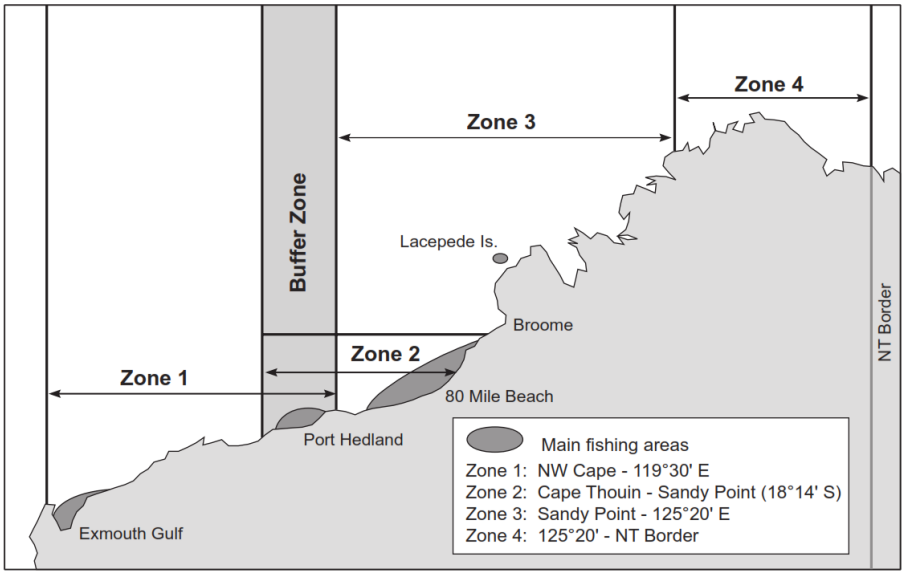
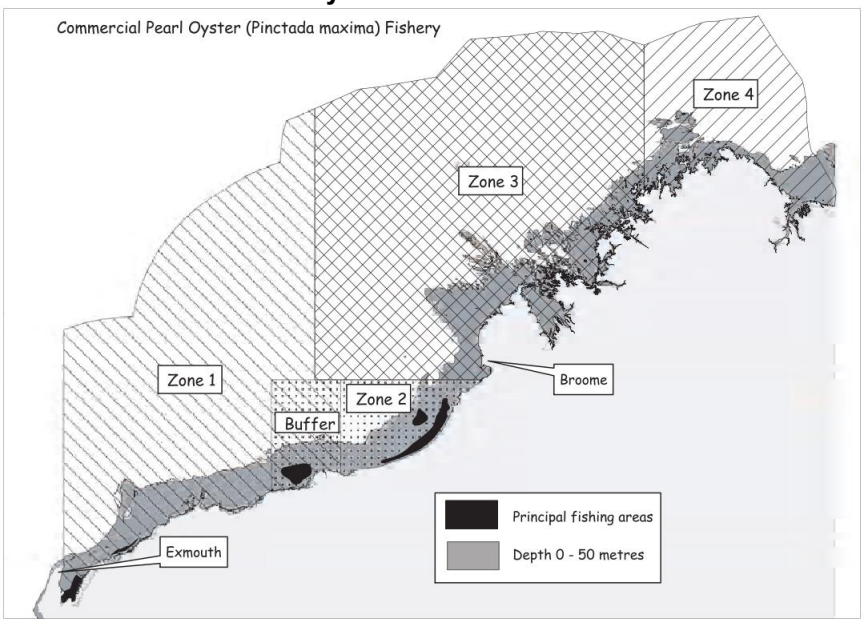


Figure 2.6 - Principal fishing areas for the Pearl Oyster Fishery and distribution of Pearl Oysters abundance



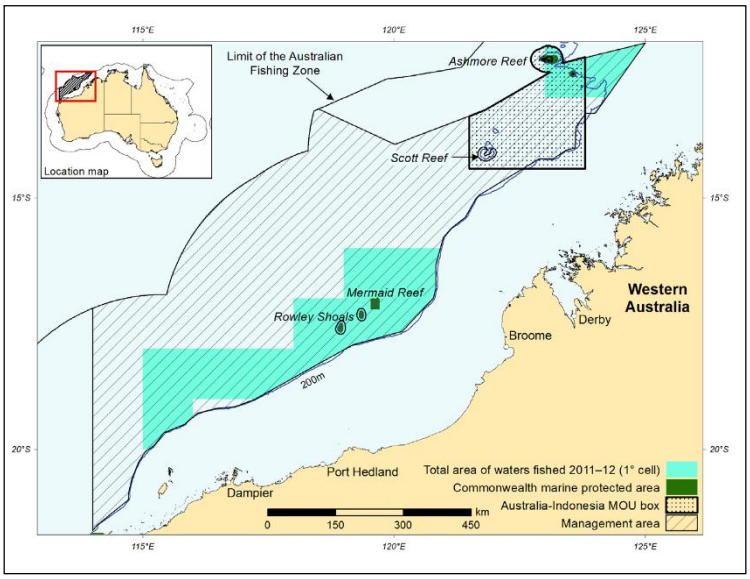
In Western Australia pearl oyster spawning begins from September to October, with peaks from late October to December and February to March, to the autumn months of April and May. There is variability from month to month, the primary spawning occurs from the middle of October to December and a smaller secondary spawning occurs in February and March. The planktonic larvae stage of the pearl oyster is 28 to 35 days, when they are ready to metamorphose they settle to the bottom and test for a suitable habitat. If an appropriate area is found, they settle on it and metamorphose into the juvenile stage. They begin growing a shell and become a sedentary bottom-dweller filter-feeder. If a suitable settlement site is not located within a short period the animals will metamorphose and die.

During the last decade the total number of oysters fished annually from the main fishing grounds of the Pearl Oyster Fishery (Zone 2/3) has remained stable, varying by less than 10% around a mean catch of 476,560 pearl oysters. Generally, pearl divers are not allowed to collect pearl oysters unless they are a minimum size of 120 mm in shell length. However, for the 2012 and 2013 fishing seasons, pearl divers are permitted to take a sustainable amount of pearl oysters of a size no less than 100 mm, on a trial basis, for research purposes. The Davros MC3D survey area is located in Fishing Zone 1 of the POMF (see **Figure 2.6**). There are five licences within this zone. However, no fishing has been undertaken in Zone 1 since 2008 and given that the POMF is a dive fishery operating in shallow coastal waters (<35 m water depth), it is extremely unlikely that there will be any activity in this fishery in the deeper offshore waters of the survey area.

The WCDSCF (Interim) Managed Fishery 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 (>150m) of the West Coast. The WCDSCF is a quota based 'pot' fishery. The fishery mostly operates in depths of 500-800 m, no fishing is permitted in depths <150 m, with the only allowable method for capture being baited pots ('traps'). 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. There are currently seven permits operating in the fishery. Each permit has a 2 tonne limit for giant and champagne crabs combined (annual combined quota of 14 tonnes), while the TAC for crystal crabs (across all permits with crystal crab entitlement) totals 140 tonnes. There were three vessels operating in 2012. The Davros MC3D survey area is located entirely in Zone 1. The northwest corner of the survey area is located in water depths from ~200 m to ~300 m, therefore fishing vessels may be encountered in this area as such water depths are considered "Optimal Fishing Areas" for the WCDSCF.

The NWSTF has traditionally targeted scampi and deep water 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 (see **Figure 2.7**). Recent effort in the fishery has been dominated by a small number of vessels based in WA. Whilst there are seven fishing permits in the NWSTF only one vessel was active in the fishery in 2010-2011, with Australian scampi being the main target. Demersal trawl gear is used in the NWSTF and most of the effort and catch occurs over soft, muddy sediments or sandy habitats, typically at depths of 350–600 m on the continental slope especially to the southwest and northeast of the Rowley Shoals. Some vessels operating in the NWSTF also fish in the Western Deepwater Trawl Fishery (WDTF) and WA State fisheries. The Davros MC3D MSS northern boundary overlaps the NWSTF zone, therefore it is possible that the NWSTF operations may occur within or adjacent to the northern boundary of the survey area.

Figure 2.7 - Area fished in the North West Slope Trawl Fishery, 2011–12



The WSF Commonwealth fishery is not active in continental shelf waters of the NWS. In recent years, activities in the WSF have largely been confined to waters in the GAB and north-east of Eden in New South Wales. No Australian vessels were active in either zone (Western or Eastern) of the WSF during the 2011–12 fishing season.

The Western Tuna and Billfish Fishery (WTBF) primarily targets broadbill swordfish (*Xiphias gladius*) yellowfin tuna (*Thunnus albacares*), bigeye tuna (*T. obesus*) and albacore tuna (*T. alalunga*). In 2012-2011, 95 permits were issued and 3 vessels operated. The majority of catch and effort in the WTBF occurs in Commonwealth waters off the central west coast of WA, with fishing effort in the northwest located north of Broome in the Kimberley, west of Scott Reef with the majority of effort concentrated south of Geraldton (approx. 30°S) and there was no activity at all in the WTBF during the 2010-2011 season. In 2011, 263 t were caught compared to 415 t in 2012.

The Southern Bluefin Tuna Fishery (SBTF) targets juvenile southern bluefin tuna (2–3 years) in the GAB using purse-seine gear, mainly from December to April. These operations are concentrated in shelf and upper slope waters of the eastern GAB, with the maximum fishing intensity in 2012 being concentrated on a relatively small area just north of the shelf break.

2.4.2. Recreational Fisheries

Recreational fishing is experiencing significant growth in the North Coast Bioregion, with a distinct seasonal peak in winter when the local population is swollen by significant numbers of metropolitan and inter-state tourists travelling through the area and visiting, in particular, the Onslow, Dampier Archipelago and Broome sections of the coastline. There are four groups of recreational fishers on the NWS: charter boat operators, land and boat-based anglers, and spearfishing divers. Approximately 2,000 recreational vessels are registered in the Pilbara region. Recreational fishing activities are concentrated around key population centres, with a seasonal peak in activity during the dry season (winter months). The areas of highest recreational fishing activity in the Montebello/Barrow Island Marine Conservation Reserves are reported to be off the north-eastern end of Trimouille Island and in the waters south of the Montebello group and throughout the islands of the Dampier Archipelago. The main demersal scalefish targeted by recreational fishers are nor-west snapper (the *lethrinids*), emperor and coral trout.

In the Pilbara area, there are 13 charter vessels, five of which have commercial fishing boat licenses and target demersal scalefish. The reported charter vessel catches for the north coast bioregion in 2011 were estimated to be approximately 4.5 t of barramundi and less than 1.0 t of threadfin salmon. There is a seasonal peak in activity during the dry season (winter months). Fishing vessels operating in the Charter Boat Industry may also operate in the vicinity of Glomar Shoals, which is (located in the northeast of the survey area) and the Montebello Islands. In addition, there are two premier game fishing tournaments which operate from Exmouth and are held annually in March. These include the Australian International Billfish Tournament and GAMEX. These events target billfish and the event can see competitors fishing at distances of 65 km radius from the Muiron Islands. Due to the timing of the Davros MC3D MSS, (no earlier than Q2 2014) the survey will not overlap the competition held in March 2014.

It is unlikely that recreational fishing vessels or fishing vessels operating in the Charter Boat Industry will operate in the deeper, offshore waters in the vicinity of the Davros MC3D survey area given the distance offshore (~47 km to the mainland coast) and the deep water depths of the majority of the survey area (>100 m). Although, it is possible that they may be encountered within or adjacent to the southwest boundary of the survey area, due to the proximity of the Montebello Islands Marine Park and shallower water depths of <40 m.

2.4.3. Petroleum Exploration

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 the region, plus the drilling of both exploration and appraisal wells. A number of production facilities are located within the NWMR including Floating Production Storage Offshore (FPSO) facilities, manned and unmanned monopods, and

larger production platforms. There are a number of gas pipelines extending from offshore areas to land-based production facilities. There are three offshore production facilities and four pipelines within the survey area.

2.4.4. Commercial Shipping

There are a number of commercial shipping lanes (shipping fairways) that directly overlap the Davros MC3D survey area. AMSA's Nautical Advice section was identified as a stakeholder and contacted regarding the proposed Davros MC3D MSS and subsequently supplied details of the location of shipping fairways that overlap, or are adjacent to the survey area, and vessel traffic for January to February 2014.

2.4.5. Tourism and Recreation

Due to the location of the survey area and the proximity of the Montebello Island Marine Park and shallower water depths of <40 m, recreational activities (such as recreational fishing and marine-based tourism may be undertaken within or adjacent to the southwest boundary of the Davros MC3D survey area.

2.4.6. Cultural Heritage

There are no known indigenous cultural heritage values or issues for the waters and seabed within the Davros MC3D survey area. Similarly, there are no current or pending Native Title Determinations for the waters and seabed within the Davros MC3D survey area. The nearest Native Title Determination (Ngarluma/Yindjibarndi FC No. WAD6017/1996 Tribunal No. WCD2005/001) is located ~22 km to the east of the southeastern corner of the survey area.

The earliest known shipwreck of European origin within Australian waters, the *Trial,* wrecked around 1622 (Shipwreck ID Number 4938) and is located approximately 17 km northwest of North West Island in the Montebello Island group. The *Trial* wreck is located in the southwestern corner of the survey area.

Archival sources suggest that a number of vessels have been lost in the vicinity of the Montebello Islands. These include: the *Wild Wave*, a Chinese brig wrecked in 1873 (Shipwreck ID Number 5113), the sailing vessel the *Vianen* wrecked in 1628 (Shipwreck ID Number 5062), the *Marietta*, believed wrecked in 1905 (Shipwreck ID Number 4457) and the sailing vessel/lugger the *Curlew*, wrecked in 1911 (Shipwreck ID 3925). These shipwrecks lie approximately 35 km to the west of the southwestern boundary of the survey area.

2.4.7. National Heritage

There are no places listed on the Commonwealth Heritage List, there are two places on the Register of National Estate place that overlaps the Davros MC3D MSS area.

- The Dampier Archipelago Marine Areas
- Trial Shipwreck

There is one matter of National Environmental Significance (NES) nominated place listed on the National Heritage Properties adjacent to the Davros MC3D survey area - the Barrow Island and the Montebello-Barrow Islands Marine Conservation Reserves located in WA State waters. The Dampier Archipelago (including the Burrup Peninsular) is registered on the National Heritage List (Place ID 105727, Place File No. 5/08/203/0056) and classed as Indigenous. The closest point to the survey area is Rosemary Island, which is located ~29 km to the east in State waters

There are no listed Ramsar wetlands within or adjacent to, the proposed Davros MC3D survey area. The closest Ramsar wetland to the survey area is Eighty Mile Beach, which is located ~148 km to the east of the north-eastern boundary of the survey area.

2.4.8. Marine Parks and Reserves

The Davros MC3D survey area overlaps the Montebello Commonwealth Marine Reserve (MCMR) Multiple Use Zone (MUZ), IUCN Category VI, and lies ~36 km from the Dampier Commonwealth Marine Reserve (DCMR) Marine National Park Zone IUCN Category II and ~58 km from the DCMR Special Purpose Zone (Ports) – IUCN Category VI.

The MCMR is categorised as an IUCN Category VI Multiple Use zone and covers ~3,413 km^2 with water depths ranging from ~15 m to ~150 m. The MCMR is located ~20 km north of Barrow Island and ~125 km west of Dampier. The reserve abuts the WA Barrow Island Marine Park and Marine Management Area and the Montebello Islands Marine Park.

The MCMR provides representation and protection of continental shelf environments and habitats. It is a resting area for migrating humpback whales, vulnerable and migratory whale sharks, and supports resident populations of common bottlenose dolphins and Indo-Pacific humpback dolphins. The Montebello Islands are located in State waters adjacent to the proposed survey area, have been identified as critical nesting and internesting habitat for green turtles, threatened and migratory hawksbill and flatback turtles. Summer mating aggregations of green turtles also occur in the area. The islands are 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 islands are also recognised as an important foraging area for migratory seabirds. The historic shipwreck the Trial is located within the MCMR.

The Davros MC3D survey area abuts the WA Montebello/Barrow Islands Marine Conservation Reserves. The reserves are comprised of three separately vested reserves, namely the Montebello Islands Marine Park, Barrow Island Marine Park and Barrow Island Marine Management Area, gazetted in 2004. The Montebello/Barrow Islands Marine Conservation Reserves also include a number of islands that are vested in the Conservation Commission and managed by the WA Department of Parks and Wildlife (DPaW). These include the Barrow Island Nature Reserve, Montebello Islands Conservation Park, Boodie, Double and Middle Islands Nature Reserve, and the Lowendal Islands Nature Reserve. Barrow Island is composed almost entirely of limestone outcrops and deposits overlain by sands and gravels. It reaches a height of 62 m above sea level.

2.4.9. Other Protected Areas

There are no listed World Heritage Properties or Ramsar Wetlands of International Importance in the Davros MC3D survey area or surrounding waters. The nearest World Heritage Property to the survey area is the Ningaloo Coast World Heritage Property, which is located ~205 km to the southwest of the survey area.

2.4.10. Defence Activities

There are no designated defence or military exercise areas (MEA) in the vicinity of the Davros MC3D survey area. The southwestern boundary of the Davros MC3D abuts a MEA, the RAAF Learmonth Defence Restricted Airspace (R853). When activated by a Notice to Airmen (NOTAM), the restricted airspace can operate down to sea level.

3. DESCRIPTION OF THE ACTIVITY

The marine seismic survey proposed is a typical 3D survey similar to most others conducted in Australian marine waters (in terms of technical methods and procedures). No unique or unusual equipment or operations are proposed.

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 eight to 12 solid streamers, with a maximum length of 8,100 m. Streamer spacing will be between 50 and 100 m and line spacing will be between 500 and 1,000 m. The source (airgun array) tow depth will be 5-9 m (+/- 1 m) and the streamer tow depth will be 6 m at the head of the streamers and 50 m at the tail. In shallow waters steamers will be towed at a depth that will not allow streamers to be closer than 10 m from the seabed, as per the CGG Standard Operating Procedure (SOP) - Close Approach Of A Natural Obstacle document (MAR SEO PRC 010E). 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 4,433 cui. These sub-arrays will be fired alternately, with a shotpoint interval of either 18.75 or 25 m horizontal distance, and will produce at source (i.e. within a few metres of the airguns) sound pulses in the order of 263 dB re 1µPa-m (sound pressure level - SPL), at frequencies extending up to approximately 200 Hz.

Broad Source Justification

With a conventional source, the source notch limits the high frequency content which can be processed for shallow targets (typically 2.5 to 100 Hz). By using guns at different depths, the BroadSource emits a larger range of frequencies which can be processed for shallow targets (typically 2.5 to 200 Hz). The increase in frequency bandwidth enables better definition of thin geological strata which needs to be imaged accurately in the Davros area. Note that as the streamer will be towed at variable depth the streamer notch will be filled and consequently does not need to be modelled. Due to the mechanical design of the BroadSource, only two volumes are available on the *Geo Caspian*; 3,366 cui and 4,433 cui. One of the aims of the Davros MC3D survey is to accurately image the basement, which is understood to be at a depth of 20 km. In order to achieve optimal imaging at this depth, it is essential to use the larger of these two sources.

CGG proposes to conduct the Davros MC3D MSS using a purpose-built seismic survey vessel, the *Geo Caspian*, which is owned by Volstad Maritime AS and operated by CGG. It has all necessary certification/registration and is fully compliant with all relevant MARPOL and SOLAS convention requirements for a vessel of this size and purpose. The vessel will travel within the survey area at an average speed of 8-9 km per hour (approximately 4.5 knots). CGG will be using one seismic vessel for the Davros MC3D marine seismic survey (if done in phases, different vessels may be used for each phase).

