Australian Government
Geoscience Australia

Geoscience Australia
Browse Basin 2013 Marine Survey (GA0340)
Environment Plan Summary

Date: 3rd May 2013

Contents

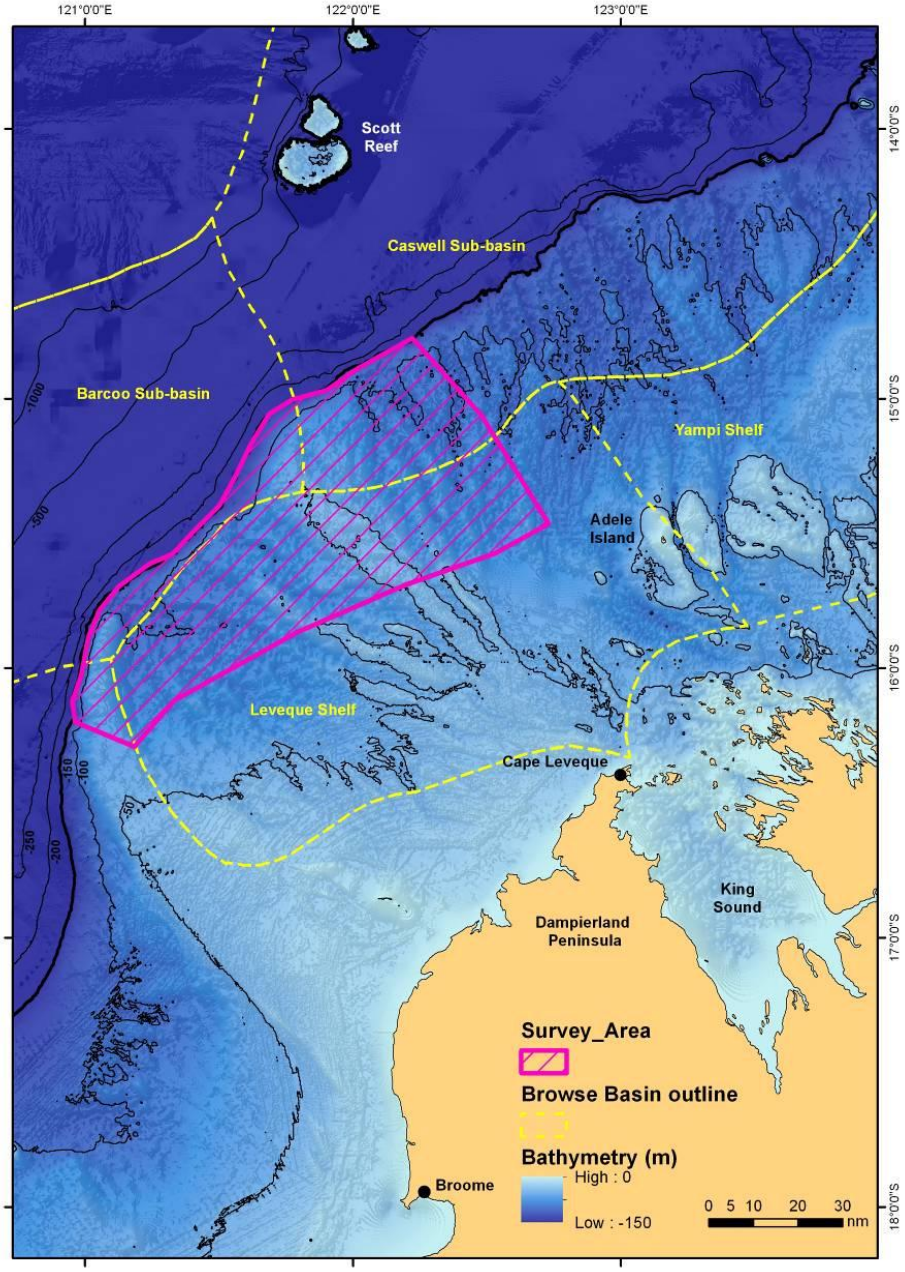
1 Introduction

Geoscience Australia (GA) is proposing to undertake the Browse Basin 2013 Marine Survey (GA0340), in the Commonwealth waters of the Browse Basin (Leveque Shelf). This survey area is located approximately 106 km northwest of Cape Leveque (WA), 45 km west of Adele Island (WA) and 73 km south-east of Scott Reef South (WA). The purpose of this survey is to collect marine data over the Leveque and Yampi Shelves in the south-eastern Browse Basin in support of a Carbon Dioxide (CO_2) storage assessment. This document provides a summary of the Environment Plan submitted to the Department of Resources Energy and Tourism (RET), and assessed by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA).

2 Survey Location and Timing

The survey area is in the Browse Basin, offshore of Western Australia, and covers parts of the Leveque and Yampi Shelves, and Barcoo and Caswell Sub-basins (**Figure 2.1)**. Data acquisition will focus on seabed and shallow sub-surface (<200 m) features with opportunistic sampling of identified features of interest. This survey area is located approximately 106 km northwest of Cape Leveque (WA), 45 km west of Adele Island (WA), and 73 km south-east of Scott Reef South (WA). The survey area maintains a minimum distance of 100 km from the mainland (Dampier Peninsula) and 200 km from Broome (**Figure 2.1)**.

Figure 2-1: Browse Basin 2013 Marine Survey Locality



The survey area covers approximately 13,500 km^2 and includes shelf and upper slope (northwest margin) in water depths ranging from 25 to 150 m (refer to **Figure 2.2** and **Table 2.1**). The survey area is bounded to the northwest by the 150 m isobath, and extends 100 km across the shelf from the north east to the southwest, where it is approximately 30 km wide.

The survey will be undertaken between the 1st and 31st May 2013 for a period of approximately 30 days.

