Chrysalids and Lemuria 3D Marine Seismic Survey

Summary Environment Plan

Karoon Gas Controlled Document

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Revision 1

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1 Introduction

Karoon Gas Australia Limited in its own right or via a subsidiary ('Karoon') is proposing to undertake the Chrysalids and Lemuria Marine Seismic Surveys (MSSs) in the Commonwealth waters of the Northern Carnarvon Basin, Western Australia (WA). The Chrysalids and Lemuria MSSs are proposed to be undertaken in Exploration Permit Areas WA-482-P, WA-363-P, WA-468-P and adjacent non-permit areas.

The purpose of the surveys is to better delineate hydrocarbon prospects in the area and accurately define possible drilling locations for future exploration activities.

Karoon, as nominated Environmental Operator for this petroleum activity within WA-482-P and under access authorities WA-45-AA and WA-46-AA for ingress into WA-363-P and adjacent vacant areas, has prepared an Environment Plan (EP) for this activity in accordance with the requirements of the *Offshore Petroleum & Greenhouse Gas (Environment) Regulations 2009*. The EP has been reviewed and accepted by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA).

This EP summary document has been prepared to comply with the requirements of Regulation 11(7) and (8) of the referenced *Offshore Petroleum & Greenhouse Gas (Environment) Regulations 2009.*

2 Activity Location

The Chrysalids and Lemuria MSS activity, shown on a regional basis in **Figure 2-1**, will be undertaken within WA-482-P, WA-363-P, WA-468-P and adjacent non-permit areas (Northern Carnarvon Basin). Activity within the WA-363-P and adjacent vacant areas will be undertaken in accordance with access authorities WA-45-AA and WA-46-AA.

Within the Chrysalids and Lemuria MSS 'vessel working area'[1] of approximately 8428km^2 (refer **Table 2-1** for coordinates) seismic data acquisition will be acquired over 3128km^2 (refer **Table 2-2** for coordinates).

The Chrysalids and Lemuria MSS areas are located approximately 180km WSW of Imperiuse Reef[2] and 250km NNW of Port Hedland (WA). Details on individual survey areas are as follows:

- The Chrysalids 3D MSS covers an area of 2376km^2 (*working area 5764km^2*) in water depths 1200-1650m.The closest proximity distance from a Chrysalids MSS boundary to Imperiuse Reef is approximately 230km (NNE);
- The Lemuria 3D MSS covers an area of 752km^2 (*working area 2660km^2*) in water depths of 1000-1750m. The closest proximity distance from a Lemuria MSS boundary to Port Hedland is 250km (SSW).

[1] Defined as the operational boundary of the Environment Plan.

[2] Measured from the Lemuria MSS boundary.

Figure 2-1: Regional Location of the Chrysalids and Lemuria MSSs

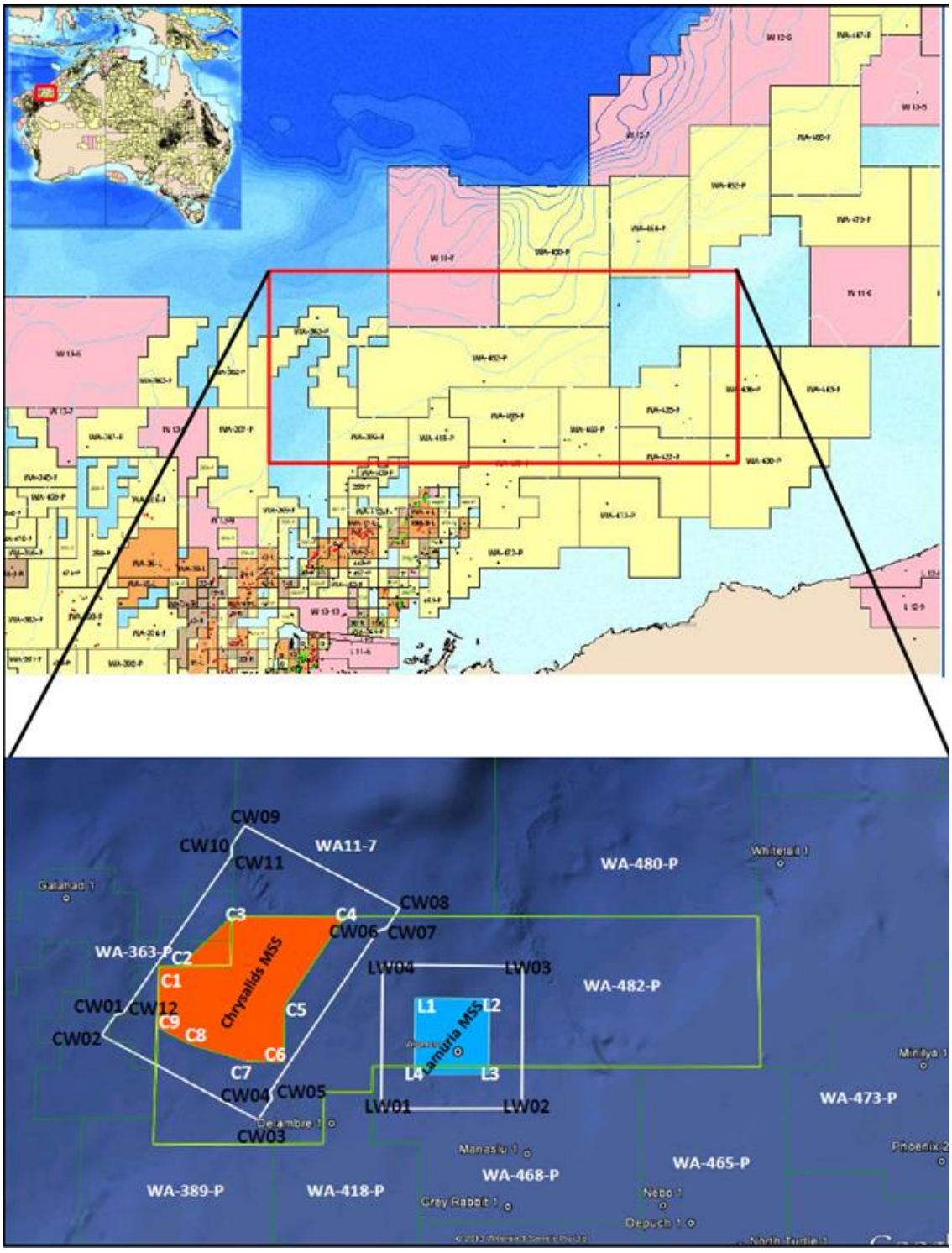


Table 2-1 Chrysalids and Lemuria MSS 'Vessel Working Areas'