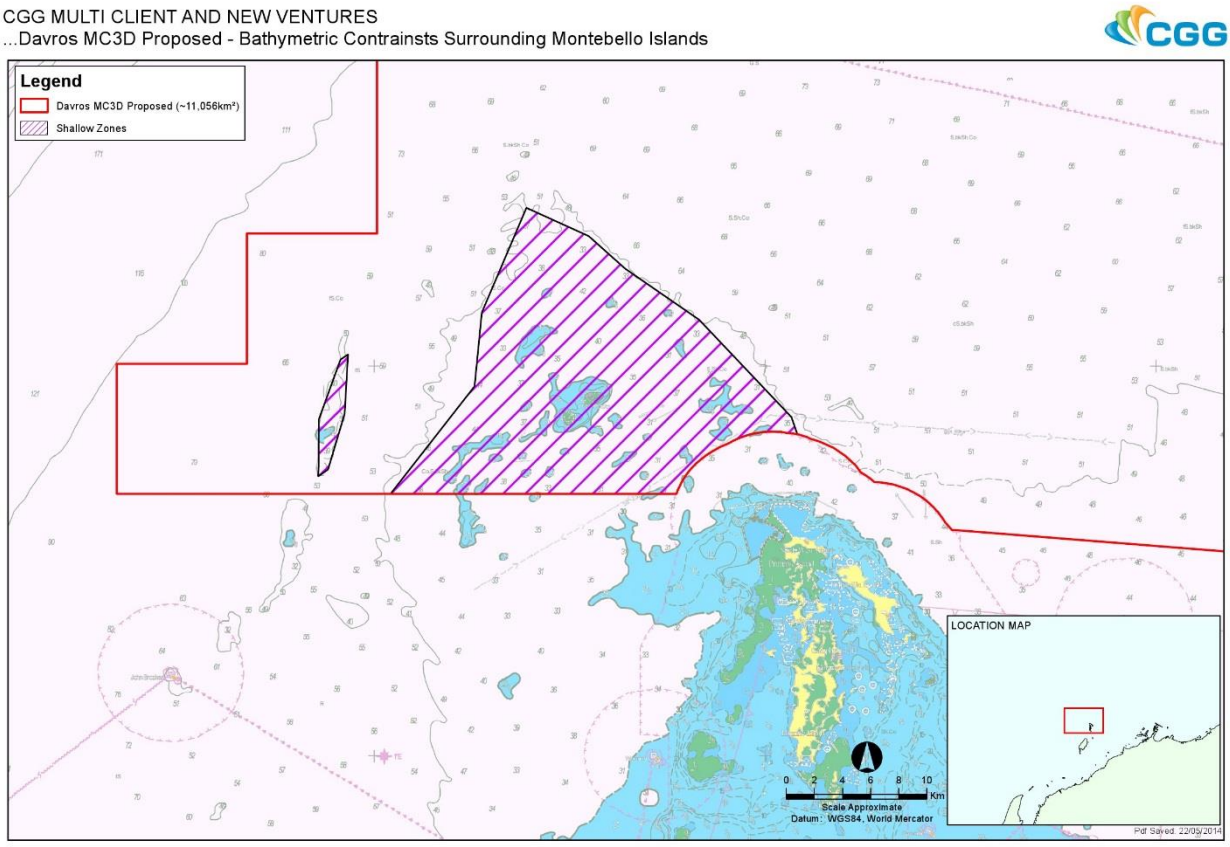
One or more support vessels will accompany the seismic survey vessel to maintain a safe distance between the survey array and other vessels and also to manage interactions with shipping and fishing activities if required. The support vessel(s), which have a crew of ~15 personnel, will also re-supply the survey vessel with fuel and other logistical supplies. If required (i.e. for vessels over 400 GRT) the support vessel(s) will have an implemented and tested Shipboard Oil Pollution Emergency Plan (SOPEP).

The survey vessel will not enter shallow waters <20 m water depth, adjacent to the Montebello Islands Marine Park. The shallow water zones are highlighted in **Figure 3.1** (shaded area).

Whilst the seismic vessel will transit WA State waters during transit to/from the survey area, there will be no acquisition within State waters. Additionally, the vessel will not conduct line turns, line run-ins or line run-outs within WA State waters.

During the survey the survey vessel will be refuelled at sea using the support vessel either within or immediately adjacent to the survey area. At sea refuelling will only take place during daylight hours, and will not take place within a distance of 25 km from any emergent land or shallow water features (<20 m water depth).

Figure 3.1 - Shallow water zone around the Montebello Islands



4. DETAILS OF ENVIRONMENTAL IMPACTS AND RISKS

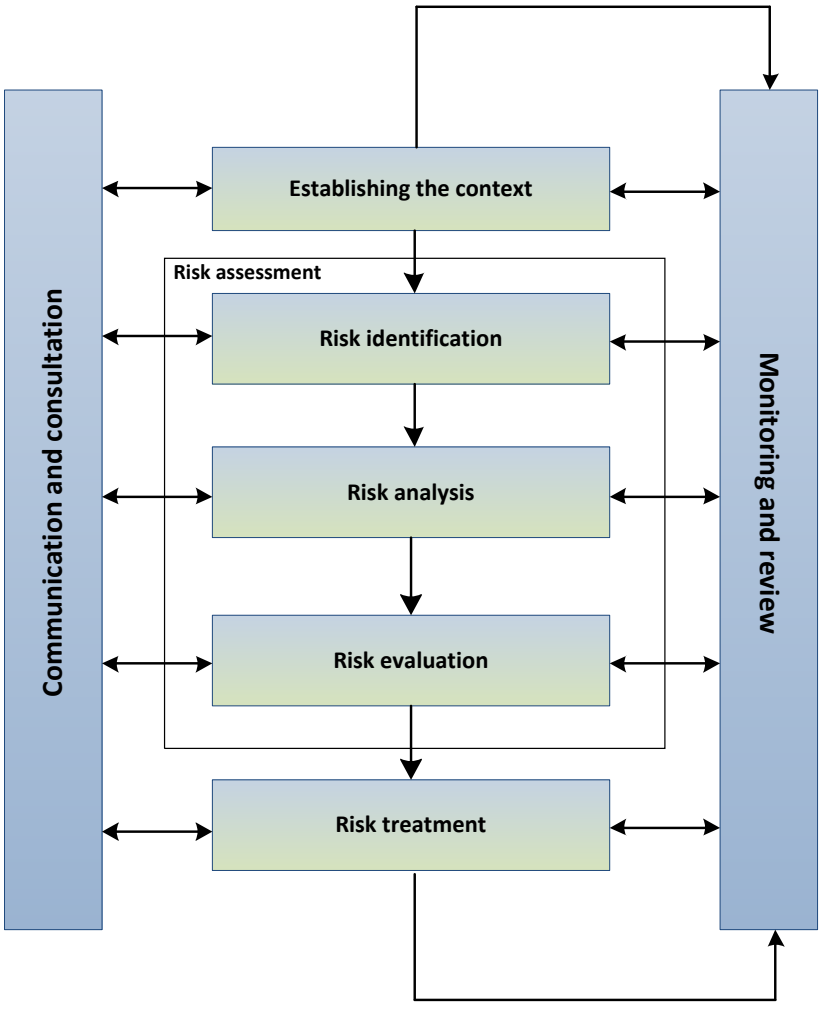
4.1. KEY RISK ASSESSMENT METHODOLOGY

An Environmental Risk Assessment (ERA) has been undertaken to understand and manage the environmental risks associated with the Davros 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–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 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

The environmental risks associated with the proposed seismic survey operations have been assessed by a methodology (see **Figure 4.1**) that:

- identifies the activities and the environmental aspects associated with them;
- identifies the values/attributes at risk within and adjacent to the survey 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.

The likelihood of occurrence for the key potential environmental impacts from the survey has been estimated based on industry incident reporting (**Table 4.1**). **Table 4.1** also includes a qualitative description of environmental effects assigned to each category of consequence.

Table 4.1 - Definitions for qualitative assessment of likelihood and environmental effects

Likelihood	**Qualitative description of likelihood**
Unlikely	Impact has not occurred in the past and there is a low probability that it will occur in exceptional circumstances.
Possible	Impact may have occurred in the past and there is a moderate probability that it will occur at some time.
Likely	Impact has occurred in the past and there is a high probability that it will occur at some time.
Highly Likely	Impact has been a common problem in the past and there is a high probability that it will occur in most circumstances.
Routine	Impact will occur, is currently a problem in the area or is expected to occur in almost all circumstances.
Consequence	**Qualitative description of environmental effects**
Slight	Possible incidental impacts to flora and fauna in a locally affected environmental setting. No ecological consequences.
Minor	Reduction of the abundance/biomass of flora and fauna in the affected environmental setting. No changes to biodiversity or ecological system.
Moderate	Reduction of abundance/biomass in the affected environmental setting. Limited impact to local biodiversity without loss of pre-incident conditions.
Severe	Substantial reduction of abundance/biomass in the affected environmental setting. Significant impact to biodiversity and ecological functioning. Eventual recovery of ecological systems possible, but not necessarily to the same pre-incident conditions.
Catastrophic	Irreversible and irrecoverable changes to abundance/biomass in the affected environmental setting. Loss of biodiversity on a regional scale. Loss of ecological functioning with little prospect of recovery to pre-incident conditions.

Table 4.2 shows the overall environmental risk assessment matrix (also referred to as an event potential matrix) that compares the likelihood and consequences of potential environmental impacts arising from the survey and assigns a level of risk.

Table 4.2 - Generic environmental risk assessment matrix

	LIKELIHOOD				
CONSEQUENCE	**Unlikely**	**Possible**	**Likely**	**Highly Likely**	**Routine**
Catastrophic	**High**	**High**	**High**	**High**	**High**
Severe	**Medium**	**Medium**	**Medium**	**High**	**High**
Moderate	**Medium**	**Medium**	**Medium**	**Medium**	**Medium**
Minor	**Low**	**Low**	**Medium**	**Medium**	**Medium**
Slight	**Low**	**Low**	**Low**	**Low**	**Low**

High Risk Level: Apply strict precautionary principle, and industry best practice to reduce to ALARP.

Medium Risk level: Apply standard cost-benefit approach to reduce risk to ALARP.

Low Risk level: Apply normal business management practice to avoid impact.

4.2. IDENTIFICATION OF RISKS AND IMPACTS

The environmental risks and potential environmental impacts of the proposed Davros MC3D MSS have been determined on the basis of CGG's previous seismic survey experience in the region and the outcomes of the ERA.

4.2.1. Environmental Aspects

A summary of the key sources of environmental risks (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 and associated equipment;
- emissions to atmosphere from vessels;
- discharge of ballast water and vessel biological fouling (biofouling);
- routine discharge of wastewater and waste to the ocean from survey and support vessels;
- accidental discharge of hydrocarbons and chemicals to the ocean from survey and support vessels;
- interactions with commercial fishing and shipping; and
- operation of the survey and support vessels within, or in the vicinity of protected areas and heritage places.

4.2.2. Environmental Impacts

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

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

4.3. ASSESSMENT OF IMPACTS AND RISKS

The potential environmental impacts identified in **Section 4.2.2** above were then risk assessed. This section of the EP Summary identifies the mitigation and management measures associated with each risk that will be implemented to reduce impacts to an acceptable level (see **Table 4.3)**.

A total of eighteen (18) potential impacts and risks were identified and assessed for the Davros MC3D MSS:

- DISTURBANCE TO MARINE FAUNA
  - Discharge of Underwater Seismic Pulses
  - Light Generation
  - Vessel and Towed Equipment Interactions with Marine Fauna
- DISTURBANCE TO BENTHIC HABITATS
  - Anchoring
  - Vessel Grounding
  - Equipment Dragging or Loss
- REDUCED AIR QUALITY FROM ATMOSPHERIC EMISSIONS
  - Operation of Machinery and Vessels Powered by Internal Combustion Engines
- INTRODUCTION OF INVASIVE MARINE SPECIES
  - Ballast Water
  - Biofouling
- MARINE POLLUTION FROM ROUTINE DISCHARGES
  - Sewage, Grey Water and Putrescible Wastes
  - Bilge Water
  - Other Wastes
- MARINE POLLUTION FROM ACCIDENTAL DISCHARGES
  - Hazardous Materials
  - Fuel and Oil Spills
  - Vessel Collisions
- DISTURBANCE TO SOCIAL AND COMMUNITY VALUES
  - Commercial Fishers
  - Shipping
  - Heritage and Conservation Values

4.3.1. DISTURBANCE TO MARINE FAUNA

McCauley (1994) provides a detailed review of the potential effects of seismic acquisition on marine animals. The review was undertaken by an Australian Independent Scientific Review Committee (ISRC). The ISRC report examined all aspects of the possible effects of seismic surveys on marine life, from whales to plankton. Potential impacts on hearing, and behaviour at different stages of development were studied. The ISRC report concluded on this note:

> *"Given the relatively small scale of seismic activity, the often large scales over which biological events occur, and the low probability of encounter between seismic surveys and 'at risk' populations at an appropriate time and place, then the wider implications of disruption by seismic surveys appear to be small for most species."*

4.3.1.1. Discharge of Underwater Seismic Pulses

The assessment of impacts and risks presented in this sub-section is based on a rigorous and robust interpretation of the currently available science. Whilst every effort has been made to source papers and reports that relate, as far as possible, to the circumstances of this particular seismic survey, it is not possible to find examples that directly apply to the specific airgun array parameters and environmental conditions (e.g. water depth range, seabed geoacoustical properties etc.) of the Davros MC3D survey. This process is further complicated by the uncertainties and shortcomings of the available literature, as outlined above.

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

- pathological effects (lethal and sub-lethal injuries) – immediate and delayed mortality and physiological effects to nearby marine organisms;
- behavioural change to populations of marine organisms;
- disruptions to feeding, mating, breeding or nursery activities of marine organisms in such a way as to affect the vitality or abundance of populations;
- disruptions to the abundance and behaviour of prey species for marine mammals, seabirds and fish; and
- altered 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.

Pathological Effects

The response of marine fauna to marine seismic survey sounds will range from no effect to various behavioural changes. Immediate pathological 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 well before they get within the ranges at which pathological effects may occur.

It is prudent to point out that there is presently confusion in some quarters caused by incorrectly associating the biological effects of high explosives with those of other types of underwater sound sources. Airguns do not produce shock waves and the effects described for high explosives do not apply to them. For example, Larson (1985) concluded from experiments with caged fish that mortality from shock waves only occurs when two criteria are met simultaneously:

- peak pressure is ≥ 2.75 x 105 Pa, and
- rise time and decay time is ≤ 1 ms

Airguns do not meet these criteria and do not cause shock waves.

Disturbance to Benthic Invertebrates

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

In an extensive and thorough review, Moriyasu *et al*. (2004) provide a summary of impacts of seismic airguns on marine invertebrates based on literature reviews. They conclude that "very limited numbers of experiments were scientifically and reasonably conducted" but the results of nine quantitative studies showed five cases of immediate (lethal or physical) impacts of seismic airguns on invertebrate species and four cases of no impacts. One study showed physiological impacts and another showed no physiological impact. Three cases showed behavioural impacts and one study showed no impact on behaviour.

Moriyasu *et al*. (2004) conclude that:

> *"Squid (McCauley et al. 2000a) and crab behavior (Christian et al. 2003) have been studied by direct observation. Pre- and post- seismic airguns comparisons of catch rates were made by La Bella et al. (1996) and Christian et al. (2003) on various invertebrate species. The quantitative and anecdotal aspects of all other studies were inadequate for assessing the effects of ..... seismic airguns on invertebrates. In addition, in-depth analyses on physiological changes in animals exposed to seismic airguns are quasi-absent."*

This review (Moriyasu *et al*. 2004) makes the comment that the papers by La Bella *et al*. (1996), McCauley *et al*. (2003) and Christian *et al*. (2003) provided the most detailed and useful information on the possible impacts of seismic airguns on invertebrates among the documents they examined.

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 that no apparent catch reductions in mantis shrimp (*Squilla mantis*) caught by gill nets, and in golden carpet shell (*Paphia aurea*), inaequivalvis ark shell (*Anadara inaequivalvis*), and purple die murex (*Bolinus brandaris*) caught by a hydraulic clam dredge in the area prospected one and two days before exposed to the same sound level mentioned above. However, purple die murex caught by gillnet showed a significant difference in catch rate. Based on the results of catch comparison of this species between hydraulic dredge and gill nets, the author concluded that this is a change in behavioural reaction to seismic guns rather than immediate mortality.

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 rms, and a strong startle response at 174 dB re 1µPa rms involving ink ejection and rapid swimming. The caged squids also moved to the sound shadowed area of the cage. The authors suggested thresholds for affecting squid's behaviour are at 161-166 dB re 1 µPa rms.

Christian *et al*. (2003; as cited in Moriyasu *et al*. 2004) did not detect any effects on the behaviour of snow crab *(Chionoecetes opilio*) placed in cages and put on the ocean bottom at a depth of 50 m after being exposed to sound levels of 197-237 dB from an airgun array. 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. The same study also 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.

A number of studies have examined the potential effects of seismic surveys on catch levels in fisheries targeting benthic crustaceans such as prawns and rock lobster. 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 that there was no damage that could be associated with 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.

Parry and Gason (2006) investigated the effect of seismic airgun discharges on southern rock lobster (*Jasus edwardsii*) via statistical analysis of the coincidence between seismic surveys and changes in commercial catch rates in western Victoria between 1978 and 2004. There was no evidence that catch rates of rock lobsters in western Victoria were affected by seismic surveys in the weeks or years following the surveys. However, most seismic surveys occurred in deep water, where impacts would be expected to be minimal. The apparent lack of impact of seismic surveys on catch rates of rock lobsters is consistent with the limited information available on the physiological effects of seismic surveys on invertebrates, including rock lobsters.

Disturbance to Planktonic Organisms

Except for fish eggs, larvae and other minute planktonic organisms within a few meters of an airgun, no planktonic organisms are likely to be affected significantly by airgun array discharges. Data presented in **Table 6.2** in the EP indicates that the range of pathological effect on fish eggs and larvae is likely to be restricted to less than approximately 2 m. Calculations show that less than 0.02% of plankton in the area would be affected[1]. Any effect on the planktonic organisms from the seismic discharge is insignificant compared with the size of the planktonic population in a survey area or natural mortality rates for planktonic organisms.

Disturbance to Bivalve Molluscs

Sound detection capabilities of bivalve molluscs

Little is known about sound detection in invertebrates, however, many species have mechano-sensory structures that have some resemblance to vertebrate ears. Many molluscs, including bivalves, possess statocysts, which are organs that assist the organism in maintaining balance and orientation in its immediate environment.

Statocysts are fluid-filled, capsule-like sensory organs, usually including ciliated hair cells and containing a single dense body (statolith) or a number of smaller ones (statoconia). The statolith and/or statoconia interact with the cilia lining the capsule, probably (as has been shown in gastropods and cephalopods) conveying information about orientation to the organism. They may also enable the animals to detect low-frequency pressure waves in sediment—either in the porewater or as vibrational signals associated with movements of sediment particles. Additionally, proprioception (the sensing of movement of bodily tissue by acoustic energy) may be involved in the detection of sound in invertebrates, including bivalves.

It has been postulated that statocyst organs may be receptive to the particle acceleration component of a sound wave, possibly in the far-field. Franzen (1995) showed that tellinid bivalves (*Macoma balthica*) are sensitive to frequencies in the minimum range of 50-200 Hz, which corresponds to shear-wave vibrations that propagate along the sediment surface. A study on the ox-heart clam (*Glossus humanus*) has demonstrated sensitivity to vibrations and hypothesized that the sensitivity was related to sensing breaking waves on the incoming tide, to move with the tide. *Donax variabilis*, a coquina clam, responds to pressure signals in the

[1] This assumes plankton are uniformly distributed, single gun array, 18.75 m shot point interval, maximum range of pathological effect 2 m.

range of 20 Pa, or a sound pressure level of 140 dB. In at least one other bivalve species, response to sound has been evident by changes in aggregations. Low frequency sound (30 to 130 Hz) has been demonstrated as an effective control measure for zebra mussel fouling.

No information is available concerning the distances over which bivalve molluscs may be able to detect either the pressure or particle motion components of a sound wave, particularly for animals suspended in mid-water. 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.

Effects of airgun noise emissions on bivalve molluscs

Based on a number of previous papers, including a comprehensive literature review on the effects of seismic and marine noise on invertebrates, it is apparent that 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*). A summary of the results of these studies are included in **Table 6.3** in the EP.

Seismic airguns cause less impacts on benthic invertebrates than explosives, as they generate a lower maximum pressure, and they cause a lower rate of pressure change, so that 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 airgun array. No bivalve molluscs possess gas filled internal organs that would make them more susceptible to pathological effects from underwater noise sources.

The literature suggests that invertebrates, which typically do not contain gas spaces, appear to be remarkably resilient to underwater explosions. A review of recent studies suggested that molluscs are at risk of damage from seismic airgun noise only when they are closer than 1–2 m. However, previous 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.

There are only a handful of studies that have examined the potential effects of seismic airgun noise on bivalve molluscs. A summary of the results of these studies, which involved the blue mussel (*Mytilus edulis*), the Iceland scallop (*Chlamys islandicus*), a venerid clam (*Paphia aurea*), the arc clam (*Anadara inaequivalvis*), the commercial scallop (*Pecten fumatus*), and the sea scallop (*Placopecten magellanicus*), is presented in **Table 6.4** in the EP.

Given that there are only seven (7) studies that can be found that directly relate to the effects of seismic airgun noise on bivalve molluscs it is difficult to form any conclusions about the possible impacts of airgun noise on the commercial pearl oyster (*P. maxima*) from seismic acquisition in areas of the Carnarvon Basin adjacent to the Mother of Pearl (MOP) fishery off 80 Mile Beach, Exmouth Gulf and Port Hedland. That said, however, 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, found that no mortality occurred in the exposed animals over a 13 week period, at a minimum exposure range of 1 m from the blast centre.

As has already been pointed out, seismic airguns 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. It is difficult to determine what this distance may be, but the available evidence would suggest something in the order of less than 1-2 m. It is even harder to determine at what distances from an airgun array morphological, biochemical and physiological changes (indicators of some level of stress in an animal) could occur. Only one study has examined biochemical indicators of stress in bivalves exposed to seismic airgun noise. In this study, they found that hydrocortisone, glucose and lactate levels between test and control animals were significantly different ($P > 0.05$) in the venerid

clam *Paphia aurea*, showing an evidence of stress caused by acoustic noise. This was at a minimum exposure range of 7.5 m.

