ENVIRONMENTAL MANAGEMENT PROGRAMME FOR AN EXPLORATION RIGHT IN THE NORTHERN CAPE ULTRA-DEEP LICENCE AREA IN THE ORANGE BASIN, WEST COAST OF SOUTH AFRICA

Prepared for:
Petroleum Agency South Africa

On behalf of:
OK Energy Limited

Prepared by:
CCA Environmental (Pty) Ltd

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PROJECT INFORMATION

TITLE	Environmental Management Programme for an Exploration Right in the Northern Cape Ultra-deep Licence Area in the Orange Basin, West Coast of South Africa
APPLICANT	OK Energy Limited
ENVIRONMENTAL CONSULTANT	CCA Environmental (Pty) Ltd
REPORT REFERENCE	OE01SS/EMP/1
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REPORT COMPILED BY: Eloise Costandius

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Jonathan Crowther (Pr.Sci.Nat.; CEAPSA)
Managing Director

EXPERTISE OF ENVIRONMENTAL ASSESSMENT PRACTITIONER

NAME	Jonathan Crowther
RESPONSIBILITY ON PROJECT	Project leader and quality control.
DEGREE	B.Sc. Hons (Geol.), M.Sc. (Env. Sci.)
PROFESSIONAL REGISTRATION	Pr.Sci.Nat., CEAPSA
EXPERIENCE IN YEARS	26
EXPERIENCE	Jonathan Crowther has been an environmental consultant since 1988 and is currently the Managing Director of CCA Environmental (Pty) Ltd. He has expertise in a wide range of environmental disciplines, including Environmental Impact Assessments (EIA), Environmental Management Plans / Programmes, Environmental Planning & Review, Environmental Control Officer, Public Consultation & Facilitation. He has project managed a large number of offshore oil and gas EIAs for various exploration and production activities in South Africa and Namibia. He also has extensive experience in projects related to roads, property developments and waste landfill sites.

NAME	Eloise Costandius
RESPONSIBILITY ON PROJECT	Report writing and specialist study review.
QUALIFICATIONS	B.Sc. Hons (Zoo.), M.Sc. (Ecol. Ass.)
PROFESSIONAL REGISTRATION	Pr.Sci.Nat.
EXPERIENCE IN YEARS	9
EXPERIENCE	Eloise Costandius has worked as an environmental assessment practitioner since 2005 and has been involved in a number of projects covering a range of environmental disciplines, including Faunal Specialist Studies, Basic Assessments, Environmental Impact Assessments and Environmental Management Programmes. She has gained experience in a wide range of projects relating to mining (e.g. oil exploration and borrow pits), infrastructure projects (e.g. roads), and housing and industrial developments.

EXECUTIVE SUMMARY

1. INTRODUCTION

OK Energy Limited is proposing to undertake an exploration programme in the Northern Cape Ultra-deep Licence Area (Licence Blocks 3013 and 3113) off the West Coast of South Africa (see Figure 1). In 2013, OK Energy lodged an application for an Exploration Right with the Petroleum Agency SA (PASA) in terms of Section 79 of the Mineral and Petroleum Resources Development Act (No. 28 of 2002; MPRDA). PASA accepted the application (Ref. No. 12/3/274) on 12 December 2013.

The Northern Cape Ultra-deep Licence Area is located in the Orange Basin beyond the continental shelf in depths from roughly 2 500 m to beyond 3 000 m and is approximately 6 930 km^2 in extent. OK Energy is proposing to explore for oil and gas using various methodologies, which may include two-dimensional (2D) and 3D seismic surveys, boat-acquired gravity and magnetics, multi-beam bathymetry and seafloor sampling for geochemical analysis. It is anticipated that the proposed activities would take place either late in the 2013/2014 survey window period (December to May) or early in the 2014/2015 survey window period.

In terms of the MPRDA, an Exploration Right must be issued prior to the commencement of the proposed exploration activities. A requirement of obtaining an Exploration Right is that an Environmental Management Programme (EMP) must be compiled in terms of Section 39 of the MPRDA and submitted to PASA for consideration and for approval by the Minister of Mineral Resources or delegated authority.

OK Energy has contracted CCA Environmental (Pty) Ltd (CCA) to compile this EMP to meet the relevant requirements of the MPRDA and the Regulations thereto.

2. EMP APPROACH AND METHODOLOGY

2.1 OBJECTIVES

The objectives for the EMP process are:

- To provide a reasonable opportunity for Interested and Affected Parties (I&APs) to be consulted on the proposed project;
- To ensure that all potential key environmental issues and impacts that could result from the proposed project are identified;
- To identify feasible alternatives to the implementation of the proposed project;
- To assess potential impacts related to the proposed project;
- To present appropriate mitigation or optimisation measures to minimise potential impacts or enhance potential benefits; and
- Through the above, to ensure informed, transparent and accountable decision-making by the relevant authorities.

2.2 PUBLIC PARTICIPATION PROCESS

The public participation process has involved an open, participatory approach and involvement of I&APs to ensure that all potential impacts are identified and that planning and decision-making takes place in an informed, transparent and accountable manner.

As part of compiling the EMP, a Background Information Document (BID) and Response Form were distributed for a 21-day comment period (17 January 2014 to 10 February 2014). An advertisement announcing the proposed project and the availability of the BID was placed in The Cape Times and Die Burger regional newspapers on Wednesday 17 January 2014. Eight written submissions were received during the comment period.

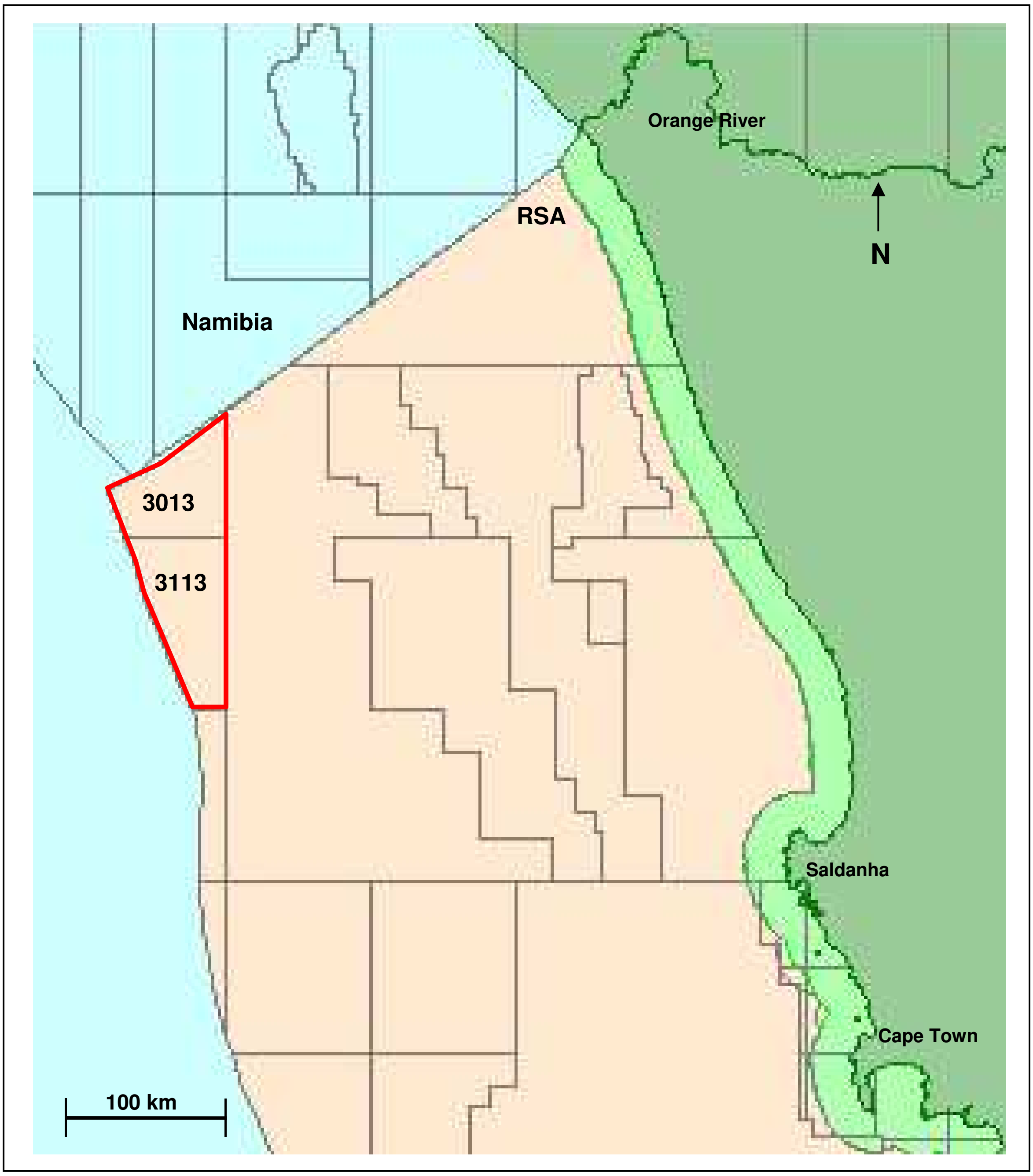

Figure 1: Location of the Northern Cape Ultra-deep Licence Area in the Orange Basin off the West Coast of South Africa.

2.3 SPECIALIST STUDIES AND REPORT COMPILATION

Two specialist studies were undertaken to address the key issues that required further investigation, namely the impact on fishing and marine fauna.

The specialist and other relevant information were then integrated into the EMP.

3. PROJECT DESCRIPTION

3.1 GENERAL INFORMATION

3.1.1 Exploration Right Applicant

OK Energy is the applicant for the Exploration Right.

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3.1.2 Financial Provision

OK Energy will comply with the requirements for financial provision as specified in Section 41 of the MPRDA and Sections 52 and 53 of the MPRDA Regulations. OK Energy will make provision for the requirements of the EMP such as monitoring and reporting as part of the normal budgeting process. Environmental management actions required as a result of an incident or accident would be covered by OK Energy's insurance.

3.1.3 Environmental Policy

OK Energy recognises its responsibility to take care of the environment throughout all its operations and is committed to complying with environmental laws and protecting the environment. They are committed to conducting operations in a manner that minimises negative impacts and promotes the maintenance and enforcement of environmental procedures.

3.1.4 Monitoring and EMP Performance Assessment

OK Energy would undertake appropriate monitoring and EMP Performance Assessments during the proposed exploration activities. OK Energy would track performance against objectives and targets specified in the EMP.

At the conclusion of the proposed exploration activities "close-out" reports (one per exploration activity, unless activities are conducted simultaneously) would be prepared, which would include a monitoring and performance assessment. These reports would outline the implementation of the EMP and highlight any problems and issues that arose during the exploration activities. Copies of these reports will be sent to PASA.

3.1.5 Plans and Procedures for Environmental Related Emergencies and Remediation

All offshore emergencies would be managed in terms of emergency plans prepared by the selected contractor/s.

3.1.6 Undertaking by the Applicant

OK Energy undertakes to comply with the specifications of the EMP and provisions of the MPRDA and Regulations thereto.

3.2 PROPOSED EXPLORATION PROGRAMME

As a minimum, the proposed exploration work programme would consist of the following:

- Acquisition of 500 km new 2D seismic infill data;
- Purchase of existing 800 km seismic data;
- Boat acquired full tensor gravity and magnetics; and
- Interpretation of data.

In addition, the contingent work programme would include the following:

- Acquisition of 1 000 km^2 3D seismic data;
- Multi-beam bathymetry; and
- Seafloor sampling for geochemical analysis.

3.2.1 Seismic survey information

Seismic surveys are carried out during marine oil and gas exploration in order to investigate subsea geological formations. During seismic surveys high-level, low frequency sounds are directed towards the seabed from near-surface sound sources towed by a seismic vessel. Signals reflected from geological interfaces below the seafloor are recorded by multiple receivers (or hydrophones) towed in a single or multiple streamers. Analyses of the returned signals allow for interpretation of subsea geological formations.

For this investigation OK Energy is proposing to undertake both 2D and 3D seismic surveys. The proposed 2D seismic survey would be approximately 500 km in length comprising a number of low density spaced survey lines covering the entire licence area (6 930 km^2). It is anticipated that the proposed survey would either commence late in the 2013/2014 survey window period or early in the 2014/2015 survey window period and would take approximately two weeks to complete. As part of the contingent work programme the acquisition of 1 000 km^2 3D data within the licence area is also proposed. The 3D survey would take approximately four weeks to complete. The planned survey period has not yet been determined.

The seismic surveys would involve a towed airgun array, which provides the seismic source energy for the profiling process, and a seismic wave detector system, usually known as a hydrophone streamer. The anticipated airgun and hydrophone array would be dependent on whether a 3D or 2D seismic survey is undertaken. The sound source or airgun array (two for 3D and one for 2D) would be situated some 100 m behind the vessel at a depth of 5 to 7 m below the surface. 3D surveys use multiple streamers (up to 12 streamers spaced 100 m apart), whereas a 2D survey typically involves a single streamer. The array can be up to 10 000 m long. A surface tail-buoy with radar reflectors would be connected to the end of the streamer/s. During surveying the vessels would travel at a speed of 4 to 6 knots.

Under the Convention on the International Regulations for Preventing Collisions at Sea (COLREGS, 1972, Part A, Rule 10), survey vessels that are engaged in surveying or towing operations are defined as a “vessel restricted in its ability to manoeuvre” which requires that power-driven and sailing vessels give way to a vessel restricted in her ability to manoeuvre. Vessels engaged in fishing shall, so far as possible, keep out of the way of the seismic survey operation. Furthermore, under the Marine Traffic Act, 1981 (No. 2 of 1981), a vessel (including seismic arrays) used for the purpose of exploration or exploitation of the seabed fall under the definition of an “offshore installation” and as such it is protected by a 500 m safety zone. It is an offence for an unauthorised vessel to enter the safety zone. In addition to a statutory 500 m safety zone, a seismic contractor would request a safe operational limit (that is greater than the 500 m safety zone) that it would like other vessels to stay beyond.

A support vessel would be commissioned as a "chase" boat for the duration of the survey. This vessel would be equipped with appropriate radar and communications to patrol the area during the seismic survey to ensure that other vessels adhere to the safe operational limits. The chase boat would assist in alerting other vessels (e.g. fishing, transport, etc.) about the proposed survey and the lack of manoeuvrability of the survey vessel. The chase boat will also be required to perform logistics support to the survey vessel. Helicopters may be utilised for crew / supply transfers between the seismic and support vessels and the mainland.

4. THE AFFECTED ENVIRONMENT

4.1 PHYSICAL ENVIRONMENT

The Northern Cape Ultra-deep Licence area is located in the Orange Basin off the West Coast of South Africa, more than 300 km offshore on the southern side of the border with Namibia. The licence area lies within the southern zone of the Benguela Current region and is characterised by the cool Benguela upwelling system.

Wind and weather patterns along the West Coast are primarily due to the South Atlantic high-pressure cell and the eastward movement of mid-latitude cyclones, south of the subcontinent. The majority of swells are generated by mid-latitude cyclones and originate from the south-west. Wave height decreases with both distance north along the West Coast and with distance offshore. Tides along the West Coast are subject to a simple semi-diurnal tidal regime.

The continental shelf along the West Coast is generally both wide and deep, although large variations in both depth and width occur. The shelf maintains a general north-north-west trend north of Cape Point, being narrowest in the south between Cape Columbine and Cape Point (40 km), widening to the north of Cape Columbine to its widest off the Orange River (180 km).

The most important current is the Benguela current, which constitutes a broad, shallow and slow north-west flow along the West Coast between the cool coastal upwelled waters and warmer Central Atlantic surface waters further offshore. The current is driven by the moderate to strong south to south-east winds which are characteristic of the region and is most prevalent at the surface, although it does follow the major seafloor topographic features. Current velocities in continental shelf areas generally range between 10–30 cm/s.

The Benguela region is one of the world's major coastal upwelling systems. Upwelling is characterised by pulsed input of cold, nutrient-rich water into the euphotic zone, and in the Benguela region results from the wind-driven offshore movement of surface waters. The surface waters are replaced by cold nutrient-rich water that upwells from depth. Once upwelled, this water warms and stabilises, and moves offshore where a thermocline usually develops. Nutrient-rich upwelled water enhances primary production, and the West Coast region consequently supports substantial pelagic fisheries.

4.2 BIOLOGICAL OCEANOGRAPHY

Biogeographically, the licence area falls within the Atlantic Offshore bioregion which extends beyond the shelf break off the West Coast of South Africa. Communities within marine habitats are largely ubiquitous throughout the southern African West Coast region, being particular only to substrate type or depth zone. These biological communities consist of many hundreds of species, often displaying considerable temporal and spatial variability (even at small scales). The near- and offshore marine ecosystems comprise a limited range of habitats, namely unconsolidated seabed sediments and the water column.

Species diversity, abundance and biomass of benthic invertebrate macrofauna increases from the shore to 80 m depth. Further offshore to 120 m depth, the midshelf is a particularly rich benthic habitat, which acts as an important source of food for carnivores, such as cephalopods, mantis shrimp and demersal fish species. Outside of this rich zone biomass declines.

A geological feature of note within the vicinity of the licence area is Tripp Seamount, situated about 250 km offshore at about 29°40' S (approximately 80 km north-east of the licence area). The effect of such a seabed feature on the surrounding water masses can include the upwelling of relatively cool, nutrient-rich water into nutrient-poor surface water thereby resulting in higher productivity, which can in turn strongly influence the distribution of organisms on and around seamounts. Evidence of enrichment of bottom-associated communities and high abundances of demersal fishes has been regularly reported over such seabed features. Consequently, seamounts are usually highly unique and are usually, but not always, identified as Vulnerable Marine Ecosystems.

As many as 110 species of bony and cartilaginous fish have been identified in the demersal communities on the continental shelf of the West Coast, but information from beyond the shelf break is sparse. Changes in fish communities occur with increasing depth, with the most substantial change in species composition occurring in the shelf break region between 300 m and 400 m depth. The shelf community (<380 m) is dominated by Cape hake. Small pelagic fish species, including the sardine/pilchard, anchovy, chub mackerel, horse mackerel and round herring, typically occur in mixed shoals of various sizes within the 200 m contour. Large pelagic species, including tunas, billfish and pelagic sharks, migrate throughout the southern oceans, between surface and deep waters (>300 m) and have a highly seasonal abundance in the Benguela.

Three species of turtles, the green, leatherback and loggerhead, are found along the West Coast. However, only the Leatherback turtle (Critically Endangered) is likely to be encountered within the licence area, but their abundance is expected to be low.

A total of 49 species of pelagic seabirds occur within the southern Benguela area, of which 14 are resident species. Most of the resident species feed on fish (with the exception of the gulls, which scavenge, and feed on molluscs and crustaceans). The far offshore location of the licence area places it outside of the foraging range of most pelagic species that have breeding populations along the West Coast.

The marine mammals occurring off the West Coast include seals and cetaceans (whales and dolphins). The cetacean fauna of the West Coast comprises 28 species. The distribution of whales and dolphins on the West Coast can largely be split into those associated with the continental shelf and those that occur in deep, oceanic waters. Species from both environments may, however, be found associated with the shelf (200 - 1 000 m), making this a species-rich area for cetaceans. Cetaceans comprised two basic taxonomic groups: the mysticetes (filter-feeding baleen whales) and the odontocetes (toothed predatory whales and dolphins).

Mysticete (baleen) cetaceans occurring in the proposed survey area include the southern right, humpback, blue, fin, sei, minke, dwarf minke and two populations of Bryde's whale. Most of these species occur in pelagic waters, with only occasional visits into shelf waters. All of these species show some degree of migration either to, or through, the proposed survey area when *en route* between higher-latitude feeding grounds (Antarctic or Subantarctic) and lower-latitude breeding grounds. Depending on the ultimate location of these feeding and breeding grounds, seasonality off South Africa can be either unimodal (usually in June-August, e.g. minke and blue whales) or bimodal (usually May-July and October-November, e.g. fin whales), reflecting a northward and southward migration through the area. As whales follow geographic or oceanographic features, the northward and southward migrations may take place at different distances from the coast, thereby influencing the seasonality of occurrence at different locations.

There is almost no data available on the abundance, distribution or seasonality of the smaller odontocetes (including the beaked whales and dolphins) known to occur in oceanic waters off the shelf of the West Coast. Beaked whales are all considered to be true deep water species usually being seen in waters in excess of 1 000 – 2 000 m depth.

4.3 HUMAN UTILISATION

The only commercial fishery active in the proposed exploration area is the large pelagic long-line sector.

The majority of shipping traffic is located on the outer edge of the continental shelf with traffic inshore of the continental shelf along the South-West Coast largely comprising fishing vessels, especially between Kleinsee and Oranjemund.

Exploration for oil and gas is currently undertaken in a number of licence blocks off the West Coast. There is no current development or production from the South African West Coast offshore.

The majority of diamond mining concessions worked at present are those closer inshore. The licence area is located well offshore of the diamond mining concession areas. A number of prospecting areas for glauconite and phosphorite / phosphate are located off the West Coast, but none overlap with the licence area.

A number of Marine Protected Areas (MPAs) are located along the West Coast. There are no reserves or MPAs in close proximity to the licence area.

5. IMPACT ASSESSMENT CONCLUSIONS

A summary of the assessment of potential environmental impacts associated with the proposed seismic survey is provided in Table 1.

The majority of the impacts associated with the various exploration activities would be of short-term duration and limited to the immediate survey area. As a result, the majority of the impacts are considered to be of **VERY LOW** to **LOW** significance after mitigation.

The two key issues identified in this study relate to:

- The potential impact on marine mammals (physiological injury and behavioural avoidance) as a result of seismic noise; and
- The potential impact on the fishing industry (vessel interaction, disruption to fishing operations and reduced catch) due to the presence of the various survey vessels, potential fish avoidance of the survey area and changes in feeding behaviour.

Although most of the impacts on cetaceans are assessed to have **VERY LOW** to **LOW** significance with mitigation, the impact could be of much higher significance due to the limited understanding of how short-term effects of seismic surveys relate to longer term impacts. For example, if a sound source displaces a species from an important feeding or breeding area for a prolonged period, impacts at the population level could be more significant. In order to mitigate the potential impact on cetaceans it is recommended that the proposed seismic survey programme be planned to avoid key cetacean migration and breeding periods (the key period stretches from the beginning of June to the end of November). Various other measures are recommended to further mitigate the potential impact on marine fauna, including a 30-minute pre-watch period (visually and using PAM technology), a 20-minute "soft-start" procedure, temporary termination of survey, etc. It is also recommended that PAM be used 24-hours a day for the duration of the survey since the proposed survey would be undertaken in water depths beyond 3 000 m where sperm whales are likely to be encountered.

Due to the far offshore location of the survey area, the only fishing sector likely to be affected would be the large pelagic long-line sector. Due to the limited fishing effort taking place in the survey area, the impact is assessed to be of **VERY LOW** significance with and without mitigation. However, if fish avoid the survey area and / or change their feeding behaviour it could have a more significant impact on the fishing industry. Research has, however, shown that behavioural effects are generally short-term with duration of the effect being less than or equal to the duration of exposure, although these vary between species and individuals, and are dependent on the properties of the received sound. Similarly, if there was any interaction between the survey vessels and a fishery the significance of the impact could be higher. Thus it is important that OK Energy engage timeously with the fishing industry prior to and during the survey. Regular communication with fishing vessels in the vicinity during surveying would minimise the potential disruption to fishing operations and risk of gear entanglements.

Table 6.1: Summary of the significance of potential impacts of the proposed exploration programme in the Orange Basin off the West Coast of South Africa.

Potential impact		Significance	
		Without mitigation	With mitigation
Normal seismic / support vessels and helicopter operation:			
Emissions to the atmosphere		VL	**VL**
Deck drainage into the sea		VL	**VL**
Machinery space drainage into the sea		VL	**VL**
Sewage effluent into the sea		VL	**VL**
Galley waste disposal into the sea		VL	**VL**
Solid waste disposal into the sea		Insignificant	**INSIGNIFICANT**
Noise from seismic and support vessel operation		VL	**VL**
Noise from helicopter operation		L-M	**VL**
Impact of seismic noise on marine fauna:			
Plankton		VL	**VL**
Invertebrates	Physiological injury	VL	**VL**
	Behavioural avoidance	VL	**VL**
Fish	Physiological injury	L	**VL**
	Behavioural avoidance	M	**L**
	Spawning and reproductive success	VL	**VL**
	Masking sound and communication	VL	**VL**
	Indirect impacts	VL	**VL**
Non-diving seabirds	Physiological injury	Insignificant	**INSIGNIFICANT**
	Behavioural avoidance	Insignificant	**INSIGNIFICANT**
Diving seabirds	Physiological injury	L	**VL**
	Behavioural avoidance	L	**VL**
	Indirect impacts	VL	**VL**
Turtles	Physiological injury	L	**VL**
	Behavioural avoidance	L	**VL**
	Masking sound and communication	Insignificant	**INSIGNIFICANT**
	Indirect impacts	VL	**VL**
Seals	All impacts	Insignificant	**INSIGNIFICANT**

Potential impact		Significance: Without mitigation	Significance: With mitigation
Mysticete Cetaceans	Physiological injury	M	**L**
	Behavioural avoidance	M	**L**
	Masking sound and communication	VL	**VL**
	Indirect impacts	VL	**VL**
Odontocete Cetaceans	Physiological injury	L	**VL**
	Behavioural avoidance	VL-L	**VL**
	Masking sound and communication	M	**L**
	Indirect impacts	VL	**VL**
Impact of multi-beam noise on marine fauna:		VL	**VL**
Impact of seafloor sampling on benthic biota:		Insignificant	**INSIGNIFICANT**
Impact on other users of the sea:			
Fishing industry	Large pelagic long-line fishery	VL	**VL**
Marine transport routes		VL	**VL**
Marine prospecting and mining		Insignificant	**INSIGNIFICANT**
Exploration and production		L	**VL**
H=High M=Medium	L=Low VL=Very low	N/A=Not applicable	All impacts are negative

6. RECOMMENDATIONS

6.1 COMPLIANCE WITH ACTION PLAN, PROCEDURES AND MARPOL STANDARDS

All phases of the proposed project (including pre-establishment phase, establishment phase, operational phase, and decommissioning and closure phase) must comply with the Action Plan and Procedures presented in Chapter 7. In addition, all vessels must ensure compliance with the MARPOL 73/78 standards.