Location Point	Latitude			Longitude		
	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
Chrysalids MSS Vessel Working Area						
CW1	18	09	30.69	115	56	21.00
CW2	18	13	34.98	115	53	31.81
CW3	18	30	17.09	116	26	34.75
CW4	18	26	13.38	116	29	23.81
CW5	18	24	49.20	116	29	01.55
CW6	17	52	59.25	116	50	47.98
CW7	17	52	35.73	116	52	26.27
CW8	17	48	31.12	116	55	13.97
CW9	17	31	30.70	116	22	19.95
CW10	17	35	41.30	116	19	35.71
CW11	17	37	31.21	116	19	41.89
CW12	18	09	07.13	115	57	59.06
Lemuria MSS Vessel Working Area						
LW1	18	28	09.58	116	51	54.99
LW2	18	28	06.98	117	20	46.47
LW3	18	00	12.38	117	20	57.11
LW4	17	59	52.40	116	51	51.50

Table 2-2 Chrysalids and Lemuria 'Survey' Areas

Location Point	Latitude			Longitude		
	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
Chrysalids Survey Area						
C1	17	59	53.22	116	05	01.57
C2	17	59	53.83	116	09	32.70
C3	17	49	54.63	116	20	04.39
C4	17	49	57.52	116	43	58.66
C5	18	07	53.57	116	31	42.06
C6	18	19	01.59	116	31	43.46
C7	18	18	55.63	116	23	44.81
C8	18	15	33.62	116	12	11.27
C9	18	12	07.78	116	05	04.47
Lemuria Survey Area						
L1	18	06	28.07	116	58	39.15
L2	18	06	37.57	117	14	03.59
L3	18	21	34.35	117	13	59.62
L4	18	21	36.72	116	58	39.15

3 Seismic Program Activity Description

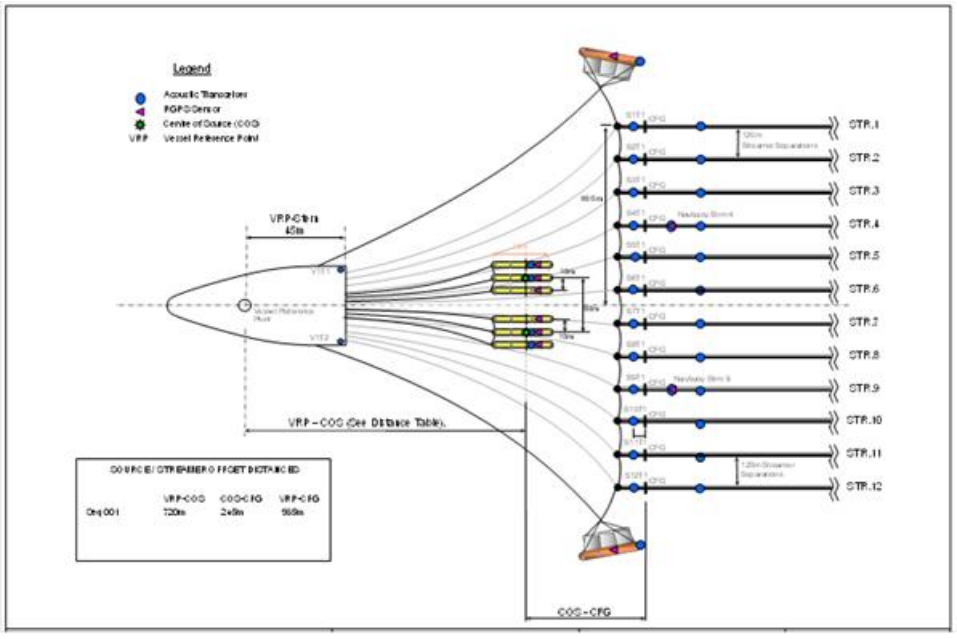
The MSS program will acquire seismic data between 1st May 2013 (earliest start date) and 31st August 2013. The activity is expected to take up to 50 days. The precise commencement and completion dates are dependent on vessel schedule, weather conditions and ongoing discussions with stakeholders. Seismic acquisition will be undertaken 24 hours per day, seven days per week.

The MSSs will be undertaken by an experienced seismic contractor utilising a purpose-built seismic vessel, towing seismic equipment along a series of pre-determined seismic lines within the 3128km^2 survey acquisition areas. The vessel will, while acquiring seismic, travel at an average speed of approximately 8–9 km/h (4–4.5 knots). As the vessel travels along the survey lines, a series of acoustic pulses activated at 18.75m or 25m intervals (approximately every 11 seconds) will be directed down through the water column into the seabed via two source arrays. Reflected sound wave are detected by sensitive hydrophones, arranged along a number of cables (streamers) towed behind the survey vessel. Data collected by the hydrophones is stored in on-board computers for processing and analysis, allowing the structure of the underlying geological strata to be mapped and potential hydrocarbon reservoir targets to be identified.

The seismic equipment will comprise of a dual source array, of volume between 2400-4000in^3 operating at pressures of 2000psi and will be towed at approximately 6m water depth. Reflected sound waves will be collected by up to fourteen (14) hydrophone collectors ('streamers') of length up to 8100m, each separated by approximately 100m, towed at a depth of approximately 8-50m depth behind the seismic vessel. These hydrophone streamers will be solid streamers.