In the past, commercial scallop fishermen have 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 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.

Similarly, in the Bass Strait scallop fishermen expressed concern that seismic acquisition might kill scallops (*Pecten fumatus*), weaken their adductor muscles, or increase the mortality of larval scallops. In a study conducted by the Victorian Marine and Freshwater Research Institute (MAFRI) (funded by Esso Australia), 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. 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 distant from the seismic testing.

This study found that the 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 (including bivalve larvae) behind the seismic survey vessel from their abundance before the passage of the vessel or 2 km distant from the vessel. High levels of variability in plankton communities meant that only large changes would have been detected, but the available literature suggests that effects on plankton are confined to ranges within 5 m of airguns.

A more recent study conducted by the Tasmanian Aquaculture and Fisheries Institute (TAFI) assessed the immediate impact of seismic surveys on adult commercial scallops (*P. fumatus*) in the Bass Strait. During late 2009, fishers who participate in the Bass Strait Central Zone Scallop Fishery (BSCZSF) were informed by the Australian Fisheries Management Authority (AFMA) of two seismic surveys, to be conducted within eastern Bass Strait during early 2010. The area selected for seismic testing was known to support significant beds of commercial scallops. Participants in the BSCZSF were concerned that this seismic surveying may have a negative impact on the adult scallops within the proposed survey region. In response to this concern from industry, TAFI was commissioned by AFMA to undertake a before and after study of the effects of the seismic survey on the target species.

The TAFI study concluded that no short-term (<2 months) impacts on the survival or health of adult commercial scallops were detected post the seismic survey. There had been 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. There was also no observable change in the size frequency distribution of scallops in the impacted and semi-impacted strata following seismic surveying.

The pelagic phase of a pearl oysters lifecycle lasts from 28 to 35 days, after which they become a benthic sedentary bottom-dweller. It is during the pelagic phase that they are more likely to be impacted by seismic surveys. CGG performed a Larval Distribution Area (LDA) analysis for a hypothetical seismic survey located entirely within the pearl oyster LDA (see **Appendix M** in the EP). The results predict that the natural mortality rates for pearl oysters are ~3.19% d^{-1}, compared to animals located within <10 m of the seismic airguns the mortality rate is ~ 0.43%d^{-1}. The potential airgun noise induced mortality of pearl oyster pelagic stages are likely to be insignificant compared to the rates of natural mortality.

Conclusions

Overall, based on the available information it would appear that significant impacts on bivalve molluscs, such as the pearl oyster, from airgun noise emissions will only occur within very short distances from the source. A conservative estimate for a minimum distance beyond which significant effects are unlikely, is approximately 10 m, but this will depend on the source dynamics and propagation characteristics of the area.

Disturbance to Fish

Studies with caged fish 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. Conditions that could result in fish being trapped and unable to move more than a few metres from the noise source as the survey vessel traverses the area do not exist in the proposed survey area (indeed it is difficult to conceive of any vessel-based seismic survey causing fish to be trapped within a few metres of the noise source). Therefore, it is considered that the risk of physiological effects on fish is negligible.

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. Sound levels of this intensity are likely to occur approximately 100 to 300 m from an airgun array. Based on this an approximate range of 200 m is given as the minimum distance at which fish may move away from an operating array and below which physical effects may occur. More recent studies have found that active avoidance may occur in some fish species at sound levels of approximately 161–168 dB re 1µPa rms, which corresponds to a distance of approximately 1 km from the survey vessel.

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

- short ranges and high sound intensities (i.e. <200 m range from source);
- populations that cannot move away from operating arrays (e.g. site-attached reef species);
- surveys that take place over protracted periods close to areas important for the purposes of feeding, spawning or breeding; and
- surveys that take place over protracted periods close to areas that constitute narrow, restricted migratory paths.

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

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

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

These effects are expected to be short-lived, with duration of effect less than or equal to the duration of exposure, are expected to vary between species and individuals, and be dependent on the properties of received sound. The ecological significance of such effects is expected to be low, except where they influence reproductive activity.

The threshold received sound exposure levels (SEL) that could result in various behavioural effects in fish outlined above are:

Low level behavioural effects:

- avoidance at >140 dB re 1µPa^2.s (pelagic species and the more nomadic demersal species);

- startle/alarm at >160 dB re 1µPa^2.s (species with limited home ranges or site-attached and/or territorial strategies).

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).

There are no documented cases of fish mortality upon exposure to seismic airgun noise under field operating conditions (DFO 2004).

The threshold received SELs that could result in various sub-lethal and/or physiological effects are:

- onset of short term reversible loss in hearing sensitivity (temporary threshold shift - TTS) at >180 dB re 1µPa^2.s (site-attached species);
- onset of longer term loss in hearing sensitivity (TTS/permanent threshold shift – PTS) at >187 dB re 1µPa^2.s (site-attached species); and
- TTS onset but no injury to non-auditory tissues to ~ 1 kg sized fish at >200 dB re 1µPa^2.s (site-attached species).

The potential effects of marine streamer seismic surveys have been summarised as part of a detailed environmental assessment of geophysical exploration for mineral resources on the Gulf of Mexico outer continental shelf. This assessment concluded that negligible to potentially adverse effects on fish may occur from seismic surveys. However, these effects were not considered biologically significant due to the following factors:

- seismic survey noise may disturb fish and may produce temporary or permanent hearing impairment in some individuals, but it is unlikely to cause death or life-threatening injury;
- seismic surveys are not expected to cause long term or permanent displacement of any listed species from critical/preferred habitat; and
- seismic surveys are not expected to result in destruction or adverse modification of critical or essential fish habitat.

Disturbance to Whale Sharks

Limited research has been conducted on shark responses to marine seismic surveys. Myrberg (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 whale sharks are therefore, expected to be limited to short-term behavioural responses, possibly including avoidance of the operating airgun array. These behavioural responses are unlikely to be significant at a population level, particularly as the waters of the Davros MC3D survey area do not represent critical habitat for whale sharks. Any whale sharks in the area are likely to be transient—i.e. moving through the survey area and adjacent waters during migratory movements to and from the Ningaloo Reef area.

It is unlikely that the underwater noise emissions from the airgun array would cause any pathological effects (lethal and sub-lethal injuries), resulting in immediate and delayed mortality and physiological effects, on whale sharks.

Disturbance to Cetaceans (Baleen whales)

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. This combined with studies of their hearing apparatus suggests that their hearing is also best adapted for low frequency sound. Baleen whales make individual sounds that may last for up to 16 seconds and humpback whales are known to "sing" for long periods. These sounds are thought to be used in social interactions and communication between individuals and groups.

McCauley *et al.* (2003) report humpback whale song components reaching 192 dB re 1µPa^2 (pk-pk) as well as levels of 180 to 190 dB re 1µPa^2 (pk-pk) for humpback pectoral fin slapping and breaching sounds. Physical damage to the auditory system of cetaceans may occur at noise levels of about 230 to 240 dB re 1µPa, which is equivalent to a distance of about one to two metres from the energy source. Because of the good swimming abilities of marine mammals and their avoidance of either the vessel or the airgun array, it is highly unlikely that any marine mammals will be exposed to levels likely to cause pathological damage.

Noise associated with airguns used during seismic surveys can cause significant behavioural changes in whales. Behavioural responses to airgun noise include swimming away from the source, rapid swimming on the surface and breaching. The level of noise at which response is elicited varies between species and even between individuals within a species. Stone (2003) suggests 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. Richardson *et al.* (1995) notes that:

> *"Baleen whales seem quite tolerant of low and moderate level noise pulses from distant seismic surveys. They usually continue their normal activities when exposed to pulses with received levels as high as 150 dB re 1µPa, and sometimes even higher".*

This noise level equates to a distance of about two kilometres from the source of the size proposed for this survey.

A comprehensive study carried out by McCauley *et al.* (2003) monitored the effects of seismic survey noise on humpback whales in the Exmouth Gulf region of Western Australia. 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, then it is unlikely that animals will be at any 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^2, which is still well below the source levels of the highest components of humpback whale song (192 dB re 1µPa^2). 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.

With regards to avoidance behaviour by baleen whales, it is known that baleen whales will avoid operating seismic vessels and the distance over which the avoidance occurs seems to be highly variable between species and even within species. It is considered that this avoidance behaviour represents only a minor effect on either the individual or the species unless avoidance results in displacement of whales from nursery, resting or feeding areas, at an important period for the species. The survey area and adjacent waters are not known critical habitats for any cetacean species.

McCauley *et al*. (2003) found that migrating humpback whales show a general avoidance of an operating seismic source at 157 to 164 dB re 1µPa (rms). Resting cow pods show avoidance at somewhat lower levels—for example, a mean sound level for avoidance of 140 dB re 1µPa (rms) and a mean standoff range at 143 dB re 1µPa (rms).

Disturbance to Toothed Whales

Toothed whales produce a wide range of whistles, clicks, pulsed sounds and echolocation clicks. The frequency range of toothed whale sounds excluding echo location clicks are mostly <20 kHz with most of the energy typically around 10 kHz, although some calls may be as low as 100 to 900 Hz. Source levels range from 100 to 180 dB re 1 µPa. The sounds produced, other than echo location clicks, are very complex in many species and appear to be used for communication between members of a pod in socialising and coordinating feeding activities.

For toothed whales exposed to single short pulses, the TTS threshold appears to be, to a first approximation, a function of the energy content of the pulse. In their review, Gordon *et al.* (2004) considered the potential for TTS and concluded that the threshold for TTS was approximately 195 dB re 1 µPa. This is consistent with the review and calculations contained with Richardson and Moulton (2006) who considered the TTS threshold to be 192 to 202 dB re 1 µPa and reasonably consistent with the value presented by DEWHA (2008b) of 186 dB re 1 µPa. Seismic pulses with received levels of 186 dB re 1 µPa or more are usually restricted to a radius of no more than about 300 m around a seismic airgun array, therefore the potential for TTS is extremely low as it would be necessary for the whale to be less than one kilometre from the airgun array and remain within this range as the vessel traversed a distance of four to five kilometres.

There is little systematic data on the behavioural response of toothed whales to seismic surveys. Richardson *et al*. (1995) reports 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 recent study supported by the US Minerals Management Service 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 poor hearing in the low frequency range of airgun array noise (10 to 300 Hz) and seismic operators sometimes report dolphins and other small toothed whales near operating airgun arrays. However, there is a component of seismic pulses in the higher spectrum and in general most toothed whales do show some 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 shows small toothed whale species tend to move away from operating airguns.

The hearing capability of larger toothed whales (such as the killer whale) is unknown, but it is possible that they can hear better in the lower frequencies than the smaller toothed cetaceans. If this is the case, in lieu of any other information, their reactions to seismic survey vessels may be akin to those of the baleen whales.

It is considered that the potential adverse effect on toothed whales would only occur if the whale is within close range (i.e. less than a few hundred metres).

Disturbance to Marine Turtles

Electro-physical studies have indicated that the best hearing range for marine turtles is in the range 100 to 700 Hz, which overlaps with the frequency range of maximum energy in the horizontally propagating component of a seismic array ‘shot’. Studies indicate that marine turtles may begin to show behavioural responses to an approaching seismic array at received sound levels of approximately 166 dB re 1 µPa (rms), and avoidance at around 175 dB re 1 µPa (rms). This corresponds to behavioural changes at approximately two kilometres, and avoidance from approximately one kilometre.

Marine turtles may possibly be exposed to noise levels sufficient to cause physical damage if airgun arrays start suddenly with turtles nearby (less than 30 m). In circumstances where arrays are already operating, (i.e. as a vessel moves along an acquisition line), individuals would be expected to implement avoidance measures before entering ranges at which physical damage might take place.

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

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

Feeding areas and migratory paths of turtles traverse both shallow and deep-water areas, and therefore individuals of all sizes may be encountered in a seismic survey area. It has been speculated that migrating turtles may use various acoustic cues and that acoustic disturbances might interfere with their navigational ability. The auditory sensitivity of marine turtles is reported to be centred in the 400 to 1,000 Hz range, with a rapid drop-off in noise perception on either side of this range. This auditory range matches their weak vocalisation abilities, which are also in the low frequency range (100 to 700 Hz).

From airgun exposure tests on a caged green turtle and a loggerhead turtle 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 two kilometres and avoidance behaviour at one kilometre 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.

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.

Overlap with Critical Cetacean Habitat and Peak Periods of Activity

Humpback whales

The Davros MC3D MSS area and surrounding waters do not represent critical habitat (e.g. calving, nursing, resting, breeding, feeding area, narrow restricted migratory pathways) for any cetacean species that may occur in the region.

The timing of the proposed Davros MC3D survey has not yet been finalised and the survey has an expected duration of approximately nine months. It is likely, therefore that the survey will occur during the northern and/or southern migration of humpback whales in 2014. However, any individuals encountered will be transient as the proposed survey area is not located in habitat that is considered critical for breeding, calving or feeding.

Blue whales

The northward component of blue whale migration in the region (centred on the 500 m depth contour) takes place from May to mid-August, with a peak in July-August. Consequently, it is unlikely that migrating (and

possibly feeding) blue whales will be encountered in the Davros MC3D MSS area and adjacent waters, given the water depth range (~20 m to ~300 m).

By applying comprehensive cetacean interaction management procedures, including the use of Part A Standard Management Procedures as defined in DEWHA [2008a]: soft starts, a 2 km low-power zone and 500 m shut down zone, plus the additional mitigation measure of two dedicated Marine Fauna Observers [MFO]), direct adverse physiological effects on any whales that may be encountered during the survey are extremely unlikely and any potential disturbance would be minimised.
The MFO will be aboard the survey vessel for the entire duration of the Davros MC3D survey.

Whale sharks

The Davros MC3D survey overlaps the Biologically Important Areas (BIA) (e.g. foraging areas) for EPBC Act-listed whale sharks. Whilst the proposed survey activities may overlap the period when whale sharks aggregate to feed in the waters off Ningaloo Reef any whale sharks encountered in the Davros MC3D survey area are likely to be transient—i.e. moving through the survey area and adjacent waters during migratory movements to and from the Ningaloo Reef area. The southwestern corner of the Davros MC3D survey area is ~205 km from North West Cape and Ningaloo Reef.

Overlap with Critical Turtle Habitat and Peak Periods of Activity

As described in **Section 4.3.4**, there are Biologically Important Areas (BIA) (e.g. breeding, nesting, foraging areas) for EPBC Act-listed species of marine turtles that overlap the Davros MC3D survey area.

The timing of the proposed Davros MC3D MSS has not yet been determined and the survey is expected to extend for a duration of ~9 months. Therefore, it is possible the Davros MC3D MSS will coincide with the nesting, internesting and hatching periods for green, flatback, hawksbill and loggerhead turtles in the region.

Cumulative Impacts Assessment

In the future, petroleum exploration and production is anticipated to continue offshore of Western Australia, subject to government approvals. Hence a number of seismic exploration activities are underway and have been proposed. There is a possibility that these activities coinciding over the same area may result in a cumulative impact on matters of National Environmental Significance (NES). This section assesses the potential cumulative impact the Davros MC3D MSS may have when coinciding with concurrent seismic activities. A review of both approved and proposed seismic surveys within the region has been undertaken by CGG at the request of DoE (letter dated 16 January 2014) and are discussed below.

Dirk MC3D MSS

The CGG Dirk MC MSS Environment Plan was accepted by NOPSEMA in November 2013 and the survey is proposed to commence in 2014. The survey area is approximately 320 km southwest of the Davros MC3D MSS polygon. Given the spatial and temporal separation between the Dirk and Davros MC3D survey and the fact they are likely to be acquired using the same survey vessel (*Geo Caspian*), there will be no concurrent acquisition and therefore no expected cumulative impacts to any matters of NES.

Contos MC3D and Supertubes MC3D MSS

The proposed TGS-NOPEC Geophysical Company Pty Ltd Contos MC3D (CT-13) and Supertubes MC3D (ST-13) MSS has been assessed as not a controlled action with particular manner conditions (EPBC referral 2013/6901). The ST-13 MC3D MSS is now complete and the CT-13 MC3D MSS commenced in December 2013, running for 68 days with completion anticipated in early February. No cumulative impacts are expected as the survey will be completed before the Davros MC3D MSS would commence.

Huzzas Phase 2 MC3D MSS

The TGS Huzzas Phase 2 MC3D MSS is proposed to run for 26 days ~140 km south of the Davros MC3D MSS polygon. The survey started in January 2014 and is expected to be completed by February 2014. No cumulative impacts are expected as the survey will be completed before the Davros MC3D MSS would commence.

Babylon 3D MSS, Bianch 3D MSS and Centaurus 3D MSS

The Woodside Babylon 3D MSS is proposed ~110 km south west of the Davros MC3D MSS polygon. If granted approval the survey would commence in March 2014, running for 28 days and completing in May. The Apache Bianch 3D MSS is proposed ~100 km south west of the Davros MC3D MSS polygon. If granted approval the survey will run for 30 days between January and June 2014. The Woodside Centaurus 3D MSS is approximately 230 km south east of the Davros MC3D MSS and is estimated to run for 21 days from February to March 2014. Given the large spatial and temporal separation between the Davros MC3D MSS and aforementioned seismic surveys there are no expected cumulative impacts to any matters of NES.

Stag 4D and Reindeer MAZ MSS

Apache Energy Ltd (Apache) is proposing to undertake the Stag 4D and Reindeer Multi-Azimuth (MAZ) MSS within the Davros MC3D MSS polygon. The Stag operational area comprises approximately 1,243 km^2 and the Reindeer operational area 1,053 km^2. The surveys are scheduled to occur in 2014, between January and June, with a total duration of approximately 30 days each. It is proposed that a purpose built seismic survey vessel such as the PGS *Ramform Explorer* will be used for both the Stag 4D and Reindeer MAZ MSS and therefore, there will be no concurrent acquisition.

CGG has contacted Apache Energy Ltd with regards to the timing of acquisition of the Stag 4D and Reindeer MAZ MSS. Apache have confirmed to CGG their intention to acquire from May to June 2014 and CGG proposes to undertake the Davros MC3D MSS in the third quarter of 2014. Thereby removing any potential for cumulative noise impacts resulting from concurrent surveys.

In the unlikely event that the timing of the proposed Stag 4D and Reindeer MAZ MSS and Davros MC3D MSS overlapped, the surveys would not be undertaking seismic activity in proximity, due to the potential for noise interference to affect acquisition data. Concurrent surveys usually require a minimum separation distance of ~60 km between any two operating seismic survey vessels. If separation distances between the survey vessels are closer than 60 km then the two proponents routinely work out procedures for simultaneous operations to eliminate or minimise the potential for noise interference and data corruption. Measures such as, a time-sharing arrangement where, over a 24 hour period each vessel will acquire for a period of 12 hours whilst the airgun arrays of the other vessel are shut down.

Additionally the towed streamer arrays on the Davros MC3D MSS vessel will be up to 8 km long and 1–2 km wide, therefore it is imperative that each survey vessel maintain appropriate separation distances from all vessel traffic for safety and operational reasons. In summary, the acquisition of these surveys will be temporally and spatially separated as a result of the following factors:

- the surveys acquiring data over different timeframes;
- to reduce data interference;
- to reduce safety risks associated with towed equipment;
- CGG engagement with Apache Energy Ltd to avoid overlap of the survey area at the same time.

Given the factors outlined above, it is expected that sound exposure levels associated with both the Stag 4D and Reindeer MAZ MSS and Davros MC3D MSS will have attenuated well below known behavioural avoidance response levels for marine fauna at the closest distance to concurrent surveys. Prior to commencement of the Davros MC3D MSS CCG will consult with other geophysical companies operating in Australian waters plus titleholders of petroleum titles adjacent to the Davros MC3D MSS polygon to ascertain if there are any other seismic surveys proposed for areas adjacent to the survey area, over the same time period. Additionally the mitigation controls proposed for the Davros MC3D MSS relating to marine fauna as outlined in Section 4, are also expected to be consistent with the mitigations proposed by Apache Energy Ltd, which would require the implementation of pre-start visual observations, soft starts and shutdowns for whales and whale sharks (consistent with the measures applied in *EPBC Act Policy Statement 2.1*) and no seismic

acquisition zones in proximity to marine turtle nesting areas. Consequently, the cumulative impacts of concurrent seismic exploration activities are unlikely to result in a significant impact to matters of NES.

Mitigation and Management Measures

See **Table 4.3** and **Section 1.1** for the systems, practices and procedures that will be implemented during this activity to ensure that the impacts and risks to marine fauna associated with the discharge of underwater seismic pulses are continuously reduced to ALARP.