6.2 RECOMMENDATIONS SPECIFIC TO SEISMIC SURVEY PROCEDURES

6.2.1 Survey timing, scheduling and equipment

The exploration activities should be undertaken outside of the key cetacean migration and breeding periods (the key period stretches from the beginning of June to the end of November).

'Turtle-friendly' tail buoys should be used by the survey contractor or existing tail buoys should be fitted with either exclusion or deflector 'turtle guards'.

6.2.2 PAM technology

All survey vessels must be fitted with PAM technology, which detects cetaceans through their vocalisations. PAM technology must be used during the 30-minute pre-watch period and when surveying at night or during adverse weather conditions and thick fog. It is also recommended that PAM be used 24-hours a day for the duration of the survey since the proposed survey would be undertaken in water depths beyond 3 000 m where sperm whales are likely to be encountered. The PAM hydrophone streamer should ideally be towed behind the airgun array to minimise the interference of vessel noise, and be fitted with two hydrophones to allow directional detection of cetaceans.

In order to avoid unnecessary delays to the survey programme, it is recommended that a spare PAM cable and sensor are kept on-board should there be any technical problems with the system. However, if there is a technical problem with PAM during surveying, visual watches must be maintained by the MMO during the day and night-vision/infra-red binoculars must be used at night while PAM is being repaired.

6.2.3 "Soft-start" procedure and airgun firing

All initiations of seismic surveys must be carried out as "soft-starts" for a minimum of 20 minutes. This requires that the sound source be ramped from low to full power rather than initiated at full power, thus allowing a flight response by marine fauna to outside the zone of injury or avoidance. Where possible, "soft-starts" should be planned so that they commence within daylight hours.

"Soft-start" procedures must only commence once it has been confirmed (visually and using PAM technology during the day and using only PAM technology at night or during periods of poor visibility) that there are no seabirds (diving), turtles or marine mammal activity within 500 m of the vessel. For cetaceans, the period of confirmation should be for at least 30 minutes prior to the commencement of the "soft-start" procedures, so that deep or long diving species can be detected. However, in the case of seals, which are often attracted to survey vessels, the normal "soft-start" procedures should be allowed to commence, if after a period of 30 minutes seals are still within 500 m of the airguns.

All breaks in airgun firing of longer than 20 minutes must be followed by a 30-minute pre-shoot watch and a "soft-start" procedure of at least 20 minutes prior to the survey operation continuing. Breaks of shorter than 20 minutes should be followed by a visual assessment for marine mammals within the 500 m mitigation zone (not a 30-minute pre-shoot watch) and a "soft-start" of similar duration.

Airgun use should be prohibited outside of the licence area.

The use of the lowest practicable airgun volume, as defined by the operator, should be defined and enforced.

During surveying, airgun firing should be terminated when:

- obvious negative changes to turtle, seal and cetacean behaviour is observed;
- turtles or cetaceans are observed within 500 m of the operating airgun and appear to be approaching the firing airgun; or
- there is mass mortality of fish or mortality / injuries to seabirds, turtles, seals or cetaceans as a direct result of the survey.

The survey should remain terminated until such time the time MMO confirms that:

- Turtles or cetaceans have moved to a point that is more than 500 m from the source;
- Despite continuous observation, 30 minutes has elapsed since the last sighting of the turtles or cetaceans within 500 m of the source; and
- Risks to seabirds, turtles, seals or cetaceans have been significantly reduced.

A log of all termination decisions must be kept (for inclusion in both daily and "close-out" reports).

6.2.4 MMO and PAM operator

An independent onboard MMO and PAM operator must be appointed for the duration of the seismic survey. The MMO and PAM operator must have experience in seabird, turtle and marine mammal identification and observation techniques. The duties of the MMO would be to:

Marine fauna:

- Observe and record responses of marine fauna to the seismic survey, including seabird, turtle and cetacean incidence and behaviour and any mortality of marine fauna as a result of the seismic survey. Data captured should include species identification, position (latitude/longitude), distance from the vessel, swimming speed and direction (if applicable) and any obvious changes in behaviour (e.g. startle responses or changes in surfacing/diving frequencies, breathing patterns) as a result of the survey activities;
- Record airgun activities, including sound levels, “soft-start” procedures and pre-firing regimes;
- Request the temporary termination of the seismic survey, as appropriate. It is important that the MMOs’ decisions to terminate firing are made confidently and expediently;

Other:

- Monitor compliance with international marine pollution regulations (MARPOL 73/78 standards); and
- Prepare daily reports of all observations. These reports should be forwarded to the key stakeholders.

The duties of the PAM operator would be to:

- Confirm that there is no marine mammal activity within 500 m of the vessel prior to commencing with the “soft-start” procedures;
- Record species identification, position (latitude/longitude) and distance from the vessel, where possible;
- Record airgun activities, including sound levels, “soft-start” procedures and pre-firing regimes; and
- Request the temporary termination of the seismic survey, as appropriate.

All data recorded by MMO and PAM operator should form part of the survey “close-out” report.

6.2.5 Onboard FLO

An independent onboard FLO that is familiar with fisheries operational in the area must be appointed for the duration of the seismic survey. The duties of the FLO would be to:

- Identify fishing vessels active in the area and associated fishing gear;
- Advise on actions to be taken in the event of encountering fishing gear;
- Provide back-up on-board facilitation with the fishing industry and other users of the sea. This would include communication with fishing and shipping / sailing vessels in the area in order to reduce the risk of interaction between the proposed survey and other existing or proposed activities; and
- Provide daily electronic reporting on vessel activity and recording of any communication and/or interaction should be undertaken in order to keep key stakeholders informed of survey activity and progress.

6.2.6 Record of positioning data

A record should be kept of the hourly positioning of the survey vessel for the duration of the seismic survey. Positioning data should be provided to the Namibian government task force for use in their current research into the potential impact of seismic survey activities on migration routes of albacore tuna along the southwest coast of Africa.

6.3 RECOMMENDATIONS SPECIFIC TO THE MULTI-BEAM BATHYMETRY SURVEY

6.3.1 Survey timing

The multi-beam bathymetry survey should, as far as possible, be planned to avoid cetacean migration periods which stretch from the beginning of June to the end of November.

6.3.2 Multi-beam survey procedures

- An onboard Independent Observer(s) must be appointed for the duration of the multi-beam survey to act as the and MMO. The duties of the MMO are detailed in Section 6.2.4.
- Surveying must only commence once it has been confirmed by the MMO (visually during the day) that there is no large cetacean activity within 500 m of the vessel for a 15-minute period.
- If the source level is greater than 210 dB re 1 µPa at 1 m the following is recommended:
  - > Where equipment allows, a “soft-start” procedure shall be implemented for a period of 20 minutes. Where this is not possible, the equipment should be turned on and off over a 20 minute period to act as a warning signal and allow cetaceans to move away from the sound source;
  - > “Soft-starts” should, as far as possible, be planned to commence within daylight hours;
  - > “Soft-start” procedures must only commence once it has been confirmed by the MMO (visually during the day) that there is no large cetacean activity within 500 m of the vessel for a 15-minute period.
  - > “Soft-start” procedures must also be implemented after breaks in surveying (for whatever reason) of longer than 20 minutes. Breaks of shorter than 20 minutes should be followed by a “soft-start” of similar duration; and
  - > Should surveying in the sensitive cetacean period be unavoidable, PAM technology must be implemented 24 hours a day from beginning of June to end of November. If there is a technical problem with PAM during surveying, visual watches must be maintained by the MMO during the day and night-vision/infra-red binoculars must be used at night while PAM is being repaired. A PAM operator must be appointed during this period. The duties of the PAM operator are detailed in Section 6.2.4.
- Surveying should be terminated temporarily if cetaceans show obvious negative behavioural changes within 500 m of the survey vessel or equipment; and
- The survey should be terminated until such time the MMO confirms that cetaceans have moved to a point that is more than 500 m from the source or despite continuous observation, 15 minutes has elapsed since the last sighting of the cetaceans within 500 m of the source.

6.4 SEAFLOOR SAMPLING PROGRAMME

- Sampling sites must avoid existing submarine telecommunications cables within the proposed exploration area.

6.5 HELICOPTER OPERATIONS

Mitigation relating to helicopter operations includes:

- Flight paths must be pre-planned to ensure that no flying occurs over seal and seabird colonies, coastal reserves or marine islands;
- Extensive coastal flights (parallel to the coast within 1 nautical mile of the shore) should be avoided;
- Aircraft may not approach to within 300 m of whales without a permit or exemption in terms of the Marine Living Resources Act, 1998;

- The contractor should comply fully with aviation and authority guidelines and rules; and
- All pilots must be briefed on ecological risks associated with flying at a low level parallel to the coast.

6.6 OTHER MITIGATION MEASURES COMMON TO ALL EXPLORATION ACTIVITIES

Other mitigation measures that should also be implemented during the survey in order to ensure that any potential impacts are minimised include the following:

Permit / exemption requirement
An exemption is required from DEA to approach or remain within 300 m of whales;

Vessel safety
- The survey vessel must be certified for seaworthiness through an appropriate internationally recognised marine certification programme (e.g. Lloyds Register, Det Norske Veritas). The certification, as well as existing safety standards, requires that safety precautions would be taken to minimise the possibility of an offshore accident;
- Collision prevention equipment should include radar, multi-frequency radio, foghorns, etc. Additional precautions include:
  - > A support / chase vessel with FLO familiar with the fisheries expected in the area (for seismic survey only);
  - > The existence of an internationally agreed 500 m safety zone around the survey vessel;
  - > Cautionary notices to mariners; and
  - > Access to current weather service information.
- The vessels are required to fly standard flags, lights (three all-round lights in a vertical line, with the highest and lowest lights being red and the middle light being white) or shapes (three shapes in a vertical line, with the highest and lowest lights being balls and the middle light being a diamond) to indicate that they are engaged in towing surveys and are restricted in manoeuvrability, and must be fully illuminated during twilight and night;
- Report any emergency situation to SAMSA;

Vessel lighting
- Lighting on board survey vessels should be reduced to the minimum safety levels to minimise stranding of pelagic seabirds on the survey vessels at night. All stranded seabirds must be retrieved and released during daylight hours;

Emissions, discharges into the sea and solid waste
- Ensure adequate maintenance of diesel motors and generators to minimise the volume of soot and unburned diesel released to the atmosphere;
- Ensure adequate maintenance of all hydraulic systems and frequent inspection of hydraulic hoses;
- Undertake training and awareness of crew members of the need for thorough cleaning up of any spillages immediately after they occur, as this would minimise the volume of contaminants washing off decks;
- Use of low toxicity, biodegradable detergents during deck cleaning to further minimise the potential impact of deck drainage on the marine environment;
- Collect deck drainage in oily water catchment systems;
- Discharge effluent (e.g. sewage and galley waste as per MARPOL requirements) into the sea as far as possible from the coast;
- Initiate an on-board waste minimisation system;
- Ensure on-board solid waste storage is secure;
- Ensure that contractors co-operate with the relevant local authority to ensure that solid and hazardous waste disposal is carried out in accordance with the appropriate laws and ordinances;

Communication and key stakeholders

- Prior to survey commencement the following key stakeholders should be consulted and informed of the proposed survey activity (including navigational coordinates of the survey area, timing and duration the proposed activities) and the likely implications thereof:
  - > Fishing industry/associations: South African Tuna Association, South African Tuna Long-Line Association, Fresh Tuna Exporters Association, South African Deep-Sea Trawling Industry Association, South African Hake Long-Line Association and South African Pelagic Fishing Industry Association; Namibian Large Pelagic Long-Line Association; and
  - > Other key stakeholders include: DAFF, Port Captains, SAMSA and South African Navy Hydrographic office.
- OK Energy must request, in writing, the South African Navy Hydrographic office to release Radio Navigation Warnings and Notices to Mariners throughout the seismic survey period. The Notice to Mariners should give notice of (1) the co-ordinates of the proposed survey area, (2) an indication of the proposed survey timeframes and day-to-day location of the survey vessel, and (3) an indication of the 500 m safety zones and the proposed safe operational limits of the survey vessel. These Notices to Mariners should be distributed timeously to fishing companies and directly onto vessels where possible;
- Ongoing notification is to be undertaken throughout the duration of survey / sampling activities with the submission of daily reports (via email) indicating the vessel's location to key stakeholders; and
- Marine mammal incidence data and data arising from the survey should be made available, if requested, to the Marine Mammal Institute, DEA: Branch Oceans and Coasts, DAFF and PASA.

TABLE OF CONTENTS

List of appendices

List of figures

List of tables

ACRONYMS

2D	Two-dimensional
BID	Background Information Document
BOD	Biological oxygen demand
CCA	CCA Environmental (Pty) Ltd
CO	Carbon monoxide
CO_2	Carbon dioxide
COLREGS	Convention on the International Regulations for Preventing Collisions at Sea
DEA	Department of Environmental Affairs
DEA: BOC	Department of Environmental Affairs: Branch Oceans and Coasts
DWA	Department of Water Affairs
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
ETA	Estimated Time of Arrival
GDP	Global Drifter Programme
GN	Government Notice
GRT	Gross Registered Tonnage
HSE	Health, Safety and Environment
IAEA	International Atomic Energy Agency
IAGC	International Association of Geophysical Contractors
I&APs	Interested & Affected Parties
ICRC	International Commission on Radiological Protection
IMO	International Maritime Organisation
ISO	International Standards Organisation
LOSC	United Nations Convention on Law of the Sea, 1982
MARPOL	International Convention for the Prevention of Pollution from Ships, 1973/1978
MMO	Marine Mammal Observer
MPRDA	Mineral and Petroleum Resources Development Act, 2002 (No. 28 of 2002)
NEMA	National Environmental Management Act, 1998 (No. 107 of 1998)
NO_X	Nitrogen oxides
OPRC	Oil Pollution Preparedness, Response and Co-operation
PAM	Passive Acoustic Monitoring
PASA	Petroleum Agency South Africa
PPE	Personal Protective Equipment
PTS	Permanent Threshold Shifts
SAFE	South Africa Far East
SAMSA	South African Maritime Safety Authority
SAN	South African Navy
SASAR	South African Search and Rescue
SAT3	South Atlantic Telecommunications cable no.3
SAWS	South African Weather Service
SO_X	Sulphur oxides
SWE	Silver Wave Energy (Pte) Ltd
TAE	Total Applied Effort
TTS	Temporary Threshold Shifts
VOS	Voluntary Observing Ships
WASC	West African Submarine Cable

1. INTRODUCTION

This chapter provides background to the proposed project, presents the assumptions and limitations of the study, and describes the structure of the report.

1.1 BACKGROUND

OK Energy Limited is proposing to undertake an exploration programme in the Northern Cape Ultra-deep Licence Area (Licence Blocks 3013 and 3113) off the West Coast of South Africa (see Figure 1.1). In 2013, OK Energy lodged an application for an Exploration Right with the Petroleum Agency SA (PASA) in terms of Section 79 of the Mineral and Petroleum Resources Development Act (No. 28 of 2002; MPRDA). PASA accepted the application (Ref. No. 12/3/274) on 12 December 2013.

The Northern Cape Ultra-deep Licence Area is located in the Orange Basin beyond the continental shelf in depths from roughly the 2 500 m depth contour to beyond 3 000 m and is approximately 6 930 km^2 in extent. OK Energy is proposing to explore for oil and gas using various methodologies, which may include two-dimensional (2D) and 3D seismic surveys, boat-acquired gravity and magnetics, multi-beam bathymetry and seafloor sampling for geochemical analysis. It is anticipated that the proposed activities would take place either late in the 2013/2014 survey window period (December to May) or early in the 2014/2015 survey window period.

In terms of the MPRDA an Exploration Right must be issued prior to the commencement of the proposed exploration activities. A requirement of obtaining an Exploration Right is that an Environmental Management Programme (EMP) must be compiled in terms of Section 39 of the MPRDA and submitted to PASA for consideration and for approval by the Minister of Mineral Resources or delegated authority.

OK Energy has contracted CCA Environmental (Pty) Ltd (CCA) to compile this EMP to meet the relevant requirements of the MPRDA and the Regulations thereto.

1.2 ASSUMPTIONS AND LIMITATIONS OF THIS EMP

This EMP was prepared with the following assumptions and limitations:

- CCA has been provided with all relevant project description information;
- There will be no significant changes to the project description or surrounding environment between the completion of the report and implementation of the proposed project that could substantially influence findings, recommendations with respect to mitigation and management, etc.;
- The assessment is based to a large extent on a generic description of the proposed exploration activities;
- The study assumes that all mitigatory measures incorporated into the project description would be implemented as proposed;
- Specialists had all relevant information in order to produce accurate and unbiased assessments; and
- This report will be released for a 30-day review and comment period at the same time it is submitted to PASA for consideration. Any comments received will be forwarded directly to PASA for consideration.

These assumptions and limitations, however, are not considered to have any implications in terms of the results of the study or the required management actions included in this EMP.

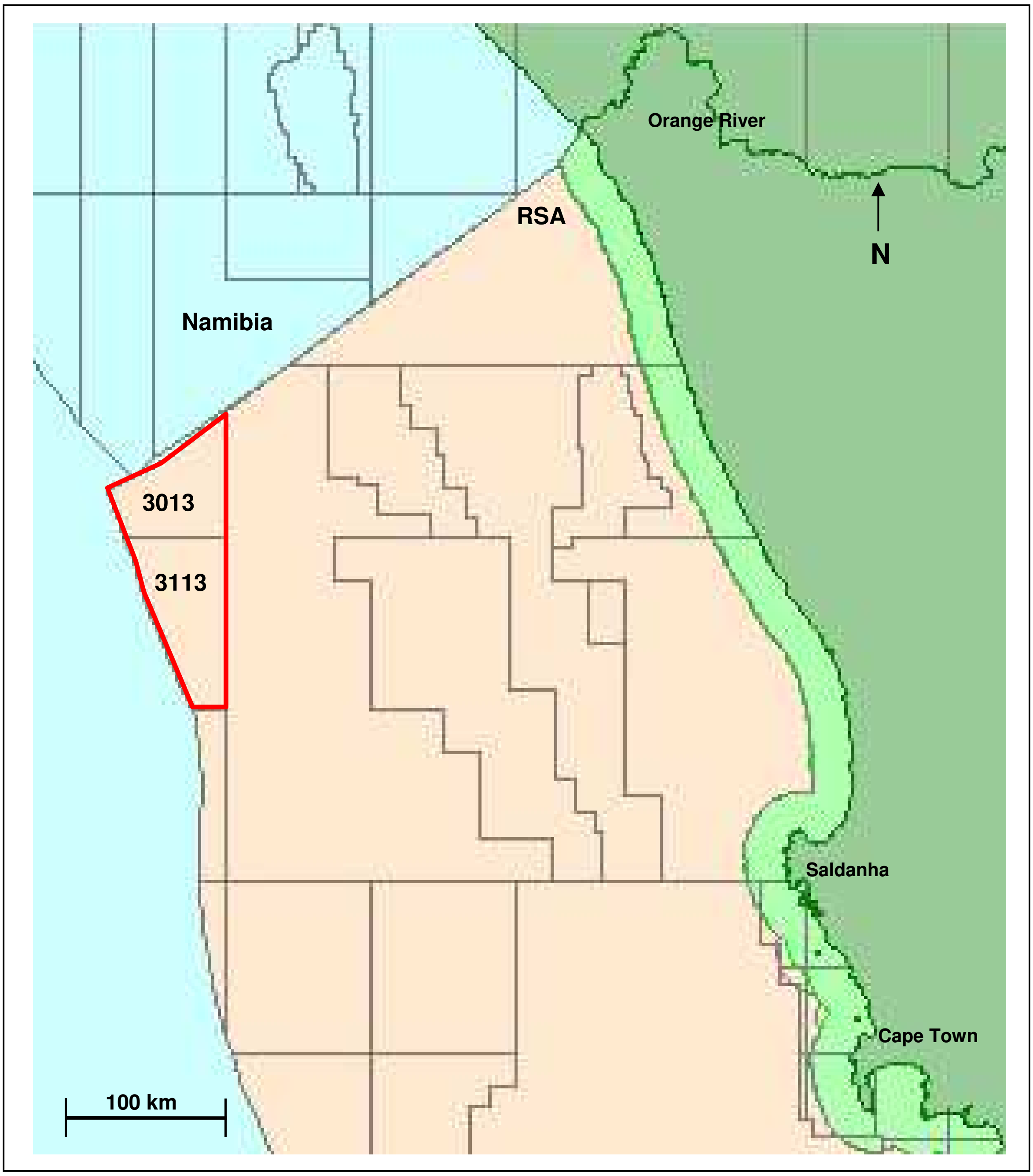

Figure 1.1: Location of the Northern Cape Ultra-deep Licence Area in the Orange Basin off the West Coast of South Africa (red outline).

1.3 STRUCTURE OF THIS REPORT

This report consists of eight chapters and six appendices as shown below.

Section	Contents
Executive Summary	Provides an overview of the main findings of the EMP.
Chapter 1	**Introduction** Provides background to the proposed project, the assumptions and limitations of the study, and describes the structure of the report.
Chapter 2	**Approach and Methodology** Covers the legislative requirements of the EMP process and presents the process undertaken.

Section	Contents
Chapter 3	**Project Description** Provides general information on the proposed project and a description of the proposed exploration activities.
Chapter 4	**The Affected Environment** Describes the existing biophysical and socio-economic environment that could be affected by the proposed project.
Chapter 5	**Environmental Impact Assessment** Describes and assesses the potential impacts of the proposed project on the affected environment. It also presents mitigation measures that could be used to reduce the significance of any negative impacts or enhance any benefits.
Chapter 6	**Conclusion and Recommendations** Provides conclusions to the EMP and summarises the recommendations for the proposed project.
Chapter 7	**Environmental Protection Activities and Procedures** Provides the environmental protection activities and procedures for the proposed exploration programme.
Chapter 8	**References** Provides a list of the references used in compiling this report.
Appendices	
Appendix 1	Public Participation Summary Report
Appendix 2	Convention for assigning significance ratings to impacts
Appendix 3	Fishing Industry Assessment
Appendix 4	Marine Faunal Assessment
Appendix 5	Undertaking by Applicant
Appendix 6	Selected Annexures of MARPOL 73/78

2. APPROACH AND METHODOLOGY

This chapter outlines the key legislative requirements for the proposed project and outlines the methodology and public participation process undertaken in the study.

2.1 LEGISLATIVE REQUIREMENTS

2.1.1 MINERAL AND PETROLEUM RESOURCES DEVELOPMENT ACT, 2002

As noted earlier, an EMP is a requirement of obtaining an Exploration Right. The EMP must comply with Section 39 and Regulation 52[1] of the MPRDA.

In terms of Section 39[2] of the Act an EMP must:

3 (a) Establish baseline information concerning the affected environment to determine protection, remedial measures and environmental management objectives;
- (b) Investigate, assess and evaluate the impact of the proposed project on:
  - (i) The environment; and
  - (iii) Any national estate referred to in Section 3(2) of the National Heritage Resources Act (No. 25 of 1999), with the exception of the national estate contemplated in Section 3(2)(i)(vi) and (vii) of that Act.
- (d) Describe the manner in which the Applicant intends to:
  - (i) Modify, remedy, control or stop any action, activity or process which causes pollution or environmental degradation;
  - (ii) Contain or remedy the cause of pollution or degradation and migration of pollutants; and
  - (iii) Comply with any prescribed waste standard or management or practices.

In terms of Regulation 52 of the MPRDA an EMP must include the following:

2 (a) A description of the environment likely to be affected by the proposed exploration;
- (b) An assessment of the potential impacts of the proposed exploration on the environment, socio-economic conditions and cultural heritage, if any;
- (c) A summary of the assessment of the significance of the potential impacts, and the proposed mitigation and management measures to minimise adverse impacts and benefits;
- (d) Financial provision;
- (e) Planned monitoring and performance assessment of the EMP;
- (f) Closure and environmental objectives;
- (g) A record of the public participation process undertaken and the results thereof; and
- (h) An undertaking by the Applicant regarding the execution of the EMP.

This EMP has been compiled to meet the legislative requirements indicated above.

[1] In terms of Section 79(4)(b) of the MPRDA an *Environmental Management Programme* is a requirement for an Exploration Right. However, in terms of Section 69(2)(vii) "prospecting rights must be construed as reference to exploration rights" and a prospecting right requires an *Environmental Management Plan* in terms of Section 16(4)(a). Although this EMPr is referred to a *Programme,* it includes the contents of a Plan.

[2] Subsection (7) of Section 39 states that "*The provisions of subsection (3)(b)(ii) and subsection (3)(c) do not apply to the applications for reconnaissance permissions, prospecting rights or mining permits.*"

2.1.2 NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 1998

The Environmental Impact Assessment (EIA) Regulations 2010 promulgated in terms of Chapter 5 of the National Environmental Management Act, 1998 (No. 107 of 1998) (NEMA), as amended, provide for the control of certain activities that are listed in Government Notices (GN) R544 (Listing Notice 1), R545 (Listing Notice 2) and R546 (Listing Notice 3). Activities listed in these notices must comply with the regulatory requirements listed in GN R543, which prohibits such activities until written authorisation is obtained from the competent authority.

There are currently no activities listed in Listing Notice 1, 2 or 3 applicable to the proposed exploration programme. Two key activities that require mentioning include:

- Activity 18(ii) in Listing Notice 1 relating to "*the removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 5 m^3 from the sea*". This activity is not applicable as less than 5 m^3 of material would be removed during the proposed seafloor sampling programme; and
- Activity 21 in Listing Notice 2 relating to "*any activity which requires an exploration right or renewal thereof*" in terms of the MPRDA. This activity is not yet in effect (refer to GN No. R662) and is, therefore, not applicable.

Thus, neither a Basic Assessment nor a Scoping and EIA is required in terms of NEMA.