A typical towing diagram of a 3D MSS vessel is provided in **Figure 3-1.**

Figure 3-1: Typical 3D MSS Towing Diagram



The MSS vessel will traverse the survey areas along defined transects (or seismic lines) approximately 400-800m apart (dependent on number of streamers and streamer separation). The Chrysalids and Lemuria MSSs will run in a northeast-southwest and north/south direction.

Logistical support will be provided by one vessel[3] and will be on standby to direct any shipping traffic away from the MSS area. Additionally, the seismic vessel and streamers will display appropriate

[3] The seismic and support vessels may mobilise from Australian or International waters.

navigational safety measures such as day shapes, lights and reflective tail buoys to indicate that the vessel is in tow and restricted in its ability to manoeuvre. A visual and radar watch will be maintained on the bridge at all times by trained and competent crew (STCW95) and in addition, Automated Radar Plotting Aid (ARPA) will be utilised on both the MSS and support vessel to monitor for vessels in the area.

The vessels will also operate under an approved Shipboard Oil Prevention Emergency Plan (SOPEP) which details actions to be taken in the event of a shipboard emergency or oil spill in accordance with MARPOL 73/78 Annex I requirements.

Seismic operations will utilise the Port of Broome or Dampier as a supply port, however refuelling of vessels at sea may occur. Crew changes will preferably occur during port calls however helicopter personnel transfer may also occur. Helicopter transfer, if required, from Dampier or Port Hedland will occur during daylight hours. There will be no helicopter refuelling on-board the seismic vessel.

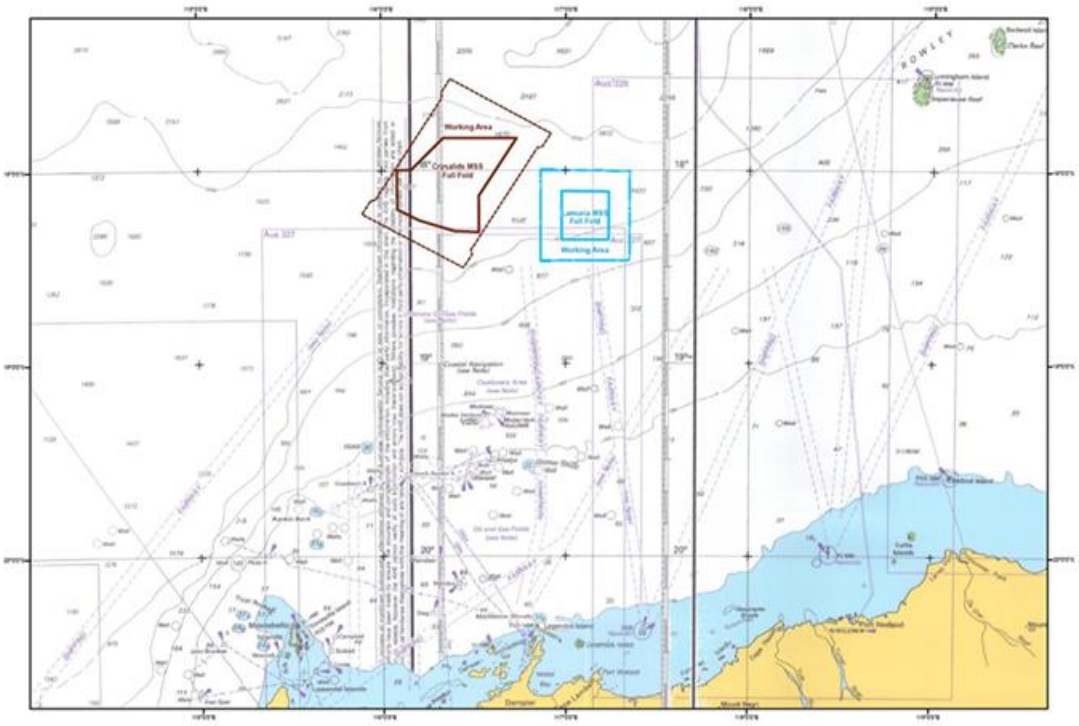
4 Receiving Environment

4.1 General

The Chrysalids and Lemuria MSS areas are located in the Northwest Transition Bioregion (DEWHA, 2008). The bioregion supports a number of geomorphic features including abyssal plains, continental slope and emergent reef systems such as Mermaid, Clerke and Imperieuse reefs (collectively known as the Rowley Shoals).

The nearest[4] environmentally sensitive location is Rowley Shoals which is a series of north-south oriented isolated, reef-rimmed platforms rising vertically to the surface from water depths of about 400m on the continental slope (refer **Figure 4-1**). Mermaid Reef is a Commonwealth Marine Reserve that covers an area of 5.4km^2, and includes seabed and substrate to a depth of 1000m (DEWHA, 2008). Rowley shoals is a biodiversity hot-spot of intertidal and sub-tidal coral reefs containing 184 species of corals, 264 species of molluscs, 82 species of echinoderms and 389 species of finfish (DEC, 2007 cited in DEWHA, 2008). The reefs attract a large number of migratory pelagic species including cetaceans, tuna, billfish and sharks (including grey reef shark and silvertip whaler shark) (DEWHA, 2008).

Figure 4-1: Chrysalids and Lemuria MSS Areas relative to Rowley Shoals



Conservation Areas

No areas of high conservation significance are present in the Chrysalids and Lemuria MSS areas. The nearest Commonwealth Marine Reserves to the MSS areas are:

- Argo-Rowley Terrace Commonwealth Marine Reserve (located approximately 10km north of the Chrysalids MSS area); and

[4] Located approximately 180km ENE of the Lemuria MSS boundary.