The implementation of specific whale monitoring and interaction procedures will be used to minimise the potential for any adverse effects to whales throughout the survey. These procedures are adapted from the *EPBC Act Policy Statement 2.1 Part A - Standard Management Procedures*. For interactions involving acoustic energy source operations, the procedures are based on a tiered response depending on the 'safety zone' occupied by observed whales. The key elements of the procedures are:

- **Visual observations**: 30 minutes before the commencement of the soft start procedure. observations are to be made, where visibility allows, extend to 3+ km (observation zone) from the vessel but with particular focus on the low power and shut-down zones around the acoustic source. If no whales have been sighted within the low power (2 km radius) and shutdown zone (500 m radius) during the pre-start-up procedure, the soft start procedure outlined below may commence.
- **Soft start procedures**: A sequential build-up of warning pulses (over a period of 30 minutes) must be made at the start of each acquisition line ('soft start') to warn and deter whales from approaching the survey vessel. If a whale is sighted within or is about to enter the low power zone, the acoustic source should be powered down to the lowest possible setting (e.g. a single gun). If a whale is sighted within, or enters the shutdown zone, the acoustic source should be shut down completely.
    - Resuming soft start procedures should only occur after the whale has been observed to move outside the low power zone, or when 30 minutes have lapsed since the last whale sighting.
- **Continuous watch**: A continuous watch for whales must be maintained during 'soft start' sequences and during operations to determine the presence or absence of whales within 3 km of the vessel.
- **Power down procedures**:
    - Within 3 km: If a whale is sighted within the 3 km observation zone the operator of the acoustic source will be placed on stand-by to power down the acoustic source. An additional trained crew member or Marine Fauna Observer should also be brought to the bridge to continuously monitor the whale whilst in sight.
    - Within 2 km: If a whale is sighted within or is immediately approaching the low power zone the acoustic source should be powered down to the lowest possible setting.
    - Within 500 m: If a whale is sighted within or enters the shutdown zone the acoustic source should be shutdown completely.
- **Recommencement**: Power-up of the acoustic source with soft-start procedures should only occur after the whale has been observed to move outside the low power zone, or when 30 minutes have lapsed since the last whale sighting.

Two dedicated, expert MFO will be aboard the survey vessel for the entire duration of the survey. Only appropriately qualified and experienced MFO (as determined by a review of their CVs in the project proposal submitted by the provider) will be contracted to undertake the Davros MC3D MS survey.

The key role of the MFO will be to visually monitor the waters around the survey vessel for the presence of cetaceans, whale sharks and turtles during daylight hours. The MFO will be responsible for ensuring that the interaction procedures are implemented and followed correctly during survey activities. The MFO will also be responsible for recording any cetacean, whale shark and turtle sightings during the survey on the appropriate sightings forms, using the Cetacean Sighting Application (CSA) software for cetacean sightings. The MFO will be required to compile a Final Report following completion of the survey. The MFO Final Report will be provided to DoE and also to NOPSEMA via the PERR.

Residual Risk Level

The residual risk ranking for this potential impact is **Low** (**Table 4.3**).

4.3.1.2. Light Generation

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 subsequently affect some marine species, primarily seabirds and turtles.

Potential Impacts

Artificial lighting has the potential to affect marine fauna, notably marine turtles. 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. 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. Innate sea finding relies on light cues that include horizon brightness, shape and colour. Once in the ocean, hatchlings are thought to remain close to the surface, orient by wave fronts and swim into deep offshore waters for several days to escape the more predator-filled shallow inshore waters. During this period, light spill from coastal port infrastructure and ships may 'entrap' hatchling swimming behaviour, reducing the success of their seaward dispersion and potentially increasing their exposure to predation via silhouetting.

The potential for lighting from the survey vessel to disorientate or attract turtle hatchlings during the Davros MC3D MSS is likely to be minimal given the management measures (buffer/exclusion zone from nesting areas during peak nesting periods) that are being applied to the survey. Additionally, the vessel will be moving continually, albeit at a low speed, and consequently the effects of artificial lighting are likely to be less than for a stationary source, such as a drill rig, or FPSO facility.

Owing to their migratory habits, all six species of turtle have the potential to be present in open ocean habitats throughout the survey area, albeit in low densities. Whilst the survey area is adjacent to islands that are important nesting areas for turtles, the density of animals in the vicinity of the Davros MC3D MSS area is likely to be low, given the management measures (acquisition buffer/exclusion zone from nesting areas during peak nesting periods) that are being applied to the survey. Therefore, the probability of artificial light impacts on turtles is also low, particularly given the distance between the survey area and the nearest shallow water/emergent feature (Montebello Islands ~6 km to the south of the survey area, plus the 20 km exclusion area for peak nesting periods for green and hawksbill turtles and the 80 km exclusion area for peak nesting periods for flatback turtles). Therefore, there is no possibility of artificial light generated by the survey and support vessels impacting upon turtle hatchlings at nesting sites on these islands.

It is possible that seabirds may fly over the survey area. However, it is not anticipated that the seismic survey will have any impact on any species of seabird, due to their mobility and distance of the survey area to any nesting sites for seabirds. For example, Montebello Islands (~6 km), Barrow Island (~38 km) and the Muiron Islands (~180 km) all located to the southwest of the survey area.

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

Mitigation and Management Measures

See **Table 4.3** for the systems, practices and procedures will be implemented during this activity to ensure that the impacts and risks to marine fauna associated with the light generation are continuously reduced to ALARP.

Residual Risk Level

The residual risk ranking for this potential impact is **Low** (**Table 4.3**).

4.3.1.3. Vessel and Towed Equipment Interactions with Marine Fauna

Survey and support vessels working within, and travelling to and from, the survey area may present a potential physical hazard (e.g. animal displacement or vessel strike) to marine fauna including whales, dolphins, whale sharks and turtles. Additionally, there is a potential risk of turtles becoming trapped in the tail buoys that are attached to the end of each seismic streamer.

Potential 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. Vessel collisions contribute to the mortality of marine fauna, notably turtles and large cetaceans. Vessel traffic has severely affected North Atlantic right whales (*Eubalaena glacialis*), for which collisions have been identified as a major source of mortality. Stranding records from Queensland indicate that 14% of dead marine turtles had been struck by vessels. These records are largely from populated areas of the state and comprise an unknown proportion of the total mortality.

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 and several sharks bear scars that have probably been caused by boat contact. There have been several reports of whale sharks being impaled on the bows of larger ships in other regions.

Marine seismic surveys involve the use of two or more vessels travelling at slow speed (around 4 knots) along defined paths. The timing and location of the survey may coincide with major fauna migrations for example humpback whale, blue whale and whale shark migrations. The survey area does not include any shallow water features that may represent feeding areas for turtles.

The Davros MC3D MSS is in the vicinity of important breeding areas for marine turtles. The closest known breeding areas for green turtles are the Montebello Islands, located ~6 km to the south, and the islands of the Dampier Archipelago ~30 km to the southeast of the survey area. The density of animals in the area is likely to be low, given the management measures (acquisition buffer/exclusion zone from nesting areas during peak nesting periods) that are being applied to the survey and as such the probability of adverse fauna interactions is low.

Turtle entrapments with streamer tail buoys can lead to mortalities. 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 don’t represent a threat as far as turtle entrapment. The tail buoys (PartnerPlast 900L) are designed to skim along the surface with just a single chain extending beneath the surface. The *Geo Caspian* is not fitted with this model of tail buoy and continues to use turtle guards to prevent entrapment. However, as the availability of the *Geo Caspian* is not confirmed, alternative vessels that may undertake the Davros MC3D MSS would use this type of tail buoy and therefore, turtle guards would not be required.

Mitigation and Management Measures

See **Table 4.3** for the systems, practices and procedures will be implemented during this activity to ensure that the impacts and risks to marine fauna associated with vessel and towed equipment interactions are continuously reduced to ALARP.

Support vessel-marine fauna interaction procedures have been prepared to ensure any interactions between the support vessel and cetaceans, whale sharks and turtles are managed in accordance with Part 8 of the EPBC Regulations 2000 and with guidelines from the Commonwealth Government (DEH 2005b). The support vessel Masters, and the crew will be made aware of these requirements at induction prior to commencement of the survey.

Residual Risk Level

The residual risk ranking for this potential impact is **Low** (**Table 4.3**).

4.3.2. DISTURBANCE TO BENTHIC HABITATS

4.3.2.1. Anchoring

The potential and significance of impacts caused by anchoring is dependent on the type of receiving environment, the size of the anchor and chain and the frequency of anchoring. Soft sediment benthic areas relatively devoid of sensitive habitats (i.e. coral reefs, seagrass meadows) and consisting of sandy /silt substrate is the predominant benthic receiving environment within, and adjacent to, the survey area. Anchoring in these habitats typically cause minimal disruption to the soft sediment and, given the widely distributed benthic inflora and fauna found within these areas, would have a minimal to insignificant impact to the benthic communities. However, with respect to routine operations during any proposed Davros MC3D MSS, these impacts are unlikely to occur, as anchoring within the survey area will not occur due to the water depths within the area (~20 m to ~300 m). Anchoring outside the survey area would only occur in emergency circumstances and the seismic and support vessels are fitted with highly sophisticated position fixing equipment.

Mitigation and Management Measures

See **Table 4.3** for the systems, practices and procedures will be implemented during this activity to ensure that the impacts and risks to benthic habitats and communities from vessel anchoring are continuously reduced to ALARP:

4.3.2.2. Vessel Grounding

The potential for the survey and support vessel to become grounded while working within the survey area is non-existent due to the absence of shallow waters (<20 m water depth) and any emergent features within or immediately adjacent to the survey area. Water depths in the survey area are ~20 m to ~300 m.

The *Geo Caspian* has a draft of 5.9 m, and the support vessel is expected to have a shallower draft than this. Therefore, there is no possibility that either vessel could run aground as there are no shallow water (<20 m water depth) or emergent features within or adjacent to the Davros MC3D survey area. Whilst the vessels are in transit to/from the survey area there is the possibility of grounding in shallow waters in the vicinity of Barrow Island or other coastal islands. However, the scope of the Davros MC3D MSS EP does not cover transfer of the survey or support vessels to and from the survey area—i.e. from port to the survey area; and on completion of the survey from the survey area to the either port or another location.

Potential Impacts

Vessel impact and grounding has the potential to damage living resources, cause fracturing, reef rock displacement, and sediment production. These are caused by vessel contact with the ocean bottom, by prop wash and cable dragging during attempts by operators and/or salvagers to refloat 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.

Mitigation and Management Measures

See **Table 4.3** for the systems, practices and procedures will be implemented during this activity to ensure that the impacts and risks to benthic habitats and communities from vessel grounding are continuously reduced to ALARP.

Residual Risk Level

The residual risk ranking for this potential impact is **Low** (**Table 4.3**).

4.3.2.3. Equipment Dragging or Loss

Potential Impacts

In the unlikely event of damage to or loss of a solid seismic streamer, potential environmental effects will be limited to physical impacts on benthic communities arising from the cable and associated equipment sinking to the seabed. Seismic streamers and vanes are fitted with pressure-activated, self-inflating buoys 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 streamers along the seabed may result in localized physical disturbance of substrates, benthic habitats and communities. However, given the water depth range across the Davros MC3D survey area (~20 m to ~300 m), the absence of any shallow waters (<20 m water depth) and any emergent features within or immediately adjacent to the area, the risk of significant impacts resulting from equipment dragging or loss is considered to be very low.

Mitigation and Management Measures

See **Table 4.3** for the systems, practices and procedures will be implemented during this activity to ensure that the impacts and risks to benthic habitats and communities from equipment dragging or loss are continuously reduced to ALARP.

Residual Risk Level

The residual risk ranking for this potential impact is **Low** (**Table 4.3**).

4.3.3. REDUCED AIR QUALITY FROM ATMOSPHERIC EMISSIONS

4.3.3.1. Operation of Machinery and Vessels Powered by Internal Combustion Engines

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 workboat; and
- incineration of oily sludges aboard the survey vessel.

Potential 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 sludges 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.

Mitigation and Management Measures

See **Table 4.3** for the systems, practices and procedures will be implemented during this activity to ensure that the impacts and risks from vessel atmospheric emissions are continuously reduced to ALARP.

Residual Risk Level

The residual risk ranking for this potential impact is **Low** (**Table 4.3**).

4.3.4. INTRODUCTION OF INVASIVE MARINE SPECIES

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. Not all marine

species introduced into an area will thrive and therefore have the potential to establish themselves as a pest. Species of concern are those that are not native to the region; are likely to survive and establish in the region; and are able to spread by human mediated or natural means.

IMS have been introduced and translocated around Australia by a variety of natural and human means including for example, discharge of ballast water, biofouling, aquaculture operations and aquarium imports.

In the case of CGG's proposed activities, the key vectors requiring management attention include:

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

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 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.

4.3.4.1. Ballast Water

Potential Impacts

Ballast water which may potentially harbour invasive marine species can be released by seismic and support vessels during marine seismic surveys. Once introduced IMS can cause serious environmental, social and economic impacts through predation or displacement of native species. These direct or indirect impacts have the potential to threaten a range of sectors including commercial fisheries and aquaculture, the tourism industry, human health, shipping and infrastructure.

The Australian Quarantine Inspection Service (AQIS) is the lead agency for management of ballast water from international vessels. AQIS has introduced the mandatory Australian Ballast Water Management Requirements that are enforced under the *Quarantine Act 1908*. Under these arrangements all vessels that have travelled from international waters are obligated to assess and manage their ballast water in accordance with the AQIS requirements. These arrangements prohibit the discharge of high-risk ballast water within Australian territorial seas (within 12 nautical miles of Australian territories) including Australian ports. It is also recommended by AQIS that ballast exchanges be conducted as far as possible away from shore and in water at least 200 m deep.

Mitigation and Management Measures

See **Table 4.3** for the systems, practices and procedures will be implemented during this activity to ensure that the impacts and risks of IMS associated with ballast water discharge are continuously reduced to ALARP.

Residual Risk Level

The residual risk ranking for this potential impact is **Low** (**Table 4.3**).

4.3.4.2. Biofouling

Potential Impacts

Biofouling on vessel hulls and other external niche areas, biofouling on internal niches and biofouling on equipment routinely immersed in water all pose a potential risk of introducing IMS into Australia. Under the National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Commonwealth of Australia 2009) a risk assessment approach is recommended to manage biofouling.

The potential biofouling risk presented by the survey and support vessels selected to acquire the Davros MC3D survey will relate to the length of time that these vessels have already been operating in Australian waters or, if they have been operating outside Australian waters, the location/s of the surveys they have been undertaking, the length of time spent at these location/s, and whether the vessels have undergone hull inspections, cleaning and application of new anti foulant coating prior to returning to operate in Australia.

Survey Vessel

The *Geo Caspian* has been operating in Australian waters since October 2013, when it arrived to acquire the CGG Schild Phase II MC3D MSS. These operations included port calls within WA State waters. Accordingly, the vessel was required to meet the biosecurity standards of the WA Department of Fisheries (DoF), who have significant powers to prevent the arrival and establishment of IMS of concern. 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*.

If an alternative vessel from the CGG fleet, which has not been operating in Australian waters, is mobilised the vessel will be required to meet the biosecurity standards of the DoF, who have significant powers to prevent the arrival and establishment of IMS of concern. 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*.

An independent IMS inspection will be undertaken to ensure the vessel is compliant with the aquatic biosecurity standards set out under the *Fisheries Resources Management Act 1994*.

Support Vessels

At this stage, the support vessel(s) that will be used for the Davros MC3D survey are not confirmed. However, these vessels will be contracted from companies operating in Australia, and will be vessels that routinely operate out of either Broome, Darwin or Dampier. On this basis, the support vessels will pose a low risk of introducing any IMS of concern to Australian waters.

Mitigation and Management Measures

See **Table 4.3** for the systems, practices and procedures will be implemented during this activity to ensure that the impacts and risks of IMS associated with biofouling are continuously reduced to ALARP.

Residual Risk Level

The residual risk ranking for this potential impact is **Low** (**Table 4.3**).

4.3.5. MARINE POLLUTION FROM ROUTINE DISCHARGES

Risks to marine environmental resources in the proposed survey area (and adjacent areas) from routine discharges are considered to be negligible given that all wastes, other than sewage, grey water and putrescibles wastes, will be incinerated aboard the survey vessel or compacted and disposed of onshore.

4.3.5.1. Sewage, Grey Water and Putrescible Wastes

During the Davros MC3D MSS, the survey and support vessels will routinely discharge sewage, grey water (comprising laundry, shower and sink water) and putrescible wastes (comprising of food scraps) to the ocean in accordance with the requirements of the MARPOL 73/78 Convention (as implemented in Commonwealth waters by the PSPPS Act).

Potential Impacts

Routine discharge of wastewater to the ocean will cause a negligible and localised increase in nutrient concentrations. The total nutrient loading from vessel operations during the Davros MC3D MSS will be insignificant in comparison to the natural daily nutrient flux that occurs within the region.

Mitigation and Management Measures

See **Table 4.3** for the systems, practices and procedures will be implemented during this activity to ensure that the impacts and risks associated with routine discharge of sewage, grey water and putrescible wastes are continuously reduced to ALARP.

Residual Risk Level

The residual risk ranking for this potential impact is **Low** (**Table 4.3**).

4.3.5.2. Bilge Water

The survey and support vessels may need to discharge bilge water during the survey.

Potential Impacts

Bilge tanks receive fluids from many parts of the vessel. Bilge water can contain water, oil, dispersants, detergents, solvents, chemicals, particles and other liquids, solids or chemicals. This can cause a localised reduction in water quality if not treated prior to discharge.

Mitigation and Management Measures

See **Table 4.3** for the systems, practices and procedures will be implemented during this activity to ensure that the impacts and risks associated with routine discharge of bilge water are continuously reduced to ALARP.

Residual Risk Level

The residual risk ranking for this potential impact is **Low** (**Table 4.3**).

4.3.5.3. Other Wastes

The vessel will also produce a variety of other solid and liquid wastes, including packaging and domestic wastes, such as aluminium cans, bottles, paper and cardboard.

Potential Impacts

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, for example marine fauna can become entangled in waste plastics.

Mitigation and Management Measures

See **Table 4.3** for the systems, practices and procedures will be implemented during this activity to ensure that the impacts and risks associated with routine handling and disposal of garbage are continuously reduced to ALARP.

Residual Risk Level

The residual risk ranking for this potential impact has been classified as **Low** (**Table 4.3**).

4.3.6. MARINE POLLUTION FROM ACCIDENTAL DISCHARGES

The survey and support vessels will store and use fuel and a variety of hazardous materials such as lubricating oils and cleaning chemicals. During the survey, the survey vessel will be refuelled at sea using the support vessel, either within or immediately adjacent to the survey area. At sea refuelling will only take place during daylight hours and will not take place within a distance of 25 km of any emergent land or shallow water features (20 m or less depth).

4.3.6.1. Hazardous Materials

The vessel will store and use a variety of hazardous materials such as lubricating oils, cleaning chemicals and batteries.

Potential Impacts

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 litre capacity and stored / used in internal areas where any leak or spill would be retained on board and cleaned up in accordance with the 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 litres.

Mitigation and Management Measures

See **Table 4.3** for the systems, practices and procedures will be implemented during this activity to ensure that the impacts and risks associated with accidental discharge of hazardous materials are continuously reduced to ALARP.

Residual Risk Level

The residual risk ranking for this potential impact is **Medium** (**Table 4.3**).

4.3.6.2. Fuel and Oil Spills

The hazards associated with fuel and oil spills during the Davros MC3D MSS (that are considered most credible) are:

- on-deck leak or spill of small quantities (up to 50 litres) of hydraulic oil or lubricating oil;
- loss of up to 125 litres of diesel during refuelling operations, as a result of hose failure;
- loss of up to 200 m^3 from tank overflow during refuelling; and
- larger volume (up to 283 m^3) loss of diesel from a ruptured fuel storage tank, resulting from vessel collision or grounding.

Potential Impacts

The accidental discharge of fuel and oil 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.

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) the annualised spill frequency for transfer spills in Australian waters is 0.0384 (19.9%), whilst the spill frequency for vessel collisions is 0.224 (11.6%) and for vessel grounding (powered

and drift) is 0.392 (20.4%). Therefore, spills resulting from vessel collision will have a much lower probability of occurring than transfer spills. 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 (http://www.atsb.gov.au/publications/safety-investigation-reports.aspx?Mode=Marine), 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.

A collision between the survey vessel and another vessel unconnected with the activity is unlikely, given the limited commercial fisheries and shipping activity in the survey area and surrounding waters, and the comprehensive control and mitigation measures in place to manage the risk of vessel collisions (see **Section 4.3.6**). However, a possibility remains of a collision occurring between the survey vessel and the support vessel during occasions when the vessels are manoeuvring close to each other.

As described in **Section 4.3.6**, there is no possibility of the survey or support vessels grounding within, or immediately adjacent to the survey area for the Davros MC3D survey, given the water depths in the survey area (~20 m to ~300 m) and the absence of any shallow water or emergent features.

The size of potential hydrocarbon spills on the decks of the survey and support vessels is likely to be less than 50 L (based on shipping industry leak frequency analyses). This quantity relates primarily to the capacity of storage containers commonly used, plus volumes of hydraulic oil in hoses. In the case of deck spills, most of the spilt material is likely to be contained with bunds or containment lips installed to prevent discharge to sea. Portable containers used on the vessels for storage of oil range in size from less than a litre up to 200 litre (drums). Some spills may occur when small containers of oil are being used in open areas, where there is a risk of some entering the sea if spilled. Larger containers up to 200 litres may be used for oils such as engine lubricating oil, however, these will always be used and stored in internal and/or bunded areas where any spill or leak would be fully contained onboard.