2.1.3 OTHER RELEVANT LEGISLATION

In addition to the foregoing, OK Energy must also comply with the provisions of other relevant international and national legislation and conventions, which include, but are not limited to, the following:

International Marine Pollution Conventions

- International Convention for the Prevention of Pollution from Ships, 1973/1978 (MARPOL);
- Amendment of the International Convention for the Prevention of Pollution from Ships, 1973/1978 (MARPOL) (Bulletin 567 – 2/08);
- International Convention on Oil Pollution Preparedness, Response and Co-operation, 1990 (OPRC Convention);
- United Nations Convention on Law of the Sea, 1982 (UNCLOS);
- Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (the London Convention) and the 1996 Protocol (the Protocol);
- International Convention relating to Intervention on the High Seas in case of Oil Pollution Casualties (1969) and Protocol on the Intervention on the High Seas in Cases of Marine Pollution by substances other than oil (1973);
- Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal (1989); and
- Convention on Biological Diversity (1992).

Other International Legislation

- International Commission on Radiological Protection (ICRC); and
- International Atomic Energy Agency (IAEA) Regulations for the Safe Transport of Radioactive Material, 1984.

Other South African legislation

- Carriage of Goods by Sea Act, 1986 (No. 1 of 1986);
- Dumping at Sea Control Act, 1980 (No. 73 of 1980);

- Hazardous Substances Act, 1983 and Regulations (No. 85 of 1983);
- Marine Living Resources Act, 1998 (No. 18 of 1998);
- Marine Traffic Act, 1981 (No. 2 of 1981);
- Marine Pollution (Control and Civil Liability) Act, 1981 (No. 6 of 1981);
- Marine Pollution (Prevention of Pollution from Ships) Act, 1986 (No. 2 of 1986);
- Marine Pollution (Intervention) Act, 1987 (No. 65 of 1987);
- Maritime Safety Authority Act, 1998 (No. 5 of 1998);
- Maritime Safety Authority Levies Act, 1998 (No. 6 of 1998);
- Maritime Zones Act 1994 (No. 15 of 1994);
- Merchant Shipping Act, 1951 (No. 57 of 1951);
- Mine Health and Safety Act, 1996 (No. 29 of 1996);
- National Environmental Management: Air Quality Act, 2004 (No. 39 of 2004);
- National Environmental Management: Biodiversity Act, 2004 (No. 10 of 2004);
- National Environmental Management: Integrated Coastal Management Act, 2008 (No. 24 of 2008);
- National Environmental Management: Waste Act, 2008 (No. 59 of 2008);
- National Heritage Resources Act, 1999 (No. 25 of 1999)
- National Nuclear Energy Regulator Act, 1999 (No. 47 of 1999);
- National Ports Act, 2005 (No. 12 of 2005);
- National Water Act, 1998 (No. 36 of 1998);
- Nuclear Energy Act, 1999 (No. 46 of 1999);
- Occupational Health and Safety Act, 1993 (No. 85 of 1993) and Major Hazard Installation Regulations;
- Sea-Shore Act, 1935 (No. 21 of 1935);
- Sea Birds and Seals Protection Act, 1973 (No. 46 of 1973);
- Ship Registration Act, 1998 (No. 58 of 1998); and
- Wreck and Salvage Act, 1995 (No. 94 of 1995).

2.2 EMP PROCESS

2.2.1 OBJECTIVES

The objectives of the EMP process are:

- To provide a reasonable opportunity for Interested and Affected Parties (I&APs) to be consulted on the proposed project;
- To ensure that all potential key environmental issues and impacts that could result from the proposed project are identified;
- To identify feasible alternatives to the implementation of the proposed project;
- To assess potential impacts related to the proposed project;
- To present appropriate mitigation or optimisation measures to minimise potential impacts or enhance potential benefits; and
- Through the above, to ensure informed, transparent and accountable decision-making by the relevant authorities.

2.2.2 PROCESS UNDERTAKEN

2.2.2.1 Initial public participation process

The public participation process has involved an open, participatory approach and involvement of I&APs to ensure that all potential impacts are identified and that planning and decision-making takes place in an informed, transparent and accountable manner.

Steps undertaken in the public participation process are summarised below and all supporting information is presented in the Public Participation Summary Report (see Appendix 1):

1. A preliminary I&AP database was compiled of authorities (local and regional), Non-Governmental Organisations, Community-based Organisations and other key stakeholders (including the fishing industry). This database was compiled using databases of previous studies in the area and responses to newspaper advertisements. To date 210 I&APs have been registered on the project database;
2. A Background Information Document (BID) was prepared and distributed to all registered I&APs for a 21-day comment period (17 January 2014 to 10 February 2014). The purpose of the BID was to convey information on the proposed project to I&APs and allowed them the opportunity to comment on the proposed project. To simplify the commenting process, a Response Form was included with the BID; and
3. Advertisements announcing the proposed project and the availability of the BID were placed in the Cape Times and Die Burger regional newspapers on Friday 17 January 2014.

A total of eight written submissions were received from I&APs during the initial public participation process (see Appendix 1). These comments have been collated into an Issues and Responses Trail. Where applicable, responses to comments and questions are given or cross-referenced to the relevant section of text in the EMP where this concern has been addressed.

2.2.2.2 Specialist studies

Two specialist studies were undertaken to address the key issues that required further investigation, namely the impact on fishing and marine fauna. A list of the specialists and their details are provided in Table 2.1.

The specialist studies involved the gathering of data relevant to identifying and assessing environmental impacts that may occur as a result of the proposed project. These impacts were then assessed according to pre-defined rating scales (see Appendix 2). Specialists also recommended appropriate mitigation / control or optimisation measures to minimise potential negative impacts or enhance potential benefits, respectively.

Table 2.1: List of specialist studies and specialists.

No.	Specialist study	Specialist/s	Qualifications	Company	Appendix
1	Fishing	Mr Dave Japp	MSc (Ichthyology and Fisheries Science), Rhodes University	CapFish cc	3
		Ms Sarah Wilkinson	BSc (Hons) (Botany), University of Cape Town		
2	Marine fauna	Dr Andrea Pulfrich	PhD (Fisheries Biology), Christian-Albrechts University, Kiel, Germany	Pisces Environmental Services (Pty) Ltd	4

2.2.2.3 EMP Compilation and I&AP Review

The specialist and other relevant information have been integrated into this EMP. Many of the issues associated with the proposed exploration activities are generic in nature and have been assessed based on numerous previous exploration programmes undertaken off the coast of South Africa. In addition, information has been incorporated into the EMP in order to ensure compliance with Section 39 and Regulation 52 of the MPRDA.

This EMP aims to present all information in a clear and understandable format and suitable for easy interpretation by authorities, I&APs and other key stakeholders (e.g. operator and contractors).

2.2.2.4 Way Forward

The EMP is submitted to PASA for consideration and approval by the Minister or delegated authority. The EMP has also been distributed for a 30-day review and comment period and any comments received will be forwarded directly to PASA for consideration.

3. PROJECT DESCRIPTION

This chapter provides general information on the proposed project and a brief background description of the proposed exploration activities.

3.1 GENERAL INFORMATION

3.1.1 EXPLORATION RIGHT APPLICANT

OK Energy is the applicant for the Exploration Right.

Address: OK Energy Limited
3229 N Peebly
Midwest City, Oklahoma
United States of America, 73110
Project Manager: Dr Erika Syba
Cell: + 1 405 887 7357
E-mail: erika.syba@ok-energy.uk.com

3.1.2 DETAILS OF EXPLORATION RIGHT AREA

The Northern Cape Ultra-deep Licence Area includes Licence Blocks 3013 and 3113 and is located off the continental shelf in the Orange Basin off the West Coast of South Africa (see Figures 1.1 and 3.1). The Exploration Right area is approximately 6 930 km^2 in extent and located more than 300 km from the coast in water depths beyond 2 500 m. The South African border with Namibia forms the northern boundary of the Exploration Right area.

The boundary co-ordinates of the proposed Exploration Right area are provided in Table 3.1.

Table 3.1: Co-ordinates of the proposed Exploration Right area (Northern Cape Ultra-deep).

Point	Latitude (S)	Longitude (E)
1	30° 17’ 10.6540’’	14° 00’ 00.0000’’
2	32° 00’ 00.0000’’	14° 00’ 00.0000’’
3	32° 00’ 00.0000’’	13° 53’ 36.4149’’
4	31° 36’ 53.0971’’	13° 41’ 22.2828’’
5	30° 49’ 50.2000’’	13° 24’ 16.6446’’
6	30° 39’ 39.1957’’	13° 21’ 00.0000’’
7	30° 33’ 45.5921’’	13° 33’ 51.0417’’

3.1.3 FINANCIAL PROVISION

OK Energy will comply with the requirements for financial provision as specified in Section 41 of the MPRDA and Sections 52 and 53 of the MPRDA Regulations. OK Energy will make provision for the requirements of the EMP such as monitoring and reporting as part of the normal budgeting process. Environmental management actions required as a result of an incident or accident would be covered by OK Energy’s insurance.

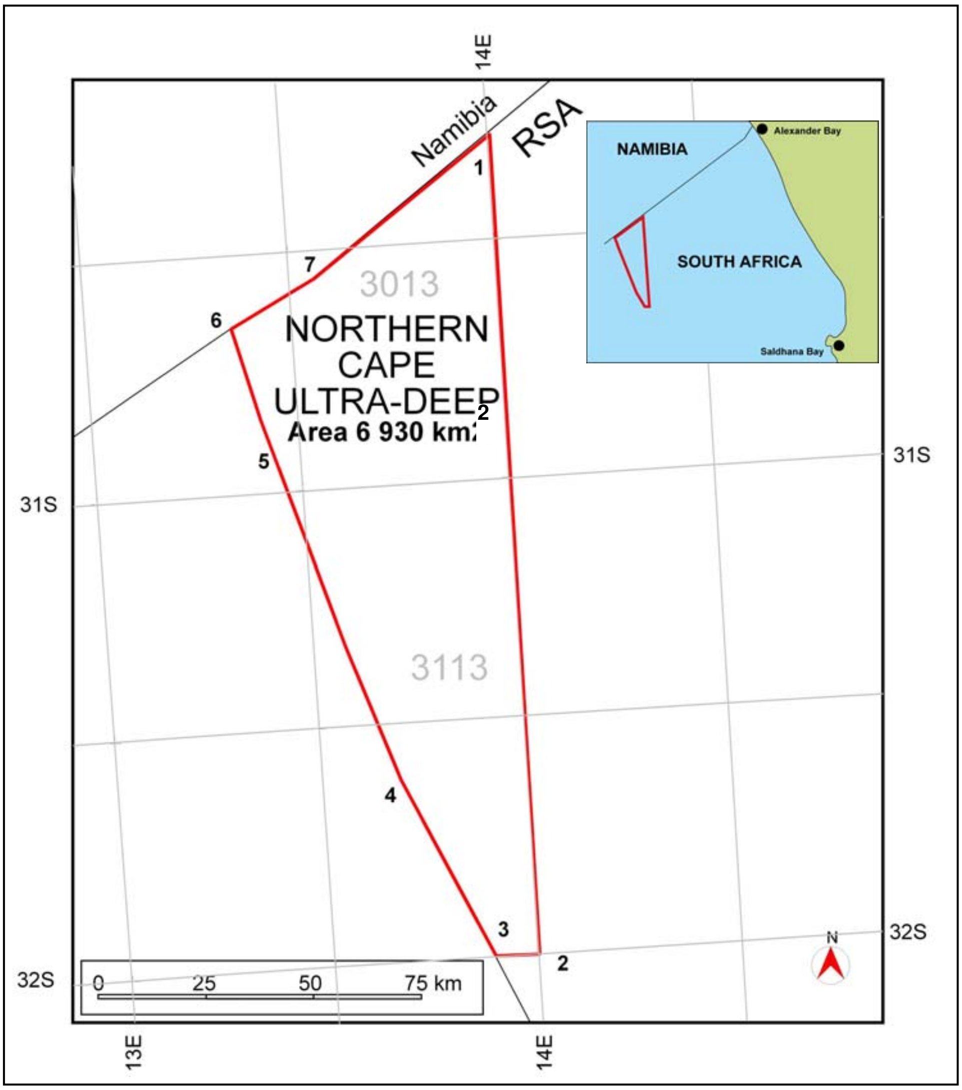

Figure 3.1: Map of the proposed Exploration Right area off the West Coast of South Africa.

3.1.4 ENVIRONMENTAL POLICY STATEMENT

OK Energy recognises its responsibility to take care of the environment throughout all its operations and is committed to complying with environmental laws and protecting the environment. They are committed to conducting operations in a manner that minimises negative impacts and promotes the maintenance and enforcement of environmental procedures.

3.1.5 MONITORING AND EMP PERFORMANCE ASSESSMENT

OK Energy would undertake appropriate monitoring and EMP Performance Assessments during the proposed exploration activities. OK Energy would track performance against objectives and targets specified in the Action Plan and Procedures (see Chapter 7).

At the conclusion of the proposed exploration activities "close-out" reports (one per exploration activity, unless activities are conducted simultaneously) would be prepared, which would include monitoring and performance assessment. These reports would outline the implementation of the EMP and highlight any problems and issues that arose during the exploration activities. Copies of these reports will be sent to PASA.

3.1.6 PLANS AND PROCEDURES FOR ENVIRONMENTAL RELATED EMERGENCIES AND REMEDIATION

OK Energy would prepare a project specific Emergency Response Plan (ERP) and Shipboard Oil Pollution Emergency Plan (SOPEP) for each exploration activity, which would define their organisational structure and protocols that would be implemented to respond to any major incident in a safe, rapid, effective and efficient manner. The ERP would be submitted to PASA for information purposes as part of a formal project notification (see Section 3.2.7).

All offshore emergencies (e.g. streamer cable damage and fuel oil release) would be managed in terms of a bridging document between the ERP and the emergency response procedures and plans of the selected Contractor/s.

3.1.7 UNDERTAKING BY THE APPLICANT

OK Energy undertakes to comply with the specifications of the EMP and provisions of the MPRDA and Regulations thereto (see Appendix 5).

3.2 PROPOSED EXPLORATION PROGRAMME

3.2.1 INTRODUCTION

As a minimum, the proposed exploration work programme would consist of the following:

- Acquisition of 500 km new 2D seismic infill data;
- Purchase of existing 800 km seismic data;
- Boat acquired full tensor gravity and magnetics; and
- Interpretation of data.

In addition, the contingent work programme would include the following:

- Acquisition of 1 000 km^2 3D seismic data;
- Multi-beam bathymetry; and
- Seafloor sampling for geochemical analysis.

The proposed exploration activities are described below. The proposed exploration programme would be conducted in a phased approach. Some of the phases might, however, occur in parallel and the final order of activities may change.

The results of the seismic surveys would inform the final selection of the seafloor sampling sites for geochemical analysis.

3.2.2 SEISMIC SURVEYS

3.2.2.1 Introduction

Seismic surveys are carried out during marine oil and gas exploration in order to investigate subsea geological formations. During seismic surveys high-level, low frequency sounds are directed towards the seabed from near-surface sound sources towed by a seismic vessel. Signals reflected from geological interfaces below the seafloor are recorded by multiple receivers (or hydrophones) towed in a number of streamers (see Figure 3.2). Analyses of the returned signals allow for interpretation of subsea geological formations.

Seismic surveys are undertaken to collect either 2D or 3D data. 2D surveys are typically applied to obtain regional data from widely spaced survey grids (tens of kilometres) and infill surveys on closer grids (down to a 1 km spacing) are applied to provide more detail over specific areas of interest such as potentially drillable petroleum prospects. 3D surveys are typically applied to promising petroleum prospects to assist in fault line interpretation, distribution of sand bodies, estimates of oil and gas in place and the location of boreholes.

3.2.2.2 Survey Methodology and Airgun Array

The seismic surveys would be conducted using a purpose-built seismic vessel. The seismic survey vessel would travel along transects of a prescribed grid within the survey area. During surveying, the seismic vessel would travel at a speed of between four and six knots (i.e. 2 to 3 metres per second).

The seismic surveys would involve a towed airgun array, which provides the seismic source energy for the profiling process, and a seismic wave detector system, usually known as a hydrophone streamer. The anticipated airgun and hydrophone array would be dependent on whether a 3D or 2D seismic survey is undertaken. The sound source or airgun array (two for 3D and one for 2D) would be situated some 100 m behind the vessel at a depth of 5 to 7 m below the surface. 3D surveys use multiple streamers (up to 12 streamers spaced 100 m apart), whereas a 2D survey typically involves a single streamer. The array can be up to 10 000 m long. A surface tail-buoy with radar reflectors would be connected to the end of the streamer/s. A typical 3D seismic survey configuration and safe operational limits for 2D and 3D surveys are illustrated in Figure 3.3.

The airgun would be fired at approximately 10-20 second intervals. The sound waves reflected by boundaries between sediments of different densities would be processed by computer after being recorded by the hydrophone streamer(s).

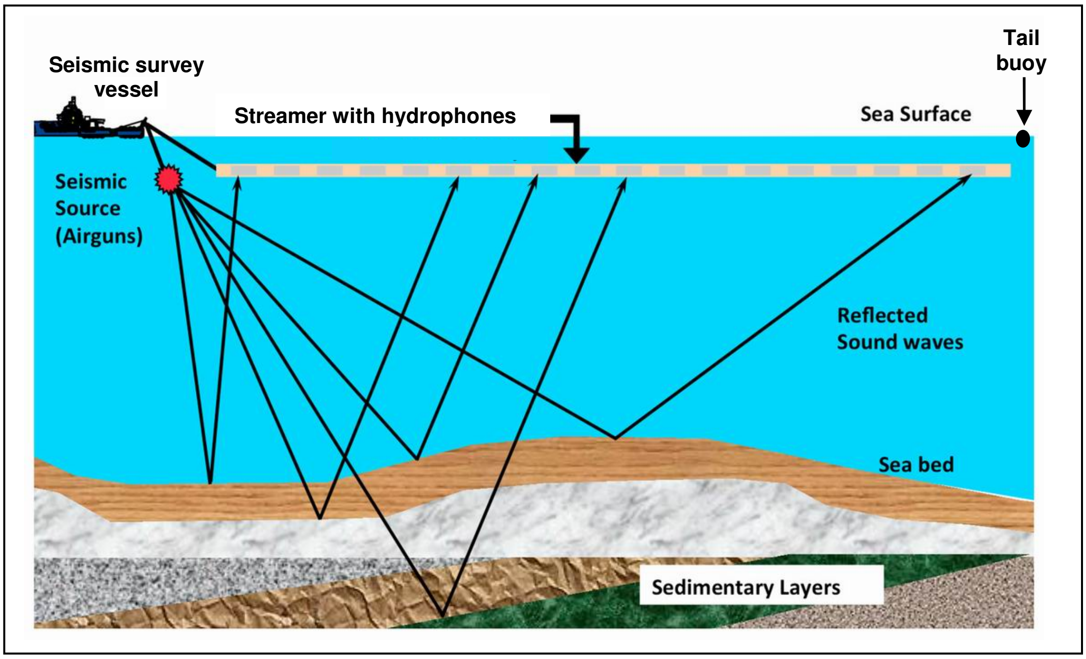

Figure 3.2: Principles of offshore seismic acquisition surveys (adapted from www.api.org).

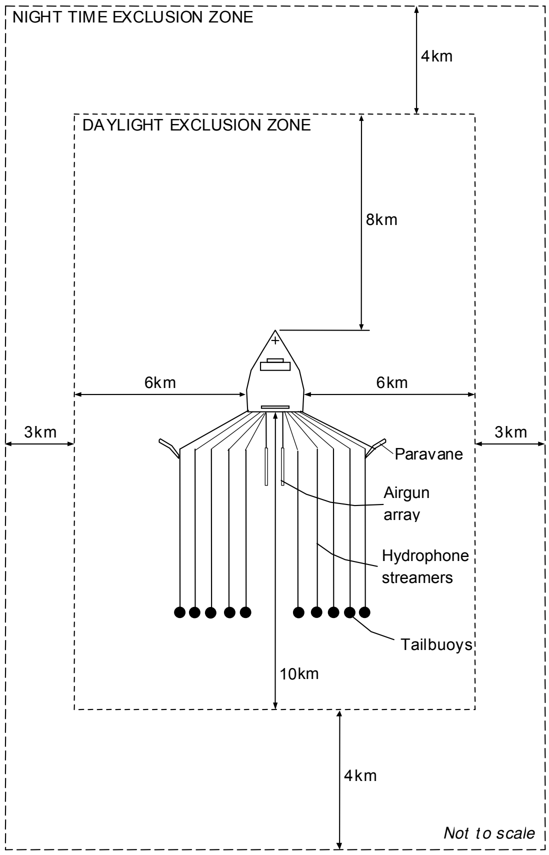

Figure 3.3: Typical configuration for a 3D seismic survey operation. Safe operational limits applicable to both 2D and 3D surveys are also shown.

Airguns, which are the most common sound source used in modern seismic surveys, would be used for the proposed surveys. The airgun is an underwater pneumatic device from which high-pressure air is released suddenly into the surrounding water. On release of pressure the resulting bubble pulsates rapidly producing an acoustic signal that is proportional to the rate of change of the volume of the bubble. The frequency of the signal depends on the energy of the compressed air prior to discharge. Airguns are used on an individual basis (usually for shallow water surveys) or in arrays. Arrays of airguns are made up of towed parallel strings, usually comprised of a total of 20-40 airguns.

3.2.2.3 Sound Pressure Emission Levels

A single airgun could typically produce sound levels of the order of 220-230 dB re 1 mPa @ 1m, while arrays produce sounds typically in the region of 250 dB re 1 mPa @ 1m. The majority of energy produced is in the 0 to 120 Hz bandwidth, although energy at much higher frequencies is also recorded. High-resolution surveys and shallow penetration surveys require relatively high frequencies of 100-1000 Hz, while the optimum wavelength for deep seismic work is in the 10-80 Hz range.

One of the required characteristics of a seismic shot is that it is of short duration (the main pulse is usually between 5 and 30 milliseconds). The main pulse is followed by a negative pressure reflection from the sea surface of several lower magnitude bubble pulses (see Figure 3.4). Although the peak levels during the shot may be high, the overall energy is limited by the duration of the shot.

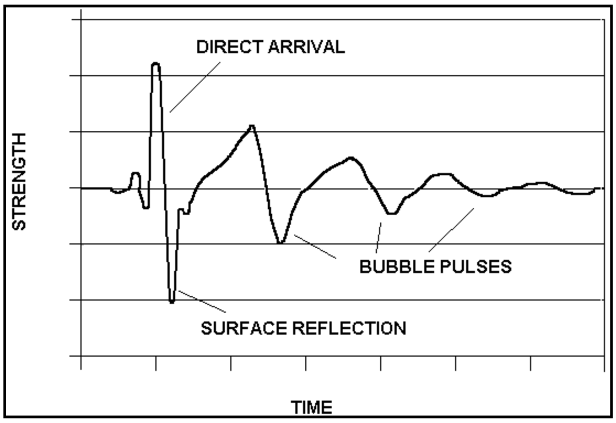

Figure 3.4: A typical pressure signature produced on firing of an airgun.

3.2.2.4 Recording Equipment

Signals reflected from geological discontinuities below the seafloor are recorded by hydrophones mounted inside streamer cables. Hydrophones are typically made from piezoelectric material encased in a rubber plastic hose. This hose containing the hydrophones is called a streamer. The reflected acoustic signals are recorded and transmitted to the seismic vessel for electronic processing. Analyses of the returned signals allow for interpretation of subsea geological formations**.**

3.2.2.5 Extent, duration and timing

The proposed 2D seismic survey would be approximately 500 km in length comprising a number of low density spaced survey lines covering the entire licence area (6 903 km^2). It is anticipated that the proposed seismic survey would either commence late in the 2013/2014 survey window period or early in the 2014/2015 survey window period and would take approximately two weeks to complete.

As part of the contingent work programme the acquisition of 1 000 km^2 3D data within the licence area is also proposed. The 3D survey would take approximately four weeks to complete. The planned survey period has not as yet been determined.

3.2.3 BOAT ACQUIRED FULL TENSOR GRAVITY AND MAGNETICS

During the seismic survey operations, full tensor gravity and magnetic data would also be acquired. Gravity gradiometry measures the gradients of the earth’s gravity field and is used during hydrocarbon and mineral exploration to map small density variations in subsurface structures. Unlike conventional gravity surveys which record only a single component of the gravitational force, full tensor gravity gradiometry measures all three components in all three directions. The information is used to build a 3D geological picture of subsurface anomalies at the seismic scale, thereby reducing the uncertainty associated with interpolation of widely-spaced 2D acquisition lines. The gravimeter would be located within the hull of the seismic vessel and measures small fractional changes within the earth's gravity caused by nearby geologic structures or the shape of the seafloor.

Magnetic field strength would be measured using a magnetometer which would be towed off the back of the vessel alongside the airgun array. The magnetometer is used to detect variations in the total magnetic field of the underlying seafloor. Increased magnetisation can indicate the presence of certain geological features on the seafloor. Magnetic data can be used to estimate the age and thickness of rock layers.

3.2.4 MULTI-BEAM BATHYMETRY SURVEY

A multi-beam bathymetry survey may also be conducted as part of the contingent work programme. This survey produces a digital terrain model of the seafloor. The survey vessel would be equipped with a multi-beam echo sounder to obtain swath bathymetry and a sub-bottom profiler to image the seabed and the near surface geology (see Figure 3.5). The multi-beam system provides depth sounding information on either side of the vessel's track across a swath width of approximately two times the water depth. Although this type of survey typically does not require the vessel to tow any cables, it is "restricted in its ability to manoeuvre" due to the operational nature of this work.

The multi-beam echo sounder typically emits a fan of acoustic beams from a transducer at frequencies ranging from 10 kHz to 200 kHz and typically produces sound levels in the order of 207 db re 1µPa at 1m (approximately 1 000 time less than the seismic survey). The sub-bottom profiler emits an acoustic pulse from a transducer at frequencies ranging from 3 kHz to 40 kHz and typically produces sound levels in the order of 206 db re 1µPa at 1m.