Figure 2-2: Browse Basin 2013 Marine Survey Area and coordinate boundaries

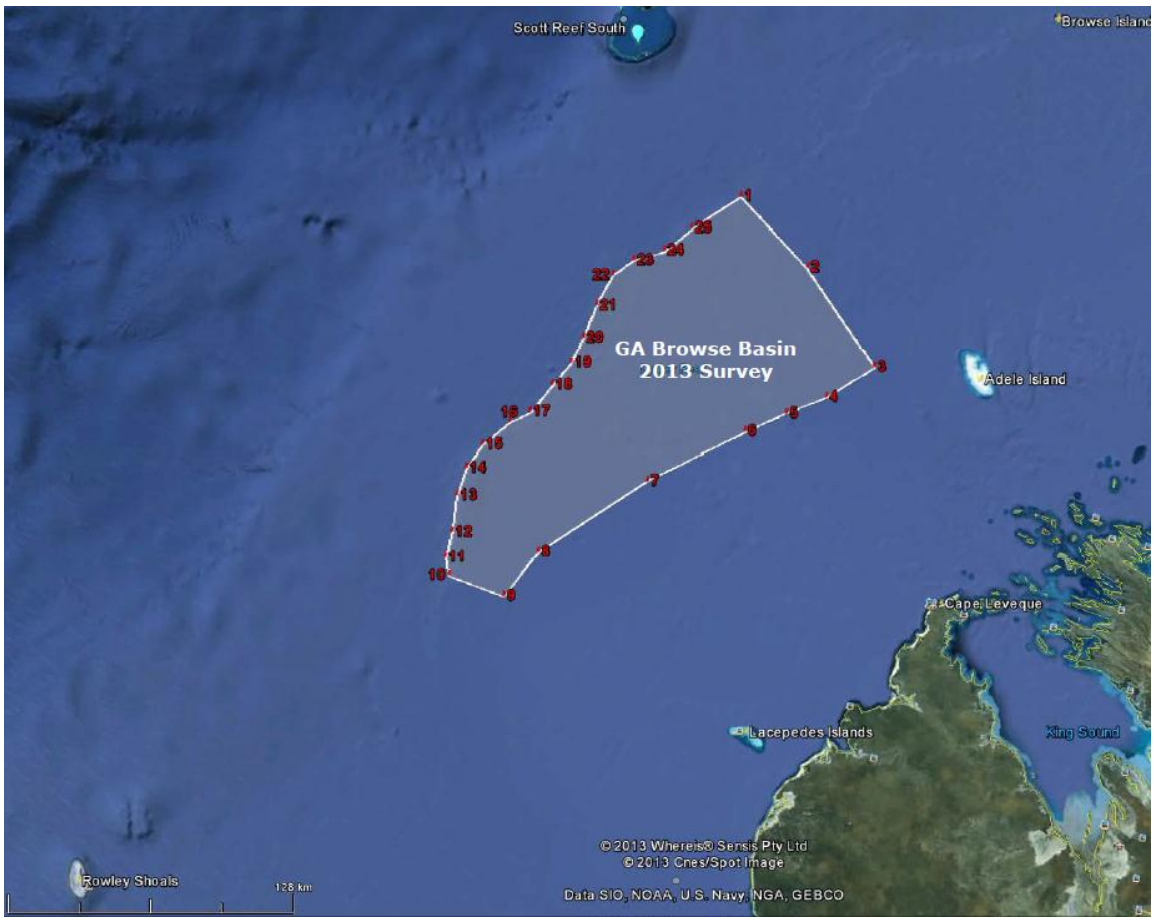


Table 2-1: Browse Basin 2013 Marine Survey Coordinates

Location Point	Latitude			Longitude		
	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
1	14	46	28.44	122	13	09.44
2	15	3	36.37	122	28	34.58
3	15	27	52.59	122	43	42.58
4	15	34	26.63	122	31	43.03
5	15	37	52.22	122	21	47.69
6	15	41	30.65	122	11	30.93
7	15	52	00.26	121	47	18.98
8	16	7	12.54	121	19	54.30
9	16	17	29.30	121	10	54.64
10	16	12	00.88	120	57	45.13
11	16	7	28.04	120	57	04.45
12	16	1	34.95	120	59	02.15
13	15	53	04.92	121	0	40.23
14	15	46	52.22	121	3	17.16
15	15	41	41.12	121	7	35.50
16	15	36	44.11	121	14	24.11
17	15	34	34.75	121	19	28.45
18	15	28	33.70	121	25	11.46
19	15	23	39.45	121	30	05.70
20	15	17	46.36	121	33	21.86
21	15	10	15.19	121	36	57.64
22	15	3	23.24	121	41	12.66
23	15	0	07.08	121	46	26.52
24	14	58	09.38	121	53	57.69
25	14	53	19.61	122	0	52.76

For the purpose of defining the operational boundaries of this EP, the R/V *Solander* is considered to be undertaking the GHG activity when located within the survey area delineated by **Table 2-1**. Mobilisation and demobilisation activities associated with port calls or deployment from site associated with emergencies or refuge is not included within the operational boundary of this EP and is controlled by Australian maritime legislation.

3 Description of Activities

The survey program will be undertaken in May 2013 for a period of approximately 30 days. Activities will be undertaken during all hours and days of the survey period. The following activities will be undertaken:

A **multibeam mapping sonar system** (Kongsberg EM3002) will be used to collect bathymetry data over 100 per cent of selected study areas (within the survey bounds). The bathymetry data will be gridded at an optimal resolution (2–5 m) to create a surface representing the seabed that will allow identification and mapping of geomorphic features. Water column data will also be collected simultaneously with this system. It is estimated that 50–70 per cent of the total survey time will be allocated to multibeam data collection.

A **single beam echosounder** (Kongsberg ES70) will be used to collect water depth and water column data. The ES70 operates at a dual frequency of 38 kHz and 200 kHz and will be used simultaneously with the multibeam sonar system both mounted in the moon pool of the vessel.

A **Sparker multi-channel sub-bottom profiler** (Applied Acoustic Squid 2000) will be used to map the stratigraphy of the upper 100–200 m of the sub-surface sediments. Due to the reduced acquisition speed of the vessel, the Sparker data will be collected subsequent to the other acoustic data. Weather and time permitting, Sparker data will be acquired in a relatively low density grid over seabed features that show connectivity to deeper sedimentary structures (e.g. faults). It is estimated that 10–30 per cent of the total survey time will be allocated to sub-bottom profiler data collection.

A **Chirper sub-bottom profiler** (Innomar SES-2000 Parametric System) will be used to image the upper 10–50 m of the shallow sub-surface sediments. Acquisition of this data will be undertaken simultaneously with the acquisition of the multibeam sonar data. The relatively high frequency (short wave-length) of the system coupled with the dense survey grid (track lines of 120–170 m spacing) will allow mapping of shallow sub-surface features at relatively high vertical and spatial resolution. The relative timing of activity of seabed features, such as pockmarks and associated seeps, may also be possible. The Chirper sub-bottom profiler is mounted on the moon pool of the R/V Solander and equipment loss is not considered likely.

A **side scan sonar** will be used to acquire water column data.
Smith-McIntyre/Shipek grabs and a five-metre long **vibrocore** will be used to collect samples of the seabed and shallow sub-surface sediments, respectively. These samples will be collected at representative locations in the study areas to characterise the environments. Priority will be given to sample sites where gas/fluid migration or escape may have occurred in the past. Samples from others areas will also be collected to enable comparative analysis. Weather permitting, it is estimated that 20 per cent of the total survey time will be allocated to sampling. Based on present acquisition standards and previous surveys, this represents

approximately 30-60 sites. Data collected at each site will usually comprise samples and underwater videography.

The **Vibrocore** is mounted in a four-metre frame that is lowered to the seafloor. The 75 mm diameter core barrel is pushed into the soft sediments by an electrically powered vibration system. The maximum penetration depth of the core barrel is 5 m. It is expected that up to 30 cores will be obtained during the survey at locations where there is soft sediment to allow core penetration.

Water properties will be characterised by a series of conductivity, temperature and depth (CTD) casts and associated water samples. CTD casts and water samples will be collected in areas associated with fluid/gas escape and migration to identify the nature of the material escaping, and in other areas for comparison with ambient conditions. Water column features for sampling will be determined through analysis of the multibeam sonar (Kongsberg EM3002) and single beam echo sounder data (Kongsberg ES70). Weather permitting, it is estimated that 20 per cent of the total survey time will be allocated to sampling. Based on present acquisition standards and previous surveys, this percentage represents approximately 30–60 sites. Approximately 20 samples of water will be taken during the survey.