The realistic worst case volume of diesel spilled during refuelling operations is 125 litres, arising from the total loss of the contents of the transfer hose (e.g. 3" hose of 28 m length) during refuelling. Dry break couplings would prevent any more than the hose volume being spilled in the event of hose failure. In reality, a more likely scenario is a pin hole leak or a large hole in the hose (from abrasion or mechanical damage), resulting in a highly visible sheen on the sea surface enabling action to be taken to stop the leak (by the operation supervisor(s)) before more than a few litres had been spilled.

The volume of a tank overflow spill during refuelling is limited to less than or equal to 200 m^3 – the maximum quantity of diesel which will be transferred during bunkering/refuelling operations.

The fuel that will be used by the *Geo Caspian* is Marine Gas Oil (MGO) (marine diesel). The *Geo Caspian* has no MGO tanks adjacent to the hull. All the MGO tanks are located in the interior of the vessel, and are separated from the hull by tanks for other fluids (fresh water, grey/black water, bilge water, ballast water, sludge etc.). The largest diesel oil tanks on the *Geo Caspian* are 903 (port side and starboard side), which have a maximum capacity of 268.5 m^3.

Therefore, in the extremely unlikely (improbable) event of a ruptured fuel tank as a result of collision, the maximum spill size possible would be in the order of ~268 m^3 of MGO. However, this could only occur in the event of a rupture of one of the vessels largest MGO tanks and complete loss of all of its contents. This is highly unlikely to occur as a result of a vessel collision or grounding incident, given the location of these tanks in the interior of the vessel. Additionally, the volume of the fuel lost to the marine environment would be expected to be less than the total capacity of the tank due to:

- the MGO tanks are never filled to maximum capacity;

- if the tank was holed below the water line, then it would only leak down to a level equivalent to the water line, and
- emergency procedures would be carried out to transfer the contents of the tank to other MGO tanks aboard the vessel.

It should be noted that while it is not expected the full volume would be released to the marine environment the full tank capacity (i.e. 268m^3) was used as the volume to represent an overly conservative and therefore worst case scenario in the spill risk assessment.

MGO is a light petroleum distillate that, given the high energy and warm water environment that prevails in the proposed area of operations, is expected to undergo rapid dispersion and evaporation:

Survey-specific Hydrocarbon Spill Modelling
For the proposed Davros MC3D MSS, Scope Resources commissioned RPS Applied Science Associates (RPS-ASA) to undertake a quantitative oil spill risk assessment for a large volume diesel spill at two locations to inform the assessment of potential environmental impacts and aid spill contingency / response planning (RPS-ASA 2013). The risk assessment included a spill scenario of a 268 m^3 surface discharge of MGO at a location ~6 km north of the Montebello Islands and ~30 km northwest of the Dampier Archipelago.

Two spill scenarios were modelled:

- **Scenario 1**: A total release of 268 m^3 of MGO (marine diesel) discharged over 6 hours (44.7 m^3/hr) onto the surface at a location ~6 km north of Montebello Islands (Site 1: 20.3244°S, 115.5694°E).
- **Scenario 2**: A total release of 268 m^3 of MGO (marine diesel) discharged over 6 hours (44.7 m^3/hr) onto the surface at a location ~30 km northwest of the Dampier Archipelago (Site 2: 20.4055°S, 116.2633°E).

The assessment for these spill scenarios was undertaken using the three-dimensional oil spill model (SIMAP) (Spill Impact Mapping and Analysis Program), which is designed to simulate the transport, spreading and weathering of specific oil types under the influence of changing meteorological and oceanographic forces.

Stochastic modelling was carried out using samples of historic met ocean data for the each of the three seasons - summer months (December to February), transitional period (March, September to November) and winter months (April to August). Stochastic modelling involves producing a large number of replicate simulations, with each simulation forced by a different, time-varying, sample of met ocean conditions. These samples are selected from a longer time-series by randomly-selecting a point in time. For this study, the longer data set spanned from 2009-2013, inclusive and 100 replicate simulations were run for each season for each scenario, i.e. summer, transition and winter for the two scenarios, adding up to 300 simulations for each scenario and 600 simulations in total. This process is designed to gain a representative set of potential outcomes for spills occurring at both locations across the three seasons.

Threshold concentrations specified for this study were as follows:

- Surface slicks – 1 g/m^2;
- Entrained oil – 10, 100, 500 ppb; and
- Dissolved aromatics – 6, 50, 400 ppb.

Indicative thresholds of oil mass per surface area, equivalent to oil films displaying sheen (0.1 g/m^2, ~0.1 µm thickness), rainbow sheen (1 g/m^2, ~1 µm thickness) and dull metallic colours (10 g/m^2, ~10 µm thickness) were applied to surface slicks. These thresholds are likely to be conservative in terms of environmental effects. For example, the minimal thickness of floating oil films that will cause harm to seabirds on the water surface has been estimated by different researchers as 10-25 g/m^2 (French 1998, Koops *et al*. 2004). However, the 1 g/m^2 threshold may be considered indicative of the perceived area of effect of a spill, defining the area where surveillance may be required, or where socio-economic impacts might result. On this basis, and to be

consistent with the analysis of risks for a 268 m^3 MGO spills presented in **Tables 1** to **18** (in the EP) and discussed above, the results of the modelling for surface slicks at the 1 g/m^2 threshold are summarized below.

As can be expected for a large release of diesel at a location ~6 km north of the Montebello Islands and ~30 km northwest from the Dampier Archipelago, the results of the modelling indicate potential exposure to hydrocarbon concentrations above defined thresholds for both State waters and to the islands. The main findings are summarized below.

Scenario 1: Simulation of a MGO spill (268 m^3 over 6 hours) onto the sea surface at Site 1 near the Montebello Islands.

1. Summary of Surface Oil Risks

- Floating diesel at concentrations equal or larger than threshold concentrations is most likely to drift to the east-northeast of the spill site if spills begin during summer months, drift to the west-northwest of the spill site if spills begin during transitional months and drift to the west of the spill site if spills begin during winter months.
- Floating oil concentrations ≥1 g/m^2 have up to a 47% probability of contacting shorelines among the Montebello Islands if the spill occurred in winter, and a 24% probability if a spill occurred in summer. During transitional months the probability of shoreline contact is 35%.
- At the ≥1 g/m^2 threshold, there is a <1 % probability of shoreline contact from surface slicks for all the other islands and reefs in the region.
- The minimum time before contact could occur at the shoreline among the Montebello Islands is 2-3 hours during summer and winter months and 2-5 hours during transitional months.
- The potential for accumulation of diesel is indicated for shorelines among the Montebello Islands and on Barrow Island.
- Predicted maximum accumulated volumes of diesel along shorelines are up to 80 m^3 for the Montebello Islands and 28 m^3 on Barrow Island during summer months.

2. Summary of Entrained Oil Risks

- Entrained oil concentrations equal or larger than thresholds are most likely to occur in waters to the east-northeast of the spill site if a spill begins in the summer months and the west-southwest if a spill begins in transitional or winter months.
- The potential for contact by entrained oil ≥100 ppb is indicated for the Montebello Islands, with the highest probability of 29% for a spill in winter, 17% during the summer months and 15% during transitional months.
- Exposure to entrained oil concentrations of ≥100 ppb is also predicted to occur for the Dampier Archipelago (1% during summer), Lowendal Islands (5%, 1%, 1%) and Barrow Island (4%, 2%, 2%) for summer, transitional and winter months respectively.
- Exposure to entrained oil concentrations of ≥100 ppb was predicted to occur <1% for the other islands and reefs in the region.
- The Montebello Islands have a minimum time to contact of 2-3 hours (in all seasons).
- Predicted maximum concentrations of entrained oil at any water depth at the Montebello Islands is ~6 ppm, if the spill occurred in winter.

3. Summary of Risks for Aromatic Hydrocarbons Concentrations

- Dissolved aromatic hydrocarbons concentrations ≥50 ppb are forecast to occur at low probabilities in patches of waters to the northeast of the spill site if a spill begins during summer months, to the southwest and northwest if a spill begins during transition months and to the west-southwest if a spill begins during winter months.
- Contact by dissolved aromatic hydrocarbons at concentrations ≥50 ppb is predicted to have low probability of occurrence among the Montebello Islands - 2% and 1% respectively, if a spill were to commence during winter or summer months.

- Dissolved aromatic hydrocarbons concentrations ≥50 ppb are forecast to occur at <1% for the other islands and reefs in the region.
- Exposure to any shoreline was predicted to be <1% at the higher concentrations of dissolved aromatics modelled (≥100 ppb).
- The Montebello Islands has a 1% probability of receiving an integrated exposure level of >576 ppb.hr. The peak estimate is ~1.3 ppb.hr.

Scenario 2: Simulation of a MGO spill (268 m^3 over 6 hours) onto the sea surface at Site 2 near the Dampier Archipelago.

1. Summary of Surface Oil Risks

- Floating diesel at concentrations equal or larger than threshold concentrations is most likely to drift to the northeast of the spill site if spills begin during summer months, to the west and north if spills begin during transition months and to the west if spills begin during winter months.
- Shorelines surrounding this location are forecasted to have a low probability (<1%) of contact by floating oil concentrations ≥1 g/m^2, during summer, transitional, and winter periods.
- Some potential for accumulation of oil on the shorelines of the Montebello Islands and Barrow Island is indicated, but at low volumes (<2 m^3). Dampier Archipelago is unlikely to accumulate oil, despite the closer proximity due to the wind and current patterns in the area.

2. Summary of Entrained Oil Risks

- Entrained oil concentrations >100 ppb are most likely to occur in waters to the northeast of the spill site if spills begin in summer months, to the west and north if spills begin in transition months and to the west if spills begin in winter months.
- Entrained oil >100 ppb could occur in waters adjacent to a number of coastlines, including the Montebello Islands, Barrow Island, the Lowendal Islands, and Dampier Archipelago irrespective of the season.
- There is a very low probability (4%) of exposure to entrained oil at a concentration ≥100 ppb predicted for the Montebello Islands during summer. During the transitional months there is a 9% probability of exposure, and there is a predicted 21% probability of exposure during the winter months.
- There is a very low probability (3%) of exposure to entrained oil at a concentration ≥100 ppb predicted for the Dampier Archipelago during summer. During the transitional and winter months there is a <1% probability of exposure.
- Highest maximum entrained concentrations, at any water depth, are predicted to be ~2.5 ppm for waters adjacent to the Montebello Islands (for spills commencing during any season).

3. Summary of Risks for Dissolved Aromatic Hydrocarbon Concentrations

- Dissolved aromatic hydrocarbons concentrations ≥50 ppb are forecast to occur at low probabilities in patches in waters to the west and northeast of the spill site if a spill begins during summer or winter months and to the west and north if a spill begins during transition months.
- Contact by dissolved aromatic hydrocarbons ≥50 ppb is only predicted to potentially occur at waters offshore of the Montebello Islands, with a highest probability of 2% (transitional) (see and a highest maximum concentration of 113 ppb at any depth, predicted for summer.
- There is a very low probability (1-2%) of exposure to dissolved aromatics at a concentration ≥50 ppb predicted for the Montebello Islands and the Dampier Archipelago (<1%) over all seasons.

Assessment of Consequence

Sensitivities at risk within and adjacent to the Davros MC3D survey area in the scenario of an accidental release of marine diesel resulting from a vessel collision with the survey vessel are: protected marine fauna such as seabirds, cetaceans, whale sharks and turtles.

Protected Marine Fauna

The potential effects of a hydrocarbon spill on the marine environment varies greatly depending on factors such as the weather and sea state at the time of release, response measures, and the sensitivities of the habitats and species potentially affected. In the open ocean habitat where most survey activities will occur any spilled diesel fuel would be subject to rapid dispersal, weathering, evaporative losses and dissipation throughout the water column. Potentially affected biota includes seabirds, cetaceans, whale sharks and turtles that may come into contact with a surface diesel slick in the period prior to the disappearance of these slicks due to natural dispersion and evaporation. Contact with hydrocarbon slicks can have lethal or sub-lethal physical and toxic effects to seabirds, cetaceans, whale sharks and turtles due to external and internal exposure.

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. However, due to the characteristics of diesel and its rapid natural degradation and dispersion in the open ocean, the temporal and spatial extent of any adverse effects is likely to be limited. Air breathing fauna including cetaceans and turtles would be at greater risk through inhalation of hydrocarbons if they surfaced within a fresh slick, although the extent and duration of potential exposure would be limited due to the rapid evaporation rates for volatile components of diesel. Seabirds are particularly vulnerable to hydrocarbon spills owing to high potential for contact with the sea surface or shoreline where they feed, rest or moult. As most fish survive beneath floating slicks, they will continue to attract foraging seabirds, which typically do not exhibit avoidance behaviour. Whale sharks often feed on dense aggregations of prey (e.g. krill, bait fish) close to the sea surface and could therefore come into contact with surface diesel slicks. The low viscosity of diesel results in ready dispersion in the water column when winds reach 5-7 knots or with breaking waves and as the diesel is lighter than water, it remains as a slick on the sea surface.

Marine Turtles

Marine turtles are vulnerable to the effects of hydrocarbon spills at all life stages (eggs, post hatchlings, juveniles and adults) whilst in the water or onshore. Contact with hydrocarbons can have lethal or sub-lethal physical or toxic effects or impair mobility. Marine turtles are in frequent contact with the sea surface and they may also feed at or below the water surface or rest at the surface. This frequent contact with the sea surface and a lack of avoidance behaviour makes turtles susceptible to coating with spilled hydrocarbons and inhalation of toxic hydrocarbon vapours. On contact with surface slicks, turtles may experience irritation and injury to airways or lungs, eyes and mucous membranes of the mouth and nasal or other cavities.

Corals

The most vulnerable coral colonies to direct contact with surface slicks resulting from a diesel spill would be those close to the shoreline or periodically exposed at spring low tides. The potential for direct contact with surface slicks will be most pronounced when the presence of a slick coincides with periods when the reef top becomes tidally exposed, particularly at spring and low tides. This contact with corals would however, be expected to be temporary as the slick may be lifted off the reef top by the flooding tide. Below a depth of 3-4 m, coral colonies would be separated from surface slicks by the overlying waters. Although not subject to smothering by surface slicks, these sub-tidal corals may be subject to contact with dispersed hydrocarbon droplets (entrained oil) introduced into the water column by wave action on surface slicks. Experimental studies and field observations in the aftermath of hydrocarbon spills indicate contact with hydrocarbons may result in no observable injury through to complete or partial mortality of the colony with tissue death occurring on the coral colony's surface where oil has adhered. Tolerance varies among coral species, with for example, branching corals appearing to be among the more sensitive to injury on contact with hydrocarbons than other species with different coral growth forms.

Other than direct contact, exposure of sib-tidal corals to water soluble hydrocarbon fractions has the potential to result in lethal or sub-lethal toxic effects. Concentrations of dissolved hydrocarbon fractions can be expected to rapidly diminish with depth below surface slicks, thereby diminishing the susceptibility of corals to impacts with depth in the event of a surface spill. However, mixing of the water column under rough sea conditions can

lead to higher hydrocarbon concentrations at depth leading to a greater potential for toxicity effects to corals. Although exposure to hydrocarbon in the water column is much less than from direct contact with a slick, there is the potential for lethal impacts, particularly to some sensitive species. Impacts to corals will depend on species' tolerance as well as exposure concentrations and length of exposure.

Shorelines

The shorelines along the Montebello Islands are potentially at risk from surface diesel slicks or entrained hydrocarbons. 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 2012a). Shorelines exposed to diesel in Norway resulted in a thickness of 1-10 mm on shore following a diesel spill. Following clean up however, no significant difference between contaminated and reference uncontaminated locations were found.

Mangroves

"Oil slicks enter mangrove forests when the tide is high, and are deposited on the aerial roots and sediment surface as the tide recedes. This process commonly leads to a patchy distribution of the oil and its effects, because different places within the forests are at different tidal heights. It can be very difficult to assess the extent and distribution of oiling in a dense forest shortly after a spill, because oil on the ground can be invisible from the air if hidden by a closed forest canopy, and invisible from the sea if the seaward fringe has escaped contamination because of its lower tidal height. Mangroves can be killed by heavy or viscous oil that covers the trees' breathing pores thereby asphyxiating the subsurface roots which depend on the pores for oxygen. Mangroves can also be killed through the toxicity of substances in the oil, especially lower molecular weight aromatic compounds, which damage cell membranes in the subsurface roots. This in turn impairs the normal salt exclusion process, and the resulting influx of salt is a source of stress to the plants.

The organisms among and on the mangrove trees are affected in two ways. First, there may be heavy mortalities as a direct result of the oil. For example, oil may penetrate burrows in the sediments, killing crabs and worms, or coat molluscs on the sediment surface and aerial roots. Second, dead trees rot quickly, leading to loss of habitat for organisms living in the branches and canopy of the trees, and in the aerial root systems. Over time several factors reduce the toxicity of oil that has been deposited in mangrove forests. The amount of oil in the soil is reduced by rain and tides. In addition the oil weathers, a process in which some of the more toxic volatile fractions evaporate, and chemical changes such as oxidation make the residual oil less toxic. Eventually the soil can support mangrove growth once more, with the time-scale involved varying according to local conditions such as the amount of water circulation in the immediate area. Oil degradation can be rapid in the tropics and there are instances of natural seedling establishment and growth in oiled soil within a year of a spill."

Socio-economic Environment

As described in **Section 2.4.1**, the main commercial fisheries that will be operating in the area overlapped by the Davros MC3D survey area include the MMF, PFTIMF, PTMF, PLF and WCDSCF. It is possible fishing operations in the MMF and the Pilbara Demersal Fisheries could operate in the vicinity of the Davros MC3D MSS area. The WCDSCF operates in the shelf edge waters greater than 150 m but primarily within water depths of 500 - 800 m. Therefore, the potential impacts from a surface slick would be indirect – i.e. exclusion of fishers from areas they normally fish due to the presence of surface diesel slicks, and/or oiling of vessel hulls and trap gear (traps, buoys, lines) if the equipment is deployed or retrieved through surface slicks. Direct (toxicity) effects on target species would not occur, as the target species forage and breed close to hard substrate features on the seabed. The catch is not likely to be directly impacted as the diesel fuel would form a surface slick and fish are mobile and routes of exposure to organisms living in the water column or on the ocean floor would be limited.

The potential for impacts to other socio-economic sensitivities and values within or adjacent to the survey area is limited, due to the low frequency or absence of other marine users (shipping, tourism, recreational fishing etc.) in the offshore waters where the proposed seismic acquisition activities will take place. The highest risk

of potential impacts to socio-economic sensitivities and values probably occurs in waters adjacent to the southwest boundary of the survey area, due to the proximity of the Montebello Island Marine Management Area and shallower water depths of <40 m.

There are no shallow water (<20 m water depth) or emergent features within the Davros MC3D MSS area or surrounding waters. The closest shoreline is North West Island, part of the Montebello Island group, and located ~ 6 km to the south.

Pearl Culture Activities

If a surface slicks and entrained hydrocarbons resulting from a large diesel spill during the Davros MC3D survey were to enter the shallow waters (<20 m water depths) around the Montebello Islands, pearl culture activities (grow-out of pearls on pearl farm leases) could be significantly impacted. Paspaley Pearling Company hold 14 lease areas in the Montebello Islands, covering approximately 550 ha. They also have a quarantine site in Claret Bay, which is used for any shell which is imported from outside the DoF pearling zone (DEC 2007). Surface diesel slicks or entrained hydrocarbons could impact these pearl aquaculture activities in the following ways:

- direct effects on the pearl oysters themselves (lethal or sub lethal);
- direct effects on the aquaculture operations (oiling of fixed equipment such as cages, racks, buoys, lines, vessel hulls and other equipment); and
- indirect effects through ecosystem disturbance (e.g. impacts on food chains).

The direct effects of oil on inshore shellfish beds, and fish and shellfish in aquaculture units is an issue of particular concern. There is evidence that wild fish are able to detect and avoid oil-contaminated waters, but captive fish and shellfish are unable to swim away into unpolluted areas. There are documented instances of oil spills in which shellfish have been killed in significant numbers (e.g. clams following the *Arrow* and *Amoco Cadiz* spills). The presence of oil pollutants may significantly add to the stresses already imposed by keeping animals in artificial conditions.

Oysters can be exposed to oil through dermal contact, feeding and respiration in all life stages and through filtration (feeding) for adult life stages. Direct impacts on eggs and larval survival, or changes in the ecosystem that support the oyster (e.g. reduced water quality) due to oil impacts, also constitute modes of exposure. Adult oysters may experience reduced growth and reproductive impairment when exposed to oil. Exposure to water quality changes has both direct and indirect impacts on adult oysters as well as on eggs and larval survival. Exposure to water quality changes can also adversely impact the health of oyster habitat and the ecosystem that supports oysters.

Polycyclic aromatic hydrocarbons (PAHs) and other chemicals can accumulate in the tissues of pearl oysters, inhibiting their metabolism and growth rates, and their ability to produce pearls. Exposure to low concentrations of PAHs causes oysters to work harder to feed, leaving less energy for other functions such as growth.