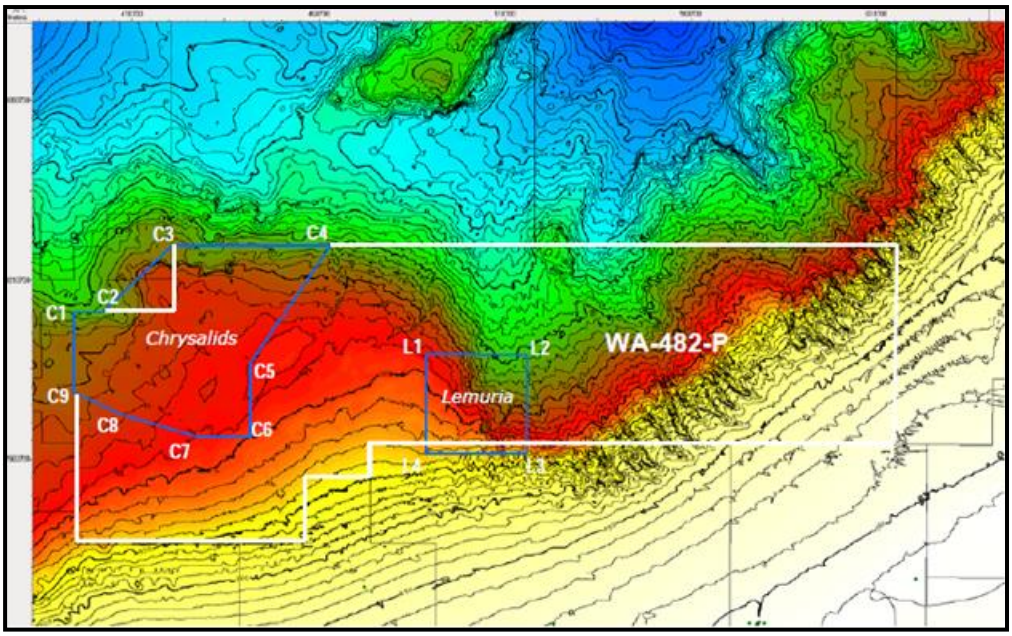
- Mermaid Reef Commonwealth Marine Reserve (located approximately 270km ENE of the Lemuria MSS area).

The other two reef systems of the Rowley Shoals, Clerke Reef and Imperieuse Reef are managed by the Western Australian Government as the Rowley Shoals Marine Park.

4.2 Bathymetry

The Chrysalids and Lemuria MSS areas are located in water depths of 1000-1750m over continental slope areas (refer **Figure 4-2**). The sediments of the slope are dominated by carbonate sands (DEWHA, 2008). Mud content increases with water depth on the mid-lower slope with extensive carbonate sand deposits at the shelf edge (Baker et al, 2008).

Figure 4-2: Bathymetry of the Chrysalids and Lemuria MSS Areas



4.3 Marine Fauna

The deep ocean habitats are likely to support meiofauna (e.g. nematodes), larger infauna (e.g. polychaete worms and isopods) and sparsely distributed epibenthic communities (e.g. sea-pens). Mobile benthic seafloor species such as deep-water cucumbers, crabs and polychaetes are likely to be present as well as sparse populations of bentho-pelagic fish and cephalopods (in low densities) (Brewer et al 2007; cited in DEWHA, 2008).

Demersal fish communities of the continental slope in the Northwest Transition Bioregion have been assessed to contain more than 500 species of fish of which 64 species are considered to be endemic (DEWHA, 2008). This is the second richest area for demersal fish species across the Australian continental shelf. The continental slope within the bioregion has two distinct demersal community types - the upper slope (water depths of 225-500m) and mid-slope (water depths of 750-1000m). No mid-upper slope biome is present (DEWHA, 2008). This feature is identified as a Key Ecological Feature (KEF) within the north-west marine region.

Dominant crustacean species include copepods, prawns, scampi and crabs. Few endemic species of crustacean are present (DEWHA, 2008). The North-West Slope Trawl Fishery targets scampi in the region.

As defined in the EPBC Protected Matters Database (SEWPC, 2012a), the MSS area supports a number of marine species (refer **Table 4-1**). This includes:

- Twenty-two (22) EPBC-listed cetacean species including six (6) species listed as migratory and two (2) species listed as threatened/endangered. The timing of the MSS may encounter the Blue Whale during their northern migration. Encounter with the Humpback Whale is considered unlikely due to the distance from the Western Australian coastline and other migratory cetacean species nominated may transit the MSS area, however encounter is also considered low;
- Sixteen (16) EPBC-listed reptile species, of which five (5) turtle-species are listed as threatened and migratory. Given the depth of water and distance from known biologically significant habitats for turtles, encounter is expected to be low;
- Two (2) shark species listed as having a migratory status under the EPBC Act.

Table 4-1: EPBC listed Threatened & Migratory Species in the MSS Areas (SEWPC, 2012a)

Status:
E: Endangered
V: Vulnerable
M: Migratory

Likelihood of Occurrence:
LO: Species or species habitat likely to occur in area
MO: Species or species habitat may occur within area
FMO: Foraging/Feeding may occur within area
FKO: Foraging/Feeding known to occur in area
FLO: Foraging/Feeding likely to occur in area
BO: Breeding known to occur in area

Species Type	Scientific Name	Common Name	EPBC Status	Type of Presence
Marine Mammals	*Balaenoptera musculus*	Blue Whale	E, M	MO
	Megaptera novaeangliae	Humpback Whale	V, M	MO
	Balaenoptera bonaerensis	Antarctic Minke Whale	M	MO
	Balaenoptera edeni	Bryde's Whale	M	MO
	Orcinus orca	Killer Whale	M	MO
	Physeter macrocephalus	Sperm Whale	M	MO
Sharks	*Isurus oxyrinchus*	Shortfin Mako	M	LO
	Isurus paucus	Longfin Mako	M	LO
Reptiles	*Caretta caretta*	Loggerhead Turtle	E, M	LO
	Chelonia mydas	Green Turtle	V, M	LO
	Dermochelys coriacea	Leatherback Turtle	E, M	LO
	Eretmochelys imbricata	Hawksbill Turtle	V, M	LO
	Natator depressus	Flat-back Turtle	V, M	LO

4.4 Socio-Economic Environment

Commercial Shipping

AMSA has identified that the MSS areas are in an area of major shipping, in particular the Dampier Shipping Fairway and the Port Walcott to Lombok route. As such significant traffic will be encountered. A scout vessel to identify potential shipping threats, together with navigational warnings will be implemented prior to MSS commencement to alert commercial vessels of the activity.