Towed video: Underwater towed video and stills photographs will be collected along representative transects over seabed features to characterise the physical habitats and biological communities associated with different seabed environments. Priority will be given to sampling seabed environments that are indicative of gas or fluid migration in the subsurface or escape at the seabed (e.g. pockmarks, ridges). Weather permitting, it is estimated that 20 per cent of the total survey time will be allocated to sampling, which includes video tows. Based on present acquisition standards and previous surveys, this represents approximately 30–60 sites. The underwater camera will be towed at 1-2 m above the seafloor in transects of several hundred metres.

CO_2/hydrocarbon sensor: A CO_2/hydrocarbon sensor will be used to identify, where possible, the source of any identified fluid and/or gas escape. Ideally, these samples and sensor will be attached to the underwater camera and be collected contemporaneously with the video transects.

4 Vessel Details

The marine survey will utilise the R/V *Solander*, owned by the Australian Institute of Marine Science (AIMS). This Australian-registered vessel will mobilise from Broome and will refuel in port facilities (i.e. no refuelling at sea). The vessel was dry-docked for cleaning and anti-fouling paint application in January 2013. The vessel works solely within Australian waters, has travelled between Exmouth and Darwin since the time of last cleaning and does not present a risk of invasive marine species (IMS) introduction. The R/V *Solander* 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, including a Shipboard Oil Pollution Emergency Plan (SOPEP) in accordance with Regulation 37 of Annex I of MARPOL 73/78.

5 Description of the Environment

5.1 General Environmental Setting

5.1.1 Regional Setting – Northwest Shelf Province

The survey area is located in the Northwest Shelf Province area of the Northwest Marine Region (DEWHA, 2008). The Northwest Marine Region comprises Commonwealth waters that extend from the Northern Territory/Western Australia border in the north, to south of Shark Bay, WA and covers over 1.07 million km^2 (SEWPC, 2013a).

The Northwest Marine Region is characterised by shallow water, tropical marine ecosystems with high species richness (SEWPC, 2013a). The variety of seafloor features, currents and diversity of habitats create a complex and unique range of ecosystems. Cetaceans, reptiles, marine birds and an array of fish and crustaceans all live within and around the Northwest Shelf Province.

5.1.2 Bathymetry and Seabed Type

The survey area is located in water depths of approximately 25-150 m and covers part of the Barcoo and Caswell Sub-basins, and part of the Yampi and Leveque Shelves (plateaux). The area is located approximately 100 km from the mainland and approximately 200 km north of Broome. The survey is located on the continental shelf. Seafloor sediment in the survey area is highly variable with sand dominating in some areas and gravel in other areas with no discernible spatial pattern. There are also areas of hard substrate. The seafloor of this area is affected by cyclonic storms, long-period swells and internal tides. As a result, sediments are mobile and can resuspend within the water column.

5.1.3 Climate

The climate in the survey area is typically mild and dry over winter (April to September) and hot and wet during summer (October to March) (Woodside, 2011). The wettest months tend to be January to March with the mean maximum temperature around 30^0C for most of the year (BOM, 2013). Rainfall is influenced by the monsoon and associated thunderstorms, whereas extreme climatic conditions occur with the presence of tropical cyclones. High winds, heavy rain and large swell and storm surges accompany the cyclones which predominantly occur in the period December to April (BOM, 2013).

5.1.4 Oceanography

The waters of the Northwest Marine Region are relatively shallow, with 40 per cent of the total region located in water depths less than 200 m. This is due to the presence of the continental shelf and continental slope over a large part of the area (DEWHA, 2008). Major surface currents head from the equator down the coast. The water is warm, low in salinity and low in nutrients (DEWHA, 2008). The surface Indonesian Through-flow Current and the Leeuwin current are the main influencing currents of the Northwest Marine Region. The Indonesian Through-flow current is a warm, oligotrophic, low-salinity current. The Leeuwin current is a

warm, shallow, narrow current (50–100 km wide) that centres along the continental shelf break.

Sea surface temperatures range from 29°C (summer) to 26°C (winter) (Woodside, 2011). One of the most significant oceanographic features of the Northwest Marine Region is the presence of internal (underwater) waves. As a result of pronounced temperature difference in the water column (warm, tropical water on the surface, cold temperate waters underneath) and the interaction between currents and the sea floor, internal waves of large amplitudes (up to 75 m) help mix the water column (DEWHA, 2008).

Wave climate in the Northwest Marine Region is influenced by locally generated wind waves, generally from the west during summer monsoon, and east during winter (RPS Metocean, 2008b cited in Woodside, 2011). Wave heights in the Northwest Marine Region average between 1–2 m, and are typically less than 2.3 m. Peak spectral wave periods tend to be around 10–12 seconds (RPS Metocean, 2008b cited in Woodside, 2011).

Tides in the Northwest Marine Region can be broadly described as semi-diurnal with two high and two low tides per day. Areas with water depths less than 150 m in the Browse basin have been recorded as having a mean sea level (MSL) range of between +3.65 m to -3.55 m (Metocean Engineers, 2005; cited in Woodside, 2011).

5.2 Marine Conservation Areas

This survey area is located approximately 106 km north west of Cape Leveque (WA), 45 km west of Adele Island (WA) and 73 km southeast of Scott Reef South (WA).

5.2.1 The Kimberley Commonwealth Marine Reserve (KCMR)

The KCMR is located in Commonwealth waters off the coast of Northwest WA Management plans will come into effect for the Park in July 2014. Until then, transitional provisions apply and provide for no change 'on the water' for users of these areas.

The survey will be taken predominately within the boundaries of the Kimberley Commonwealth Marine Reserve (KCMR). A smaller portion of the survey will occur in the Commonwealth waters outside the KCMR. The zoning of the area covered by the survey within the KCMR is Multi Use Zone (IUCN Category VI). Multiple Use Zones allow activities such as commercial fishing (excepting demersal fishing), Tourism, Mining, Research, Indigenous activities and recreational activities (SEWPC, 2013c).

5.2.2 The Western Australian Camden Sound State Marine Park

The Camden Sound Marine Park is located approximately 300 km north east of Broome and 100 km east of the GA survey area. Zoning within the marine park has not yet been finalised (DEC, 2010).

5.3 Marine Species

5.3.1 General

The flora and fauna of the Northwest Marine Region is predominately tropical, but there is a transition between tropical, subtropical and temperate in the southern areas of the Region. As a result, species diversity is rich and varied across the entire Northwest Marine Region (DEWHA, 2008).

The EPBC Act lists both threatened and migratory species that are protected under Commonwealth legislation and various international conventions and treaties. A search of the Commonwealth EPBC Act Protected Matters Database (SEWPC, 2013p) identified the following:

- Twenty-four (24) cetacean species are listed as possibly occurring in the area. Two of these species have a threatened status and seven species have a migratory status under the EPBC Act;
- Twenty-six (26) reptile species are listed as possibly occurring in the area. Seven are listed as threatened and migratory; and eighteen (18) sea-snake species are listed;
- Four (4) species of shark are listed as possibly occurring in the area. Two species have a threatened status and three have a migratory status under the EPBC Act;
- Six (6) species of marine birds are recorded as occurring in the area and have been listed as Migratory;
- Thirty-two (32) listed fish species are recorded as occurring in the area and include twenty-seven (27) species of pipefish and five (5) species of seahorse.