Mitigation and Management Measures

With the mitigation and management measures put in place the risk of an oil spill is very low. See **Table 4.3** for the systems, practices and procedures will be implemented during this activity to ensure that the impacts and risks associated with accidental discharge of fuel and oil are continuously reduced to ALARP.

Residual Risk Level

The residual risk ranking for this potential impact is **Medium** (**Table 4.3**).

4.3.6.3. Vessel Collisions

Potential Impacts

The potential environmental impact as a result of a significant vessel collision could cause localised chronic/acute toxicity effects on marine organisms from a hydrocarbon spill. However, it is highly unlikely that

such a collision would occur during the Davros MC3D MSS, as the survey and support vessels will be required to adhere to standard maritime safety and navigational procedures, such as use of lights, beacons, notification of vessel presence via Notice To Mariners (NTM), radio contact and through use of the support vessel.

Mitigation and Management Measures

See **Table 4.3** for the systems, practices and procedures will be implemented during this activity to ensure that the impacts and risks associated with vessel collision are continuously reduced to ALARP.

Residual Risk Level

The residual risk ranking for this potential impact is **Medium** (**Table 4.3**).

4.3.7. DISTURBANCE TO SOCIAL AND COMMUNITY VALUES

4.3.7.1. Commercial Fishers

Potential Impacts

As described in **Section 2.4.1**, there is only limited commercial fishery activity in the area of the proposed Davros MC3D survey.

Disruption to commercial fisheries in the area could result from:

- direct effects of underwater noise disturbance on target fish populations;
- indirect effects of underwater noise disturbance on fish prey species;
- restriction of access to fishing grounds due to vessel movements and operations;
- seismic equipment loss and subsequent interference with fishing gear (entanglement);
- loss of fishing gear e.g. buoyed fish traps; and
- recreational take of finfish species from the survey and support vessels.

The risk of potential impacts to commercial fisheries in or adjacent to the survey area for the Davros MC3D MSS is considered to be minimal, given the small number of fishing vessels operating in the area, (the ONPR, NBPR, and POMF fisheries are not actively fishing within the Davros MC3D MS survey area). Fishing companies and individual licence holders operating in the MMF, NBPR, ONPR, PFTIMF, PTMF, PLF, POMF and WCDSCF have been contacted by CGG directly and via the appropriate peak fishing industry organisations, and informed of the location and timing of the survey (see **Section 8**). CGG will continue to liaise and inform stakeholders of vessel operations within the Davros MC3D MSS throughout the entire duration of the project as part of the ongoing consultation process for the activity (see **Section 8.3**).

There will be no discharge of the seismic source (‘no firing zone’) within 1,500 m of the 50 m isobath around Glomar Shoals

Mitigation and Management Measures

See **Table 4.3** for the systems, practices and procedures will be implemented during this activity to ensure that the impacts and risks to commercial fishery activities are continuously reduced to ALARP.

A Safe Navigation Area (SNA) (exclusion zone for other vessels) will be in place for the duration of the Davros MC3D survey. The extent of this SNA will be determined in-field (depending on the frequency of encounters with commercial fishing vessels and shipping) upon commencement of the survey. The SNA is likely to cover at least an 10.1 km radius from the survey vessel, to account for the length of the towed streamer spread (8 km), plus an additional 2 km. The support vessels will be used to implement this exclusion zone if approaching vessels fail to heed navigational warnings (NTM, beacons, lights, radio contact).

Residual Risk Level

The residual risk ranking for this potential impact is **Low** (**Table 4.3**).

4.3.7.2. Shipping

Potential Impacts

Shipping activity in the survey area and surrounding waters is moderate (see **Section 2.4.4**). The survey vessel and towed array represent a potential navigational hazard and other vessels will need to avoid the seismic vessel to prevent collisions, entanglement of streamers, and other incidents. Any vessels contracted by CGG are required to comply with MARPOL requirements and other applicable maritime laws and will need to operate strictly in accordance with SOP for marine operations. Loss of equipment may interfere with shipping activity.

Mitigation and Management Measures

See **Table 4.3** for the systems, practices and procedures will be implemented during this activity to ensure that the impacts and risks to shipping activities are continuously reduced to ALARP.

Residual Risk Level

The residual risk ranking for this potential impact is **Low** (**Table 4.3**).

4.3.7.3. Heritage and Conservation Values

Potential Impacts

There are no places listed on the Commonwealth Heritage List or the Register of National Estate within or immediately adjacent to the Davros MC3D MSS area. The nearest Commonwealth Heritage site to the survey area is the Ningaloo Marine Area - Commonwealth Waters, which is located ~205 km to the southwest of the southwest corner of the survey area (see **Section 2.4.5 to 2.4.9**)

The Davros MC3D MSS overlaps the MUZ of the Montebello Commonwealth Marine Reserve. It is unlikely the Davros MC3D will impact on the heritage and conservation values of the protected area due to the application of the mitigation and management measures as outlined below. Given the location of the survey area in offshore waters, seabed and Demersal fish communities are not at risk from diesel slicks, or entrained/dissolved hydrocarbons resulting from accidental releases.

Mitigation and Management Measures

See **Table 4.3** for the systems, practices and procedures will be implemented during this activity to ensure that the impacts and risks to heritage and conservation values are continuously reduced to ALARP.

Residual Risk Level

The residual risk ranking for this potential impact is **Low** (**Table 4.3**).

4.3.8. Summary of environment risk assessment for the Davros MC3D survey

The risk assessment indicates that the potential impacts arising from the proposed Davros MC3D MSS can be categorised as having Low to Medium risk levels. No risks were assessed as High. **Table 4.3** presents a summary of the assessed level of residual (post-mitigation) environmental risk associated with the proposed seismic survey. The environmental aspects of the survey that have the potential to cause significant environmental effects (Medium or High risk levels) have been determined through an evaluation of the proposed activity, the surrounding environment including specific sensitivities and values, and legislative requirements.

These environmental aspects are:

- Accidental discharge of hazardous materials.
- Accidental fuel and oil spills from the survey vessel.
- Vessel collisions resulting in fuel and oil spills.

In this case a number of additional control measures were also assessed, and were found to be not practicable—i.e. the cost, time and effort required to implement the measure is grossly disproportionate to the benefit gained. The assessment of these additional control measures are in shown in **Table 5.2**.

Table 4.3 - Summary of environment risk assessment for the Davros MC3D survey

Hazard	Environmental aspect	Potential environmental impacts	Risk				
			Consequence of impact	Likelihood of the identified consequence	Residual risk level	Assessment section	Management strategy
Disturbance to marine fauna	Discharge of underwater seismic pulses	Behavioural and physiological effects on cetaceans, whale sharks, turtles and fish	Slight	Possible	**Low**	**6.1.1**	**M1**
		Physiological effects on benthic invertebrates and plankton	Slight	Possible	**Low**	**6.1.1**	
	Light generation from vessels	Behavioural effects on dolphins, turtles, fish and seabirds	Slight	Possible	**Low**	**6.1.2**	
	Vessel and towed equipment interactions	Behavioural and physical effects on cetaceans, whale sharks and turtles	Minor	Possible	**Low**	**6.1.3**	
Disturbance to benthic habitats	Deployment and retrieval of anchors	Localised physical damage to benthic habitats	Slight	Possible	**Low**	**6.2.1**	**M2**
	Vessel grounding		Minor	Unlikely	**Low**	**6.2.2**	
	Equipment damage, dragging or loss		Slight	Possible	**Low**	**6.2.3**	
Atmospheric emissions	Operation of machinery and vessels powered by internal combustion engines	Localised reduction air quality Greenhouse gas emissions	Slight	Likely	**Low**	**6.3.1**	**M3**
Invasive marine species	Discharge of ballast water from vessels	Introduction and establishment of IMS and displacement of native marine species	Minor	Possible	**Low**	**6.4.1**	**M4**
	Biofouling of vessel hulls, other niches and immersible equipment		Minor	Possible	**Low**	**6.4.2**	
Marine pollution from routine discharges	Discharge of sewage, grey water and putrescible wastes	Localised reduction in water quality due to nutrient enrichment	Slight	Routine	**Low**	**6.5.1**	**M5**
	Discharge of bilge water	Acute toxicity effects on marine fauna and flora Localised reduction in water quality	Slight	Possible	**Low**	**6.5.2**	
	Discharge of other wastes i.e. garbage	Localised reduction in water quality Physical impacts on marine fauna i.e. from plastics	Minor	Possible	**Low**	**6.5.3**	
Marine pollution from accidental discharges	Hazardous materials	Toxic effects on marine fauna and flora Localised reduction in water quality Indirect effects on commercial fisheries	Moderate	Possible	**Medium**	**6.6.1**	**M6**
	Fuel and oil spills		Moderate	Possible	**Medium**	**6.6.2**	

Hazard	Environmental aspect	Potential environmental impacts	Risk				
			Consequence of impact	Likelihood of the identified consequence	Residual risk level	Assessment section	Management strategy
	Vessel collisions		Moderate	Unlikely	**Medium**	**6.6.3**	
Disturbance to social and community values	Interaction with commercial fisheries	Disruption to commercial fishing vessels Potential direct and indirect noise impacts on target species Restriction of access to fishing grounds, loss/damage to gear Recreational take of finfish species	Minor	Possible	**Low**	**6.7.1**	**M7**
	Interaction with shipping	Disruption to shipping activities	Slight	Possible	**Low**	**6.7.2**	
	Operation of vessels within protected areas and heritage places	Disturbance to heritage and conservation values	Slight	Possible	**Low**	**6.7.3**	

4.4. IMPLEMENTATION STRATEGY

4.4.1. Environmental Management Framework

The design and execution of the proposed Davros MC3D MSS will be conducted under the framework of the CGG Environment Policy and CGG HSE Management System. The programme will also operate under CGG Event Management Standard Operating procedure (MAR QPM PRC 005E) and a project-specific HSE Plan. To ensure CGG's environmental management standards and performance outcomes are achieved, Volstad Maritime AS will be required to comply with all relevant requirements of CGG's HSE systems/policies and standards.

CGG and its contractor will apply a tiered approach to optimising the environmental performance of the project and ensuring that CGG's environmental management standards and performance outcomes 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.

A series of work instructions, procedures and plans will be used for the Davros MC3D MSS 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 CGG as well as documents written specifically for the Davros MC3D MSS. Many of the procedures apply to all vessels in the CGG fleet. However, the associated work instructions are generally vessel specific.

The contractor specific documentation will be updated in accordance with the EP and other client requirements. The Project HSE Plan, which compliments this EP, includes procedures for the following:

- Emergency response;
- Waste management;
- Hazardous materials and handling; and
- Fuel/oil spills.

The Implementation Strategy for the EP includes an outline of:

- Environmental management strategies.
- Roles and responsibilities.
- Training and competency.
- Monitoring.
- Auditing.
- Management of non-conformance.
- Record keeping.
- Emergency response and contingency planning.
- EP review.

4.4.2. Management Strategies

This section of the EP outlines the management strategies in place to ensure that the environmental impacts and risks associated with the activity are continuously reduced to ALARP (as low as reasonably practicable), and to ensure compliance with all relevant legislation.

Environmental management strategies have been formulated to address the identified environmental hazards for the survey, categorised in the following groups:

- Disturbance to Marine Fauna.
- Disturbance to Benthic Habitats.
- Atmospheric Emissions.
- Invasive Marine Species.
- Marine Pollution from Routine Discharges.
- Marine Pollution from Accidental Discharges.
- Disturbance to Social and Community Values.

The environmental management strategies incorporate the environmental performance outcomes (EPO), environmental performance standards (EPS) and measurement criteria (MC) referred to in Division 2.3, Clause 13(7) of the Environment Regulations. The EPO defined in the environmental management strategies are based on the identified environmental aspects, associated environmental impacts and the assessed risks, corporate policies and performance commitments, and applicable regulatory requirements.

4.4.3. ALARP Demonstration

Regulation 10A (b) of the Environment Regulations require a demonstration that environmental impacts are reduced to ALARP.

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) has been adapted from the UKOOA Industry Guidelines on a Framework for Risk Related Decision Support.

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

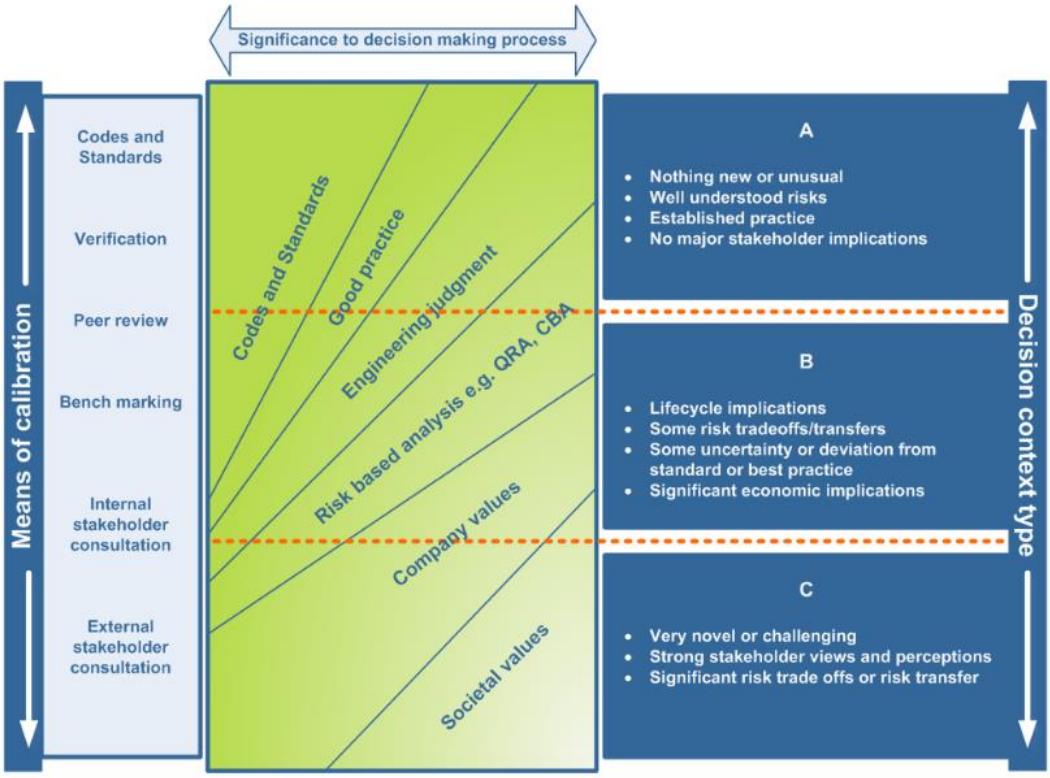
- Determine the relative importance of the various methods of assessing risk (e.g. by reference to standards, cost benefit analysis (CBA), or societal values).
- Judge which of these methods is best placed to determine whether the risks are tolerable and ALARP.

Figure 4.2 illustrates the UKOOA framework.

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

- Codes and Standards.
- Good Practice.
- Engineering Judgment.
- Risk Analysis.
- Company Value.
- Societal Values.

Figure 4.2 - Risk related decision support framework



Source: NOPSEMA (2011).

A summary of the application of these decision making tools and protocols in relation to the different levels of risk identified in **Table 4.3** of this EP is provided in **Table 4.4**.

Table 4.4 - Decision making tools and protocols

Risk rating	Decision making tools	Decision making protocols
Low Risk (Acceptable Zone)	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 "Acceptable" and the control measures are consistent with applicable standards and 'good oilfield 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 Risk (ALARP Zone)	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 "Acceptable" zone. However, if the risk associated with a hazard cannot be reasonably reduced to the "Acceptable" zone without grossly disproportionate sacrifice; then the mitigated environmental risk is considered to be ALARP.
High Risk (Intolerable and Unacceptable Zone)	All of above decision-making tools apply plus consideration of company values and societal values	If the environmental risk of the hazard 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.

The risk assessment approach described above implies a level of proportionality wherein the principles of decision making applied to each particular impact category (or hazard) are proportionate to acceptability of environmental risk of that potential impact. The decision making principles for each level risk are based on the precautionary principle (as defined in the EPBC Act) and provide assurance that the environmental impacts and risks are of an acceptable level and reduced to ALARP.

For the purposes of determining whether the identified risks associated with the Davros MC3D MSS have been reduced to ALARP, the "decision context" for each of the risks identified in the survey ERA was reviewed. All of the risks associated with the survey (see **Table 4.3**) correspond to the description of Decision Context Type "A" (see **Figure 4.2**) - i.e. they do not represent anything new or unusual; are well understood risks; control measures represent established "good practice"; and there are no major stakeholder implications.

The control measures described in **Table 5.1** have been assessed for practicability. All represent existing, recognised 'good practice', have been found to be practicable, and accordingly, will be implemented during the survey.

From the ERA process there were three environmental aspects assessed as having a Medium level of risk (accidental discharge of hazardous materials; accidental fuel and oil spills from the survey vessel; and vessel collisions resulting in fuel and oil spills). All three of these aspects are associated with one hazard (marine pollution from accidental discharges), which falls into the ALARP Zone (see **Table 4.2**). In this case a number of additional control measures were also assessed, and were found to be not practicable—i.e. the cost, time and effort required to implement the measure is grossly disproportionate to the benefit gained. The assessment of these additional control measures are in shown in **Table 5.2**.

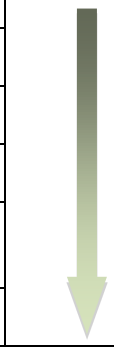
When formulating control measures for each environmental hazard, the 'Hierarchy of Controls' philosophy is applied. The Hierarchy of Controls is a system used in industry to minimise or eliminate exposure to hazards, and is part of CGG's HSE Management System. The Hierarchy of Controls are, in order of effectiveness:

- Eliminate;
- Substitute;
- Engineer;
- Isolate;
- Administration; and
- Protection.

Although commonly used in the evaluation of occupational health and safety (OHS) hazard control, the Hierarchy of Controls philosophy is also a useful framework to evaluate potential environmental controls to ensure reasonable and practicable solutions have not been overlooked.

Treatments considered by CGG to be reasonably practicable have been implemented, while those considered to be not reasonably practicable have not been implemented, and a description of the justification for this position is provided in the EP a manner consistent with the Hierarchy of Controls, shown in **Table 4.5**. The assessment of additional control measures that were found to be not practicable are in shown in **Table 5.2**.

Table 4.5 - Hierarchy of Controls

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).

4.4.4. Demonstration of Acceptability

Regulation 10A(c) of the Environment Regulations requires a demonstration that environmental impacts are of an acceptable level.

CGG considers a range of factors when evaluating the acceptability of environmental impacts and risks associated with its activities. This evaluation works at several levels, as outlined in **Table 4.6**

Table 4.6 - Acceptability test

Test	Question	Acceptability demonstrated
Policy compliance	Is the proposed management of the impact or risk aligned with the CGG Environment 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 CGG Environment Policy and HSE management system?	Where specific CGG 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, and 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, which includes that ESD principles be integrated into company decision-making.	The Davros MC3D 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.

A description of demonstration of acceptability has been undertaken in the Davros Environment Plan in a manner consistent with the Acceptability test, as shown in **Table 4.6**.

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*. CGG will adhere to the EPBC Act 2.1- Part A Standard Management Procedures and selected Part B Additional Management Measures.

Two dedicated, expert Marine Fauna Observers (MFOs) will be aboard the survey vessel for the duration of the Davros MC3D MSS. The key role of the MFOs will be to monitor the waters around the survey vessel for the presence of cetaceans, whale sharks and turtles during daylight hours. The MFOs will be responsible for ensuring that the management and mitigation procedures are implemented and followed correctly during survey activities. The MFOs will also be responsible for recording any cetacean, turtle and whale shark sightings during the survey on the appropriate sightings forms, using the DoE CSA database.

The survey will be conducted in water of ~20 m to ~300 m and in an area that is adjacent to islands that are important nesting areas for turtles, the density of animals in the vicinity of the Davros MC3D MSS area is likely to be low, given the management measures (acquisition buffer/exclusion zone from nesting areas during peak nesting periods) that are being applied to the survey. (20 km exclusion area for peak nesting periods for green and hawksbill turtles and the 80 km exclusion area for peak nesting periods for flatback turtles).

It is possible that seabirds may fly over the survey area. However, it is not anticipated that the seismic survey will have any impact on any species of seabird, due to their mobility and distance of the survey area to any nesting sites for seabirds. For example, Montebello Islands (~6 km), Barrow Island (~38 km) and the Muiron Islands (~180 km) all located to the southwest of the survey area.

The survey is unlikely to have any significant effects on benthic communities due to the water depths across the survey area. The support vessel will scout ahead confirming water depth prior to survey vessel passing and the survey and support vessel will not enter WA State waters or shallow waters <20 m water depth adjacent to the Montebello Islands Marine Park. In shallow waters steamers will be towed at a depth that will not allow streamers to be closer than 10 m from the seabed. Anchoring of the survey or support vessel(s) will only occur in emergency circumstances and vessels are fitted with highly sophisticated position fixing equipment. At sea refuelling of the survey vessel will only take place during daylight hours, and will not take place within a distance of 25 km from any emergent land or shallow (<20 m water depth) water features. There will be no close proximity operations / activities (such as bunkering, supply or equipment transfer, crew change, unless in case of emergency) undertaken within 1,500 m of the 50 m isobath surrounding Glomar Shoals and the shallow water zone adjacent to the Montebello Islands Marine Park.