Commercial Fishing

The Chrysalids and Lemuria MSS area lies within the following commercial fishing management areas:

- Western-Australian state-managed:
  - Mackerel Fishery (Area 2 - Pilbara) (not active within the MSS acquisition area but present within 20km);
  - North Coast Shark Fishery (active in the MSS area between 1 October-31 January and not present during the MSS timeframe);
  - North Coast Demersal Scale-fish Fishery and West Coast Deep Sea Crab Fishery (not identified by WA Department of Fisheries as being active in the MSS area).
- Commonwealth-managed:
  - North-west Slope Trawl Fishery (consultation has identified that this fishery is not active in water depths of 1000m^{+});

- Western Tuna and Billfish Fishery (predominant fishing activity occurs south of Carnarvon and unlikely to be present in the MSS area); and
- Skipjack Tuna and Southern Bluefin Tuna Fishery (AFMA data indicates both fisheries are not active in the MSS area).

Fishing effort within the MSS areas during the proposed timeframes will be low.

Oil & Gas Development

The North-west Marine region is significant for the production of petroleum products accounting for 90% of current Australian gas reserves with the northern Carnarvon Basin producing 97% of Western Australia's oil and gas (IRC, 2007). The nearest WA-482-P Permit boundary lies approximately 110km north of North Rankin A Platform and approximately 75km north of the Modec Venture II (GA, 2013).

Commonwealth Heritage

The nearest Commonwealth Heritage Place lying in proximity to the MSS Areas is Mermaid Reef-Rowley Shoals located approximately 270km ENE (Mermaid Reef)(SEWPC, 2012b).

Review of the National Shipwreck Database (SEWPC, 2012c) has identified that the nearest historic shipwrecks lie approximately 200km north east ('*Alfred*' and '*Pelsart*') and approximately 270km ENE ('*Lively*') of the MSS area.

5 Major Environmental Hazards and Controls

In accordance with the Offshore *Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* R14(3) & R14(3A), an environmental hazard identification and risk assessment has been undertaken to evaluate the potential sources of environmental impact associated with the Chrysalids and Lemuria MSS activity. This included an assessment of risks arising from operational activities, unplanned events (non-routine/accident) and incident response activities and can be grouped into the following broad categories:

- Mobilisation of the seismic and support vessels to the proposed survey area:
  - Introduction of invasive marine species (IMS) from ballast water discharge or biofouling.
- Physical presence of the Seismic Vessel:
  - Disruption to commercial fishing activities and commercial shipping; and
  - Lighting impacts due to 24 hour activities.
- Seismic acquisition:
  - Discharge of acoustic source sound pulses in the proposed survey area;
  - Sound from operation of vessels; and
  - Sound from operation of helicopters.
- General vessel operations:
  - Routine waste discharges from the seismic and support vessels (oily water, sewage, food-scraps); and
  - Air emissions (combustion and ozone depleting substances).
- Non-Routine (accidental) events:
  - Oil Spill from Vessel Collision;
  - Chemical/oil spill through deck drain system;
  - Oil spill during refuelling at sea;
  - Solid non-biodegradable/hazardous waste overboard incident;
  - Seismic streamer loss in the marine environment;
  - Seismic streamer liquid leak in the marine environment; and
  - Vessel collision with a cetacean.

Implemented control measures identified in **Table 5-1** ensures that the environmental risks associated with these impacts are as low as reasonably practicable (ALARP). Control measures are taken into consideration in calculating the residual risk associated with the activity of impact reflected in **Table 5-1**.

Table 5-1: Chrysalids and Lemuria MSS Aspects, Potential Environmental Impacts and Controls

Aspect	Possible Impacts	Control/Mitigation Measures	Residual Risk
Mobilisation			
Vessel Entry to Australian Waters (Introduction of IMS)	Alteration of local ecosystem by IMS through Ballast Water Discharges	Prevention Controls: MSS vessels to undergo Ballast water Exchange prior to entry to Australian waters in accordance with DAFF *Guidelines on Ballast Water Management* (2011); Support vessel sourced locally from within Australian Waters (wherever possible); Vessels to submit QPAR form to AQIS and ballast water logs 96hrs prior to arrival into Australian Port. Mitigations: Water depth of survey area is 1000-1750m which is light-limited. This limits the success of IMS colonisation.	Low
	Alteration of local ecosystem by IMS through Vessel Bio-fouling	Prevention Controls: Vessels entering North West Shelf waters will be 'clean' of biofouling in accordance with the *National Biofouling Management Guidance for the Petroleum Production and Exploration Industry* (2009) and Western Australian *Marine Pest Management Guidelines* (WA DoF, 2013); All infield equipment, when retrieved to the MSS vessel, will be inspected and cleaned as necessary to remove biofouling. Mitigations: Water depth of survey area is 1000-1750m which is light-limited. This limits the success of IMS colonisation.	Low
Presence of Vessel in Permit Areas			
Presence of Vessel Activities	Interference with Commercial/ Recreational Fishing Activities (Spatial Conflicts)	Prevention Controls: Stakeholder consultation with fisheries to advise of activity, understand issues and identify practicable controls to reduce impacts; Notifications to relevant marine users prior to survey commencement and on survey completion; Vessel activity reports to AMSA RCC who will issue shipping notifications to minimise potential for marine activity conflicts; Notice to Mariners issued by AHO for activity; Support vessel available to advise fishermen of seismic presence. Mitigation: Limited duration of MSS activity (50 days). Low to no fishing activities within the Chrysalids and Lemuria MSS areas.	Low