5.3.2 Benthic Fauna and Flora

CSIRO (2007; cited in Woodside 2011) has surveyed the benthic habitat of Northwest Shelf waters from 100–1000 m water depth between Barron Island and Ashmore Reef. At the continental shelf margin (~100 m) Williams et al (2010; cited in Woodside 2011) reported very similar benthic habitats across the breadth of the Northwest Shelf. Habitats at this depth comprised of a mix of riffled muddy sand with gravel-pebble size rubble, cobbles, boulders and some rock outcrops. Typical epifauna found at these depths included scattered isolated hydroids, sea fans and soft corals and often small sponges (Woodside, 2011).

Woodside for the Browse LNG Development also surveyed benthic communities inhabiting the soft sediment habitat in water depths ranging from 25 m to >600 m. In the shallower depths, epifaunal assemblages were sparse and scattered and consisted of a variety of typical common and widespread taxa including isolated seafans and whips, featherstars, bryozoans, seapens, hydroids, isolated small coral colonies and urchins. Growth of larger sessile epifauna was generally associated with patchy coarser sediment that serves as hard substrate for attachment. Beyond ~80 m depth, sparse epifauna coverage was encountered (Woodside, 2011).

There is no evidence of seagrass communities present in the survey area (Woodside, 2011).

5.3.3 Fish and Sharks

The Northwest Region contains more coastal and shelf fish species than anywhere else on the Western Australian coast, particularly in the Kimberley and Northwest Shelf with over 1400 species recorded in the region (DEWHA, 2008). Bulman (2006) outlines species present in the Northwest Shelf region between the depths of 20-200m. They include coastal shark species, rays, small tunas, shallow lenthrinids, red emperor, lizardfish and other small pelagic fishes.

The EPBC Act Protected Matters database (SEWPC, 2013p) identified the following threatened/migratory species as possibly having habitat within the area:

- Whale shark (*Rhincodon typus*) (vulnerable and migratory);
- Shortfin mako shark (*Isurus oxyrinchus*) and Longfin mako shark (*Isurus paucus*) (migratory); and
- Green sawfish (*Pristis zijsron)* (vulnerable).

It is possible that these species will be encountered in the survey area, however, the whale sharks and mako sharks will primarily be migrating through the survey area. It is possible that the green sawfish will be present in the survey area. It is unlikely that pipefish and seahorse species will be encountered as these are predominantly shallow water dwellers.

5.3.4 Cetaceans

The EPBC Act Protected Matters Search database (SEWPC, 2013p) lists 25 cetacean species that may have habitat in or around the proposed survey area. Of these, the following species are listed as threatened and/or migratory under the EPBC Act:

- Blue whale (*Balaenoptera musculus*) and humpback Whale (*Megaptera novaeangliae*) are listed as threatened and migratory; and
- Brydes whale (*Balaenoptera edeni)*, killer whales (*Orcinus orca),* sperm whales (*Physeter macrocephalus),* Antarctic minke Whales (*Balaenoptera bonaerensis*) and spotted bottlenose dolphins (*Tursiops aduncus*) are listed as migratory.

5.3.4.1 Humpback Whale

Aerial and boat-based surveys undertaken by BHP Billiton and Woodside indicate a northbound migration from early June to early August (BHPB, 2004; BHPB, 2005), with the peak of the northbound migration between Exmouth Gulf and the Dampier Archipelago occurring around early July, on or within the 200 m depth contour (Jenner *et al.,* 2001). The southbound return migration peaks in late August andearly September (DEWHA, 2008).

Given the survey activities are planned for the month of May, humpback whales are unlikely to be encountered.

5.3.4.2 Blue Whale

Blue whales appear to migrate south from Indonesian waters, passing Exmouth through November to late December each year. Observations suggest that most

blue whales pass along the shelf edge in water depths of 500– 1000 m (McCauley and Jenner, 2010; cited in SEWPC, 2012).

Monitoring studies undertaken for Chevron's Wheatstone Project indicate that during southern migration blue whales were recorded between the 750 m and 850 m isobaths and between the 300 m and 350 m isobaths (RPS, 2010). This data also showed a seasonal migration pattern further west in deeper waters from May to August (moving northwards) (RPS, 2010).

No known breeding or feeding areas are within the survey area. Due to the timing of the survey activities (May) and the survey depth (25–150 m), it is unlikely that blue whales will be encountered during the survey activities.

5.3.5 Other Marine Mammals

The dugong (*Dugong dugon*) inhabits tropical and semi-tropical waters from Shark Bay in the west to Moreton Bay QLD in the east. The Western Australian populations occur in Shark Bay, Ningaloo Marine Park, Exmouth Gulf and the Kimberley Coast Region (SEWPC, 2013g). Dugongs frequent coastal waters, but also estuarine creeks and streams. Feeding tends to occur in wide shallow bays, wide shallow mangrove channels and the lee side of islands. These areas all support seagrass environments on which dugongs feed. Dugongs stay predominately within shallow coastal waters, with some recorded in offshore waters up to 58 km from the coast and 37 m deep (SEWPC, 2013g), reflecting the presence of deep-water seagrasses such as *Halophina spinulosa*. The species is highly migratory likely in response to their search for suitable seagrass species or warmer waters (SEWPC, 2013g). In Australia, most movements have been localised to the vicinity of seagrass beds. At the high-latitude limits of their range (e.g. Shark Bay WA), studies indicate that dugongs move over 100 km northwest to warmer waters during winter and returned during the onset of warmer conditions during summer (SEWPC, 2013g).

Dugong encounters are not expected during survey activities because the survey is located at distance from land (106 km northwest of Cape Leveque, 45 km west of Adele Island) and in deeper waters (25–125 m), and does not contain suitable dugong habitat (seagrass).

5.3.6 Reptiles

Six species of EPBC Act threatened marine turtles are reported as having habitat in the survey waters (SEWPC, 2013p). These include:

- Hawksbill turtle (Eremochelys imbricate);
- Flatback turtle (Natator depressus);
- Green turtle (*Chelonia mydas*);
- Loggerhead turtle (*Caretta caretta);*
- Leatherback turtle (*Dermochelys coriacea);* and
- Olive Ridley Turtle (*Lepidochelys olivacea*).

As most of these turtle species feed in shallower waters and breed predominantly in the summer months, they are unlikely to be encountered in great numbers in

the survey area. However, it is possible that they will be encountered transiting through the survey area. In particular the loggerhead and leatherback turtles feed in deeper waters and might be more commonly encountered. The nearest nesting sites to the survey area are Adele Island (approximately 45 km to the east), Ashmore and Cartier Nature Reserves (approximately 300 km to the north) and Lacepede islands (approximately 110 km to the southeast).

The EPBC database lists eighteen (18) seasnake species as possibly being present in the survey area as the seas of tropical Australia also support significant and diversified endemic seasnake fauna. Most seasnakes have shallow benthic feeding patterns and are rarely found in depths exceeding 30 m (Cogger, 1975). The only pelagic species known to inhabit open water habitats and feeds at the surface is *Pelamis platurus* (Heatwole and Seymour, 1975). This seasnake species is usually found within a few kilometres if the coast and prefers shallow inshore waters (SEWPC, 2013x). It is unlikely to be encountered during GA survey activities.