The survey-specific hydrocarbon three-dimensional oil spill modelling spill risk assessment, which was conducted as part of the evaluation of environmental impacts and risks for the proposed survey, indicated that the probability of surface diesel slicks contacting the Montebello Islands, and the Dampier Archipelago is significantly lower during the summer months (December to February) than during the winter months (April to August). With the mitigation and management measures put in place the risk of an oil spill is very low.

Implemented control measures documented in Table 5.1 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 activity of impact. Given the control measures that will be implemented for environmental aspects of the survey, the risk of significant adverse environmental effects from the proposed Davros 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.

5. SUMMARY OF THE CONTROL MEASURES FOR THE ACTIVITY

Table 5.1 - Summary of the control and mitigation and management measures for key aspects of the Davros MC3D MSS

Impact Category	Potential Impacts	Control and Mitigation Measures	Residual Risk Level

Disturbance to marine fauna	•Behavioural and physiological effects on cetaceans, whale sharks, turtles and fish (underwater seismic pulses)
	
	•Behavioural effects on dolphins, turtles, fish and seabirds (light emissions)
	
	•Behavioural and physical effects on cetaceans, whale sharks and turtles (vessel and towed equipment interactions)
		• Adherence to EPBC Act Policy Statement 2.1, with application of 2 km low power zone for entire duration of survey
		• Adherence to specific Part B Additional Management Measures of the EPBC Act Policy Statement 2.1, as specified in the Decision Instrument, Particular Manner Conditions (EPBC 2013/7092), this includes:
		  ○ Mitigation measures for night-time or during low visibility conditions
		  ○ Temporal and spatial limitations to acquisition adjacent to turtle BIA's during peak turtle nesting seasons - Seismic operations must not occur within the BIA for Green Turtle (Chelonia mydas), Hawksbill Turtle (Eretmochelys imbricata) and Loggerhead Turtle (Caretta caretta), during the peak nesting period for these species between 1 October to 28 February and for the Flatback Turtle (Natator depressus) during the peak nesting period between 1 December and 31 January
		  ○ Application of precautionary principle: 500 m shutdown zone 1 August – 31 October for whale sharks
		  ○ 50 km buffer between concurrent seismic operations during the period of 1 June to 30 November - to minimise cumulative impacts to humpback whales
		• Use of two MFO for entire duration of survey
		• Pre-survey induction includes coverage of EPBC Act Policy Statement 2.1 requirements
		• No discharge of the seismic source ('no firing zone') within 1,500 m of the 50 m isobath around Glomar Shoals
		• The survey and support vessel will not enter WA State waters or shallow waters <20 m water depth, adjacent to the Montebello Islands Marine Park
			Low

Impact Category	Potential Impacts	Control and Mitigation Measures	Residual Risk Level

		• Vessel Master will ensure that external lighting of survey vessel is minimised to that required for navigation, vessel safety, safety of deck operations, except in the case of an emergency
		• The survey will be conducted in water depths of ~20 m to ~300 m and away from any shallow water areas that may be important for marine turtle nesting, foraging
		• Adherence to the Australian National Guidelines for Whale and Dolphin Watching
		• Application of support vessel-marine fauna interaction procedures
		• Use of streamer tail buoys fitted with appropriate turtle guards, if required
		• Application of relevant CGG procedures and work instructions:
		  ○ Environment Management (GRP HSE GEI 07E)
		  ○ Soft Start Procedure (MAR HSE PRC 012E)
		  ○ Standard Operating Procedure (MAR HSE PRC 014E - Contingency Procedure for Marine Animal Event)
		  ○ Minimizing Acoustic Disturbance to Marine Life (MAR HSE PRC 013E)	

Disturbance to benthic habitats	•Localised physical damage to benthic habitats	• Anchoring in survey area will not be undertaken due to water depths across the area (~20 m to ~300 m)
		• Anchoring in shallow waters near shoals (e.g. reefs, islands or Pilbara coastline will only occur in an emergency. All measures will be taken to avoid sensitive benthic habitats (corals, seagrasses, macroalgal beds)
		• Use of approved navigation systems and depth sounders
		• Support vessel will scout ahead confirming water depth prior to survey vessel passing
		• The survey and support vessel will not enter WA State waters or shallow waters <20 m water depth, adjacent to the Montebello Islands Marine Park
		• Where possible in-water equipment lost will be recovered
		• In shallow waters steamers will be towed at a depth that will not allow streamers to be closer than 10 m from the seabed
		• Application of relevant CGG procedures and work instructions:
		  ○ CGG Environment Management General Instruction (GRP_HSE_GEI_07E)
		  ○ CGG APAC Marine Contingency Management Planning (MAR HSE PRC 010E)
		  ○ Close Approach Of A Natural Obstacle (MAR SEO PRC 010E)
			Low

Impact Category	Potential Impacts	Control and Mitigation Measures	Residual Risk Level
		○ CGG Technical Note Drifting Streamer Recovery to Chaseboat (MAR INS TEN 027E) ○ Work Instruction for an Incident Situation with Towed Equipment (MAR MSS MNL 002E)	
Atmospheric emissions	•Localised reduction air quality •Greenhouse gas emissions	• Adherence to Marine Orders – Part 97 • Implementation of Planned Maintenance System (PMS) aboard survey vessel • Use of low sulphur diesel fuel • Incinerator compliant with MARPOL Annex VI requirements • Implementation of Ship Energy Efficiency Management Plan (SEEMP)	**Low**
Introduction of invasive marine species	•Introduction and establishment of invasive marine species and displacement of native marine species	• Adherence to Marine Orders – Part 98 • No routine discharge of ballast water from survey and support vessels • Adherence to Australian Ballast Water Management Requirements • Recent dry-dock, hull inspection/cleaning and AF coating application for survey and support vessels • AF coating meets IMO 2001 Convention requirements • Survey and support vessel will have worked only in Australian waters prior to commencement of survey • Survey and support vessels will have all necessary AQIS clearances to operate unrestricted anywhere in Australian waters	**Low**
Marine pollution from routine discharges	• Localised reduction in water quality • Acute toxicity effects on marine fauna and flora • Physical impacts on marine fauna i.e. from plastics	• Adherence to Marine Orders – Part 96 • All sewage and putrescible wastes handled and disposed of in accordance with MARPOL Annex IV requirements • Application of sewage and putrescible wastes treatment and discharge requirements: ○ Sewage and putrescible wastes macerated where possible prior to disposal. ○ no discharge of sewage or putrescible waste within 12 nm of the Montebello Islands Marine Park. ○ Discharge restrictions for treated versus non-treated sewage (treated >3 nm from land; non-treated >12 nm from land). • Survey vessel equipped with grinder/comminuter for maceration of sewage and putrescible wastes	**Low**

Impact Category	Potential Impacts	Control and Mitigation Measures	Residual Risk Level

		• Survey vessel equipped with IMO approved / MARPOL compliant sewage treatment system (including biological reduction and disinfection prior to discharge)
		• Provision of appropriate segregation facilities on survey vessel including tanks for storage of grey and black water
		• Bilge water treated and disposed of in accordance with MARPOL Annex I requirements
		• Application of bilge water treatment and discharge requirements: Bilge water contaminated with hydrocarbons must be contained and disposed of onshore, except if the oil content of the effluent, without dilution, does not exceed 15 ppm or an IMO approved oil/water separator is used to treat the bilge water. The vessel must not be stationary when undertaking discharge.
		• Bilge water contaminated with chemicals must be contained and disposed of onshore, except if the chemical is demonstrated to have a low toxicity
		• Provision of appropriate segregation facilities on survey and support vessel, including tanks for storage of bilge water
		• Adherence to Marine Orders – Part 95
		• Garbage handled and disposed of in accordance with MARPOL Annex V requirements
		• Application of garbage, solid and liquid wastes handling and disposal requirements:
		  ○ No discharge of plastics or plastic products of any kind from survey or support vessel
		  ○ No discharge of domestic wastes or maintenance wastes from survey and support vessel
		  ○ All waste receptacles aboard survey and support vessel covered with tightly fitting, secure lids to prevent any solid wastes from blowing overboard
		  ○ All solid, liquid and hazardous wastes (other than sewage, grey water and putrescible wastes) will be incinerated or compacted (if possible) and stored in designated areas and sent ashore for recycling, disposal or treatment
		  ○ Hydrocarbons located above deck stored with some form of secondary containment to contain leaks or spills (e.g. bund, containment pallet, transport packs)
		  ○ Correct segregation of solid and hazardous wastes	

Impact Category	Potential Impacts	Control and Mitigation Measures	Residual Risk Level
		○ Incinerator will be operated in accordance with established operating procedures that align with manufacturers specifications by trained personnel • Provision of appropriate segregation facilities on survey and support vessel including integral waste oil tank for oils and sludge • Application of relevant CGG procedures and work instructions: ○ CGG Environment Management General Instruction (GRP HSE GEI 07E) ○ Survey Vessel Garbage Management Plan ○ Survey Vessel Handling and Storage of Dangerous Products Procedure	
Marine pollution from accidental discharges	•Acute toxicity effects on marine fauna, such as marine turtles, fishes and seabirds, from accidental discharges of hazardous materials	• Adherence to Marine Orders – Part 94 • All chemical and hazardous wastes will be segregated into clearly marked containers prior to onshore disposal • 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 • All hazardous substances will have an MSDS in place that is readily available aboard the survey and support vessels • Application of relevant CGG procedures and work instructions: ○ CGG Environment Management General Instruction (GRP HSE GEI 07E) ○ Survey Vessel Handling and Storage of Dangerous Products Procedure	**Medium**
	•Acute toxicity effects on marine fauna from fuel and oil spills	• No close proximity operations / activities (such as bunkering, supply or equipment transfer, crew change, unless in case of emergency) will be undertaken within 1,500	**Medium**

		m of the 50 m isobath surrounding Glomar Shoals and the shallow water zone adjacent to the Montebello Islands Marine Park (see **Figure 3.1**)
		• Adherence to Marine Orders – Part 21, Part 30, Part 59, Part 91, and COLREGS
		• SOPEP implemented and tested for survey vessel. Drill conducted in Australian waters prior to survey or during project mobilisation phase prior to commencement of operations of the survey
		• At least one SOPEP drill will be conducted aboard the survey vessel during the survey
		• A SOPEP drill will be conducted aboard the survey vessel prior to commencement of the Davros MC3D MSS and then at three monthly intervals (which is a SOP) during the course of the survey
		• Spill response bins/kits located in close proximity to hydrocarbon storage areas
		• The kits will be checked for their adequacy and replenished as necessary prior to the commencement of activities and on a regular basis thereafter. Identified personnel will be trained in the use of this equipment, via the SOPEP drills
		• Issuing of appropriate NTM by the AHS
		• Approval must be obtained from the Vessel Operations Manager before any at sea refuelling can proceed
		• AMSA notified (via phone call) prior to the commencement of all bunkering operations.
		• Refuelling at sea subject to CGG Bunkering Offshore Instruction (MAR MSS PRC 007E), and specific additional requirements:
		  ○ application of 25 km exclusion zone from emergent land or shallow water features (20 m or less depth) for at sea refuelling operations
		  ○ refuelling of vessels will be undertaken under favourable wind and sea conditions as determined by the vessel Masters;
		  ○ refuelling will take place during daylight hours only;
		  ○ Job Hazard Analysis (JHA) or equivalent in place and reviewed before each fuel transfer;
		  ○ all valves and flexible transfer hoses checked for integrity prior to use;
		  ○ dry break couplings (or similar) in place for all flexible hydrocarbon transfer hoses	

Impact Category	Potential Impacts	Control and Mitigation Measures	Residual Risk Level

		• In the event of any fuel or oil spills to sea SOPEP / OPEP procedures will be followed for notification and consultation with AMSA and DoT, to ensure prompt and appropriate mobilisation of NATPLAN or MOSCP as appropriate
		• When a fuel/oil spill to sea occurs the vessel Master will inform the RCC Australia using POLREP. RCC Australia, in turn, notify AMSA and/or DoT
		• Type I Operational Monitoring implemented for spill surveillance and tracking
		• Allow small diesel spills to disperse and evaporate naturally, and monitor position and trajectory of any surface slicks
		• Physical break up (using propwash from the support vessel) by repeated transits through slick may be considered for larger diesel slicks (after consultation with relevant Combat Agency – AMSA or DoT)
		• Implementation of NATPLAN (by AMSA) or MOSCP (by DoT), if required
		• AMSA and DoT consulted to ensure agreement in place for SOPEP interface with NATPLAN and MOSCP
		• Notification and engagement with appropriate stakeholders identified in this EP
		• Stakeholders (identified in Section 6.6.2) contacted for the development of a Type II scientific monitoring plan that would be applied in the event of a large diesel spill from the Davros MC3D survey impacting upon the Montebello Islands Marine Park
		• CGG 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
		• CGG has insurance policies in place to cover the cost of environmental monitoring or clean-up post spill
		• Application of relevant CGG procedures and work instructions:
		  ○ CGG Event Management Standard Operating Procedure (MAR QPM PRC 005E)
		  ○ CGG APAC Marine Contingency Management Planning (MAR HSE PRC 010E)
		  ○ CGG Environment Management General Instruction (GRP HSE GEI 07E)
		  ○ CGG Support Vessel Operations Manual (MAR MNL 01E)
		  ○ CGG Chase Vessel Operations Manual (MAR MSS MNL 002E)	

Impact Category	Potential Impacts	Control and Mitigation Measures	Residual Risk Level
Interaction with commercial fisheries and shipping activities	•Interference to commercial fishing vessels and shipping operating within or near the survey area and surrounding waters Potential direction and indirect noise impacts on target species Restriction of access to fishing grounds, loss or damage to fishing gear	• Adherence to Marine Orders – Part 21, Part 30, Part 59, and COLREGS • Consultation with AMSA (Nautical Advice) prior to survey commencing to determine level of commercial shipping in the vicinity of survey area • Notification of activity details to relevant commercial fisheries management agencies, fishing industry bodies and individual companies and licence holders that were identified in the stakeholder consultation process three weeks prior to the survey commencing, to inform them about the location of the survey area, survey and support vessel specifications, timing of operations (phases of acquisition), contact phone numbers, map of the area surrounding Glomar shoals where there will be no discharge of the acoustic source and to ascertain if proposed operations overlaps any key fishing grounds • Implementation of the CGG Davros MC3D MSS Communications and Management Protocol. • Relevant fisheries stakeholders, identified in Section 7.10.1, notified of proposed activities in advance of survey operations commencing via AHS NTM • No discharge of the seismic source ('no firing zone') within 1,500 m of the 50 m isobath around Glomar Shoals • Use of a support vessel to manage vessel interactions • Issuing of appropriate NTM by AHS • Survey and support vessels will use approved navigation systems and adhere to standard maritime safety / navigation procedures • Compliance with AMSA administered marine safety regulations and marine notification requirements. • Strict adherence to equipment handling and acquisition procedures • Other mariners alerted of vessels presence and extent of towed array • Fishermen alerted of vessels presence and extent of towed array • Establishment of a vessel exclusion zone around the survey vessel • The SNA is likely to cover at least a 10.1 km radius from the survey vessel, to account for the length of the towed streamer spread. The support vessels will be used to implement this exclusion zone if approaching vessels fail to heed navigational warnings (NTM, beacons, lights, radio contact). • Display of appropriate navigational beacons and lights, radar watch, radio contact	**Low**

Impact Category	Potential Impacts	Control and Mitigation Measures	Residual Risk Level

		• Where possible in-water equipment lost will be recovered
		• Recreational fishing from survey and support vessels is prohibited
		• Adherence to relevant CGG procedures and work instructions:
		  ○ CGG Environment Management General Instruction (GRP HSE GEI 07E)
		  ○ CGG APAC Marine Contingency Management Planning (MAR HSE PRC 010E)
		  ○ CGG Chase Vessel Operations Manual (MAR MSS MNL 002E)
		  ○ CGG Work Instruction for Prevention of Vessels crossing Streamer (MAR MSS MNL 002E)	

Operation of survey vessel within protected and heritage areas	Disturbance to heritage and conservation values	• Survey and support vessels will not enter waters of the Montebello/Barrow Islands Marine Conservation Reserves, including the Montebello Islands Marine Park • The survey and support vessel will not enter WA State waters or shallow waters <20 m water depth adjacent to the Montebello Islands Marine Park • Adherence to relevant CGG procedures and work instructions: • CGG Environmental Management General Instruction (GRP HSE GEI 07E). • All CGG and contractor personnel made aware of, and comply with, requirements of accepted EP	**Low**

Table 5.2 - Assessment of the additional control measures for 'Medium' Residual Risk Level

Marine Pollution from Accidental Discharges	
Demonstration of ALARP	
A "Medium" residual risk level is considered to be ALARP by CGG and therefore the activity is allowed to proceed carefully with continuous improvement The following ALARP analysis provides additional assurance that all risk treatment options have been considered A number of additional controls measures (in **bold** text below) have been considered, and were found to be not practicable—i.e. the cost, time and effort required to implement the measure is grossly disproportionate to the benefit gained	
Eliminate	Hazardous materials Hazardous materials (e.g. hydraulic fluid, lubricating oils, cleaning chemicals, paints, solvents, batteries etc.) are required routinely for safe and efficient operation of the vessels. Potential introduction of additional safety risks to personnel (e.g. inability to clean up spills, maintain vessels in good working order etc.) if use of these materials is eliminated. At sea refuelling Very substantial additional cost (~$8 million) – acquisition downtime, and increase in survey duration as seismic operations would have to cease during survey vessel transit to Broome or Dampier for refuelling Vessel collision **The seismic survey will not be undertaken** - CGG would be unable to meet seismic data delivery requirements of clients. The title holders would be unable to meet their work commitments for the petroleum titles covered by the Davros MC3D MSS
Substitute	Hazardous materials Additional cost (~$50K) involved in identifying / sourcing nonhazardous alternatives (if available) At sea refuelling Alternative fuels to MGO are Marine Diesel Oil (MDO), Intermediate Fuel Oil (IFO) and Heavy Fuel Oil (HFO), which would result in greater environmental impacts if spilled, due to their more persistent nature Risk of spills/leaks during fuel transfer operations in Broome or Dampier ports. Additional vessel collision risks introduced by survey and support vessel movements between operational area and Broome or Dampier
Engineering	Use of solid streamers (avoiding risk of Isopar leaks / spills) Fuel day tank fitted with an overflow routed to a containment tank to prevent spills if overfilled Remote manually operated shut-down devices for pumps; mechanical closure devices are fitted to vents Bunding of hazardous material storage areas and drip trays under equipment Hydrocarbons located above deck stored with some form of secondary containment to contain leaks or spills e.g. bund, containment pallet, transport packs etc.
Isolation	At sea refuelling **Fuel transfers can only take place outside the survey area** - substantial additional cost (~$2 million) - acquisition downtime, and increase in survey duration as seismic operations would have to cease during transit to at sea refuelling location outside survey area. Little benefit given lack of sensitive receptors within survey area (emergent land or very shallow water features <10 m water depth). Potential increase in spill exposure risk to sensitive areas outside the survey area Vessel collision **Seismic acquisition will only occur during daylight hours** - substantial additional cost (>$15 million) – doubling of survey duration to >12 months instead of >9 months. CGG would be unable to meet seismic data delivery requirements of clients
Administrative	Application of relevant CGG procedures and work instructions SOPEP implemented and tested for survey vessel Implementation of NATPLAN (by AMSA) or DoT MOSCP (by DoT), if required

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

Environmental performance of the Davros MC3D MSS is reviewed in a number of ways. These reviews are undertaken to:

- ensure all significant environmental aspects of the activity are covered in the EP;
- ensure that environmental management measures to achieve EPO and EPS are being implemented, reviewed and where necessary amended;
- identify potential non-conformances and opportunities for continuous improvement;
- ensure that all EPO and EPS have been met before completing the activity: and
- ensure 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:

- An inspection(s) of the vessels will be carried out before or during the activity to ensure that procedures and equipment for managing routine discharges and emissions are in place to enable compliance with the EP.
- A summary of the key information, commitments, EPO, EPS and MC for the activity (ECR) will be distributed aboard the survey vessel, and implementation of the environmental EPO and commitments will be monitored on a regular basis by the Client Site Representative.

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

7.1. OIL SPILL EMERGENCY PLAN

The Oil Pollution Emergency Plan (OPEP) for the proposed Davros MC3D survey, taking into account the nature and scale of the activity and the potential spill risks involved (see above) comprises components of the survey vessel SOPEP that manage the environmental impacts of a spill, supported as required by applicable established, statutory OPEPs (e.g. DoT MOSCP; NATPLAN). In summary, the following plans are in place as a contingency in the unlikely event of an oil spill, which as a whole, represent the OPEP for this activity:

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

7.2. VESSEL SOPEP

The survey vessel SOPEP, which has been prepared in accordance with the IMO guidelines for the development of shipboard oil pollution emergency plans (resolution MEPC.54(32) as amended by resolution MEPC.86(44)), includes emergency response arrangements and provisions for testing the SOPEP (oil pollution emergency drills), as required under Regulations 14(8AA), 14(8A) and 14(8B) to 14(8E) of the Environment Regulations. The last SOPEP drill undertaken was on 22 November 2013 during the CGG Schild Phase II MC3D MSS.