Aspect	Possible Impacts	Control/Mitigation Measures	Residual Risk
	Interference with Commercial Shipping (Diversion)	Prevention Controls: Stakeholder consultation with commercial shipping to advise of activity, identify any issues and controls to minimise impacts; Seismic acquisition lines are aligned in a direction which minimises interaction with commercial shipping; Support vessel available to advise & deter of third party presence; Bridge manned 24/7 by STCW95 competent crew to identify third party vessel presence via vessel radar, radio, ARPA and AIS; Vessel activity reports to AMSA RCC; Notice to Mariners issued by AHO for activity. Mitigation: Seismic program in Chrysalids and Lemuria MSS area is short in duration (50days).	Medium
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 inspection activities during nightfall are minimised as far as possible; Pre-mobilisation audit identifies opportunities to eliminate deck light spill with corrective actions implemented prior to mobilisation. Mitigation: Survey area not located within, or in close proximity to known light-sensitive fauna aggregation areas (e.g. turtle breeding beaches); Survey duration is limited (approx. 50days) and vessel is constantly moving.	Low
Survey Operations			

Aspect	Possible Impacts	Control/Mitigation Measures	Residual Risk
Operation of Seismic Sources	Damage to &/or behavioural changes to marine fauna (Cetaceans, Turtles)	Prevention Controls: All field personnel provided with an induction which includes the environmental sensitivities associated with the Chrysalids and Lemuria MSS area; Lowest size source is selected which achieves seismic objectives for the MSSs. Implement & comply with requirements of the DEWHA Industry Guidelines *Policy Statement 2.1 – Interaction between Offshore Seismic Exploration and Whales (2008) (includes 30minute prestart watch, 35min soft-start, 3km precautionary zone, 2km low power zone & power-down procedures, 500m shutdown zone & shut-down procedures; controls for start-up during periods of low visibility);* Low visibility controls as determined by EPBC Referral 2013/6761; The acoustic source will be powered down to the lowest practicable settings on line turns; Two MMOs available on-board the vessel during survey with continuous monitoring during daylight hours while acoustic source is operational; All vessel crews inducted/trained in cetacean observation as part of induction process to assist in identifying cetaceans & sighting data provided to SEWPC/NOPSEMA. Mitigation: Cetacean/reptiles species will avoid area if sound disturbance is too high; MSS area not recognised as containing critical habitat for species; MSS duration limited (50 days).	Low
	Damage/ behavioural changes to shark species (long-term)	Mitigation: Shark species appear unaffected by acoustic array sound; Vessel is constantly moving (i.e. not situated in one stationary area).	Low
	Damage/ behavioural change (displacement) to fish species (long-term)	Prevention Controls: Implement & comply with requirements of the DEWHA Industry Guidelines *Policy Statement 2.1 – Interaction between Offshore Seismic Exploration and Whales (2008) (provides for soft-start procedures which will alert and disperse fish)* Mitigation: No lethal effects have been observed for adult fish exposed to seismic arrays; Effects of seismic transitory except for fish eggs/larvae at very close range; Fish species sensitive to noise will temporarily disperse in high sound areas; Vessel is constantly moving (i.e. not situated in one stationary area).	Low

Aspect	Possible Impacts	Control/Mitigation Measures	Residual Risk
Propulsion of all Vessels	Sound Pollution & Behavioural Disturbance to Cetaceans/Reptiles	Prevention Controls: Vessel propulsion equipment is routinely maintained to reduce sound levels emitted; All vessels not towing source array and streamers must not: • Travel at greater than 6knots within 300m (caution zone) of a cetacean; • Approach closer than 100m of a cetacean known to be in the area; • Change course or speed if a dolphin approaches the vessel or comes within 100m. MSS vessel shall not exceed 6knots in MSS working area. Requirements will be included in the environmental induction for the survey. Mitigation: Sound levels emitted from vessels are below levels which cause significant damage to marine fauna; Small area of impact given the rapid dissipation of sound in the marine environment; Marine species will avoid area if noise disturbance is too high; and Survey duration limited (50days).	Low
Helicopter Use (Supply/Crew Change)	Sound Pollution & Disturbance to Cetaceans	Prevention Controls: Comply with proximity distances as required for cetaceans in Part 8 of the EPBC Regulations 2000. Crew changes to preferentially occur at port calls; Helicopter propulsions systems undergo regular preventative maintenance and inspection. Mitigation: Small area of impact given the rapid dissipation of sound in the marine environment; Marine Fauna will avoid area if sound disturbance is too high; Very short duration of disturbance (helicopters at low altitude for small period of time).	Low
Standard Vessel Discharges			

Aspect	Possible Impacts	Control/Mitigation Measures	Residual Risk
Oily water discharges from equipment spaces (All Vessels)	Reduction in water quality (organics & toxics) with impacts to marine fauna	Prevention Controls: Discharge to comply with MARPOL Annex I requirements. For vessels with an oil-water separation system: - Vessel to have a current IOPP capable of achieving an oil-in-water content of 15ppm; - Oily water passes through an oil/water separator and treated to an oil-in-water content <15ppm prior to discharge; - Oily water is discharged via an approved Oil-in-water (OIW) meter as per MARPOL 73/78 Annex I with alarm and shutdown/divert on-board for further treatment or on-board storage on excursion above 15ppm (recorded in oil record book); - Oil Detection Monitoring Equipment (ODME) is regularly calibrated and certified; - Equipment routinely maintained (Preventative/Planned Maintenance System); - Separated oil store in dedicated tank for onshore disposal or incineration. For vessels without an oil-water separation system: - Oily water residues are retained on-board for onshore disposal. Mitigation: Low volumes discharged and rapid dilution/dispersion in North West Shelf waters. Seismic survey is for a limited duration only (50days).	Low
Grey water/sewage disposal (All vessels)	Reduction in water quality (organics & visual amenity) with impacts to marine fauna	Prevention Controls: Discharge to comply with MARPOL 73/78 Annex IV requirements. For vessels with a STP: - Have a current ISPP (or equivalent for class). - STP reduces BOD /organic loadings and disinfected prior to discharge at distances >3nm. - STP routinely maintained and inspected (Vessel's Preventative/Planned Maintenance System); - POB strictly controlled on vessel; and - On breakdown of equipment discharge directed on-board for storage until equipment operational or discharged to onshore facility. For vessels without a STP: - Untreated sewage discharged at a distance of more than 12nm from land whilst proceeding *en-route* or to an onshore facility. Mitigation: Low volume of sewage generated with small numbers of personnel on board; High dispersal/dilution in North West Shelf marine environment; Seismic survey is for a limited duration only (50days).	Low