5.3.7 Seabirds

The EPBC database (SEWPC, 2013p) lists six migratory species of birds as possibly being present in the survey area:

- Brown booby (Sula leucogaster);
- Red-footed booby (*Sula sula*);
- Lesser frigate bird (*Fregata ariel*);
- Great frigatebird (*Fregata minor*);
- Streaked shearwater (*Calonectis leucomelas*); and
- Streaked shearwater (*Puffinus leucomleas*).

It is possible that the birds listed may overfly the survey area or use the area for foraging. The majority of these species breed in areas outside the survey area. The brown booby and the red-footed booby breed closest to the survey area at the Lecepede Islands (approximately 110 km to the southeast) and Adele Island (approximately 45 km to the east of the survey area).

5.4 Socio-economic Environment

The Kimberley coastline is generally remote from infrastructure and contains marine habitats recognised as having high environmental value. This is reflected by the extensive network of existing and proposed conservation areas along the shoreline and offshore.

5.4.1 Commercial Shipping

AMSA have advised that only local commercial shipping traffic (i.e. no major shipping lanes) will be encountered in the proposed survey area (AMSA, 2012).

5.4.2 Tourism and Recreation

The Kimberley Coast region is becoming a popular visitor destination for Australian and international tourists. Tourism contributes significantly to the local economy in terms of income and employment. Tourist activities include fishing, swimming, diving and boating. More recently, nature based tourism has become popular,

including seasonal attractions such as snorkelling and scuba diving, humpback whale watching in Camden Sound, whale shark encounters and tours of turtle hatching. The majority of these activities occur within 2 nautical miles of the shoreline (Woodside, 2006).

5.4.3 Fisheries

A valuable and diverse commercial and recreational fishery operates in the offshore and coastal waters in the region off the Kimberley Coast. The major fisheries target tropical finfish, large pelagic fish species and pearl oysters (Woodhams et al, 2012). A number of restriction and exclusion zones exist in the region with temporal and spatial restrictions on some fisheries to allow sustainability of the industry. Commercial fishing vessels in the area operate mainly out of Broome (Woodhams et al, 2012).

5.4.3.1 Commonwealth Fisheries

The GA survey area intersects the following Commonwealth-managed commercial fishing areas:

- Western Tuna and Billfish Fishery (WTBF): During 2005–2011, there has been no reported WTBF activity within the survey area. WTBF fishermen are unlikely to be present in the survey area during survey activities;
- Skipjack Tuna Fishery (STF) (Western: During 2008/9 fishing season two vessels were active in the western area reducing to nil in the 2009/10 and 2010/11 seasons. When present in Australian waters, the main fishing areas have historically been off south-east Australia and the Great Australian Bight (Woodhams et al, 2012). STF are unlikely to be present on the survey area during survey activities;
- Southern Bluefin Tuna Fishery (SBTF): Fishermen associated with the SBTF are unlikely to be present in the survey area as the higher fished grounds occur off South Australia, Eastern Australia and Tasmania.

5.4.3.2 Western Australian Fisheries

The WA Department of Fisheries has advised that the following state fisheries have reported fishing activity in the survey area (Fletcher and Santoro, 2012);

- Western Australian Mackerel Fishery (WAMF)
- Northern Demersal Scalefish Fishery (NDSF)
- North Coast Shark Fishery (NCSF)
- Pearl Oyster Managed Fishery (POMF) (Zone 3)

All WA fisheries identified were contacted as part of GA's stakeholder consultation. The Kimberley area of the fishery is the most productive section of the WAMF (Fletcher and Santoro, 2012), and 90 per cent of the NDSF catch and effort comes from water depths 30–200 m. It is therefore likely that these fishermen will be present in the area during the survey activities. The NCSF unlikely to be present in the survey area, and the POMF have advised that survey activities should not impact on operations.

5.4.3.3 Recreational Fisheries

Recreational fishing in the area tends to be concentrated in State waters adjacent to population centres (Woodside, 2011). RecFishWest (2013) have advised that survey activities should not impact on recreational fishing activities in the area.

5.4.4 Cultural Heritage

5.4.4.1 Shipwrecks

The National Shipwrecks Database (SEWPC, 2013w) shows that no shipwrecks are located within the survey area.

5.4.4.2 Heritage Places

There are no World Heritage properties, National Heritage Places or Wetlands of International Significance listed within the survey area, or within the immediate area surrounding the survey area.

Given the distance of the survey from the nearest coastline (Adele Island 45 km to the east) no indigenous heritage areas are affected.

5.4.5 Defence

The Australian Defence Force has a restricted area off the Kimberley coast which is used for the training, research, testing or major exercise activity. The restricted area is the Royal Australian Air Force (RAAF) Curtin Air-to-Air Weapons Range R811 (Woodside, 2011). The GA survey area lies within this restricted area. GA has undertaken stakeholder consultation with Defence to ensure no military activities coincide with the GA survey.

5.4.6 Oil and Gas Development

The Browse Basin is one of Australia's most hydrocarbon rich basins. The basin contains several significant gas and condensate fields, some of which are being developed. A significant amount of hydrocarbon reserves have been discovered and developed in adjacent areas of the Northwest Shelf.

This survey will cover the Petroleum Exploration Permits WA-414-P (Hunt Oil); WA-423-P (Murphy Oil); WA-396-P (Woodside); and WA-397-P (Woodside). The operators of these permits have been contacted as part of GA's stakeholder consultation.

6 Major Environmental Hazards and Controls

Identifying the environmental hazards associated with the activity is the first step in the ERA process. This involves collection of information on all activities and identification of potential environmental 'hazards' within the environmental context of the activity. The analysis identifies all environmental hazards from routine (i.e. discharge) or accidental events (i.e. incident).

Environmental hazard identification is undertaken via brainstorming and peer reviews utilising industry experts which cover different 'areas' of the survey operation. Reviewers have included vessel operator representatives, experienced survey proponents, GA representatives and environmental specialists. Information utilised within the hazard identification process has been obtained from the following sources:

- Survey program details including acoustic equipment type, proposed location, timing of survey and the activities which are proposed (e.g. possible wastes generated);
- An understanding of general vessel activities/operations during the survey and the possible threats to marine species and habitats;
- The environmental sensitivity of the receiving environment with respect to species distribution, subsea habitat types and location of environmentally sensitive areas (i.e. breeding, resting, etc.) undertaken as part of literature reviews; and
- Feedback from marine stakeholders to understand possible socio-economic activities which may conflict with survey operations via communication and consultation activities.

Within this context a listing of relevant environmental aspects, hazards and possible impacts have been identified which could affect the environment from the survey program. For each hazard, the environmental consequence and the likelihood of occurrence have been assessed.