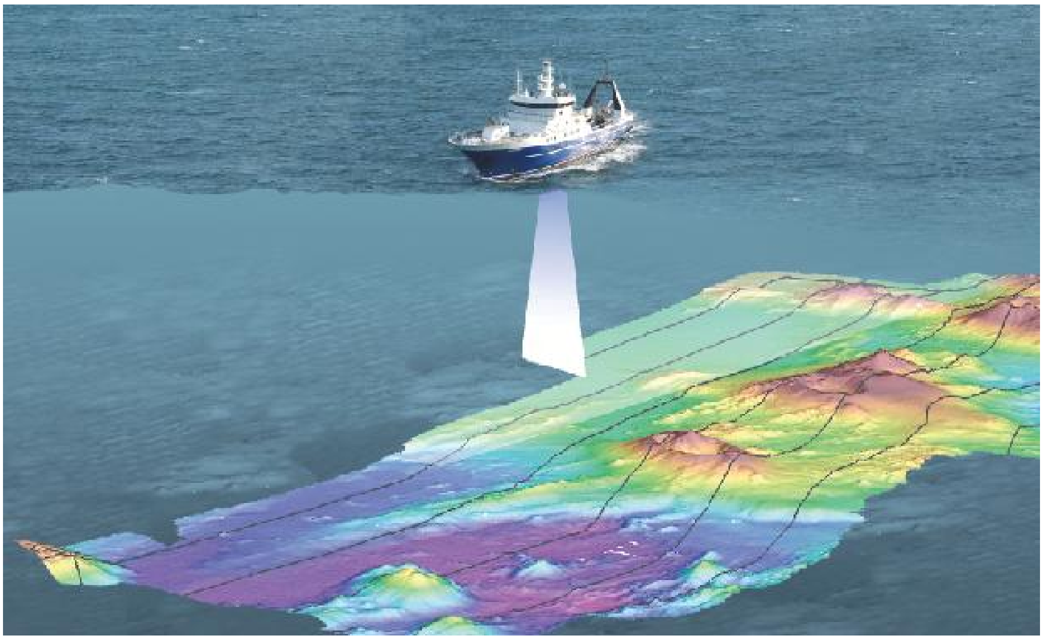

Figure 3.5: Illustration of a vessel using multi-beam depth/echo sounders (http://www.gns.cri.nz/).

The multi-beam bathymetry survey, if deemed necessary, would likely be undertaken over the majority of the licence area. It is anticipated that data acquisition would take in the order of two to three weeks to complete at a vessel speed of 5 to 8 knots.

3.2.5 SEAFLOOR SAMPLING PROGRAMME

The seafloor sampling programme would consist of collecting seafloor sediment samples for laboratory geochemical analyses in order to determine if there are any naturally occurring hydrocarbons present.

Piston coring would be used to collect seabed geological samples. Piston coring is one of the more common methods used to collect seafloor geochemical samples, with the sequence of operation illustrated in Figure 3.6. The piston coring rig is comprised of a trigger assembly, the coring weight assembly, core barrels, tip assembly and piston. The programme would likely utilise a core barrel capable of retrieving sediment samples that are up to 6 m in length and 6.7 cm in diameter.

A piston coring device with ultra-short baseline (USBL) navigation would be used to collect the seafloor samples. The USBL navigation system is used to accurately track the position of the core through the water column and position the core over the desired target for sampling. The piston corer is lowered over the side of the survey vessel and allowed to free fall from about 3 m above the seafloor to allow good penetration (A). As the trigger weight hits the bottom (B), it releases the weight on the trigger arm and the corer is released to "free-fall" the 3 m distance to the bottom (B & C), forcing the core barrel to travel down over the piston into the sediment (D). The movement of the core barrel over the piston creates suction below the piston and expels the water out the top of the corer. When forward momentum of the core has stopped, a slow pullout of the winch commences. This suction triggers the separation of the top and bottom sections of the piston (E).

The recovered cores are visually examined at the surface for indications of hydrocarbons (gas hydrate, gas parting or oil staining) and sub-samples retained for further geochemical analysis in an onshore laboratory. The remaining sediment would be returned to the seafloor.

Water depth, date, time and latitude and longitude would be recorded for each sample.

It is anticipated that up to 5 core samples would be collected across the licence area. Each individual piston core would have a potential disturbance volume of 0.02 m³, resulting in a total disturbance volume of approximately 0.1 m³. The exact volume of an individual core is dependent on the recovery which is rarely 100%, i.e. the potential disturbance of an individual core would likely be <0.02 m³. The exact number and location of core samples would be identified following the analysis of the 3D seismic and / or the multi-beam bathymetric survey results.

It is anticipated that the seafloor sampling programme would take in the order of two to three weeks to complete.

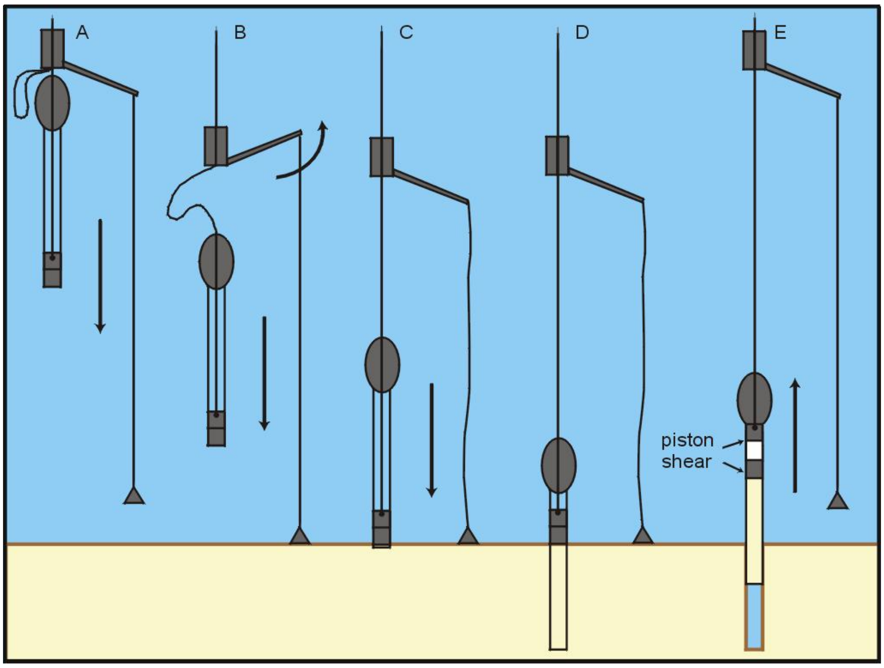

Figure 3.6: Schematic of the piston core operation at the seafloor (Source: TDI-Brooks).

3.2.6 EXCLUSION ZONE

The acquisition of high quality seismic data requires that the position of the survey vessel and the array be accurately known. Seismic surveys consequently require accurate navigation of the sound source over pre-determined survey transects. This, and the fact that the array and the hydrophone streamers need to be towed in a set configuration behind the tow-ship, means that the survey operation has little manoeuvrability while operating.

Under the Convention on the International Regulations for Preventing Collisions at Sea (COLREGS, 1972, Part A, Rule 10), survey vessels that are engaged in surveying or towing operations are defined as a "vessel restricted in its ability to manoeuvre" which requires that power-driven and sailing vessels give way to a vessel restricted in her ability to manoeuvre. Vessels engaged in fishing shall, so far as possible, keep out of the way of the seismic survey operation. Furthermore, under the Marine Traffic Act, 1981 (No. 2 of 1981), a vessel (including seismic arrays) used for the purpose of exploration or exploitation of the seabed fall under the definition of an "offshore installation" and as such it is protected by a 500 m safety zone. It is an offence for an unauthorised vessel to enter the safety zone. In addition to a statutory 500 m safety zone, a seismic contractor would request a safe operational limit (that is greater than the 500 m safety zone) that it would like other vessels to stay beyond. Typical safe operational limits for 2D and 3D surveys are illustrated in Figure 3.3.

At least a 500 m exclusion / safety zone will need to be imposed around the survey vessels at all times. The appointed seismic contractor would also commission a support / chase vessel equipped with appropriate radar and communications to patrol the area during the seismic survey to ensure that other vessels adhere to the safe operational limits and do not cross the deployed streamer. The chase vessel would assist in alerting other vessels (e.g. fishing, transport, etc.) about the proposed survey and the lack of manoeuvrability of the survey vessel. As some fishing vessels (e.g. long-line and demersal trawl vessels) are also restricted in their manoeuvrability, clear communications and cooperation with the fishing industry would ensure that the impact on each other's operations due to the required safety zones is minimised. The chase boat would also be required to perform logistics support to the survey vessel. Notices to Mariners will be communicated through the proper channels and harbour / port masters will be informed of the exclusion zones.

3.2.7 ENVIRONMENTAL NOTIFICATION

At this stage no vessels have been contracted for the various exploration activities. Thus, specific detail would only be available when the operator has appointed a contractor/s and contracted vessel/s. The specific details of the contractor/s and vessel/s would be compiled into an Environmental Notification that would be prepared per exploration activity and submitted to PASA for information purposes 30 days prior to the commencement thereof. The Environmental Notification may include, depending on the activity, the following:

- Survey lines / sampling target areas;
- Number of samples;
- Survey timing and duration;
- Contractor details;
- Vessel specifications;
- Plans not included in the EMP (e.g. ERP and SOPEP); and
- Details of Marine Mammal Observer, Passive Acoustic Monitoring Operator and Fisheries Liaison Officer, where applicable.

4. THE AFFECTED ENVIRONMENT

This chapter provides a description of the biophysical and socio-economic environment that is likely to be affected by the proposed exploration activities in the Northern Cape Ultra-deep Licence Area in the Orange Basin off the West Coast of South Africa. The information provided here is based on previous information compiled for the area (CCA Environmental 2007a; 2007b; 2005; 2011, 2013) and the specialist marine fauna and fishing studies undertaken as part of this study. This chapter has been divided into two sections, *viz.* marine environment and nearshore environment.

4.1 MARINE ENVIRONMENT (OFFSHORE)

This section provides a general overview of the physical and biological oceanography and human utilisation of the South African West Coast and, where applicable, detailed descriptions of the marine environment that may be directly affected by the proposed survey.

The licence area lies within the southern zone of the Benguela Current region and is characterised by the cool Benguela upwelling system (Shillington 1998; Shannon 1985). A conceptual model of the Benguela system (see Figure 4.1) summarises much of the physical oceanography of the region.

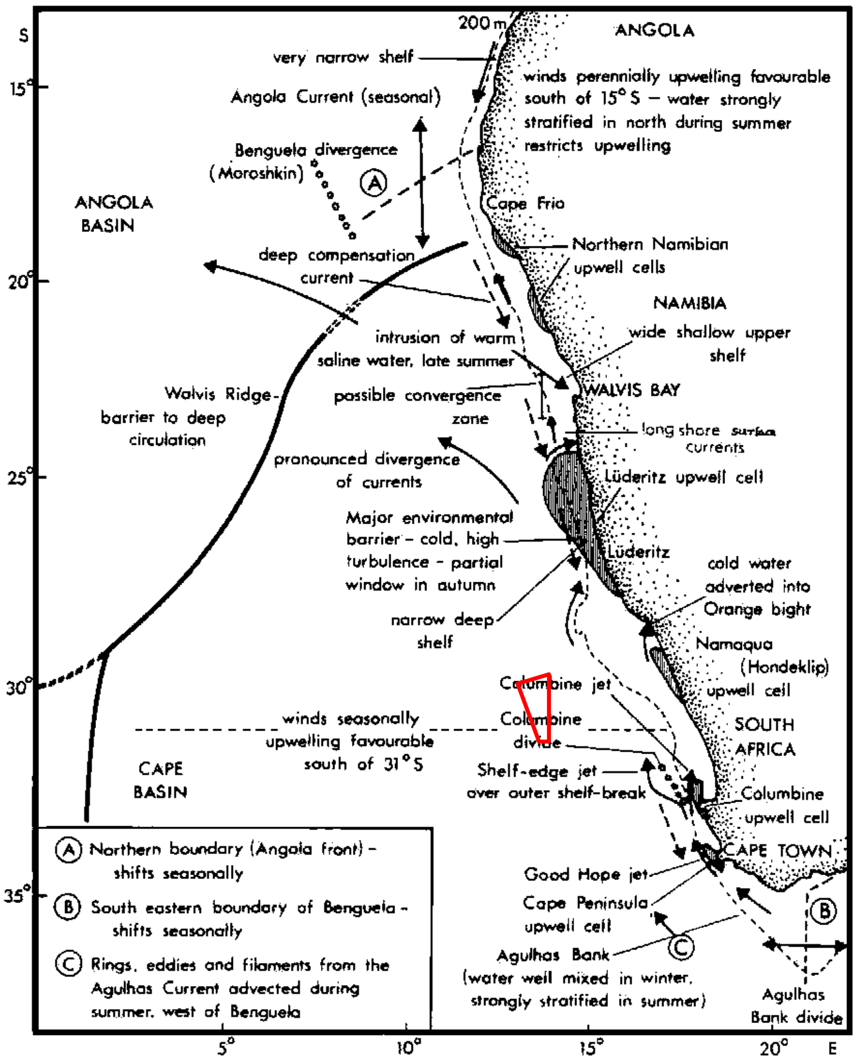

Figure 4.1: A conceptual model of the Benguela system (after Shannon 1985). Approximate location of the licence area is also indicated.

4.1.1 METEOROLOGY

The meteorological processes of the South African West Coast have been described by numerous authors, including Andrews and Hutchings (1980), Heydorn and Tinley (1980), Nelson and Hutchings (1983), Shannon (1985), Shannon and Nelson (1996), and Shillington (1998).

Wind and weather patterns along the West Coast are primarily due to the South Atlantic high-pressure cell and the eastward movement of mid-latitude cyclones (which originate within the westerly wind belt between 35° to 45°S), south of the subcontinent.

The South Atlantic high-pressure cell is perennial, but strongest during austral summer when it attains its southernmost extension to the south and south-west (approximately 30°S, 05°E) of the subcontinent. Linked to this high-pressure in summer is a low-pressure cell that forms over the subcontinent due to strong heating over land. The pressure differential of these two systems induces moderate to strong south-easterly (SE) winds near the shore during summer. Furthermore, the southern location of the South Atlantic high-pressure cell limits the impact that mid-latitude cyclones have on summer weather patterns so that, at best, the mid-latitude cyclones cause a slackening of the SE winds. During the austral winter both the weakening and north-ward migration of the South Atlantic high-pressure cell (to approximately 26°S, 10°E) and the increase in atmospheric pressure over the subcontinent result in the eastward moving mid-latitude cyclones advancing closer to the coast.

Strong north-westerly (NW) to south-westerly (SW) winds result from mid-latitude cyclones passing the southern Cape at a frequency of 3 to 6 days. Associated with the approach of mid-latitude cyclones is the appearance of low-pressure cells, which originate from near Lüderitz on the Namibian coast and quickly travel around the subcontinent (Reason and Jury 1990; Jury, Macarthur and Reason 1990). Mid-latitude cyclones can generate cut-off lows during winter. Cut-off lows are associated with extreme weather patterns, such as powerful convection updrafts and very strong atmospheric instability, resulting in a range of severe types of weather. Extreme weather conditions along the West Coast include very strong gale forces winds, rough seas (> 5 m) and torrential rain, leading to flooding and associated damages. No hurricanes are likely to occur off the West Coast.

A second important wind type that occurs along the West Coast are katabatic ‘berg’ winds during the formation of a high-pressure system (lasting a few days) over, or just south of, the south-eastern part of the subcontinent. This results in the movement of dry adiabatically heated air offshore (typically at 15 m/s). At times, such winds may blow along a large proportion of the West Coast north of Cape Point and can be intensified by local topography. Aeolian transport of fine sand and dust may occur up to 150 km offshore.

4.1.2 PHYSICAL OCEANOGRAPHY

4.1.2.1 Waves

The direction and size of waves present at different sites along the West Coast have been reported by Heydorn and Tinley (1980), Bickerton (1981a and b, 1982) and Morant (1984).

Wave patterns along the West Coast are strongly influenced by the seasonal meteorology. The majority of swells are generated by mid-latitude cyclones to the south of the country, and thus originate from the SW. Wave period is similar and unimodal along the West Coast to the north of Cape Point. Peak energy periods range from 9.7 to 15.5 seconds.

Typical seasonal swell-height rose-plots, compiled from Voluntary Observing Ship (VOS) data off Oranjemund, are shown in Figure 4.2. The wave regime along the West Coast shows only moderate seasonal variation in direction, with virtually all swells throughout the year coming from the SW - S direction. Winter swells, however, are strongly dominated by those from the SW – south-south-west (SSW), which occur almost 80% of the time, and typically exceed 2 m in height, averaging about 3 m, and often attaining over 5 m. With wind speeds capable of reaching 100 km/h during heavy winter south-westerly storms, winter swell heights can exceed 10 m.

In comparison, summer swells tend to be smaller on average, typically around 2 m, not reaching the maximum swell heights of winter. There is also a more pronounced southerly swell component in summer. These southerly swells tend to be wind-induced, with shorter wave periods (approximately 8 seconds) and are generally steeper than swell waves (CSIR 1996). These wind-induced southerly waves are relatively local and, although less powerful, tend to work together with the strong southerly winds of summer to cause the northward-flowing nearshore surface currents, and result in substantial nearshore sediment mobilisation, and northwards transport, by the combined action of currents, wind and waves.

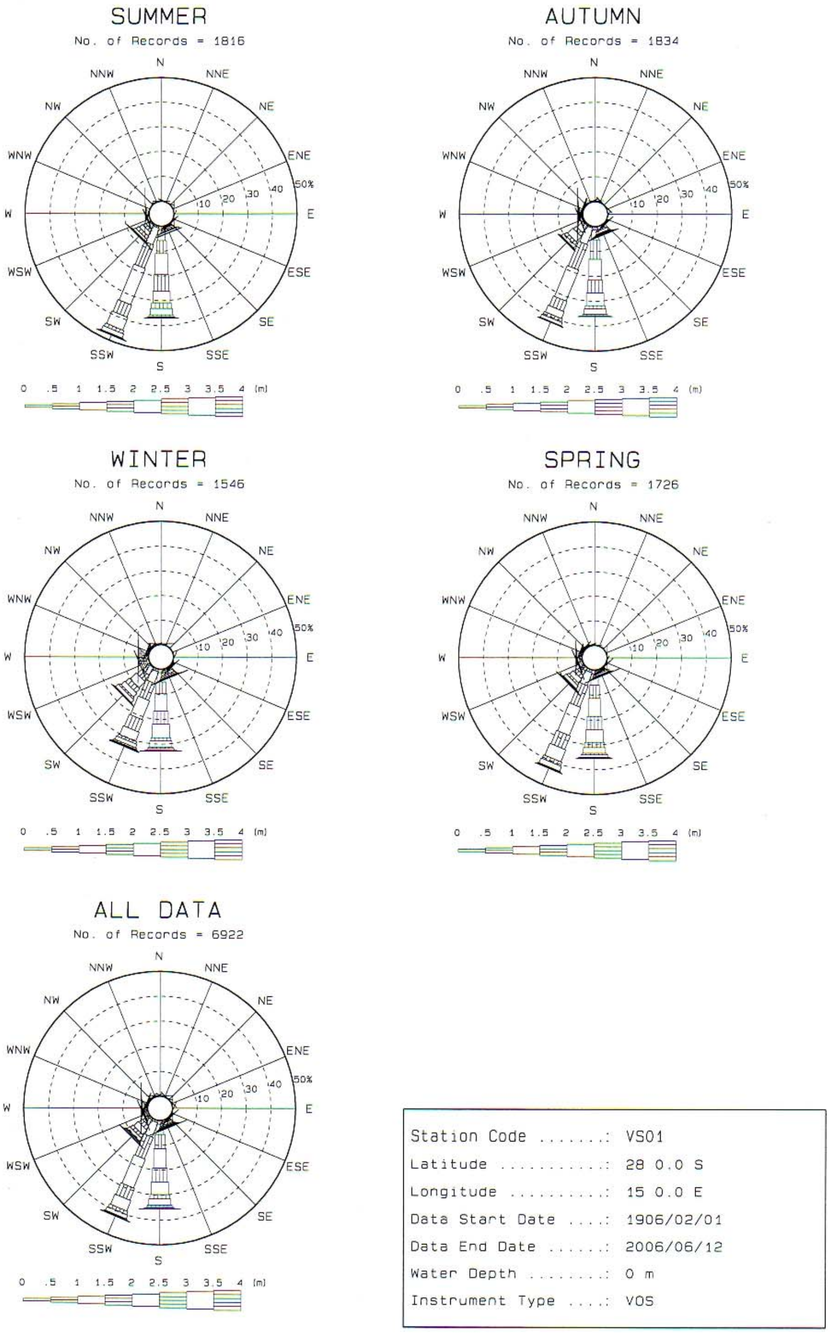

Figure 4.2: Voluntary Observing Ship (VOS) data Wave Height vs Wave Direction data for the offshore area (28°-29°S; 15°-16°E recorded during the period 1 February 1906 and 12 June 2006)) (Source: Southern African Data Centre for Oceanography (SADCO)).

4.1.2.2 Tides

Tides along the West Coast are subject to a simple semi-diurnal tidal regime with a mean tidal range of about 1.57 m (at least 50% of the time in the nearshore area), with spring tides as much as 2.24 m and neap tides in the order of 1 m. Tides arrive almost simultaneously (within 5 to 10 minutes) along the whole of the West Coast. Other than in the presence of constrictive topography, e.g. an entrance to enclosed bay or estuary, tidal currents are weak.

4.1.2.3 Bathymetry and topography

The bathymetry and topography of the West Coast offshore region has been described by Nelson and Hutchings 1983; Shannon 1985; Shannon and Nelson 1996 and Dingle *et al.* 1987.

The continental shelf along the West Coast is generally both wide and deep, although large variations in both depth and width occur (Figure 4.3). The shelf maintains a general north-north-west (NNW) trend north of Cape Point, being narrowest in the south between Cape Columbine and Cape Point (40 km) and widening to the north of Cape Columbine to its widest of the Orange River (180 km).

The immediate nearshore area consists mainly of a narrow (to about 8 km wide) rugged rocky zone which initially slopes steeply seawards to a depth of about 30 m and then gradually to about 80 m. The middle and outer shelf normally lacks relief and slope gently seawards reaching the shelf break (where the slope becomes significantly steeper) at a depth of approximately 300 m.

Banks on the continental shelf include the Orange Bank (Shelf or Cone), a shallow (160 to 190 m) zone that reaches maximal widths (180 km) offshore of the Orange River, and Child's Bank, situated about 150 km offshore at about 31°S (approximately 200 km east of the licence area). Tripp Seamount is a geological feature 80 km north-east of the licence area, which rises from the seabed at approximately 1 000 m water depth to a depth of 150 m. A number of submarine canyons cut into the shelf between 31° and 35°S, the most prominent being the Cape Canyon and the Cape Point Valley.

The nature of the shelf break varies off the West Coast. Between Cape Columbine and the Orange River, there is usually a double shelf break, with the distinct inner (closest to shore) and outer slopes separated by a gently sloping ledge.

The Northern Cape Ultra-deep Licence Area covers an area of approximately 6 930 km^2 in water depths of beyond 2 500 m.

4.1.2.4 Sediments

Figure 4.4 illustrates the distribution of seabed surface sediment types off the West Coast. The inner shelf is underlain by Precambrian bedrock (also referred to as Pre-Mesozoic basement), whilst the middle and outer shelf areas are composed of Cretaceous and Tertiary sediments (Dingle 1973; Birch *et al.* 1976; Rogers 1977; Rogers & Bremner 1991).

As a result of erosion on the continental shelf, the unconsolidated sediment cover is generally thin, often less than 1 m. Sediments are finer seawards, changing from sand on the inner and outer shelves to muddy sand and sandy mud in deeper water. However, this general pattern has been modified considerably by biological deposition (large areas of shelf sediments contain high levels of calcium carbonate) and localised river input. An almost 500 km long mud belt (of up to 40 km wide and of 15 m average thickness) is situated over the outer edge of the middle shelf between the Orange River and St Helena Bay (Birch *et al*. 1976). Within the broad area of the proposed survey area, sediment is dominated by sands, sandy muds and muds. The continental slope, seaward of the shelf break, has a smooth seafloor, underlain by calcareous ooze.

Present day sedimentation is limited to input from the Orange River. This sediment is generally transported northward. Most of the sediment in the area is therefore considered to be relict deposits by now ephemeral rivers active during wetter climates in the past. The Orange River, when in flood, still contributes largely to the mud belt as suspended sediment is carried southward by poleward flow. In this context, the absence of large sediment bodies on the inner shelf reflects on the paucity of terrigenous sediment being introduced by the few rivers that presently drain the West Coast coastal plain.

Nearshore sediments are subject to suspension by waves and longshore transport. This effect penetrates to 90 m. Natural turbidity levels range from 3 and 12 mg/l with significantly higher concentrations associated with storm waves and floods.