Aspect	Possible Impacts	Control/Mitigation Measures	Residual Risk
Putrescible waste (food-scraps) Discharges	Reduction in water quality (organics & visual amenity) with impacts to marine fauna	Prevention Controls: All food scrap discharges will be compliant with MARPOL 73/78 Annex V requirements: - Macerated waste to a particle size of less than 25mm discharged at distances>3nm from land; - Non-macerated waste at distances>12nm from land. Vessels operate under a Shipboard Garbage Management Plan with placards on-board to advise of waste management requirements; Macerator routinely maintained and inspected (Preventative/planned Maintenance System); Personnel trained in the requirements of the Shipboard Garbage Management Plan; Breakdown of maceration equipment results in food-scraps collected in bins on-board for storage and disposal onshore until equipment operational. Mitigation: Low volumes discharged and rapid dilution/dispersion in marine waters; Seismic survey is for a limited duration only (50days).	Low
Air Emissions: Equipment Combustion & Incinerator Activity	Reduction in air quality (NO_x, SO_x, CO_2) such that impacts to marine species occur & aesthetic impacts of smoke	Prevention Controls: All combustion emissions from marine utilities are in accordance with MARPOL 73/78 Annex VI (R13) requirements. MDO/MGO used to fuel survey vessels (MARPOL compliant for sulphur content) Vessels carry a current IAPP; On-board incinerator will meet the requirements of and operate in accordance with MARPOL 73/78 Annex VI (R16) requirements and waste disposed recorded in the Garbage Record Book; Regular equipment monitoring and maintenance undertaken on incinerator and combustion equipment via PMS to ensure maximum efficiencies are obtained; and Fuel monitoring undertaken to identify equipment inefficiencies. Mitigation: Low volumes generated and rapid dilution/dispersion in atmosphere; Seismic survey is for a limited duration only (50days).	Low
Air Emissions: Release of ODS	Reduction in Ozone Protection Layer	Prevention Controls: Vessels manage ODS systems in accordance with MARPOL 73/78 Annex VI (R12) requirements; Maintenance of closed refrigeration systems on-board the vessel undertaken by suitably qualified personnel in accordance with approved procedures; Any repair or maintenance of equipment containing ODS is recorded in the ODS Record Book Mitigation: Accidental Releases are recorded in the ODS Record Book; Seismic survey is for a limited duration only (50days).	Low
Non-Routine Activities (Incidents)			

Aspect	Possible Impacts	Control/Mitigation Measures	Residual Risk
Oil spill (MDO/MGO) due to vessel collision (Spill volume – largest 'at risk' fuel tank is 200m^3)	Toxic & Physiological impacts to marine biota (including Cetaceans, Turtles)	Prevention Controls: Consultation with and notification to, marine stakeholders of activity; Notification to AMSA RCC who will issue AusCoast warnings; Notification to AHO who will issue a Notice to Mariners; Radio communication (MSS & support vessel), AIS and Navigation lights on vessels; Vessel operated by experienced and competent crew (STWC95) with 24/7 bridge watch; MSS lines will be acquired in a direction which minimises vessel interaction; Availability of a support vessel to detect third party vessels and avoid interference; ARPA tracking of vessels on MSS and support vessel with procedural requirements to avoid collisions; and Navigation safety equipment (ARPA, AIS, radio, Navigation lights) are maintained in accordance with Manufacturers specifications via the vessel's PMS. Mitigation: Use of MDO/MGO as fuel for MSS vessels. Availability of approved, implemented and tested SOPEP and OSCP. AMSA response to oil spill as Combat Agency No landfall impacts identified with largest spill volume. *Note MSS is located adjacent to an area of high vessel traffic.*	Low
Oil/Chemical spill through deck system	Localised Reduction of Water Quality with possible impacts to marine fauna	Prevention Controls: Chemical/oil hazards are isolated from the deck drain system (e.g. bunds, etc.); Chemicals/oils are appropriately labelled, packaged, marked and tethered in accordance with IMDG Code; Information is available to all personnel on chemical handling (e.g. MSDSs). MSDSs are to be made available for all chemicals/oils; Spill kits to be provided in appropriate locations close to high-risk spill locations; Weekly inspections of spill kits and bunded areas and high levels of housekeeping maintained on the vessels; All personnel are aware of hydrocarbon/chemical response through environmental induction; Deck spills are cleaned up immediately and prior to any deck washing; and Biodegradable detergents used on vessels. Mitigation: Small volumes of chemicals/oils held on-board (usually in packages of limited volume); Availability of implemented and tested SOPEP. Campaign specific OSCP tested and implemented Low volumes generated and rapid dilution/dispersion in marine environment; Seismic survey is for a limited duration only (50days).	Low