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

- Physical presence of the Survey Vessel:
    - Disruption to commercial fishing activities and commercial shipping; and
    - Light pollution due to 24 hour activities.
- Data acquisition within the marine environment:
    - Discharge of acoustic sound in the survey area;
    - Sound from operation of vessels; and
    - Seabed Sampling:
        - Seabed disturbance during coring and sampling activities; and
        - Seabed disturbance to unexploded ordinances.
- General vessel operations:
    - Routine waste discharges from the survey vessel:
        - Oily water discharge;
        - Sewage discharges; and
        - Food-scrap discharges.

    - Air emissions (combustion emissions).
- Non-Routine events:
    - Accidental hydrocarbon spill due to collision with another vessel;
    - Chemical/oil spill through deck drain system;
    - Solid non-biodegradable/hazardous waste overboard incident;
    - Equipment loss in the marine environment;
    - Liquid loss from streamer; and
    - Collision with cetaceans.

The key environmental risks for the environmental aspects of the survey and details of control/mitigation measures to be applied to the Browse Basin Marine Survey are listed in **Appendix A**.

7 Management Approach

The Browse Basin Marine Survey will be managed in line with specifications set out in the *Browse Basin Marine Survey Environment Plan* as accepted by the Department of Resources Energy and Tourism, and other relevant environmental legislation.

The EP details the risk assessment process which has been undertaken, including identification of survey activities which potentially impact the physical and social environment, provides the environmental management strategies to control the environmental risk to ALARP, and details the environmental performance objectives, standards and measurement criteria for the survey. The document also details the implementation strategies to be followed including environmental management systems, roles and responsibilities, consultation, training, inspection, audit, review and reporting activities.

8 Consultation

Stakeholder identification for the survey was initiated in 2012 with key stakeholders identified through the following mechanisms:

- Review of relevant legislation applicable to greenhouse gas activities and marine operations in Commonwealth waters;
- Identification of marine user groups in the area (possible recreational/commercial fisheries, fishing industry groups, merchant shipping, eco-tourism providers); and
- Identification of marine 'interest' groups (e.g. technical and scientific entities, etc.).

Communication with these differing groups identified 'relevant' persons that might be reasonably impacted by the activity and hence require consultation; or additional persons to be contacted to determine possible impacts.
Communication with these parties and information obtained during this process has allowed for the collation of an Offshore Stakeholder listing, including their relevance to the Browse Basin 2013 Marine Survey, and the activity triggers which may initiate consultation / communication events.
The following organisations have been contacted and informed of the proposed survey:

- Arrow Pearl Company
- Australian Communications and Media Authority (ACMA)
- Australian Council of Prawn Fisheries
- Australian Customs and Border Protection Services
- Commonwealth Fisheries Association
- Department of Broadband Communication and the Digital Economy (DBCDE)
- Department of Defence (Capability Development Group)
- Department of Defence (Defence Support Group)
- Hunt Oil
- NOPTA
- SEWPC
- AFMA
- RecFishWest
- Kailis Brothers
- Mackerel Fishery
- Murdoch University
- Murphy Oil
- North Coast Shark Fishery
- Northern Demersal Scalefish Managed Fishery
- OceanWatch
- PGS
- Telstra
- The Pearl Oyster Managed Fishery
- University of WA
- Murdoch University
- WA Department of Fisheries
- WA Department of Transport
- WA Department of Utilities

- WA Department of Environment and Conservation
- WA Department of Mines
- WA Department of Premier and Cabinet
- WA Fishing Industry Council (WAFIC)
- WA Game Fishing Association
- Western Rock Lobster Fishery
- Woodside

GA will continue to consult with the stakeholders listed above, plus any others identified during the survey, during and after the survey as required.

9 Contact Details

For further information about the Browse Basin Marine Survey please contact:

Tanya Whiteway
Seabed Mapping and Coastal Information Section
Coastal Marine and Climate Change Group
Environmental Geoscience Division
Geoscience Australia
GPO Box 378,
Canberra ACT 2601

Phone: +61 2 6249 9249
Fax: +61 2 6249 9999
Email: Tanya.Whiteway@ga.gov.au

10 References

Australian Marine Safety Authority (AMSA), 2012 - Consultation email response from Mel Barker to Anna Potter in relation to the GA Survey Program (20th December 2012)

BHPB, 2005, Pyrenees Development Draft, Environmental Impact Statement, BHP Billiton, Perth, WA

BHPB, 2004, Stybarrow Petroleum Development WA-255-P (2), Draft Environmental Impact Statement, BHP Billiton Perth, WA

Bulman, C, 2006, Trophic Webs and Modelling of Australia's North West Shelf, Technical Report No 9, CSIRO downloaded on 9/3/13 at http://www.cmar.csiro.au/nwsjems/reports/NWSJEMS_TR9.pdf

Bureau of Meteorology (BOM), 2013, Climate Statistics for Cape Leveque, downloaded on 6/3/13 at: http://www.bom.gov.au/climate/averages/tables/cw_003004.shtml

Cogger, H.G., 1975, Sea Snakes of Australia and New Guinea, In: The Biology of Sea Snakes, Dunson, W.A., (Ed), University Park Press, Baltimore

Department of Environment and Conservation (DEC) 2010 – Proposed Camden Sound Marine Park Indicative Management Plan 2012 accessed on 28th February 2013 at: www.dec.wa.gov.au

Department of Environment, Water, Heritage and the Arts (DEWHA), 2008 – The Northwest Marine Bioregional Plan – Bioregion Profile – A Description of the Ecosystems, Conservation Values and uses of the North West Marine Region downloaded on 10th October 2011 at: http://www.environment.gov.au/coasts/mbp/publications/north-west/pubs/bioregional-profile.pdf

Fletcher, W.J. and Santoro, K. (eds). 2012. Status Reports of the Fisheries and Aquatic Resources of Western Australia 2011/12: The State of the Fisheries. Department of Fisheries, Western Australia

Heatwole, H., and Seymour, R., 1975, Diving Physiology, In: The Biology of Sea Snakes, Dunson, W.A., (Ed), University Park Press, Baltimore

Jenner, K.C.S, Jenner, M.N.M and McCabe, K.A, 2001 – Geographical and Temporal Movements of Humpback Whales in Western Australian Waters, APPEA Journal 2001

SEWPC, 2013a – Marine Bioregional Plan for the Northwest Marine Region, downloaded on 5/2/13 at: http://www.environment.gov.au/coasts/marineplans/north-west/pubs/north-west-marine-plan.pdf

SEWPC, 2013c – Kimberley Commonwealth Marine Reserve, downloaded on 9/2/13 at: http://www.environment.gov.au/marinereserves/north-west/kimberley/pubs/fs-nw-kimberley.pdf

SEWPC, 2013g – SPRAT Database for Dugong downloaded on 9/2/13 at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=28

SEWPC, 2013p – EPBC Act Protected Matters Report, downloaded 8/2/13 at: http://www.environment.gov.au/epbc/pmst/index.html

SEWPC, 2013w – Australian National Shipwreck Database, downloaded on 6/3/13 at: http://www.environment.gov.au/heritage/shipwrecks/database.html

SEWPC, 2013x – SPRAT Database for Yellow-bellied Seasnake, downloaded on 19/3/13 at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1091

SEWPC, 2012 – Species Group Report Card – cetaceans, Supporting the marine bioregional plan for the Northwest Marine Region, downloaded on 6/3/13 at: www.environment.gov.au/.../north-west-report-card-cetaceans.doc