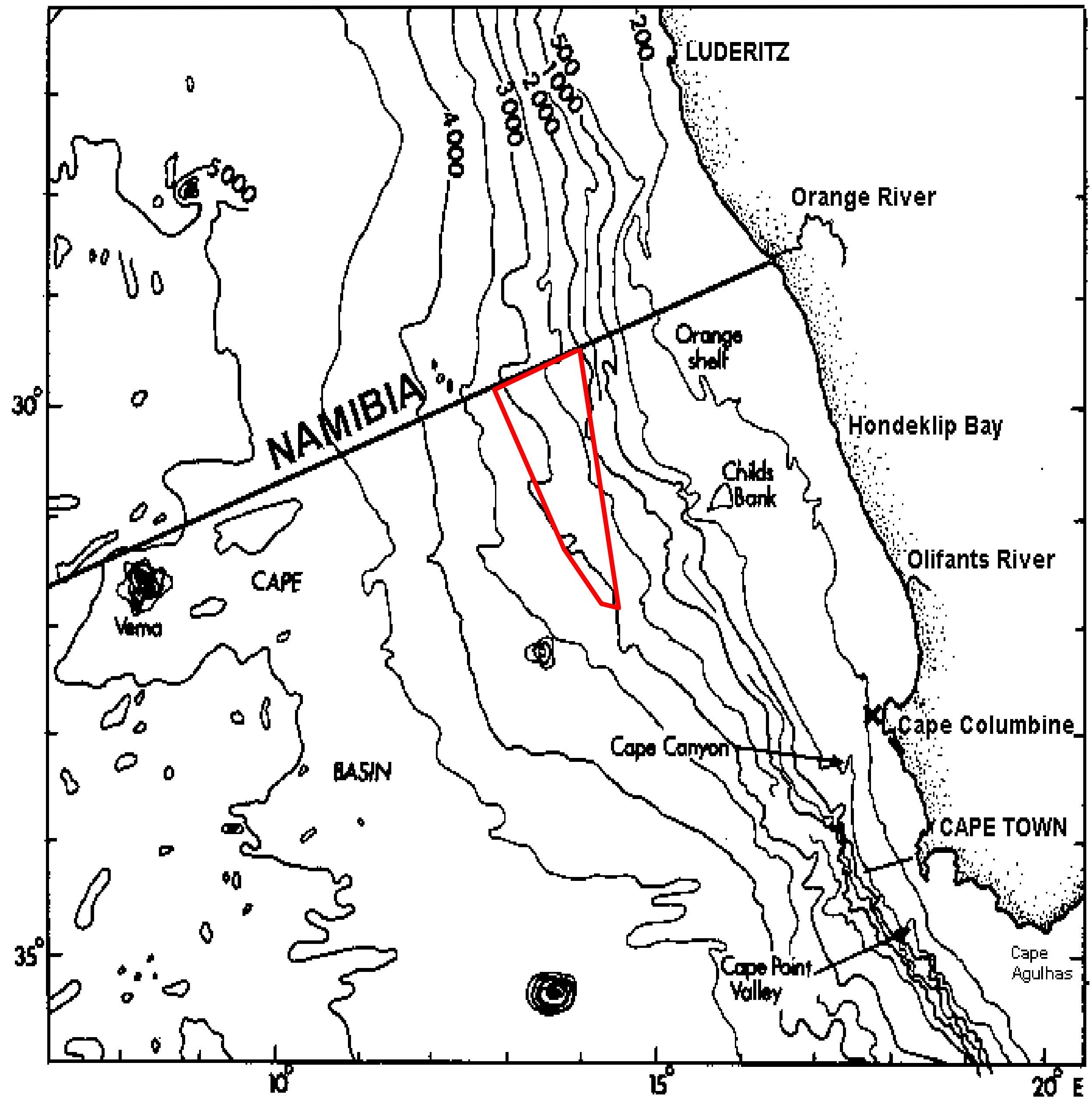

Figure 4.3: **Bathymetry of the continental shelf off the West Coast of southern Africa (after Dingle *et al.* 1987). Approximate location of the licence area is also indicated.**

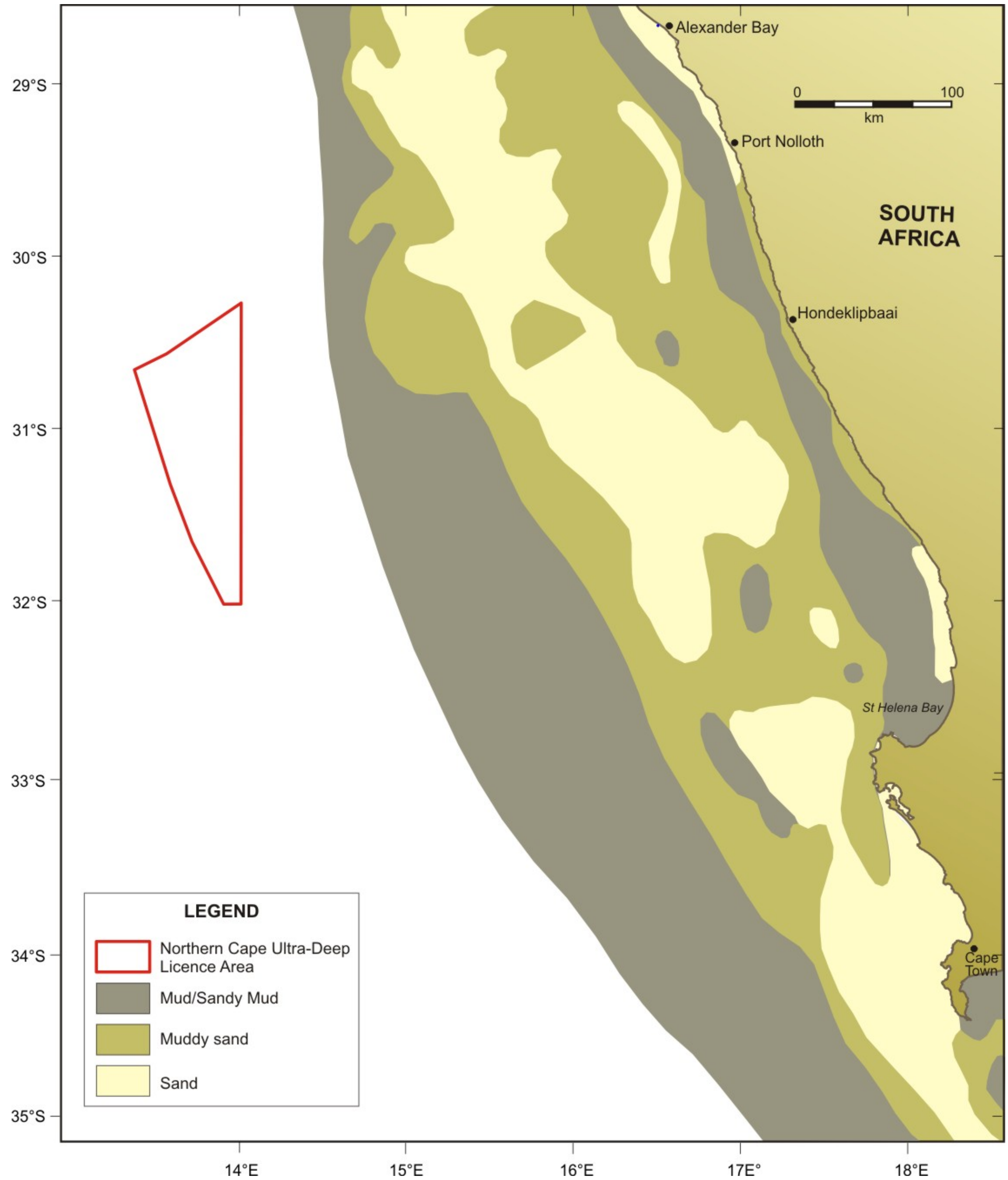

Figure 4.4: Sediment distribution on the continental shelf of the South African West Coast in relation to the licence area (Adapted from Rogers 1977).

4.1.2.5 Water masses and sea surface temperatures

A number of water masses are found along the West Coast, including tropical and sub-tropical surface waters, thermocline waters (comprising South Atlantic, South Indian and tropical Atlantic Central Water), Antarctic Intermediate Water (AAIW), North Atlantic Deep Water (NADW) and Antarctic Bottom Water (AABW). The thermocline water mass (6°C, 34.5 Practical Salinity Units (psu) – 16°C, 35.5 psu) is that which upwells along the coast and which constitutes the shelf waters of the Benguela, although in highly modified forms. Thermocline water overlies AAIW (34.2-34.5 psu with potential temperature 4-5°C). NADW has a potential temperature less than 3°C and salinity greater than 34.8 psu, and lies below the AAIW stratum. In the Cape Basin, it lies above the AABW, which is located deeper than about 3 800 m. AABW is cooler than 1.4°C and has a salinity of 34.82 psu.

Off the south-western Cape the upwelling of cool water occurs during the summer months stabilising the seawater temperature along this coastline to some extent so that the average sea surface temperature changes little throughout the year (13 to 15 °C). In the northern Benguela system where cool upwelling occurs during the winter months, a far more pronounced seasonal difference (12 to 17 °C) in sea surface temperatures occurs (Shannon 1985). The sea surface temperature along the coast of Namaqualand near Port Nolloth ranges from a minimum of 10 °C to a maximum of just over 20 °C, with 84 % of the temperatures falling within a range of 12 °C to 17 °C (Figure 4.5).

Over the continental margin, progressively colder waters encroach onto the continental shelf between the Orange River and the Cape Peninsula (Shannon and Nelson 1996). The area between 31°S and 33°S has the minimum shelf temperatures, with isotherms retreating into deeper water south of 34°S (Dingle and Nelson 1993).

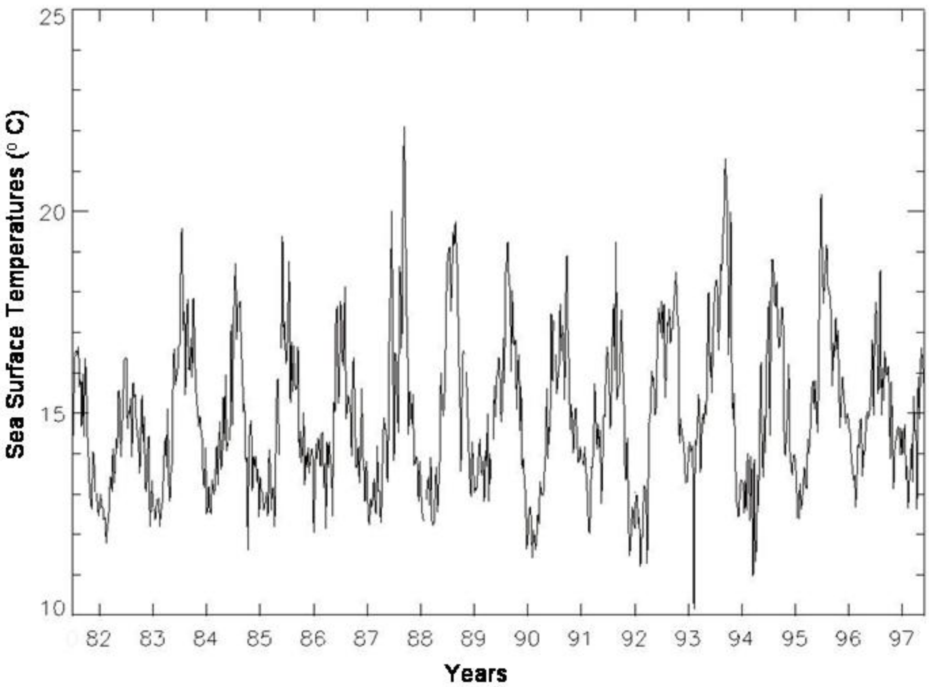

Figure 4.5: Weekly sea surface temperature recordings for the Namaqualand coastal waters, from 1980 – 1998 (Figure after Enviro-Fish Africa, Grahamstown).

4.1.2.6 Water Circulation

Water circulation off the West Coast is dominated by upwelling (see Section 4.1.2.7).

The ocean currents occurring off the West Coast are complex and are summarised in Figure 4.6. Data suggests that currents north of Cape Columbine are weaker and more variable than the currents to the south (Boyd *et al*. 1992). The most important is the Benguela current, which constitutes a broad, shallow and slow NW flow along the West Coast between the cool coastal upwelled waters and warmer Central Atlantic surface waters further offshore. The current is driven by the moderate to strong S to SE winds which are characteristic of the region and is most prevalent at the surface, although it does follow the major seafloor topographic features (Nelson and Hutchings 1983). Current velocities in continental shelf areas generally range between 10–30 cm/s (Boyd & Oberholster 1994). Shelf edge jet currents exist off both Cape Columbine (Nelson and Hutchings 1983) and the Cape Peninsula (Bang 1970; Shillington 1998), where flow is locally more intense (up to 50 cm/s off Cape Columbine and 70 cm/s off the Cape Peninsula). In the south the Benguela current has a width of 200 km, widening rapidly northwards to 750 km.

The flows are predominantly wind-forced, barotropic and fluctuate between poleward and equatorward flow (Shillington *et al.* 1990; Nelson & Hutchings 1983). Near bottom shelf flow is mainly poleward with low velocities of typically 5 cm/s. The poleward flow becomes more consistent in the southern Benguela (Pulfrich 2013). A southward flow of surface water occurs close inshore during periods of barotropic reversals and during winter when upwelling is not taking place.

Agulhas Current water does occasionally enter the south-east Atlantic in summer as warm water filaments (<50 m deep) or eddies (several 100 m wide and deep). These warm water tongues are usually at least 180 km offshore and seldom move further north than 33°S and do not appear to impact the Benguela shelf region.

4.1.2.7 Upwelling

The Benguela region is one of the world's major coastal upwelling systems, the majority of which are found off the west coasts of continents (e.g. off Chile and Peru, California and West Africa). This upwelling dominates the oceanography of the West Coast of South Africa (Andrews and Hutchings 1980; Nelson and Hutchings 1983). Upwelling is characterised by pulsed input of cold, nutrient-rich water into the euphotic zone, and in the Benguela region results from the wind-driven offshore movement of surface waters. The surface waters are replaced by cold nutrient-rich water that upwells from depth through Ekman transport. Once upwelled, this water warms and stabilises, and moves offshore where a thermocline usually develops. Nutrient-rich upwelled water enhances primary production, and the West Coast region consequently supports substantial pelagic fisheries (Heydorn and Tinley 1980; Shillington 1998).

Upwelling occurs along the West Coast from Cape Agulhas to northern Namibia. The principle upwelling centre on the West Coast lies off Lüderitz and the Lüderitz upwelling cell effectively divides the Benguela Upwelling system into a northern and southern region, which are meteorologically distinct (Pitcher *et al.* 1992). In the south upwelling-favourable SE winds are most prevalent during spring and summer, and upwelling occurs mostly between September and March. Upwelling in the southern Benguela area is highly variable on macro, meso and micro scales. Both continental shelf bathymetry and upwelling winds drive upwelling in the southern Benguela which is further influenced by local topography and meteorology (Shannon 1985), resulting in centres of enhanced upwelling off Namaqualand (30°S), Cape Columbine (33°S) and Cape Peninsula (34°S) (Figure 4.7).

The Namaqualand upwelling zone (or Hondeklipbaai Cell) is a cool wedge-shaped zone lying between Hondeklip Bay and the Orange Bight, where the narrow shelf to the south-west of Hondeklip Bay results in enhanced upwelling. Both bathymetry and orography control upwelling at Cape Columbine. Two fronts separate a divergence zone off the Columbine Peninsula, an oceanic front at the shelf edge and a shallower inshore front. Upwelling off the Cape Peninsula is among the most marked in the world with upwelling rates estimated to average 21 m/day (maximum of 32 m/day). A well-defined front exists over the shelf break off the Cape Peninsula, outside of which is a well-developed equatorward jet reaching speeds of 60 cm.sec^{-1} on the surface and 120 cm.sec^{-1} at 150 m (Andrews and Hutchings 1980).

Although the upwelling process is active within 10 to 20 km of the shore, the influence of cold upwelled water extends approximately 150 km (Shannon and Nelson 1996). However, distinctive cold water filaments can extend 200 km offshore perpendicular to the coast, some being more than 1 000 km long (Shannon and Nelson 1996, Shillington *et al.* 1992).

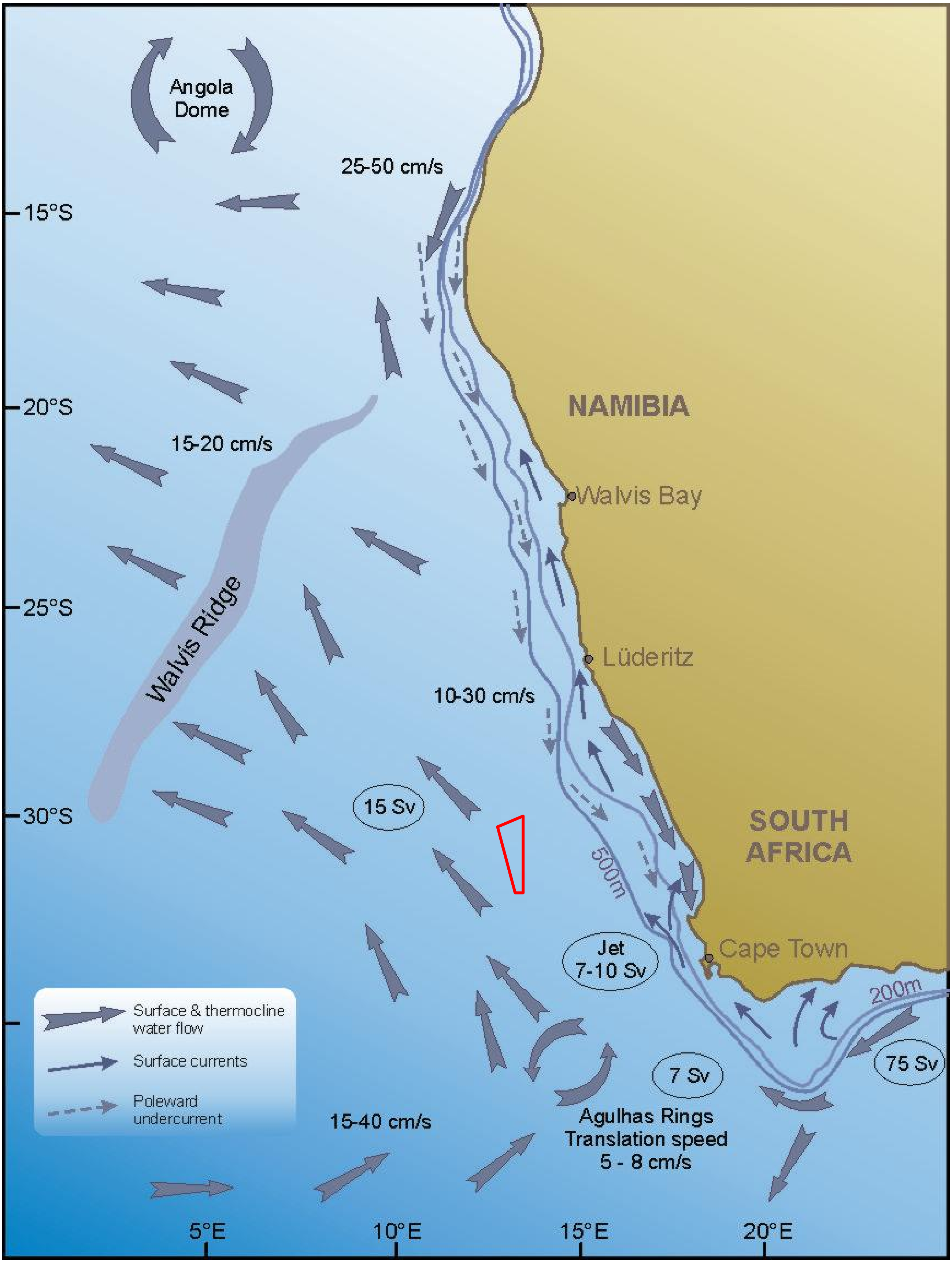

Figure 4.6: Major features of the predominant circulation patterns and volume flows in the Benguela System, along the southern Namibian and South African west coasts (re-drawn from Shannon & Nelson 1996). Approximate location of the licence area is also indicated.

4.1.2.8 Nutrient distribution

Above thermoclines (that develop as water movement stabilises) phytoplankton production consumes nutrients, thus depleting the nutrients in the surface layer. Below the thermocline, nutrient re-enrichment occurs as biological decay occurs. As upwelled water is nutrient enriched compared to surface water, nutrient distribution on the West Coast are closely linked to upwelling (Chapman and Shannon 1985). Highest nutrient concentrations are thus located at the upwelling sites (Andrews and Hutchings 1980), offshore of which it decreases (Chapman and Shannon 1985).

Phosphate levels are low at the surface and offshore, but high (up to 3.0 μM) in bottom waters of the shelf and in newly upwelled waters. Upwelled waters can at times be enriched in phosphate as they pass over phosphorus rich shelf sediments. Phosphate is unlikely to ever become a limiting nutrient in the Benguela region.

Nitrate normally occurs in greater concentrations at the bottom than in upwelling source water, and decreases in availability at the surface (to less than 1 μM). Nitrate appears to be the limiting nutrient in the Benguela region.

Silicate levels range between 5 and 15 μM within the Benguela system, although these may at times be enhanced considerably over the shelf. It is not likely to be limiting in the southern Benguela.

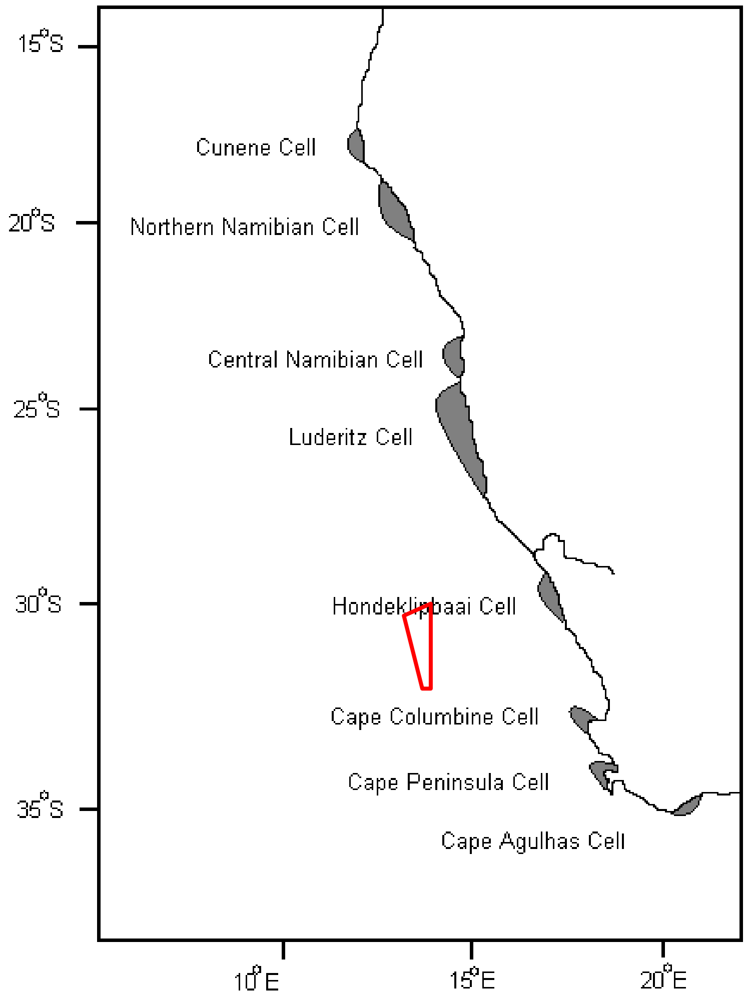

Figure 4.7: The location of three major upwelling cells along the West Coast (Shannon and Nelson, 1996). Approximate location of the licence area is also indicated.

4.1.2.9 Oxygen concentration

The Benguela system is characterised by large areas of very low oxygen concentrations with less than 40% saturation occurring frequently (Visser 1969; Bailey *et al*. 1985). The low oxygen concentrations are attributed to nutrient remineralisation in the bottom waters of the system (Chapman & Shannon 1985). The absolute rate of this is dependent upon the net organic material build-up in the sediments, with the carbon rich mud deposits playing an important role. As the mud on the shelf is distributed in discrete patches (see Figure 4.4), there are corresponding preferential areas for the formation of oxygen-poor water.

There are including three centres of oxygen-depleted shelf water; one of which is well north of the region (2°S to 24°S), another to the north of the Namaqualand upwelling cell and the third in St Helena Bay (Chapman and Shannon 1985). The spatial distribution of oxygen-poor water in each of the areas is subject to short- and medium-term variability in the volume of hypoxic water that develops.

Generally, oxygen concentrations appear to increase from the Orange River region southward. Surface oxygen levels are higher than bottom waters (water is regularly supersaturated) due to phytoplankton production, especially during less intense upwelling. Upwelling processes can move low-oxygen water up onto the inner shelf and into nearshore waters, often with devastating effects on marine communities.

Oxygen deficient water can affect the marine biota at two levels. It can have sub-lethal effects, such as reduced growth and feeding, and increased inter-moult period in the rock-lobster population (Beyers *et al*. 1994). Low-oxygen events associated with massive algal blooms can lead to large-scale stranding of rock lobsters, and mass mortalities of marine biota and fish (Newman & Pollock 1971; Matthews & Pitcher 1996; Pitcher 1998; Cockcroft *et al*. 2000). The development of anoxic conditions as a result of the decomposition of huge amounts of organic matter generated by algal blooms is the main cause for these mortalities and walkouts. Algal blooms usually occur during summer-autumn (February to April) but can also develop in winter during the 'berg' wind periods, when similar warm windless conditions occur for extended periods.

4.1.2.10 Turbidity

Turbidity is a measure of the degree to which the water loses its transparency due to the presence of suspended particulate matter. Total Suspended Particulate Matter (TSPM) can be divided into Particulate Organic Matter (POM) and Particulate Inorganic Matter (PIM), the ratios between them varying considerably. The POM usually consists of detritus, bacteria, phytoplankton and zooplankton and serves as a source of food for filter-feeders. PIM, on the other hand, is primarily of geological origin consisting of fine sands, silts and clays. Off the southern African West Coast, the PIM loading in nearshore waters is strongly related to natural riverine inputs. 'Berg' wind events can potentially contribute the same order of magnitude of sediment input as the annual estimated input of sediment by the Orange River (Shannon & Anderson 1982; Shannon & O'Toole 1998; Lane & Carter 1999).

Concentrations of suspended particulate matter in shallow coastal waters can vary both spatially and temporally, typically ranging from a few mg/l to several tens of mg/l (Bricelj & Malouf 1984; Berg & Newell 1986; Fegley *et al*. 1992). Field measurements of TSPM and PIM concentrations in the Benguela current system have indicated that outside of major flood events, background concentrations of coastal and continental shelf suspended sediments are generally <12 mg/l, showing significant long-shore variation (Zoutendyk 1995). Considerably higher concentrations of PIM have, however, been reported from southern African West Coast waters under stronger wave conditions associated with high tides and storms, or under flood conditions. Field measurements of TSPM and PIM concentrations in the southern Benguela are summarised in Table 4.1.

Superimposed on the suspended fine fraction, is the northward littoral drift of coarser bedload sediments, parallel to the coastline. This northward, nearshore transport is generated by the predominantly south-westerly swell and wind-induced waves. Longshore sediment transport varies considerably in the shore-perpendicular dimension, being substantially higher in the surf-zone than at depth, due to high turbulence and convective flows associated with breaking waves, which suspend and mobilise sediment (Smith & Mocke 2002).

On the inner and middle continental shelf, the ambient currents are insufficient to transport coarse sediments, and resuspension and shoreward movement of these by wave-induced currents occur primarily under storm conditions (see also Drake *et al*. 1985; Ward 1985).

Table 4.1: Mean concentrations of total suspended particulate matter (TSPM) and particulate inorganic matter (PIM) expresses as mg/ℓ from coastal waters in the Benguela.