Aspect	Possible Impacts	Control/Mitigation Measures	Residual Risk
Refuelling at Sea Fuel (MDO/MGO) transfer spill (Spill 1m^3)	Water quality and marine life impacts (estimate 1m^3)	Prevention Controls: Refuelling activity is a fully supervised operation which occurs in daylight hours, good visibility and in appropriate sea-states, undertaken in accordance with approved Bunkering Procedures by trained personnel with all associated equipment routinely maintained and inspected prior to use (e.g. dry-break couplings) and via the PMS; Toolbox meetings undertaken and tanks levels monitored to prevent overfill; Transfer area is bunded; Suitable absorbent material is held on the vessel to clean-up small diesel spills. Mitigation: Vessel has an approved, implemented and tested SOPEP and OSCP; OSCP in place and tested for the MSS; and Spills will be rapidly dispersed in NWS waters – no impact to shoreline expected.	Low
Solid/Hazardous Waste overboard	Toxicity impacts to marine flora & fauna Alteration to Seafloor Harm to Marine Fauna by Ingestion	Prevention Controls: Vessels to operate in accordance with Garbage Management Plan and approved Waste Management & Disposal Procedures which includes identification of waste reduction measures (at source) to prevent waste generation; 'No solid non-biodegradable or hazardous waste overboard' Policy; Waste Storage areas routinely inspected All waste clearly identified, segregated, contained (in skips or sealed drums) & labelled; All hazardous wastes are segregated and contained for onshore disposal/recycling in accordance with WA legislation; All waste disposal is documented in the Garbage Record Book; Training and reinforcement to all crew (& other) personnel of waste management requirements	Medium
Streamer Loss	Hazard to Vessels	Prevention Controls: Survey operates under approved Streamer Deployment and Retrieval Procedures; For streamer operations a secondary retaining device is used to prevent loss; An inspection and maintenance system checks bridles and harnesses for wear with damaged components replaced as necessary. Mitigation: The streamer contains buoyancy devices, are fitted with surface marker buoys and radar reflectors In the event of a streamer loss, marine stakeholders are notified.	Low
Seismic Streamer Liquid Leak	Altered water quality with possible toxic impact to fauna	Prevention Controls: Solid streamers are used for the MSSs (only small sections containing liquid); *Vessel Collision preventative controls (as above);* Low environmental hazard chemical contained in liquid sections of the streamer; Streamers routinely maintained and inspected for integrity. Mitigation Measures: Rapid dispersion in the marine environment.	Low

Aspect	Possible Impacts	Control/Mitigation Measures	Residual Risk
Collision with Marine Cetaceans	Damage/Death to Individual Cetacean	Prevention Controls: Comply with proximity distances as required for cetaceans in Part 8 of the EPBC Regulations 2000 for vessels not towing streamers. • Vessel will not travel at greater than 6knots within 300m of a cetacean known to be in the area; • A vessel will not approach closer than 100m of a whale known to be in the area; • If a dolphin approaches or comes within 100m of the vessel, the vessel master must not change course or modify speed suddenly; The MSS must follow these requirements when the streamers are not deployed. The support vessel must adhere to these requirements at all times; All vessel masters are responsible for ensuring these requirements are followed; and Information is included in environmental induction for the Chrysalids and Lemuria MSS. Mitigation: Cetaceans deterred from high noise areas.	Low

6 Summary of Management Approach

Karoon as the 'Environmental Operator' of the Chrysalids and Lemuria MSS activities is accountable for the environmental outcomes from the proposed MSSs and will ensure the activity is managed in accordance with the accepted Chrysalids and Lemuria Environment Plan (EP). The selected seismic contractor will undertake the survey operations on Karoon's behalf and, under contractual arrangements with Karoon, will implement and comply with all environmental controls and procedures nominated in the accepted Environment Plan.

Karoon is committed to protection of the environment in all activities it undertakes. Activities are undertaken in accordance with relevant legislated standards and where legislated standards do not exist, responsible standards are adopted. Successful environmental outcomes are achieved by understanding how proposed activities interact with the environment, identifying possible and foreseeable impacts, and implementing management controls which eliminate or reduce the environmental risk to ALARP.

Environmental performance objectives have been defined for each environmental aspect. Control measures adopted to manage the environmental risk to a level which is as low as reasonably practicable (ALARP) have been assigned measureable performance standards to ensure controls are meeting their environmental outcomes. Environmental performance and control measure implementation are monitored and verified throughout the activity by the Karoon Offshore Representative.

Key elements of the implementation strategy include:

- Definition of specific roles and responsibilities as they relate to environment protection and EP implementation;
- Induction activities to educate personnel of specific environmental aspects of the MSSs including the environmental sensitivities within the region, control measures which require implementation, monitoring and reporting requirements; and ongoing awareness/communication sessions to reinforce requirements and identify/resolve possible issues;
- Incident reporting and investigation of environmental incidents;
- Compliance assurance of the MSS activity and its adherence to Environment Plan requirements through auditing and inspection activities; and
- Environmental performance review at the completion of MSS activities.

Karoon adopts a philosophy of continuous improvement. Learnings from seismic performance appraisals, incident investigations and field activity reviews are documented and incorporated as improvement actions for future activities.

7 Consultation Process

In accordance with the *Offshore Petroleum and Greenhouse Gas (Environment) Regulations 2009* R(11A) and R14(9), the following stakeholders and interested parties have been identified and consulted as part of the stakeholder engagement process for the survey:

Commonwealth Department or Agency

- Australian Fisheries Management Authority (AFMA)
- Australian Maritime Safety Authority (AMSA)
- Australian Hydrographic Office (AHO)
- Department of Agriculture, Fisheries and Forests (DAFF)
- Border Protection Command
- National Offshore Petroleum Titles Administrator
- Department of Sustainability, Environment, Population and Communities (SEWPC)

Western Australian Departments or Agencies

- Department of Mines and Petroleum
- Department of Fisheries

Fishery-interest Groups

- Western Australian Fisheries Industry Council (WAFIC)
- Commonwealth Fisheries Association (CFA)
- RecFish West
- Mackerel Fishing Licencees (Pilbara – Area 2)
- Jamaclan Marine Services
- WA Seafoods
- Raptis & Sons
- Austral Fisheries
- Australian Southern Bluefin Tuna Industry Association

Adjacent Oil and Gas Operators

- ENI Australia
- Finder Exploration

Feedback obtained in these consultation activities has allowed for the development of a communication and engagement strategy for each relevant stakeholder to determine the level, type, ‘triggers’ and schedule of on-going engagement throughout the Chrysalids and Lemuria MSS. Karoon will maintain communications with stakeholders identified in this communication and engagement strategy to ensure they are informed of relevant aspects of the survey or changes that may affect them.

8 Contact Details

Further information associated with the environmental aspects of the Chrysalids and Lemuria MSS may be obtained from Karoon Gas by contacting the following:

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Melbourne, VICTORIA, 3000

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