Woodhams, J, Viera, S and Stobutzki, I (eds) 2012, *Fishery Status Reports 2011,* Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra

Woodside, 2011 – Browse LNG Development, Draft Upstream EIS, downloaded on 4 March, 2013 at: http://www.woodside.com.au/Our-Business/Browse/Pages/Approvals.aspx

Woodside 2006. Pluto LNG Development. Draft Public Environment Report/Public Environmental review. EPBC Referral 2006/2968. Assessment No. 1632. December 2006

11 APPENDIX A

Impact Category	Possible Impacts	Control/Mitigation Measures	Residual Risk Assessment
Presence of Vessel Activities	Interference with Fishing Activities (Spatial Conflicts)	Prevention Controls: • Stakeholder consultation with fisheries to advise of activity, understand issues and identify practicable controls to reduce impacts; • Notifications on mobilisation and demobilisation dates have been made to all stakeholders. Relevant stakeholders will be re-notified 5days prior to survey mobilisation and 3 days after survey completion and on any changes; • Vessel activity reports to AMSA RCC who will issue shipping notifications (Auscoast) to minimise potential for marine activity conflicts; • Ongoing consultation will be undertaken with WAFIC, RecFishwest, CFA and individual fishermen during the activity. This will include mobilisation and demobilisation advice. • A Notice to Mariners will be issued by the WA Department of Transport for local operators in WA State waters. Mitigation: • Consultation with these fisheries has identified no issues and the Pearl Producers Association/Kailis Brothers and Prawn Fisheries indicate there will be no impact on their activities. AFMA has advised that Commonwealth fishery activity is low within the survey area. • Vessel/survey equipment can easily divert to prevent spatial conflicts with fishing activities. • Program short in duration (~30 days) with vessel constantly moving.	LOW Risk

Impact Category	Possible Impacts	Control/Mitigation Measures	Residual Risk Assessment
	Interference with Commercial Shipping (Diversion)	Prevention Controls: • Stakeholder consultation with commercial shipping to advise of activity and identify any issues to identify controls to minimise impacts; • Vessel activity reports to AMSA RCC (Auscoast) to minimise potential for marine activity conflicts; • Bridge manned 24/7 to identify third party vessel presence via vessel radar, radio, navigation lighting and AIS to identify location; • Trained marine crew (STCW95/Elements of Shipboard Safety). Mitigation: • Survey program is short in duration (~30 days); • Vessel/survey equipment can easily divert to prevent spatial conflicts with fishing activities; • AMSA advise that the survey is in an area of low vessel traffic (no Notice to Mariners required).	LOW Risk
Vessel Lighting	Light-spill interfering with behaviour of marine fauna and birds	Prevention Controls: • Vessel lighting is the minimum required for compliance with navigation safety and workplace safety requirements; • In-sea inspections are minimised as far as possible during hours of darkness; • Pre-mobilisation audit to identify opportunities to reduce light spill. Mitigation: • Survey area not located within, or in proximity to, any known light-sensitive fauna aggregation areas (e.g. turtle breeding beaches). No expected change to marine species behaviour; • Survey duration is limited (~30 days) and vessel is constantly moving.	LOW Risk

Impact Category	Possible Impacts	Control/Mitigation Measures	Residual Risk Assessment
Operation of Acoustic Sub-bottom profiling Survey Sources	Damage to and/or behavioural changes to marine fauna (Cetaceans, Turtles)	Prevention Controls: • All field crew inducted into the environmental sensitivities of the GA Survey area; • Minimum source size used to acquire data (much lower SEL than seismic and military sonar sources); • Implement and comply with requirements of EPBC Act Policy 2.1 – Interaction between seismic and whales (Part A) for sub-bottom profiling sources as determined by EPBC Referral 2013/6747; • Two crew members available on-board the vessel during survey with continuous monitoring during daylight hours while acoustic source is operational; • Sighting reports issued to SEWPC. Mitigations: • Cetacean/reptiles species will avoid area if noise disturbance is too high; • Survey duration limited (~30 days) with temporary impacts. • Timing avoids 'peak' periods of threatened species presence.	LOW Risk
	Damage/ behavioural changes to fish and shark/ray species	Mitigation Controls: • Sharks are not impacted by high frequency, regular sound (cannot hear); • Sharks may withdraw from area with sudden sound increase over previous sound intensity; • Fish species are not sensitive to mid-high frequency sonar (>1.5 kHz); • Fish species react to low-mid frequency sonar with some displacement but no damage to species. • Vessel is constantly moving during survey activities (i.e. temporary, transient impacts).	LOW Risk

Impact Category	Possible Impacts	Control/Mitigation Measures	Residual Risk Assessment
Propulsion of R/V *Solander*	Sound Pollution and Behavioural Disturbance to Marine Fauna	Prevention Controls: • Sound levels emitted from R/V *Solander* is below sound levels which are thought to cause damage to marine fauna; • Vessel propulsion systems to undergo preventative maintenance and inspection; • R/V Solander to comply with proximity distances and vessel speeds as required for cetaceans in Part 8 of the EPBC Regulations 2000. This information to be included in induction. Mitigation: • Small area of impact given the rapid dissipation of vessel sound in the marine environment; • Marine species will avoid area if noise disturbance is too high; and • Survey duration limited (~30 days).	LOW Risk
Benthic and Seabed sediment sampling	Disturbance to benthic habitats (loss of function)	Prevention Controls: • Grab samples and cores will be undertaken in soft sediment in selected locations; • Grab and core samples will impact on very small areas of seabed (~1 m^2) with approximately 0.14 m^3 removed during each sample; • All sampling informed by video transects; • Use of method statements for equipment to place equipment on seabed minimising impacts (e.g. Vibrocorer method statement) • All field personnel will be provided with an induction identifying seabed sampling protocols. Mitigation: • Small and temporary area of impact for the majority of sampling types, high impact samples minimised as far as possible; • Sampling has been restricted to point sampling only (i.e. no dredging that would cover a large area and increase the impact on the marine environment); • Benthic communities are widespread in the Browse Basin.	LOW Risk

Impact Category	Possible Impacts	Control/Mitigation Measures	Residual Risk Assessment
	Disturbance of Unexploded Seabed Ordinance (Damage to Items of National Environmental Significance)	Prevention Controls: • Consult with the Department of Defence to understand the types of ordinances which could be present, any areas of high risk, the identification of these ordinances and best methods to detect presence; • All physical sampling locations will be surveyed with video prior to seabed sampling occurring; • If an ordinance is suspected, the seabed sampling location will be abandoned and the location marked for communication to the Department of Defence; Mitigation Controls: • Sampling has been restricted to point sampling only (i.e. no dredging that would cover a large area and increase the risk of striking unexploded ordinance); • Timing avoids 'peak' periods of threatened species presence	LOW Risk