Region	TSPM	PIM	Source
Dalebrook (RSA)	1.5		Cliff (1982)
Olifantsbos (RSA)		1	Zoutendyk (1995)
Oudekraal (RSA)	1.6		Stuart (1982), Stuart *et al.* (1982)
Melkbosstrand (RSA)		~4.5	Zoutendyk (1995)
Saldanha Bay (RSA)		<4	Carter & Coles (1998)
Groenrivier (RSA)		8.8	Bustamante (1994)
		2	Zoutendyk (1995)
Port Nolloth (RSA)		~2.75	Zoutendyk (1995)
Alexander Bay (RSA)		14.3	Zoutendyk (1995)
Orange River	9		Emery *et al.* (1973)
Orange River 1988 flood		7,400	Bremner *et al.* (1990)

4.1.3 BIOLOGICAL OCEANOGRAPHY

South Africa is divided into nine bioregions (see Figure 4.8), with the licence area located offshore of the Namaqua Bioregion in the Atlantic Offshore Bioregion. The Atlantic Offshore Bioregion extends from a line south-east of Cape Agulhas up into Namibia.

The South African National Biodiversity Institute (SANBI) has initiated a process to identify potential priority areas for spatial management in the offshore environment that require protection (Sink, *et al.,* 2012). Areas which have been identified as priority areas for protection are presented in Section 4.1.4.6e. The licence area does not overlap with any potential conservation priority areas (see Figure 4.35). Sink, *et al.* (2012) also mapped the ecosystem threat status of offshore benthic and pelagic habitats. The licence area coincides with an area mapped as least threatened in terms of offshore benthic and pelagic habitats (see Figure 4.9).

Communities within marine habitats are largely ubiquitous throughout the southern African West Coast region, being particular only to substrate type or depth zone. These biological communities consist of many hundreds of species, often displaying considerable temporal and spatial variability (even at small scales). The near- and offshore marine ecosystems comprise a limited range of habitats, namely unconsolidated seabed sediments and the water column. The biological communities 'typical' of these habitats are described briefly below, focussing both on dominant, commercially important and conspicuous species, as well as potentially threatened species.

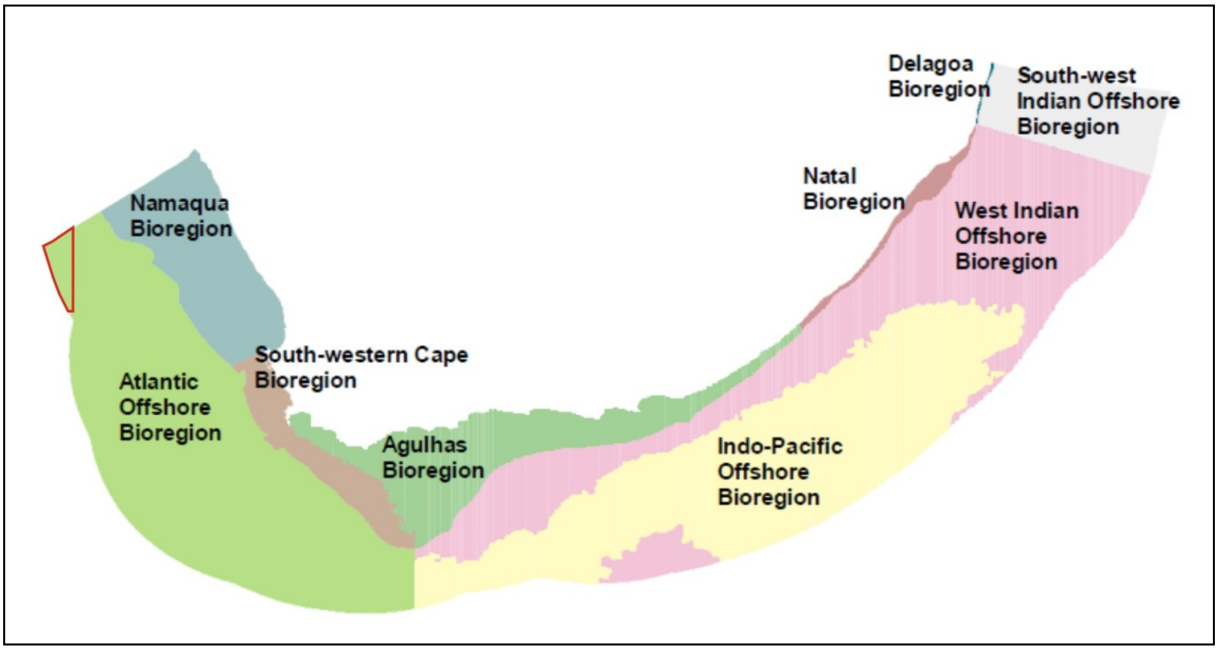

Figure 4.8: The nine bioregions defined by the NBSA study (Lombard and Strauss 2004). The approximate location of the licence area is also shown.

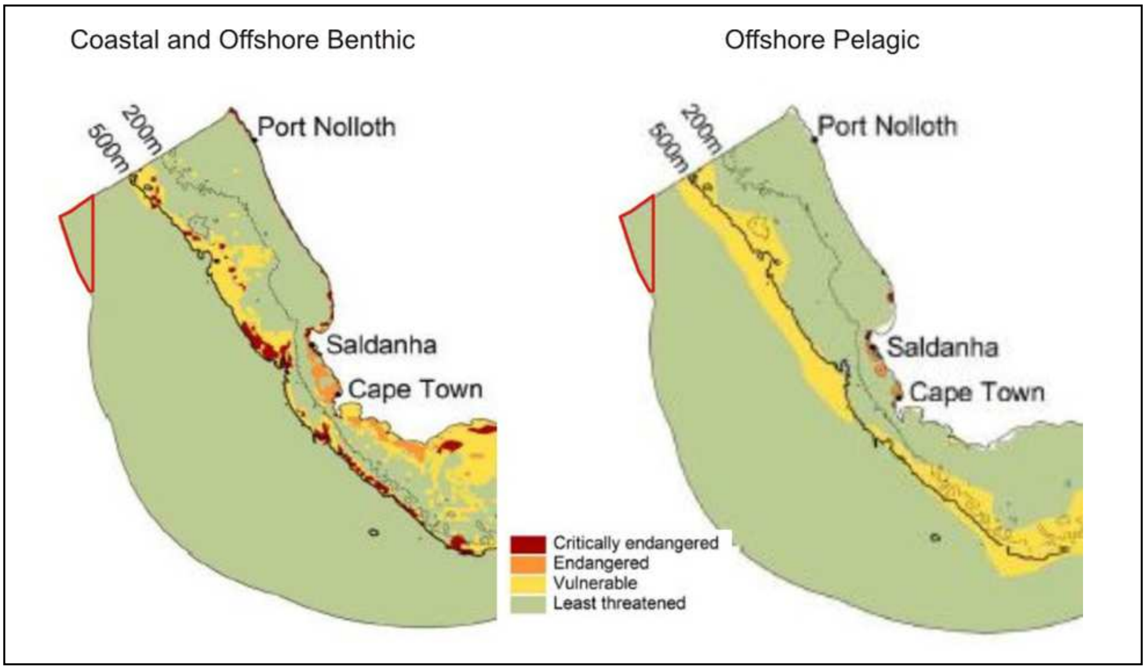

Figure 4.9: Ecosystem threat status for coastal and offshore benthic habitat types (left) and offshore pelagic habitat types on the South African West Coast (Sink, *et al.*, 2012). The approximate location of the licence area is also shown.

4.1.3.1 Plankton

Plankton comprises of three components:

(a) Phytoplankton

Features of phytoplankton distribution in the Benguela system are summarised in Figure 4.10. Phytoplankton and "*chlorophyll a*" concentrations vary seasonally along the West Coast, being minimal in winter and summer (<1-2 mg/m³) and maximal (2-4 mg/m³) in spring and autumn. Brown (1992) divided the shelf areas of the West and South Coasts into three regions; West Coast (north of Cape Columbine), the Cape Coast from Cape Columbine to Cape Agulhas and the South Coast (to the east of Cape Agulhas). Mean "*chlorophyll a"* concentrations measured in the surface 30 m of the water column in each of inshore (< 200 m depth) and offshore (200 m – 500 m depth) areas in the West Coast region are shown in Table 4.2.

Phytoplankton cells are greatest during upwelling. However, as phytoplankton production is related to nutrient supply, seeding and water column stability, production at the upwelling site *per se* is low (chlorophyll a levels range from 0.4 to 0.9 $mg.m^{-3}$), but increases offshore and 'downstream' (northward) from upwelling sites, where the water column is more stable.

Although diatoms are reported to contribute the bulk of the phytoplankton in the Benguela current (Andrews and Hutchings 1980; Olivieri 1983), dinoflagellates are also important (Chapman and Shannon 1985). An estimated 36 % of the phytoplankton is lost to the seabed annually. This natural annual input of millions of tons of organic material onto the seabed off the West Coast has a substantial effect on the ecosystems of the Benguela region. It provides most of the food requirements of the particulate and filter-feeding benthic communities that inhabit the sandy-muds and results in the high organic content of the muds in the area.

Red tides (dinoflagellate and/or ciliate blooms or harmful algal blooms) may occur inshore along the coast north of Cape Point (especially in the Lamberts Bay to St Helena Bay region), usually during relaxation of upwelling cells in late summer to autumn. Such red tides (which can range in colour) may be toxic and animals, particularly filter feeding species, may accumulate toxins in their tissues. Furthermore, decomposition of red tides may strip the remaining oxygen from the water and turn it anoxic (known as a "black tide"), having catastrophic consequences on the inshore fauna of the affected area. The massive mortality of fish, lobsters and other inter- and subtidal invertebrates between Cape Columbine and the Berg River mouth during 1994 serves as an example of a black tide.

There is considerable variation in phytoplankton abundance off the West Coast (Pitcher *et al.* 1992), in terms of both the longshore and offshore scales (productivity levels between Cape Point and the Orange River mouth range from 0.3 to 11 $gC.m^{-2}.day^{-1}$). Phytoplankton abundance in the proposed survey area is expected to be low.

Table 4.2: Mean concentrations of chlorophyll a in the southern Benguela system over the period 1971 to 1989 (after Brown 1992).

Season	Mean chlorophyll a concentrations ($mg.m^{-3}$)		
	Total shelf	Inshore shelf (< 200m depth)	Offshore shelf (200m – 500m depth)
All year	2.11	3.32	0.78
Spring	4.98	5.41	
Summer	2.28	3.62	0.79
Autumn	2.68	3.94	0.52
Winter	1.88	2.75	0.88

(b) Zooplankton

Features of the zooplankton distribution in the Benguela system are summarised in Figure 4.11.

Zooplankton biomass is related to that of phytoplankton, and is thus seasonal, being minimal during winter when the rate of upwelling is lower (Andrews and Hutchings 1980). Zooplankton biomass is low in newly upwelled waters, but increases as these waters age and develops substantial phytoplankton. However, zooplankton blooms lag phytoplankton blooms and thus are found even further offshore, with zooplankton biomass being maximal 40 to 100 km offshore in summer. During winter (when no upwelling occurs in the southern Benguela region) maximal zooplankton biomass is observed close inshore, values being low offshore. An estimated 5 % of the zooplankton is lost to the seabed annually.

Zooplankton is best described divided into mesozooplankton (>200 µm) and macrozooplankton (>1 600 µm). Copepods dominate the mesozooplankton (Andrews and Hutchings 1980; Hutchings *et al.* 1991; Verheye *et al.* 1994), and most are found in the phytoplankton-rich upper mixed layer of the water column. Mesozooplankton standing stock estimates in the southern Benguela range from 0.237 to 2.520 $gC.m^{-2}$ and generally increase from south (~0.5 to ~1.0 $gC.m^{-2}$ between Cape Point and Cape Columbine) to north (~0.5 to ~2.5 $gC.m^{-2}$ to the north of Cape Columbine); the higher northern biomass attributed to the region being downstream of two major upwelling cells.

Euphausiids (18 species) dominate the macrozooplankton (Pillar 1986), of which *Euphausia lucens* and *Nyctiphanes capensis* are the most abundant in the shelf region with *E. lucens* dominating the region between Lüderitz and Cape Agulhas (Pillar *et al.* 1992). Other important groups contributing to the southern Benguela macrozooplankton community are chaetognaths (24 species), hyperiid amphipods (over 70 species within the southern and northern Benguela) and tunicates (42 species) (see Gibbons *et al.* 1992). Macrozooplankton standing stocks are greatest north of Cape Columbine (0.5 $gC.m^{-2}$) and decline southwards and eastwards to 0.1 $gC.m^{-2}$ at the eastern boundary of the West Coast.

A deficiency of phytoplankton results in poor feeding conditions for micro-, meso- and macrozooplankton, and for ichthyoplankton. Phytoplankton, zooplankton and ichthyoplankton abundances in the survey area are thus expected to be comparatively low.

(c) Ichthyoplankton

Ichthyoplankton comprises both fish eggs and larvae, and despite comprising a small component of the overall plankton, is important due to commercial fisheries. Features of the ichthyoplankton distribution in the Benguela system are summarised in Figure 4.11 (Shannon and Pillar 1986).

Spawning areas for pilchard (*Sardinops sagax*), anchovy (*Engraulis japonicus*) and round herring (*Etrumeus Whiteheadi*) along the West Coast largely takes place inshore of the 500 m isobath. Each spring, anchovy migrate southwards from the West Coast to spawning grounds on the western Agulhas Bank (Peterson *et al.* 1992), where the fish spawn serially with frequency of spawning being dependent on food concentration (copepod biomass). Most spawning takes place to the east of Cape Point some 40 to 100 km offshore in 16 to 19°C water.

Of the demersal species, the two hake species (*Merluccius capensis* and *M. paradoxus*) spawn on the continental shelf off St Helena Bay and the western Agulhas Bank. Hake spawning occurs in spring and early summer, with a secondary spawning peak in autumn. Kingklip (*Genypterus capensis*) spawning occurs along the southern African West Coast from Cape Point northwards (Payne 1977). Eggs and/or larvae of snoek (*Thyrsites atun*), jacopever (*Helicolenus dactylopterus*), dragonet (*Paracallionymus costatus*) and saury (*Scomberesox saurus scomberoides*) have also been reported in the southern Benguela.

The proposed survey area lies to the north and offshore of the Namaqua upwelling cell, in the Orange River Cone (LUCORC) area, between approximately 29°S – 31°S. Important pelagic fish species, including anchovy, redeye round herring, horse mackerel and shallow-water hake, are reported as spawning on either side of the LUCORC area, but not within it. The area is characterised by diminished phytoplankton biomass due to high turbulence and deep mixing in the water column, and consequently is considered to be an environmental barrier to the transport of ichthyoplankton from the southern to the northern Benguela upwelling ecosystems. Ichthyoplankton abundance in the deep offshore waters of the proposed survey area is expected to be negligible.

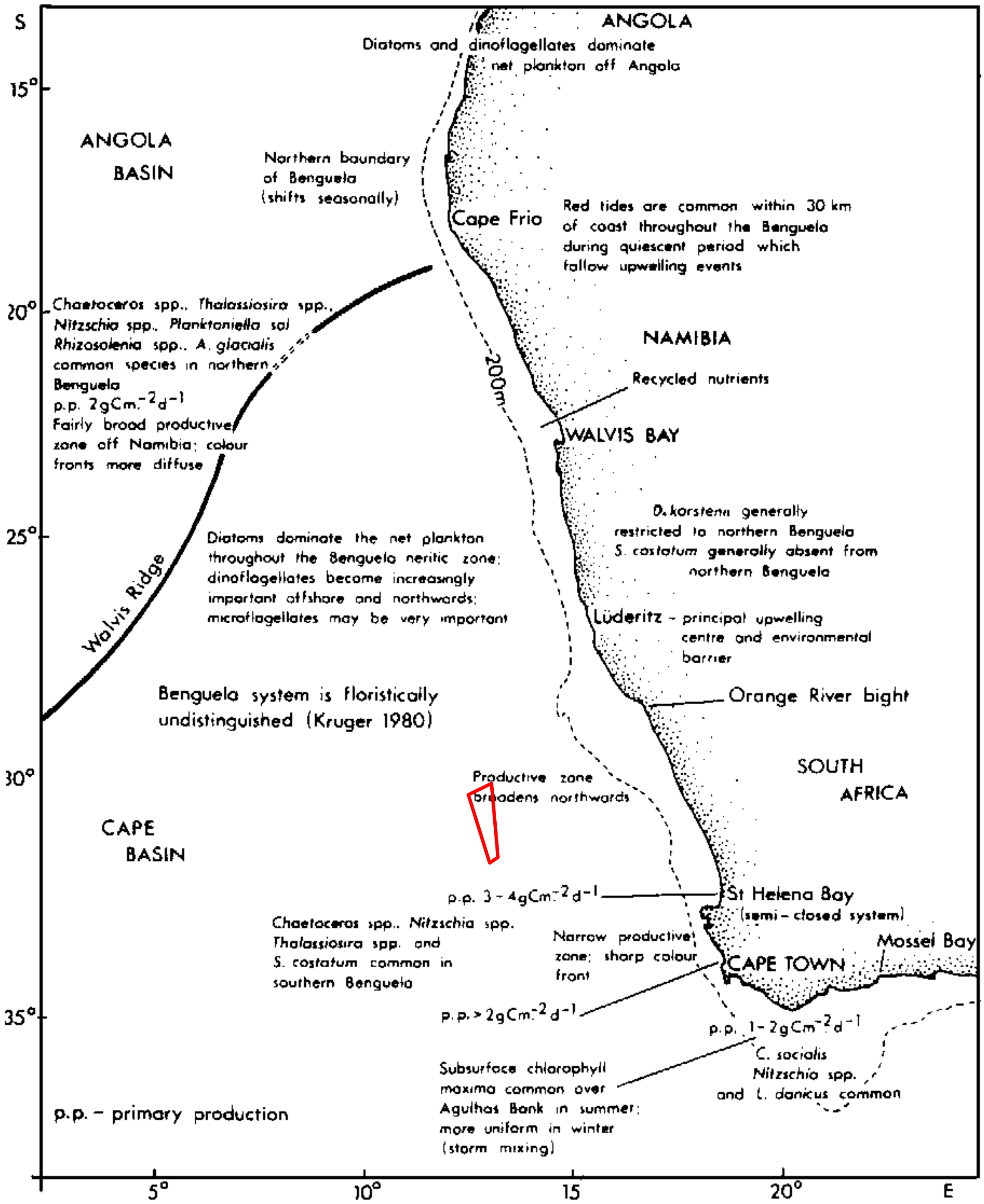

Figure 4.10: Features of phytoplankton distribution in the Benguela System (after Shannon and Pillar 1986). Approximate location of the licence area is also indicated.

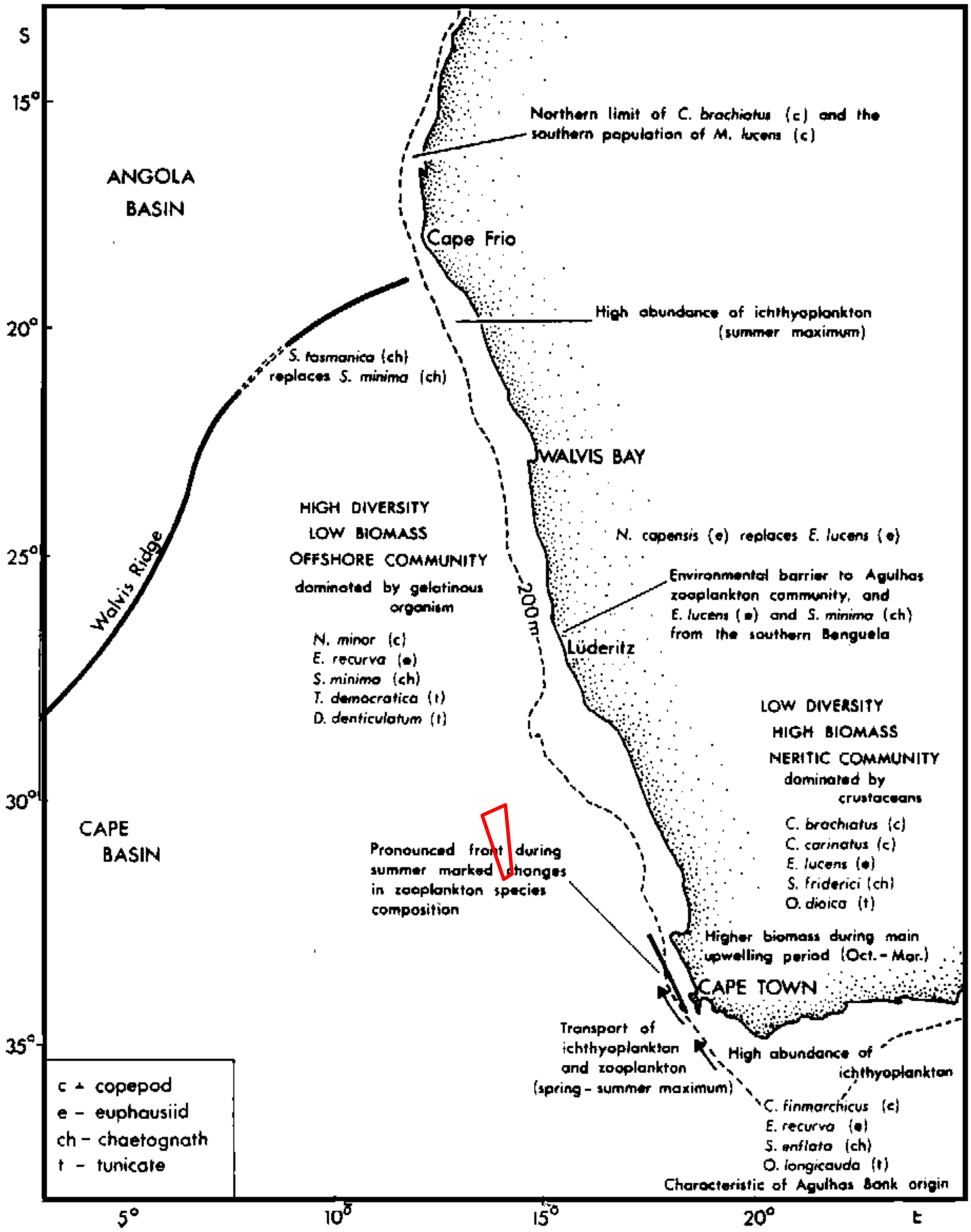

Figure 4.11: Features of zooplankton and ichtyoplankton distribution in the Benguela system (after Shannon and Pillar 1986). Approximate location of the licence area is also indicated.

4.1.3.2 Benthic invertebrate macrofauna

The benthic biota of soft-bottom substrates constitutes invertebrates that live on (epifauna) or burrow within (infauna) the sediments and are generally divided into macrofauna (animals >1 mm) and meiofauna (<1 mm). The structure and composition of benthic soft bottom communities is primarily a function of water depth and sediment composition (Steffani & Pulfrich 2004a, 2004b; 2007; Steffani 2007a; 2007b), but other factors such as current velocity, organic content and food abundance also play a role (Flach & Thomsen 1998; Ellingsen 2002).

Species diversity, abundance and biomass increase from the shore to 80 m depth, with communities being characterised equally by polychaetes, crustaceans and molluscs. Further offshore to 120 m depth, the midshelf is a particularly rich benthic habitat where biomass can attain 60 g/m^2 dry weight (Christie 1974; Steffani 2007b). This rich benthic habitat acts as an important source of food for carnivores, such as cephalopods, mantis shrimp and demersal fish species (Lane & Carter 1999). Outside of this rich zone biomass declines to 4.9 g/m^2 at 200 m depth and then is consistently low (<3 g/m^2) on the outer shelf (Christie 1974).

Typical species occurring at depths of up to 60 m included the snail Nassarius spp., the polychaetes Orbinia angrapequensis, Nepthys sphaerocirrata, several members of the spionid genera Prionospio, and the amphipods Urothoe grimaldi and Ampelisca brevicornis. The bivalves Tellina gilchristi and Dosinia lupinus orbignyi are also common in certain areas (Pulfrich, 2011). Offshore communities are dominated by polychaetes (e.g. Diopatra dubia, D. monroi, D. cuprea cuprea, Lumbrineris albidentata, Laonice cirrata), echinoderms (e.g. Amphiura sp., Ophiura sp.) and crustaceans (e.g. Ampelisca brevicornis, Hippomedon onconotus, Tanais philetaerus) (Atkinson 2009). The benthic fauna of the continental shelf and continental slope beyond approximately 450 m depth are poorly known. With little sea floor topography and hard substrate, such areas are likely to offer minimal habitat diversity or niches for animals to occupy. Detritus-feeding crustaceans, holothurians and echinoderms tend to be the dominant epi-benthic organisms of such habitats.

Soft-bottom substrates are also associated with demersal communities that comprise bottom-dwelling invertebrate and vertebrate species, many of which are dependent on the invertebrate benthic macrofauna as a food source. Atkinson (2009) reported numerous species of urchins and burrowing anemones beyond 300 m water depth off the West Coast.

4.1.3.3 Invertebrates

The West Coast supports important commercial stocks of West Coast rock lobster (*Jasus lalandii*) between Cape Agulhas and about 25º S. While larvae normally move in offshore ocean currents before settling in the shallow kelp beds of the West Coast, the adults are generally found in water depths of between 10 and about 70 m. Female West Coast rock lobsters have a well-defined moulting and spawning cycle, with moulting between May and June and the berry season between May/June and October/November. Peak hatching in October/November is synchronised with strong wind upwelling especially in the southern Benguela. Newly hatched larvae drift northwards and offshore. The return of late stage larvae is believed to be controlled by large-scale ocean circulation systems.

Studies have shown that the majority of seabed species recorded from similar areas have short life spans (a few years or less) and relatively high reproductive rates, indicating the potential for rapid recovery after natural or anthropogenic disturbance of the soft sediment environment. The only species associated with these environments that are slow growing, slow to mature, long-lived and therefore slow to recover and consequently are regarded as vulnerable are the seapens - a list of species recorded by Lopez-Gonzales *et al.* (2001) is given in Table 4.3.

Table 4.3: List of seapen species sampled by Lopez-Gonzales *et al.* (2001) during cruises in the Benguela Region.