A drill test of the oil spill emergency response arrangements will be conducted during the mobilisation phase prior to commencement of operations of the survey. All drill tests will be reported as per MARPOL Annex I (Regulation 15) requirements and reviewed three times a year as part of the ongoing monitoring and improvement of emergency control measures. The SOPEP is subject to four scheduled drills per annum, therefore a minimum of three drills will be conducted during the course of the Davros MC3D survey, fewer drills may occur if the survey duration is shortened.

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

7.3. EMERGENCY RESPONSE ARRANGEMENTS

Priority actions in the event of a fuel or oil spill are to make the area safe and to stop the leak and ensure that further spillage is not possible. Deployment of small absorbent booms and other materials will be undertaken so as to maximise recovery of spilled material. All deck spills aboard the survey vessel will be cleaned-up immediately, using appropriate equipment from the onboard spill response kits (e.g. absorbent materials etc.) to minimise any likelihood of discharge of spilt hydrocarbons or chemicals to the sea. This is a SOP for the survey vessel.

Given the offshore location of the Davros MC3D survey area 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 (see below). Physical break up (using propwash from the support vessel) by repeated transits through the slick may be considered for larger slicks (following consultation with the Combat Agency – AMSA).

7.3.1. Commonwealth Waters

For Commonwealth waters initial actions will be undertaken by the survey vessel 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. Such operations are already covered by existing NATPLAN arrangements. AMSA is the responsible 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.

7.3.2. State Waters

If surface slicks appear likely to enter WA State waters (i.e. around the Montebello Islands and islands of the Dampier Archipelago) then subsequent actions will be determined in consultation with the DoT under WestPlan–MOP and the MOSCP. The DoT is the designated combat agency for oil spills from vessels within the WA State jurisdiction.

In the event of a large diesel spill occurring during the Davros MC3D survey, CGG will inform a number of key stakeholders (including the response and combat agencies outlined above), primarily within the commercial fishing industry, but also including a number of WA State Government departments (e.g. DMP; DoF; DPAW).

7.3.3. 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, CGG 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 of the DoT MOSCP (if either of these plans are actually activated). Operational monitoring and observation in the event of a spill will inform an adaptive spill response and scientific monitoring of relevant key sensitive receptors (see below).

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. RPS-ASA 2013); and
- GIS mapping.

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

CGG will implement, assist with, or contribute to (including funding if required) any other operational monitoring as directed by the Combat Agency.

7.3.4. Type II Scientific Monitoring

The stochastic spill modelling indicates medium level probabilities of surface slicks and entrained oil from a large MGO spill at Site 1 contacting inshore waters and shorelines of the Montebello Islands during all seasons.

Given this level of risk, if a large diesel spill occurs from the survey or support vessel during the Davros MC3D survey and this incident results in surface slicks or entrained oil entering the waters of the Montebello Islands Marine Park, CGG will work with the relevant stakeholders to develop and implement appropriate Type II "Scientific Monitoring" to understand the effects of the spill and any response activities on the marine environment. This scientific monitoring will have a focus on relevant environmental and social values and sensitive receptors

For development of a Type II scientific monitoring plan that would be applied in the event of a large diesel spill from the Davros MC3D survey impacting upon the Montebello Islands Marine Park, the relevant stakeholders would be (but not necessarily be limited to):

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

This scientific monitoring in the Montebello Islands Marine Park will focus on the following key environmental and social values and sensitive receptors, as described in the current Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves 2007-2017:

- sediment and water quality;
- benthic primary producer habitat (BPPH):
    - coral reef communities;
    - macroalgal and seagrass communities; and
    - mangrove communities;
- rocky shore/intertidal reef platform communities;
- intertidal sand/mudflat communities;
- subtidal soft-bottom communities;
- turtles;
- finfish;
- benthic invertebrates;
- pearling;
- tourism; and
- commercial and recreational fishing.

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:

- the AMSA Oil Spill Monitoring Handbook; and
- the Oil Spill Monitoring Background Paper.

CGG has insurance policies in place that would cover the costs of any Type I operational monitoring and Type II scientific monitoring required in the event of a large hydrocarbon spill resulting from its' activities, or required to cover the costs of any clean-up or remediation activities following a spill. These policies cover activities in Australian Commonwealth and State waters, including the Davros MC3D survey.

7.3.5. Reporting

Any fuel or oil spills aboard either the survey or support vessels must be reported to CGG via the CGG Event Reporting Management (GRP HSE GEI 17E). In the event of spillage of any oil or diesel spills to the sea, AMSA will be notified immediately (via RCC Australia using a POLREP form) to ensure prompt and appropriate mobilisation of relevant response plans. Any significant spills (greater than 80 L) will be reported to NOPSEMA as reportable incidents.

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

Consultation with stakeholder groups, primarily within the commercial fishing industry, concerning the proposed Davros MC3D MSS has taken place prior to, and during the preparation of the EP. The stakeholder consultation will be undertaken in phases as described below:

8.1. CONSULTATION PLAN

- Phase 1: Preparatory Consultation:
  - Stakeholders notified of the proposed Davros MC3D MSS.
- Phase 2: Ongoing Consultation:
  - Includes complying with requests from stakeholders for survey updates, etc.
- Phase 3: Post-survey Notifications:
  - Includes complying with requests from stakeholders for notification of the completion of individual surveys.

8.2. DETAILS OF CONSULTATION UNDERTAKEN

The following fisheries bodies and organisations have been contacted and informed of the proposed operations during Phase 1 Preparatory Consultation via letter or email sent on 25 September, 2013 and Phase 2 Ongoing Consultation, via a project update letter or email sent on the 14th April 2014:

- A Raptis & Sons
- Austral Fisheries Pty Ltd
- Australian Fisheries Management Authority (AFMA)
- Australian Southern Bluefin Tuna Industry Association (ASBTIA)
- Commonwealth Fisheries Association (CFA)
- Kimberley Professional Fishermen's Association (KPFA)
- MG Kailis Group
- Northern Fishing Companies Association (NFCA)
- Northern Wildcatch Seafood Australia (NWSA)
- Pearl Producers Association (PPA)
- Recfishwest
- WA Fishing Industry Council (WAFIC)
- WA Seafood Exporters
- WestMore Seafoods

In addition, 108 individuals or entities holding licences in the MMF, NBPR, ONPR, PFTIMF, PTMF, PLF, and WCDSCF were informed of the proposed activities during Phase 1 Preparatory Consultation via letter or email sent on 25 September, 2013 and Phase 2 Ongoing Consultation, via a project update letter or email sent on the 14th April 2014.

The following Commonwealth and WA State government departments and agencies were informed of the proposed activities during Phase 1 Preparatory Consultation via letter or email sent on 25 September, 2013 and Phase 2 Ongoing Consultation, via a project update letter or email sent on the 14th April 2014:

- Australian Fisheries Management Authority (AFMA);
- Australian Hydrographic Service (AHS);
- Australian Maritime Safety Authority (AMSA);
- Border Protection Command (BPC);
- Coastwatch;
- Department of the Environment (DoE);
- Department of Defence (DoD):

- WA Department of Fisheries (DoF);
- WA Department of Parks and Wildlife (DPaW)
- WA Department of Mines and Petroleum (DMP - Environment); and
- WA Department of Transport (DoT).

Also included in the Phase 1 Preparatory Consultation via letter or email sent on 25 September, 2013 and Phase 2 Ongoing Consultation, via a project update letter or email sent on the 14th April 2014 was the Centre for Whale Research and The International Fund for Animal Welfare (IFAW).

In addition to the stakeholder letters, further interaction continued with the PPA such as face to face meetings, emails and other correspondence (e.g. detailed and lengthy written questions and answers).

8.3. PHASE 2 – ONGOING CONSULTATION AND PHASE 3 – POST SURVEY NOTIFICATION

Notification of activity details (three page brochure) to relevant commercial fisheries management agencies, fishing industry bodies and individual companies and licence holders that were identified in the stakeholder consultation process will be provided, three weeks prior to the survey commencing, to inform them about the location of the survey area, survey and support vessel specifications, timing of operations (phases of acquisition), contact phone numbers, map of the area surrounding Glomar Shoals where there will be no discharge of the acoustic source, and to ascertain if proposed operations overlaps any key fishing grounds.

The notification brochure will also request stakeholders not to lay traps or set fishing gear in the vicinity of the proposed acquisition plan phase, so that negative interactions with the seismic vessel, seismic equipment, fishing vessels and their fishing gear can be avoided.

Within each phase of acquisition CGG will define a seven to ten day forecast of operations and will communicate this to stakeholders on a weekly basis. The forecast of operations will contain a map of the proposed acquisition area, table of coordinates, proposed time frame and will be sent via email/fax to the vessels or direct to the fishing companies. CGG have requested all identified stakeholders to provide their best contact details for receipt of the forecast, which will be provided on a weekly basis.

At least one support vessel will be employed to assist seismic and support vessels to mitigate interference associated with concurrent seismic and commercial fishing operations, in accordance with the CGG Work Instruction for Prevention of Vessels crossing Streamer (MAR MSS MNL 002E) and the Davros MC3D MSS Communications and Management Protocol.

Consultation with stakeholders will be ongoing throughout the period the Davros MC3D MSS EP is valid. CGG will comply with requests by stakeholders for additional information and requests for updates. On completion of the survey, notification will be sent to the relevant stakeholders or those that request post survey notification.

CGG will continue to consult with stakeholders throughout the Davros MC3D MSS.

8.4. MERITS OF THE STAKEHOLDER OBJECTIONS AND CLAIMS

An assessment of the merits of objections or claims about the adverse impact of the Davros MC3D MSS was made, and where practicable those with merit were incorporated into the survey design. The following objections and claims were identified (note where possible these have been grouped into common themes):

- **Marine Safety:** Multiple stakeholders were concerned about shipping safety and interactions with fishing vessels. The survey area covers two charted commercial shipping fairways, significant traffic to/from the North Rankin Platform and commercial traffic passing east/west to the north of Montebello Island and a large portion of the Pilbara Demersal Fisheries Licence Area. All suggested control measures relating to AMSA RCC notification to initiate AusCoast warnings, AHS notification to issue

a Notice to Mariners (NTM) for the activity, use of a support vessel to manage vessel interactions, display of appropriate navigational beacons and lights, radar watch, radio contact to indicate the vessel is towing and has restricted ability to manoeuvre and a visual and radar watch will be maintained on the bridge at all times. Compliance with maritime orders, COLREGS, establishment of a SNA (Safe Navigation Area) vessel exclusion zone around the survey vessel and the CGG Davros MC3D MSS Communications and Management Protocol will be implemented to minimise disruption to commercial shipping. CGG has responded to requests from stakeholders and provided maps of the Davros MC3D MS survey area overlayed with Fisheries Licence area boundaries.

  - ***Fishing Vessel interactions:*** CGG have made multiple attempts to contact Fisheries Licence Holders to obtain information regarding fishing season timing and where are the locations of key fishing grounds that overlap the Davros MC3D MSS, which will potentially be fished during the 2014/15 season. CGG has devised a Communications and Management Protocol for seismic and support vessel operators to implement when interacting with fishing vessels.

  - CGG will continue to liaise and inform stakeholders of vessel operations within the Davros MC3D MSS throughout the entire duration of the project as part of the ongoing consultation process for the activity via the seven to ten day forecast of operations and will communicate this to stakeholders on a weekly basis. CGG has not received correspondence from any Fisheries Licence holder confirming that they wish to receive the seven to ten day forecast.

- **Commercial Fishing:**
  - ***Impacts to Fish:*** Concerns were raised from a group of stakeholders who were concerned about the impact of the Davros MC3D MSS on fish spawning areas. However, to date, DoF has not provided any specific locations of fish spawning grounds or nursery areas within the Davros MC3D survey area. Without this information CGG cannot practically devise a mitigation measure to avoid spawning locations or nursery areas. As a precautionary measure CGG have applied management and mitigation measures for the Glomar Shoals - omitting the area from the acquisition plan and implemented an exclusion buffer where there will be no discharge of the seismic source (‘no firing zone’) within 1,500 m of the 50 m isobath around Glomar Shoals.

  - ***Impacts to the Pearl Oyster Managed Fishery:*** The PPA raised concerns associated with the Davros MC3D MSS and the impacts of seismic surveys on the pearl oyster larvae and the need for scientific surveys to be undertaken on the distribution of pearl oysters and the effects of seismic surveys on the pearl oyster. Consultation activities with the PPA resulted in a risk assessment being undertaken on the effects of seismic surveys on the pearl oyster larvae via a Larval Distribution Analysis (LDA). This information was presented to the PPA at a meeting in Darwin in September 2013. CGG provided extracts of the Davros MC3D MSS Environment Plan, which included the impact assessment and implementation strategy relevant to the Pearl Oyster Managed Fishery, oil spill modelling assessment of consequence regarding pearl oyster activities at the Montebello Islands and a literature review of the effects of seismic surveys on the pearl oyster. CGG concluded from the results of the LDA, the potential airgun noise induced mortality of pearl oyster pelagic stages are likely to be insignificant compared to the rates of natural mortality. Therefore no additional controls will be implemented to reduce the impacts and risks to the pearl oyster stocks during the Davros MC3D MSS. CGG have requested advice from their peak industry body, the International Geophysical Contractors (IAGC) concerning the request for scientific surveys. CGG advised the PPA that scientific surveys and focused research will require a significant level of funding and the involvement of all relevant stakeholders, including the Department of Fisheries, as an associate member of APPEA and an IAGC member, CGG will do what they can to develop and support any cooperative industry initiatives. CGG informed the PPA that these issues can only be resolved by continuing communication and cooperation between the two industries.

- ***Impacts to Pilbara Demersal Fisheries*:** raised concerns regarding the impact of seismic surveys on this fisheries targeted demersal fish species. CGG advised stakeholders that the Davros MC3D MSS Environment Plan includes an evaluation of all the potential environmental impacts and risks for the survey, including airgun noise emission impacts on fish. CGG provided stakeholders with a summary of the risk assessment undertaken on the effects of seismic surveys on fish.

- **EPBC Protected Matters Impacts:**
  - ***Survey Timing (Impacts to migrating humpback whales):*** A number of stakeholders expressed the concern of the proposed survey impacting on migrating humpback whales. The Davros MC3D MSS was referred to the DoE on 10 December 2013 (EPBC Reference Number 2013/7092) and was assessed as "not a controlled action if undertaken in a particular manner" – i.e. the action, as proposed, did not require approval under the EPBC Act.' CGG will adhere to the Part A Standard Management Procedures of the EPBC Act Policy Statement 2.1 - *Interaction between offshore seismic exploration and whales* (September 2008) throughout the survey, with the application of a 2 km low power zone. Additionally, CGG will adhere to specific Part B Additional Management Procedures of the EPBC Act Policy Statement 2.1, as specified in the Referral Decision Instrument, Particular Manner Conditions (EPBC 2013/7092).

  - ***Survey Timing (Impacts to fishing vessels):*** CGG has not received a response from Fisheries Licence Holders regarding fishing season timing and where are the locations of key fishing grounds that overlap the Davros MC3D MSS, that will potentially be fished during the 2014/15 seasons.

- **Cumulative Seismic Impacts:** An assessment has been undertaken on the potential cumulative impacts the Davros MC3D MSS may have when coinciding with concurrent seismic activities. A review of approved and proposed seismic surveys within the region has been undertaken by CGG at the request of DoE (letter dated 16 January 2014). CGG will implement the 50 km buffer between concurrent seismic operations during the period of 1 June to 30 November - to minimise cumulative impacts to humpback whales.

- **Department of Defence Activities:** The Department of Defence has no objections to the proposed Davros MC3D MSS.

- **Impacts to State Waters & Ecotourism Activities:** Stakeholders expressed concerns regarding proximity to the WA state waters and potential impacts to the Montebello/Barrow Islands Marine Conservation Reserves. CGG provided clarification to stakeholders that whilst the seismic vessel will transit WA State waters during transit to/from the survey area, there will be no acquisition within State waters. Additionally, the vessel will not conduct line turns, line run-ins or line run-outs within State waters. CGG has implemented the following controls into the Davros MC3D MSS EP: Survey and support vessels will not enter waters of the Montebello/Barrow Islands Marine Conservation Reserves, including the Montebello Islands Marine Park and the survey and support vessel will not enter WA State waters or shallow waters <20 m water depth adjacent to the Montebello Islands Marine Park.

  - ***Vessel refuelling:*** Stakeholders expressed concerns regarding vessel refuelling activities within the Montebello Islands Marine Park. CGG informed stakeholders that the survey and support vessels will not enter waters of the Montebello Islands Marine Park. Refuelling at sea is subject to CGG Bunkering Offshore Instruction (MAR MSS PRC 007E), and specific additional requirements of the application of 25 km exclusion zone from emergent land or shallow water features (<20 m water depths) for at sea refuelling operations.

- ***At-sea garbage disposal:*** Stakeholders expressed concerns regarding at-sea garbage disposal within the Montebello Islands Marine Park. CGG informed stakeholders that the survey and support vessels will not enter waters of the Montebello Islands Marine Park. All sewage and putrescible wastes will be handled and disposed of in accordance with MARPOL 73/78 Annex IV (as implemented in Commonwealth waters by the PSPPS Act; and Marine Orders - Part 96: Marine Pollution Prevention - Sewage) including. Including the application of sewage and putrescible wastes treatment and discharge requirements such as, sewage and putrescible wastes macerated where possible prior to disposal; no discharge of sewage or putrescible waste within 12 nm of the boundary of the Montebello Islands Marine Park; and discharge restrictions for treated versus non-treated sewage (treated >3 nm from land; non-treated >12 nm from land).

- ***Impacts resulting from Environmental Incident:*** The DPaW informed CGG that if an environmental incident were to occur of detriment or risk to the Montebello-Barrow Islands Marine Conservation Reserves, reporting per relevant marine orders and direct (additional) notification must be sent to the DPaW as soon as possible. CGG informed the DPaW that relevant stakeholders will be contacted for the development of a Type II scientific monitoring plan that would be applied in the event of a large diesel spill from the Davros MC3D survey impacting upon the Montebello Islands Marine Park. Relevant stakeholders identified are as follows:
  - the Combat Agency (WA Department of Transport);
  - the WA Environmental Protection Authority (EPA);
  - the WA Conservation and Parks Commission (CPC);
  - the WA Department of Parks and Wildlife (DPaW);
  - appropriate marine research and monitoring organisations,
    - such as: the WA Marine Science Institution (WAMSI);
    - the Australian Institute of Marine Science (AIMS); and
    - environmental consultancy companies with appropriate expertise and experience in hydrocarbon spill monitoring
  - marine contractors able to provide appropriate vessels for inshore/shallow water work in the Montebello Islands.

- **Biosecurity risk:** A number of stakeholders expressed concerns regarding the risk of introduction of invasive marine species. CGG advised stakeholders that the survey vessel will have had a recent dry dock, invasive marine species (IMS) inspection and antifoulant application prior to mobilising to Australian waters and that the AF coating meets IMO 2001 Convention requirements and the survey and support vessels have all the necessary AQIS clearances to operate unrestricted anywhere in Australian waters.
  - The seismic survey vessel MV *Geo Caspian* has been operating in Australian waters since October 2013, when it arrived to acquire the CGG Schild Phase II MC3D MSS. These operations included port calls within WA State waters. Accordingly, the vessel was required to meet the biosecurity standards of the WA Department of Fisheries (DoF), who have significant powers to prevent the arrival and establishment of IMS of concern. 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*.
  - If an alternative vessel from the CGG fleet, which has not been operating in Australian waters, is mobilised the vessel will be required to meet the biosecurity standards of the DoF, who have significant powers to prevent the arrival and establishment of IMS of concern. 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.
  - At this stage, the support vessel(s) that will be used for the Davros MC3D survey are not confirmed. However, these vessels will be contracted from companies operating in Australia, and will be vessels that routinely operate out of either Broome, Darwin or Dampier. On this

basis, the support vessels will pose a low risk of introducing any IMS of concern to Australian waters.

- **Inadequate Consultation:** As identified in Section **8.1** Stakeholder Consultation Plan Phase 1, and Phase 2 has been undertaken for this activity, as well as the provision of the Notification of activity details (three page brochure). Concerns and issues arising from the Davros MC3D MSS stakeholder consultation have been thoroughly assessed and adopted into the EP where practicable and relevant. CGG's assessment of such claims was submitted to NOPSEMA via the Request For Further Written Information (RFFWI) prior to the approval of the EP. CGG has made reasonable attempts to contact fisheries licence holders and allowed sufficient time for them to respond. CGG will continue to consult with stakeholders during the Davros MC3D MSS.

9. DETAILS OF THE TITLEHOLDERS NOMINATED PERSON FOR THE ACTIVITY

For further information about the proposed CGG Davros MC3D MSS in the Carnarvon Basin offshore from WA, please contact:

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