Oily water discharges from equipment spaces	Reduction in water quality (organics and toxics) with impacts to marine fauna	Prevention Controls:
		• Discharge to comply with MARPOL Annex I requirements.
		• For R/V *Solander* with an oil-water separation system:
		  ○ Current AOPP certification.
		  ○ Oily water passes through an oil/water separator and treated to an oil-in-water content <15ppm prior to discharge;
		  ○ Oil Detection Monitoring Equipment (ODME) is regularly calibrated;
		  ○ Equipment routinely maintained (Preventative/Planned Maintenance System);
		  ○ Separated oil store in dedicated tank for onshore disposal.
		Mitigation:
		• Low volumes intermittently discharged and rapid dilution/dispersion in Browse Basin marine waters.
		• Survey is for a limited duration only (~30days).
			LOW Risk

Impact Category	Possible Impacts	Control/Mitigation Measures	Residual Risk Assessment

Grey water/ sewage disposal	Reduction in water quality (organics and visual amenity) with impacts to marine fauna	Prevention Controls:
		• Discharge to comply with MARPOL 73/78 Annex IV requirements.
		• For R/V *Solander*:
		  ○ Vessel has a current ISPP.
		  ○ STP reduces BOD /organic loadings to MEPC.2(VI) requirements and discharged at distances >3nm.
		  ○ STP routinely maintained and inspected (Vessel's Preventative/Planned Maintenance System);
		  ○ POB strictly controlled on vessel.
		  ○ On breakdown of equipment discharge directed on-board for storage until equipment operational, discharged to onshore facility or discharged at distances >12nm from shoreline whilst en-route.
		Mitigation:
		• Low volume of sewage generated with small numbers of personnel on board;
		• High dispersal/dilution in Browse Basin marine environment;
		• Survey is for a limited duration only (30 days); and
		• Survey areas not in proximity to landmass (i.e. >3 nm).
			LOW Risk

Putrescible waste (food-scraps) Discharges	Reduction in water quality (organics and visual amenity) with foraging impacts to marine fauna	Prevention Controls: • Waste Management on board vessel is in accordance with the Vessel's Garbage Management Plan with placards available advising of requirements; • Non-macerated food at distances greater than 12 nm from landfall or frozen for onshore disposal; • Personnel trained in the requirements of the Vessel's Waste Management Plan. Mitigation: • Low volumes discharged and rapid dilution/dispersion in marine waters; • Survey is for a limited duration only (~30 days).	LOW Risk

Impact Category	Possible Impacts	Control/Mitigation Measures	Residual Risk Assessment
Air Emissions: Equipment Combustion	Reduction in air quality (NO_x, SO_x, CO_2) such that impacts to marine species occur and aesthetic impacts of smoke	Prevention Controls: • Regular equipment monitoring and maintenance under vessel PMS is undertaken on combustion equipment (generator set and propulsion system) to ensure maximum efficiencies are obtained; and • Fuel monitoring undertaken to identify equipment inefficiencies. Mitigation: • Low volumes generated and rapid dilution/dispersion in marine atmosphere; • Survey is for a limited duration only (~30 days).	LOW Risk
Oil spill (MDO) due to vessel collision (Spill volume – largest fuel tank is 32m^3)	Toxic and Physiological impacts to marine biota	Prevention Controls: • Vessel is class certified; • Consultation with and notification to, marine stakeholders of activity; • Notification to AMSA RCC who will issue Auscoast warnings; • Radio communication, AIS and Navigation lights on R/V *Solander*; • Vessel operated by experienced and competent crew (STWC95) with 24/7 bridge watch; • ARPA tracking of vessels on R/V *Solander*; Mitigation: • Use of MDO as fuel for vessel; • Availability of approved, implemented and tested SOPEP and OSCP; • Oil Spill Response arrangements tested for survey activities; • AMSA response to oil spill as Combat Agency; • No landfall impacts identified with largest spill volume (32 m^3); and • Area recognised as an area of low vessel intensity.	MEDIUM Risk

Impact Category	Possible Impacts	Control/Mitigation Measures	Residual Risk Assessment
Packaged/bulk Oil/Chemical spill through deck system	Localised Reduction of Water Quality with possible impacts to marine fauna	<u>Prevention Controls:</u> • Small volumes of chemicals/oils held on-board (usually in packages of limited volume); • Deck bunding is provided for temporary activities which have a high spill risk; • Chemicals are isolated from the deck drainage system (bunding/containers); • Information available to crew members (including training) on the handling (i.e. MSDSs) and PPE requirements of specific chemicals and spill clean-up procedures; • Spill clean-up kits are strategically placed in high risk spill locations; • Deck spills are cleaned up immediately and prior to any deck washing; • Biodegradable detergents used on vessels; • Chemicals/oils are appropriately labelled, packaged, marked and tethered in accordance with IMDG Code; • High levels of housekeeping maintained on the vessel and areas are routinely inspected. <u>Mitigation:</u> • Availability of implemented and tested SOPEP. • Low volumes generated and rapid dilution/dispersion in marine environment; • Survey is for a limited duration only (~30 days).	LOW Risk

Impact Category	Possible Impacts	Control/Mitigation Measures	Residual Risk Assessment
Solid/Hazardous Waste overboard incident	Toxicity impacts to marine flora and fauna Alteration to Seafloor Harm to Marine Fauna by Ingestion	Prevention Controls: • R/V *Solander* operates in accordance with an approved Garbage Management Plan which includes identification of waste reduction measures (at source) to prevent waste generation; • No solid waste of hazardous waste overboard (waste disposal onshore policy); • Clear waste identification, segregation, containment (in skips or sealed drums) and labelling; • All wastes disposed are recorded in Garbage Record Book; • Waste storage areas are routinely inspected; • Training and reinforcement to all crew (and other) personnel of waste management requirements.	LOW Risk
Equipment Loss	Hazard to Vessels (Shipping and Fishing Hazard)	Prevention Controls: • Equipment deployment and retrieval via approved Procedures; • For towed operations a secondary retaining device is used to prevent loss; • Equipment is fit for purpose; • An inspection and maintenance system checks bridles and harnesses for wear with damaged components replaced as necessary. Mitigation: • In the event of a streamer loss, marine stakeholders are notified.	LOW Risk
Liquid Loss from Streamers (shark bite, impact from vessels, etc.)	Toxicity impacts to marine flora and fauna	Prevention Controls: • Vessel collision preventative controls (*as above*); • Low environmental hazard chemical contained in fluid sections of streamer; • Streamer is solid with only small sections of the streamer containing fluid; • Streamers maintained and inspected for integrity. Mitigation Controls: • Rapid dispersion in the marine environment	LOW Risk

Impact Category	Possible Impacts	Control/Mitigation Measures	Residual Risk Assessment

Collision with Marine Cetaceans	Damage/Death to Individual Cetacean	<u>Prevention Controls</u>:
		• Comply with proximity distances as required for cetaceans in Part 8 of the EPBC Regulations 2000 during non-acoustic survey/transit periods (avoids cetacean strikes). This includes (within caution zone – whales (300 m) and dolphins (150 m)):
		  ○ Operate vessel at a constant speed of less than 6 knots and minimise noise;
		  ○ Vessel not to drift closer than 50 m (dolphins) and 100 m (whales);
		  ○ Make sure the vessel does not restrict path of cetacean and the vessel does not pursue cetacean.
		• Records to be maintained by trained crew member of cetacean interaction during these periods.
		<u>Mitigation</u>:
		• Cetaceans/turtles deterred from high noise areas.
			LOW Risk