Species	Zoogeographic Region	Depth Range (m)*
Anthoptillum grandiflorum	Widespread	238-2 500
Amphibelemnon namibiensis	Benguela	91-304
Crassophyllum cristatum	Benguela	40-650
Distichoptilum gracile	Widespread	650-4 300
Funiculina quadriangularis	Widespread	60-2 600
Halipteris africana	Benguela	459-659
Kopholobelemnon stelliferum	Widespread	400-1 180
Pennatula inflata	Widespread	457-741
Scleroptilum grandiflorum	Widespread	500-4 200
Stylatula macpheersoni	Benguela	245-318
Umbellula thomsoni	Widespread	1300-6 200
Virgularia mirabilis	Widespread	9-400
Virgularia tuberculata	Benguela	75-1 050

*Recorded to date, but these areas are not well sampled or studied.

4.1.3.4 Deep water coral communities

There has been increasing interest in deep-water corals (depths >150 m) in recent years because of their likely sensitivity to disturbance and their long generation times. Some species form reefs while others are smaller and remain solitary. Corals add structural complexity to otherwise uniform seabed habitats thereby creating areas of high biological diversity (Breeze *et al*. 1997; MacIssac *et al*. 2001).

Deep water corals establish themselves below the thermocline where there is a continuous and regular supply of concentrated particulate organic matter, caused by the flow of a relatively strong current over special topographical formations which cause eddies to form. Nutrient seepage from the substratum might also promote a location for settlement (Hovland *et al*. 2002). Substantial shelf areas in the productive Benguela region should thus potentially be capable of supporting rich, cold water, benthic, filter-feeding communities.

4.1.3.5 Cephalopods

On the basis of abundance and trophic links with other species, eight species of cephalopod are important and a further five species have potential importance within the Benguela system (Table 4.4). The major cephalopod resource in the southern Benguela are sepiods/cuttlefish (Lipinski 1992; Augustyn *et al.* 1995). Most of the cephalopod resource is distributed on the mid-shelf with *Sepia australis* being most abundant at depths between 60-190 m, whereas *S. hieronis* densities were higher at depths between 110-250 m. *Rossia enigmatica* occurs more commonly on the edge of the shelf to depths of 500 m. Biomass of these species is generally higher in the summer than in winter.

Cuttlefish are largely epi-benthic and occur on mud and fine sediments in association with their major prey item; mantis shrimps (Augustyn *et al.* 1995). They form an important food item for demersal fish.

Table 4.4: Cephalopod species of importance or potential importance within the Benguela System (after Lipinski 1992).

Scientific Name	Importance
Important species:	
Sepia australis	Very abundant in survey catches, prey of many fish species. Potential for fishery.
Sepia hieronis	Densities higher at depths between 110-250 m
Loligo vulgaris reynaudii	Fisheries exist, predator of anchovy and hake, prey of seals and fish.
Todarodes angolensis	Fisheries exist (mainly by-catch), predator of lightfish, lanternfish and hake, prey of seals.
Todaropsis eblanae	Some by-catch fishery, predator of lightfish and lanternfish, prey of seals and fish. Potential for fishery.
Lycoteuthis lorigera	Unconfirmed by-catch, prey of many fish species. Potential for fishery.
Octopus spp.	Bait and artinisal fishery, prey of seals and sharks.
Argonauta spp.	No fisheries, prey of seals.
Rossia enigmata	No fisheries, common in survey catches.
Potentially important species:	
Ommastrephes bartramii	No fisheries.
Abraliopsis gilchristi	No fisheries.
Todarodes filippovae	No fisheries.
Lolliguncula mercatoris	No fisheries.
Histioteuthis miranda	No fisheries.

4.1.3.6 Seamount Communities

Two geological features of note within the vicinity of the proposed survey area are Child's Bank, situated approximately 150 km offshore at about 31° S (approximately 200 km east of the licence area), and Tripp Seamount, situated approximately 250 km offshore at about 29°40' S (approximately 80 km north-east of the licence area; see Figure 4.13). Features such as banks, knolls and seamounts (referred to collectively here as "seamounts"), which protrude into the water column, are subject to, and interact with, the water currents surrounding them. The effects of such seabed features on the surrounding water masses can include the upwelling of relatively cool, nutrient-rich water into nutrient-poor surface water thereby resulting in higher productivity (Clark *et al.* 1999), which can in turn strongly influence the distribution of organisms on and around seamounts. Evidence of enrichment of bottom-associated communities and high abundances of demersal fishes has been regularly reported over such seabed features.

The enhanced fluxes of detritus and plankton that develop in response to the complex current regimes lead to the development of detritivore-based food-webs, which in turn lead to the presence of seamount scavengers and predators. Deep- and cold-water corals (including stony corals, black corals and soft corals) are a prominent component of the suspension-feeding fauna of many seamounts, accompanied by barnacles, bryozoans, polychaetes, molluscs, sponges, sea squirts, basket stars, brittle stars and crinoids (Rogers 2004). There is also associated mobile benthic fauna that includes echinoderms (sea urchins and sea cucumbers) and crustaceans (crabs and lobsters) (Rogers 1994). Seamounts also provide an important habitat for commercial deepwater fish stocks, such as orange roughy, oreos, alfonsino and Patogonian toothfish, which aggregate around these features for either spawning or feeding (Koslow 1996).

The coral frameworks offer refugia for a great variety of invertebrates and fish within, or in association with, the living and dead coral framework thereby creating spatially fragmented areas of high biological diversity (biological hotspots). Such complex benthic ecosystems in turn enhance foraging opportunities for many other predators, serving as mid-ocean focal points for a variety of pelagic species with large ranges (turtles, tunas and billfish, pelagic sharks, cetaceans and pelagic seabirds) that may migrate large distances in search of food or may only congregate on seamounts at certain times (Hui 1985; Haney *et al.* 1995). Seamounts thus serve as feeding grounds, spawning and nursery grounds and possibly navigational markers for a large number of species (SPRFMA 2007). Consequently, seamounts are usually highly unique and are usually, but not always, identified as Vulnerable Marine Ecosystems (VMEs). South Africa's seamounts and their associated benthic communities have not been sampled by either geologists or biologists (Sink & Samaai 2009). There is reference to decapod crustaceans from Tripp Seamount (Kensley 1980, 1981) and exploratory deep-water trawl fishing (Hampton 2003), but otherwise knowledge of benthic communities characterising southern African seamounts is lacking. Evidence from video footage taken on hard-substrate habitats in 100 to 120 m depth off southern Namibia and to the south-east of Child's Bank suggest that vulnerable communities, including gorgonians, octocorals and reef-building sponges occur on the continental shelf. Whether similar communities may thus be expected in the Northern Cape Ultra-deep Licence Area is, however, unknown.

4.1.3.7 Fishes

Marine fish can generally be divided in three different groups, namely demersal (those associated with the substratum), pelagic (those species associated with water column) or meso-pelagic (fish found generally in deeper water and may be associated with both the seafloor and the pelagic environment). Pelagic species include two major groups, the planktivorous clupeid-like fishes such as anchovy or pilchard and piscivorous predatory fish. Demersal fish can be grouped according to the substratum with which they are associated, for example rocky reef or soft substrata. It must be noted that such divisions are generally simplistic, as certain species associate with more than one community.

a) Demersal species

As many as 110 species of bony and cartilaginous fish have been identified in the demersal communities on the continental shelf of the West Coast (Roel 1987), but information from beyond the shelf break is sparse. Changes in fish communities occur with increasing depth (Roel 1987; Smale *et al*. 1993; Macpherson & Gordoa 1992; Bianchi *et al*. 2001; Atkinson 2009), with the most substantial change in species composition occurring in the shelf break region between 300 m and 400 m depth (Roel 1987; Atkinson 2009). The shelf community (<380 m) is dominated by the Cape hake *Merluccius capensis*, and includes jacopever *Helicolenus dactylopterus*, Izak catshark *Holohalaelurus regain*, soupfin shark *Galeorhinus galeus* and whitespotted houndshark *Mustelus palumbes*. The more diverse deeper water community is dominated by the deepwater hake *M. paradoxus*, monkfish *Lophius vomerinus*, kingklip *Genypterus capensis*, bronze whiptail *Lucigadus ori* and hairy conger *Bassanago albescens* and various squalid shark species. There is some degree of species overlap between the depth zones.

Roel (1987) showed seasonal variations in the distribution ranges of shelf communities, with species such as the pelagic goby *Sufflogobius bibarbatus*, and West Coast sole *Austroglossus microlepis* occurring in shallow water north of Cape Point during summer only. The deep-sea community was found to be homogenous both spatially and temporally. However, Atkinson (2009) identified two long-term community shifts in demersal fish communities; the first (early to mid-1990s) being associated with an overall increase in density of many species, whilst many species decreased in density during the second shift (mid-2000s). These community shifts correspond temporally with regime shifts detected in environmental forcing variables (Sea Surface Temperatures and upwelling anomalies) (Howard *et al*. 2007) and with the eastward shifts observed in small pelagic fish species and rock lobster populations (Coetzee *et al*. 2008, Cockcroft *et al*. 2000).

(b) Pelagic species

Small pelagic species include sardine/pilchard (*Sadinops ocellatus*), anchovy (*Engraulis capensis*), chub mackerel (*Scomber japonicus*), horse mackerel (*Trachurus capensis*) and round herring (*Etrumeus whiteheadi*). These species typically occur in mixed shoals of various sizes, and generally occur within the 200 m contour and thus unlikely to be encountered in the proposed survey area.

Most of the pelagic species exhibit similar life history patterns involving seasonal migrations between the west and south coasts. Apart from round herring which spawn offshore of the shelf break on the West Coast, the spawning areas of the major pelagic species are distributed on the continental shelf extending from south of St Helena Bay to Mossel Bay on the South Coast (Shannon & Pillar 1986). They spawn downstream of major upwelling centres in spring and summer, and their eggs and larvae are subsequently carried around Cape Point and up the coast in northward flowing surface waters.

At the start of winter every year, juveniles of most small pelagic shoaling species recruit into coastal waters in large numbers between the Orange River and Cape Columbine. They utilise the shallow shelf region as nursery grounds before gradually moving southwards in the inshore southerly flowing surface current, towards the major spawning grounds east of Cape Point. Recruitment success relies on the interaction of oceanographic events, and is thus subject to spatial and temporal variability. Consequently, the abundance of adults and juveniles of these small, short-lived (1-3 years) pelagic fish is highly variable both within and between species.

Two species that migrate along the West Coast following the shoals of anchovy and pilchards are snoek (*Thyrsites atun)* and chub mackerel (*Scomber japonicas)*. Their appearance along the West and South-West coasts are highly seasonal. Snoek migrating along the southern African West Coast reach the area between St Helena Bay and the Cape Peninsula between May and August. They spawn in these waters between July and October before moving offshore and commencing their return northward migration (Payne & Crawford 1989). Chub mackerel similarly migrate along the southern African West Coast reaching South-Western Cape waters between April and August. They move inshore in June and July to spawn before starting the return northwards offshore migration later in the year. Their abundance and seasonal migrations are thought to be related to the availability of their shoaling prey species (Payne & Crawford 1989).

Large pelagic species include tunas, billfish and pelagic sharks, which migrate throughout the southern oceans, between surface and deep waters (>300 m) and have a highly seasonal abundance in the Benguela. Species occurring off western southern Africa include the albacore/longfin tuna (*Thunnus alalunga)*, yellowfin (*T. albacares)*, bigeye (*T. obesus)* and skipjack (*Katsuwonus pelamis)* tunas, as well as the Atlantic blue marlin (*Makaira nigricans)*, the white marlin (*Tetrapturus albidus)* and the broadbill swordfish (*Xiphias gladius)* (Payne & Crawford 1989). The distribution of these species is dependent on food availability in the mixed boundary layer between the Benguela and warm central Atlantic waters. Concentrations of large pelagic species are also known to occur associated with underwater features such as canyons and seamounts as well as meteorologically-induced oceanic fronts (Penney *et al.* 1992).

A number of species of pelagic sharks are also known to occur on the West Coast, including blue (*Prionace glauca)*, short-fin mako (*Isurus oxyrinchus)* and oceanic whitetip sharks (*Carcharhinus longimanus)*. Great whites (*Carcharodon carcharias)* and whale sharks (*Rhincodon typus)* may also be encountered in coastal and offshore areas, although the latter occurs more frequently along the South and East coasts. Of these the blue shark is listed as “Near threatened”, and the short-fin mako, whitetip, great white and whale sharks as “Vulnerable” by the International Union for Conservation of Nature (IUCN).

4.1.3.8 Turtles

Three species of turtles, namely the green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*) and loggerhead (*Caretta caretta*) are found along the West Coast. Loggerhead and green turtles are expected to occur only as occasional visitors along the West Coast.

The leatherback turtle is likely to be encountered within the survey area. However, their abundance is expected to be low. The Benguela ecosystem, especially the northern Benguela where jelly fish numbers are high, is increasingly being recognised as a potentially important feeding area for leatherback turtles from several globally significant nesting populations in the south Atlantic (Gabon, Brazil) and south east Indian Ocean (South Africa) (Lambardi *et al*. 2008, Elwen & Leeney 2011, SASTN 2011[1]).

Leatherback turtles inhabit deeper waters and are considered a pelagic species, travelling the ocean currents in search of their prey (primarily jellyfish). While hunting they may dive to over 600 m and remain submerged for up to 54 minutes (Hays *et al*. 2004), thus making them difficult to observe from the surface and potentially susceptible to seismic operations. Leatherback turtles breed on the northern KwaZulu-Natal coastline of the East Coast and in the Republic of Congo and Gabon on the West Coast.

Leatherback turtles are listed as Critically Endangered worldwide by the IUCN and are in the highest categories in terms of need for conservation in CITES (Convention on International Trade in Endangered Species), and CMS (Convention on Migratory Species). Loggerhead and green turtles are listed as "Endangered". As a signatory of CMS, South Africa has endorsed and signed a CMS International Memorandum of Understanding specific to the conservation of marine turtles.

4.1.3.9 Birds

There are a total of 49 species of seabirds occurring within the southern Benguela area, of which 14 are resident species, 25 are migrants from the southern ocean and 10 are visitors from the northern hemisphere. Table 4.5 provides a list of the common species occurring within the study area.

The area between Cape Point and the Orange River supports 38% and 33% of the overall population of pelagic seabirds in winter and summer, respectively. Most of the species in the region reach highest densities offshore of the shelf break (200 to 500 m depth) with highest population levels during their non-breeding season (winter).

The availability of breeding sites is an extremely important determinant in the distribution of resident seabirds. Although breeding areas are distributed along the whole coast, islands are especially important, particularly those between Dyer Island and Lamberts Bay (approximately 450 km east of the southernmost point of the licence area). Fourteen resident species breed along the West Coast, including Cape Gannet, African Penguin, four species of Cormorant, White Pelican, three Gull and four Tern species (Table 4.6).

Table 4.5: Pelagic seabirds common in the southern Benguela region (Crawford *et al*. 1991).

Common Name	Species name	Global IUCN
Shy albatross	*Thalassarche cauta*	Near Threatened
Black browed albatross	*Thalassarche melanophrys*	Endangered[1]
Yellow nosed albatross	*Thalassarche chlororhynchos*	Endangered
Giant petrel sp.	*Macronectes halli/giganteus*	Near Threatened

[1] SASTN Meeting – Second meeting of the South Atlantic Sea Turtle Network, Swakopmund, Namibia, 24-30 July 2011.

Pintado petrel	*Daption capense*	Least concern
Greatwinged petrel	*Pterodroma macroptera*	Least concern
Soft plumaged petrel	*Pterodroma mollis*	Least concern
Prion spp	*Pachyptila* spp.	Least concern
White chinned petrel	*Procellaria aequinoctialis*	Vulnerable
Cory's shearwater	*Calonectris diomedea*	Least concern
Great shearwater	*Puffinus gravis*	Least concern
Sooty shearwater	*Puffinus griseus*	Near Threatened
European Storm petrel	*Hydrobates pelagicus*	Least concern
Leach's storm petrel	*Oceanodroma leucorhoa*	Least concern
Wilson's storm petrel	*Oceanites oceanicus*	Least concern
Blackbellied storm petrel	*Fregetta tropica*	Least concern
Skua spp.	*Catharacta/Stercorarius* spp.	Least concern
Sabine's gull	*Larus sabini*	Least concern

Table 4.6: Breeding resident seabirds present along the West Coast (CCA & CMS 2001).

Common name	Species name	Global IUCN Status
African Penguin	*Spheniscus demersus*	Endangered
Great Cormorant	*Phalacrocorax carbo*	Least Concern
Cape Cormorant	*Phalacrocorax capensis*	Near Threatened
Bank Cormorant	*Phalacrocorax neglectus*	Endangered
Crowned Cormorant	*Phalacrocorax coronatus*	Least Concern
White Pelican	*Pelecanus onocrotalus*	Least Concern
Cape Gannet	*Morus capensis*	Vulnerable
Kelp Gull	*Larus dominicanus*	Least Concern
Greyheaded Gull	*Larus cirrocephalus*	Least Concern
Hartlaub's Gull	*Larus hartlaubii*	Least Concern
Caspian Tern	*Hydroprogne caspia*	Vulnerable
Swift Tern	*Sterna bergii*	Least Concern
Roseate Tern	*Sterna dougallii*	Least Concern
Damara Tern	*Sterna balaenarum*	Near Threatened

Cape Gannets breed only on islands and Lamberts Bay and Malgas Island are important colonies (approximately 450 km east of the licence area). Cape cormorants breed mainly on offshore islands (Dyer, Jutten, Seal, Dassen, Bird (Lamberts Bay), Malgas and Vondeling Islands), although the large colonies may associate with estuaries, lagoons or sewerage works. The bank and crowned cormorants are endemic to the Benguela system and both breed between Namibia and just to the west of Cape Agulhas. Although white-breasted cormorants occur between northern Namibia and the Eastern Cape in southern Africa, the majority of the population is concentrated between Swakopmund and Cape Agulhas.

Most of these resident species feed on fish (with the exception of the gulls, which scavenge, and feed on molluscs and crustaceans). Feeding strategies can be grouped into surface plunging (gannets and terns), pursuit diving (cormorants and penguins) and scavenging and surface seizing (gulls and pelicans). Most of the breeding seabird species forage at sea with most birds being found relatively close inshore (10-30 km). Cape Gannets, however, are known to forage up to 140 km offshore (Dundee 2006; Ludynia 2007), and African Penguins have also been recorded as far as 60 km offshore.

African penguin colonies (*Spheniscus demersus*) occur at 27 localities around the coast of South Africa and Namibia (see Figure 4.12). The species forages at sea with most birds being found within 20 km of their colonies. African penguin distribution at sea is consistent with that of the pelagic shoaling fish, which generally occur within the 200 m isobath.

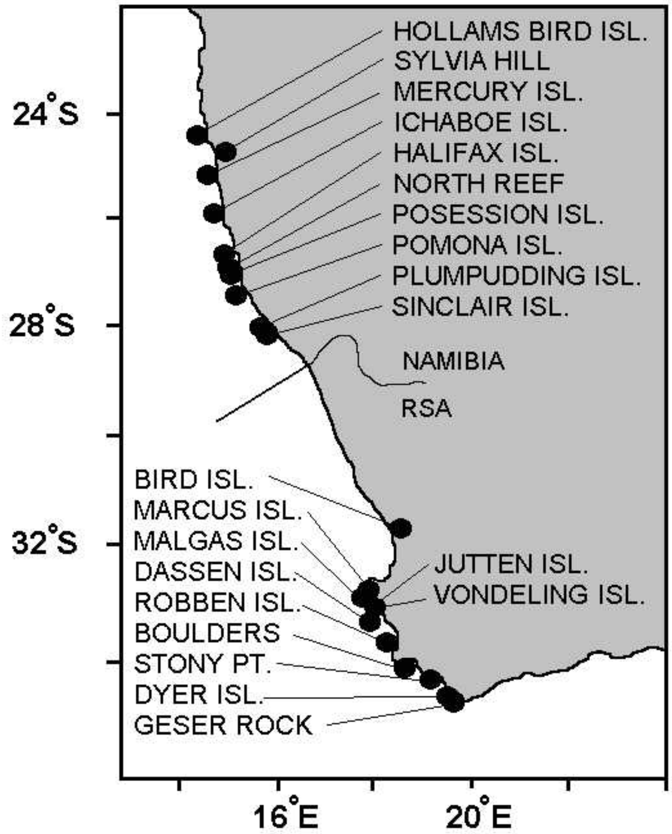

Figure 4.12: The distribution of breeding colonies of African penguins on the South African West Coast.

The Cape Gannet and Bank Cormorant are listed in the South African Red Data Book as "Vulnerable". The Caspian Tern, Cape Cormorant and Crowned Cormorant are listed in the South African Red Data Book as "Near-threatened", while the African Penguin and Damara Tern is listed as "Endangered". The decline in the African Penguin population is ascribed primarily to the removal of the accumulated guano from the islands during the nineteenth century. Penguins used to breed in burrows in the guano and are now forced to nest in the open, thereby being exposed to much greater predation and thermal stress.

The Cape Gannet, a plunge diver feeding on epipelagic fish, is thought to have declined as a result of the collapse of the pilchard, whereas the Cape Cormorant was able to shift its diet to pelagic goby. Furthermore, the recent increase in the seal population has resulted in seals competing for island space to the detriment of the breeding success of both gannets and penguins.

4.1.3.10 Marine mammals

The marine mammal fauna occurring off the West Coast of South Africa, north of Cape Columbine, include whales, dolphins and seals.

(a) Cetaceans

South of Cape Columbine, some cetacean species more commonly associated with warmer Agulhas current waters are known to occur. As the proposed survey area is north of Cape Columbine, the description below focusses on those species associated with the Benguela ecosystem proper and the waters offshore of this.

The cetacean fauna of the West Coast comprises 28 species of whales and dolphins known or to occur here (see Table 4.7). The offshore areas have been particularly poorly studied with almost all available information from deeper waters (>200 m) arising from historic whaling records. Information on smaller cetaceans in deeper waters is particularly poor.

The distribution of whales and dolphins on the West Coast can largely be split into those associated with the continental shelf and those that occur in deep, oceanic waters. Species from both environments may, however, be found associated with the shelf (200 - 1 000 m), making this the most species-rich area for cetaceans. The most common species within the proposed survey area (in terms of likely encounter rate not total population sizes) are likely to be the long finned pilot whale and humpback whale.

Cetaceans comprised two basic taxonomic groups: the mysticetes (filter-feeding baleen whales) and the odontocetes (toothed predatory whales and dolphins).

Mysticetes

Mysticete cetaceans occurring in the proposed survey area include the southern right, pygmy right, humpback, blue, fin, sei, minke, dwarf minke and two populations of Bryde's whales. Most of these species occur in pelagic waters, with only occasional visits into shelf waters. All of these species show some degree of migration either to, or through, the proposed survey area when *en route* between higher-latitude feeding grounds (Antarctic or Subantarctic) and lower-latitude breeding grounds. Depending on the ultimate location of these feeding and breeding grounds, seasonality off South Africa can be either unimodal (usually in June-August, e.g. minke and blue whales) or bimodal (usually May-July and October-November, e.g. fin whales), reflecting a northward and southward migration through the area. As whales follow geographic or oceanographic features, the northward and southward migrations may take place at difference distances from the coast, thereby influencing the seasonality of occurrence at different locations. Due to the complexities of the migration patterns, each species is discussed in further detail below.

- The most abundant baleen whales off the coast of South Africa are southern right and humpback whales (both listed as Least Concern). Southern right whales migrate to the southern Africa subcontinent to breed and calve, where they tend to have an extremely coastal distribution mainly in sheltered bays (90% <2 km from shore; Best 1990, Elwen & Best 2004). They typically arrive in coastal waters off the West Coast in June, increasing to a maximum number in September/October, with most departing in December (although animals may be sighted as early as April and as late as February). On the West Coast they are most common south of Lambert's Bay (CCA & CMS 2001), although a number of the bays between Chameis Bay (27°56'S) and Conception Bay (23°55'S) in Namibia have in recent years become popular calving sites (Currie *et al*. 2009), with sightings reported as far north as the Kunene and Möwe Bay (Roux *et al*. 2001). The Southern Right calving season extends from late June to late October, peaking in August (Best 1994; Roux *et al*. 2001), with cow-calf pairs remaining in sheltered bays for up to two months before starting their southern migration. In the last decade, Southern Rights have increasingly been observed to remain on the west coast of South Africa well after the 'traditional' South African whale season (June – November) into spring and early summer (October – February) where they have been observed feeding in upwelling zones, especially off Saldanha and St Helena Bays (Barendse *et al*. 2011; Mate *et al*. 2011). It was previously thought that whales feed only rarely while migrating (Best *et al.* 1995), but these localised summer concentrations suggest that these whales may in fact have more flexible foraging habits.

The majority of humpback whales on the West Coast are migrating past the southern African continent to breeding grounds off tropical west Africa, between Angola and the Gulf of Guinea (Rosenbaum *et al.* 2009, Barendse *et al.* 2010). In coastal waters, the northward migration stream is larger than the southward peak supporting earlier observations from whale catches (Best & Allison 2010; Elwen *et al.* 2013). Animals migrating north strike the coast at varying places mostly north of St Helena Bay (South Africa) resulting in increasing whale density on shelf waters as one moves north towards Angola. On the southward migration, there is evidence from satellite tagged animals and the smaller secondary peak in numbers in Walvis Bay, that many humpback whales follow the Walvis Ridge offshore then head directly to high latitude feeding grounds, while others follow a more coastal route (including the majority of mother-calf pairs) possibly lingering in the feeding grounds off west South Africa in summer (Elwen *et al.* 2013, Rosenbaum *et al.* in press). Therefore, although humpbacks migrate through the Benguela, there is no existing evidence of a clear 'corridor' and whales appear to be spread out widely across the shelf and into deeper pelagic waters, especially during the southward migration (Barendse *et al.* 2010; Best & Allison 2010; Elwen *et al.* 2013). Humpback whales are likely to be the most frequently encountered baleen whale in the impact site, ranging from the coast out beyond the shelf, with year round presence but numbers peaking in July – February associated with the breeding migration and subsequent feeding in the Benguela.

The most recent abundance estimate for the South African Southern right whale population (2008) put the population at approximately 4 600 individuals of all age and sex classes, which is thought to be at least 23% of the original population size (Brandão *et al.* 2011). Since the population is still continuing to grow at approximately 7 % per year (Brandão *et al.* 2011), the population size in 2013 would number more than 6 000 individuals. When the population numbers crashed, the range contracted down to just the south coast of South Africa, but as the population recovers, it is repopulating its historic grounds including Namibia. At least one third of the total South African population (approximately 1 033 - 1 577 individuals) has been estimated to use the West Coast feeding ground (Peters *et al.* 2011), showing the potential importance of this area for the population as a whole. Recent abundance estimates for Humpback Whales put the number of animals in the west African breeding population to be in excess of 9 000 individuals in 2005 (IWC 2012) and it is likely to have increased since this time at about 5% per annum (IWC 2012).

The extreme offshore location of the proposed exploration area makes encounters with whales undergoing summer migrations highly unlikely.

- Two types of Bryde's whales are recorded from South African waters - a larger pelagic form described as *Balaenoptera brydei* and a smaller neritic form (of which the taxonomic status is uncertain) but included by Best (2007) with *B. brydei* for the subregion. The migration patterns of Bryde's whales differ from those of all other baleen whales in the region. The inshore population is unique in that it is resident year round on the Agulhas Bank, south and east of Lambert's Bay, and does not migrate at all, although some movement up the West Coast in winter has been reported (Best 2007, 2001; Best *et al.* 1984). The offshore population of Bryde's whale lives off the continental shelf (>200 m depth) and migrates between wintering grounds off equatorial West Africa (Gabon) and summering grounds off the South African West Coast (Best 2001). Its seasonality within South African waters is thus opposite to the majority of the other migratory cetaceans, with abundance in the proposed exploration area likely to be highest in January - March.

- Sei whales (listed as Endangered) migrate through South African waters to unknown breeding grounds further north. Their migration pattern shows a bimodal peak with numbers west of Cape Columbine highest in May and June, and again in August to October. Based on whaling records, all whales were caught in waters deeper than 200 m with most deeper than 1 000 m (Best & Lockyer 2002). A recent sighting of a sei whale mother-calf pair in March 2012 (NDP unpubl. data) and a live stranding in July 2013 in Walvis Bay confirms their contemporary and likely year round occurrence in the Benguela.

- Fin whales (listed as Vulnerable) have a bimodal peak in the catch data suggesting animals were migrating further north during May - June to breed, before returning during August - October *en route* to Antarctic feeding grounds. Some juvenile animals may feed year round in deeper waters off the shelf (Best 2007). There are no recent data on abundance or distribution of fin whales off the West Coast although four strandings have occurred between Walvis Bay and the Knene River in the last decade (NDP unpubl. data) and a sighting of a live animal in St Helena Bay in 2011 (MRI unpubl. data).
- Two forms of minke whale occur in the southern hemisphere – the Antarctic and the dwarf minke whale, both occurring along the west coast (Best 2007; NDP unpubl. data). Antarctic species range from the pack ice of Antarctica to tropical waters and are usually seen more than 50 km offshore. The two species have similar migration patters with at least some animals migrating to the Southern Ocean in summer months. Around southern Africa, dwarf minke whales occur closer to shore than Antarctic minkes and have been seen less than 2 km from shore on several occasions. Both species are generally solitary and densities are likely to be low in the proposed survey area.
- Although blue whales (listed as Endangered) were historically caught in high numbers off the West Coast, there have been only two confirmed sightings of the species in the area since 1973 (Branch *et al*. 2007), suggesting that the population using the area may have been extirpated by whaling. However, scientific-related search effort (and thus information) in pelagic waters is very low. The chance of encountering the species in the proposed survey area is considered low.

Odontocetes

Sperm whales are the largest of the toothed whales and have a complex, well-structured social system with adult males behaving differently from younger males and female groups. They live in deep ocean waters, usually greater than 1 000 m depth, although they occasionally come onto the shelf to depths of 500-200 m (Best 2007). Seasonality of catches off the West Coast suggest that medium- and large-sized males are more abundant during winter, while female groups are more abundant in autumn (March-April), although animals occur year round (Best 2007). Sperm whales feed at great depth, during dives in excess of 30 minutes, making them difficult to detect visually, however, the regular echolocation clicks made by the species when diving make them relatively easy to detect acoustically using Passive Acoustic Monitoring (PAM).

There is almost no data available on the abundance, distribution or seasonality of the smaller odontocetes (including the beaked whales and dolphins) known to occur in oceanic waters off the shelf of the West Coast. Beaked whales are all considered to be true deep water species usually being seen in waters in excess of 1 000 – 2 000 m depth (Best 2007). Their presence in the area may fluctuate seasonally, but insufficient data exist to define this clearly.

Of the smaller odontocetes known to occur offshore, the long-finned pilot whale is likely to be the most commonly encountered in the proposed survey area (Pulfrich 2013). False killer whales, killer whales and the offshore form of the bottlenose dolphin are also likely to be encountered with some regularity in deeper waters (Findlay *et al*. 1992, Best 2007).

Inshore of the 500 m isobath, dusky dolphins are likely to be the most frequently encountered small cetacean. The species is very boat-friendly and will often approach vessels to bowride. This species is resident year round throughout the Benguela ecosystem coastal waters to depths of at least 500 m (Findlay *et al.* 1992). Although no information is available on the size of the population, they are regularly encountered in nearshore waters (Elwen *et al*. 2010) suggesting a relatively large population of several thousand at least. A hiatus in sightings (or low density area) is reported between ~27°S and 30°S, associated with the Lüderitz upwelling cell (Findlay *et al*. 1992). This area aligns fairly closely with the licence area, which suggests that sightings during the exploration activities may be rare.

Heaviside's dolphins are abundant in the southern Benguela, extending from the coast to at least 200 m depth (Elwen *et al.* 2006; Best 2007). It is estimated that around 10 000 animals live in the 400 km stretch of coast between Cape Town and Lambert's Bay (Elwen *et al.* 2009) and about 1 000 around Lüderitz (NDP unpubl. data). This species is resident year round and shows a strong diurnal movement pattern being most abundant in nearshore waters (<2 km from shore) in the early mornings and moving offshore at night to feed (Elwen *et al*. 2010). Their small group sizes and inconspicuous behaviour when offshore make monitoring their presence very difficult. However, their echolocation clicks can be detected using PAM technology at ranges up to 500 m and the characteristic high frequency and narrow band nature of the clicks (Morisaka *et al*. 2011) makes them easily distinguishable from other species in the area.

(b) Seals

The Cape fur seal (*Arctocephalus pusillus pusillus*) congregates in seven breeding and five non-breeding colonies along the West Coast (Figure 4.13). Four other seal species may occasionally be found as vagrants along the West Coast, including southern elephant seal (*Mirounga leoninas),* subantarctic fur seal (*Arctocephalus tropicalis*), crabeater (*Lobodon carcinophagus*) and leopard seals (*Hydrurga leptonyx*) (David 1989).

There are various Cape fur seal colonies east of the licence area. The colony at Kleinzee has the highest seal population and produces the highest seal pup numbers on the South African Coast (Wickens 1994). The colony at Buchu Twins, formerly a non-breeding colony, has also attained breeding status (M. Meyer, SFRI, pers. comm.). Non-breeding colonies occur south of Hondeklip Bay at Strandfontein Point and on Bird Island at Lamberts Bay, with the McDougalls Bay islands and Wedge Point being haul-out sites only and not permanently occupied by seals. All have important conservation value since they are largely undisturbed at present.

Seals are highly mobile animals with a general foraging area covering the continental shelf up to 120 nautical miles offshore (Shaughnessy 1979), with bulls ranging further out to sea than females. The timing of the annual breeding cycle is very regular occurring between November and January. Breeding success is highly dependent on the local abundance of food, territorial bulls and lactating females being most vulnerable to local fluctuations as they feed in the vicinity of the colonies prior to and after the pupping season (Oosthuizen 1991).

Table 4.7: Cetaceans occurrence off the West Coast, their seasonality and likely encounter frequency.

Common Name	Species	Shelf	Offshore	Seasonality	Likely encounter freq.
Delphinids					
Dusky dolphin	*Lagenorhynchus obscurus*	Yes (0- 800 m)	No	Year round	Daily
Heaviside's dolphin	*Cephalorhynchus heavisidii*	Yes (0-200 m)	No	Year round	Daily
Common bottlenose dolphin	*Tursiops truncates*	Yes	Yes	Year round	Monthly
Common (short beaked) dolphin	*Delphinus delphis*	Yes	Yes	Year round	Monthly
Southern right whale dolphin	*Lissodelphis peronei*	Yes	Yes	Year round	Occasional
Striped dolphin	*Stenella coeruleoalba*	No	?	?	Very rare
Pantropical spotted dolphin	*Stenella attenuate*	Edge	Yes	Year round	Very rare
Long-finned pilot whale	*Globicephala melas*	Edge	Yes	Year round	<Weekly
Short-finned pilot whale	*Globicephala macrorhynchus*	?	?	?	Very rare
Rough-toothed dolphin	*Steno bredanensis*	?	?	?	Very rare
Killer whale	*Orcinus orca*	Occasional	Yes	Year round	Occasional
False killer whale	*Pseudorca crassidens*	Occasional	Yes	Year round	Monthly
Pygmy killer whale	*Feresa attenuate*	?	Yes	?	Occasional
Risso's dolphin	*Grampus griseus*	Yes (edge)	Yes	?	Occasional
Sperm whales					
Pygmy sperm whale	*Kogia breviceps*	Edge	Yes	Year round	Occasional
Dwarf sperm whale	*Kogia sima*	Edge	?	?	Very rare
Sperm whale	*Physeter macrocephalus*	Edge	Yes	Year round	Occasional
Beaked whales					
Cuvier's	*Ziphius cavirostris*	No	Yes	Year round	Occasional
Arnoux's	*Beradius arnouxii*	No	Yes	Year round	Occasional
Southern bottlenose	*Hyperoodon planifrons*	No	Yes	Year round	Occasional
Layard's	*Mesoplodon layardii*	No	Yes	Year round	Occasional

Common Name	Species	Shelf	Offshore	Seasonality	Likely encounter freq.
True’s	*M. mirus*	No	Yes	Year round	
Gray’s	*M. grayi*	No	Yes	Year round	Occasional
Blainville’s	*M. densirostris*	No	Yes	Year round	
Baleen whales					
Minke	*Balaenoptera bonaerensis*	Yes	Yes	>Winter	Monthly
Dwarf minke	*B. acutorostrata*	Yes		Year round	Occasional
Fin whale	*B. physalus*		Yes	MJJ & ON, rarely in summer	Occasional
Blue whale	*B. musculus*		Yes	MJJ	Occasional
Sei whale	*B. borealis*		Yes	MJ & ASO	Occasional
Bryde’s (offshore)	*B. brydei*	Yes		Summer (JF)	Occasional
Bryde’s (inshore)	*B brydei (subspp)*		Yes	Year round	Occasional
Pygmy right	*Caperea marginata*	Yes		Year round	Occasional
Humpback	*Megaptera novaeangliae*	Yes	Yes	SONDJF	Daily*
Southern right	*Eubalaena australis*	Yes		SONDJF	Daily*

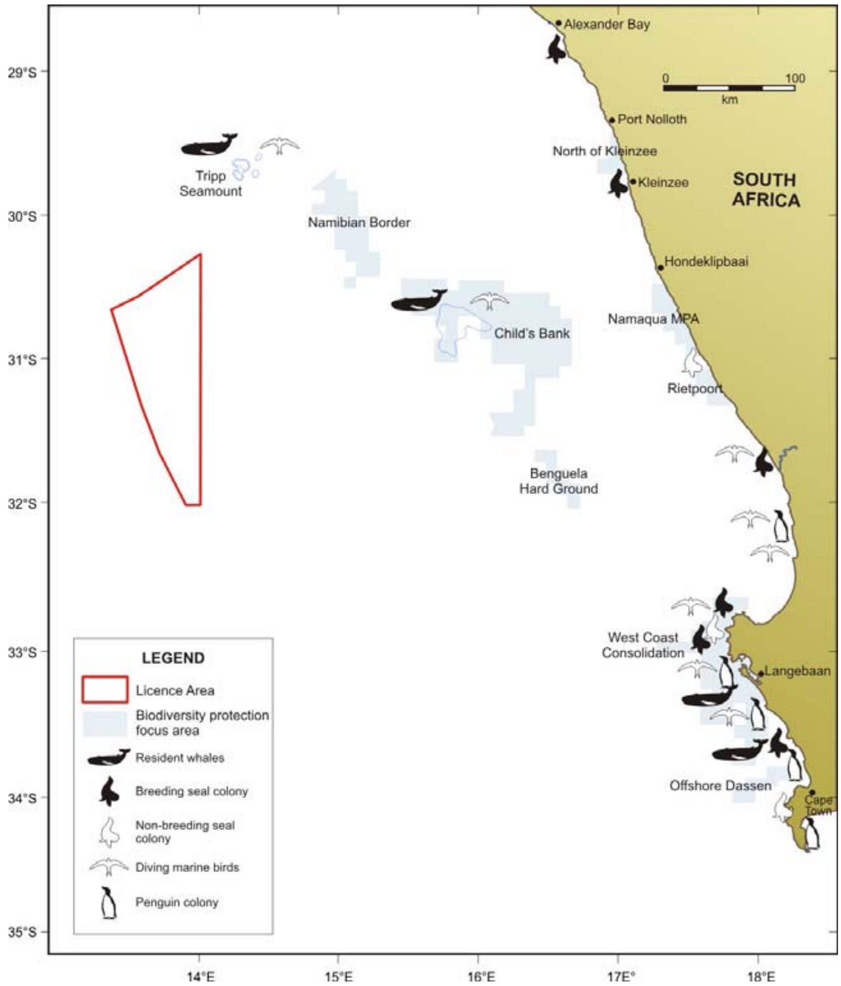

Figure 4.13: Location of seabird and seal colonies and resident whale populations in relation to the licence area.

4.1.4 HUMAN UTILISATION

4.1.4.1 Fisheries

The South African fishing industry consists of 14 commercial sectors operating within the country's 200 nautical mile Exclusive Economic Zone (EEZ). The following fisheries are active along the West Coast:

- Demersal trawl;
- Small pelagic purse-seine;
- Demersal long-line;
- Pelagic long-line;
- Tuna pole;
- Traditional line fish; and
- West Coast rock lobster.

(a) Demersal trawl

Demersal trawl is South Africa's most valuable fishery accounting for approximately half of the income generated from commercial fisheries. Demersal trawlers operate extensively around the coast primarily targeting the bottom-dwelling (demersal) species of hake (*Merluccius paradoxus* and *M. capensis*). Main by-catch species include monkfish (*Lophius vomerinus*), kingklip (*Genypterus capensis*) and snoek (*Thyrsites atun*). The hake-directed trawl fishery is split into two sub-sectors: a small inshore trawling sector active off the South Coast and a large deep-sea trawl sector operating on both the South and West coasts. There are currently 45 trawlers operating within the offshore sector. The Total Allowable Catch (TAC) of hake across all sectors is 156 075 tons (2013), of which the majority is landed by the demersal trawl sector. The deep-sea trawl sector on the West Coast operates mainly in a continuous band along the shelf edge between the 300 m and 1 000 m bathymetric contours (see Figure 4.14).

Trawl nets are generally towed along depth contours (thereby maintaining a relatively constant depth) running parallel to the depth contours in a north-westerly or south-easterly direction. Trawlers also target fish aggregations around bathymetric features, in particular seamounts and canyons (i.e. Child's Bank, Cape Columbine and Cape Canyon), where there is an increase in seafloor slope and in these cases the direction of trawls follow the depth contours. Trawlers are prohibited from operating within five nautical miles of the coastline. The towed gear typically consists of trawl warps, bridles and trawl doors, a footrope, headrope, net and codend (see Figure 4.15).

As the licence area is located in water depths of beyond 2 000 m, the proposed exploration activities would not overlap with the demersal trawl fishing grounds (see Figure 4.14).

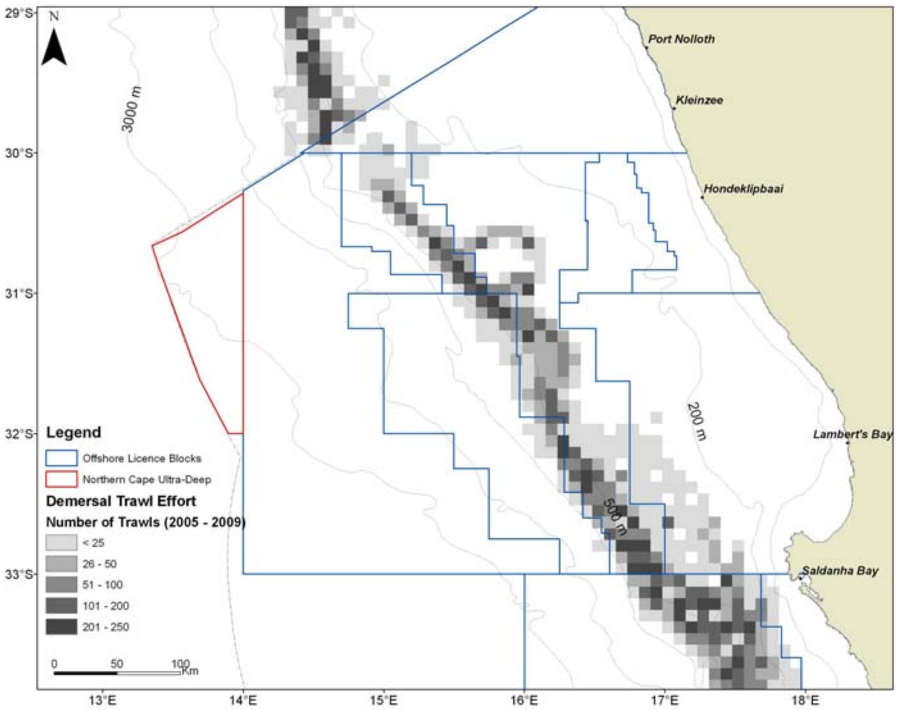

Figure 4.14: Location and effort (2005 to 2009) of the demersal trawl fishery in relation to the licence area.

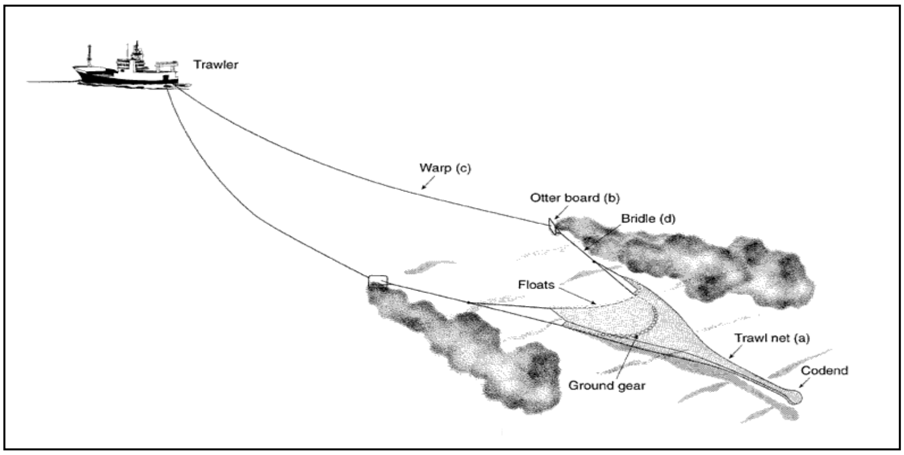

Figure 4.15: Typical gear configuration used by demersal trawlers (offshore) targeting hake.

(b) Small pelagic purse-seine

The South African small pelagic purse seine fishery is the largest fishery by volume and the second most important in terms of value. The pelagic purse-seine fishery targets small mid-water and surface-shoaling species such as sardine, anchovy, juvenile horse mackerel and round herring using purse-seine fishing techniques. Annual landings have fluctuated between 300 000 and 600 000 tons over the last decade, with landings of 391 000 tons per annum recorded between 2008 and 2012.

The South African fishery, consisting of approximately 100 vessels, is active all year round with a short break from mid-December to mid-January, with seasonal trends in the specific species targeted. The geographical distribution and intensity of the fishery is largely dependent on the seasonal fluctuation and geographical distribution of the targeted species. Fishing grounds occur primarily along the Western Cape and Eastern Cape coast up to a distance of 100 km offshore, but usually closer inshore. The sardine-directed fishery tends to concentrate effort in a broad area extending from St Helena Bay, southwards past Cape Town towards Cape Point and then eastwards along the coast to Mossel Bay and Port Elizabeth. The anchovy-directed fishery takes place predominantly on the South-West Coast from St Helena Bay to Cape Point and is most active in the period from March to September. Round herring (non-quota species) is targeted when available and specifically in the early part of the year (January to March) and is distributed South of Cape Point to St Helena Bay. The fishing grounds of the small pelagic purse-seine fishery do not extend into the licence area (see Figure 4.16).

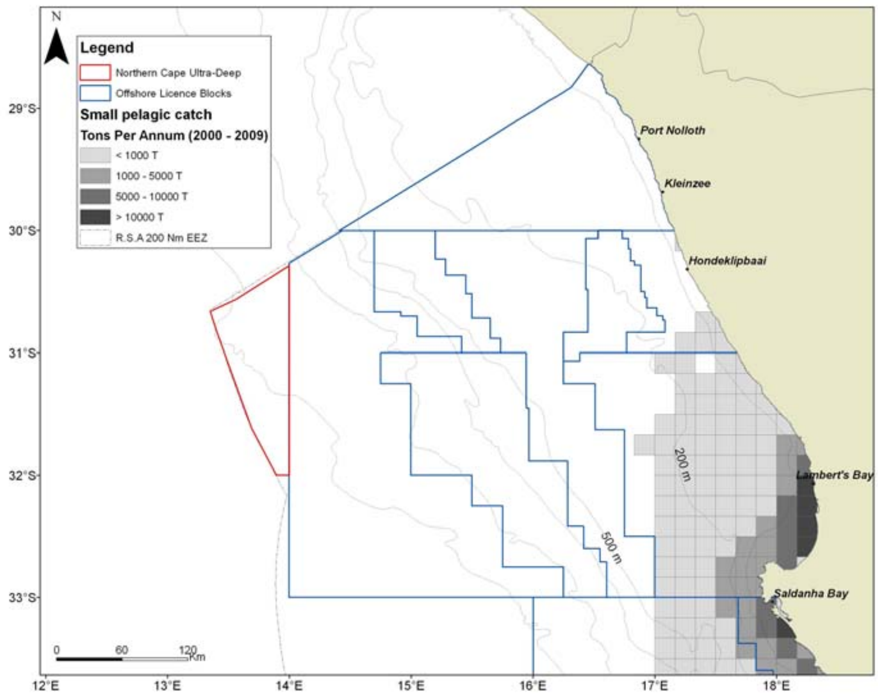

Figure 4.16: Spatial distribution of the catch (2000 to 2009) by the purse-seine fishery in South African waters in relation to the licence area.

Once a shoal has been located the vessel steams around it and encircle it with a large net. The depth of the net is usually between 60 m and 90 m. Netting walls surround aggregated fish both from the sides and from underneath, thus preventing them from escaping by diving downwards. These are surface nets framed by lines: a float line on top and lead line at the bottom (see Figure 4.17). Once the shoal has been encircled the net is pursed and hauled in and the fish are pumped onboard into the hold of the vessel. After the net is deployed the vessel has no ability to manoeuvre until the net has been fully recovered onboard, which may take up to 1.5 hours. Vessels usually operate overnight and return to offload their catch the following day.

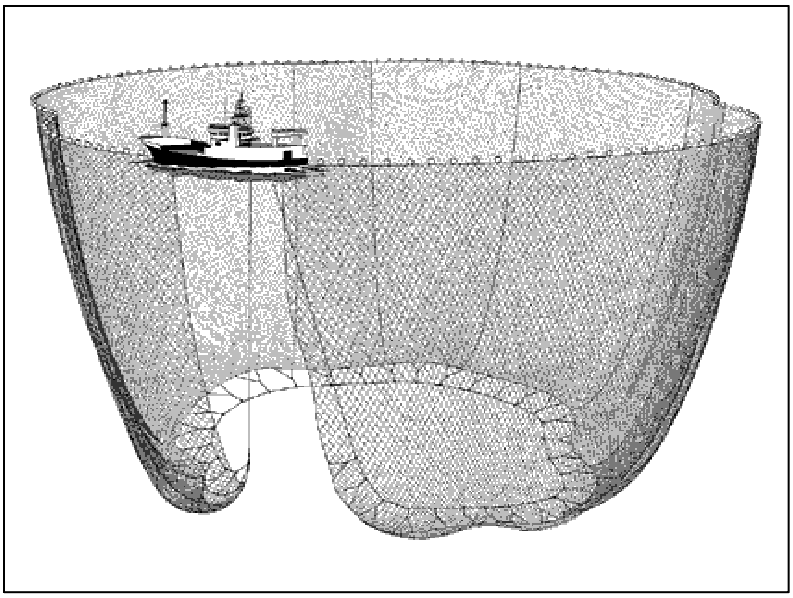

Figure 4.17: Pelagic purse-seine gear configuration.

(c) Demersal long-line

In South Africa the demersal long-line fishery operates in well-defined areas extending along the shelf break from Port Nolloth to Cape Agulhas and targets the Cape hakes, with a small non-targeted commercial by-catch that includes kingklip. Currently 64 vessels are operational within the South African fishery, most of which are based at the harbours of Cape Town and Hout Bay. Operations are *ad hoc* and intermittent, subject to market demand. Approximately 8 000 tons of hake are landed by South African long-line vessels (2011).

Demersal long-lining is expected to occur in similar areas used by the hake-directed trawling, i.e. along the shelf edge from 300 m to a water depth of 1 000 m with lines usually set parallel to bathymetric contours. The spatial extent of demersal long-line effort off the West Coast of South Africa in the vicinity of the proposed survey area is presented in Figure 4.18. The hake-directed and shake-directed demersal long-lining grounds do not overlap with the licence area (see Figures 4.18 and 4.19).

Bottom-set long-line gear is robust and comprises two lines as well as dropper lines with subsurface floats attached (see Figure 4.20). Lines are typically between 10 km and 20 km in length, carrying between 6 900 and 15 600 hooks each. Baited hooks are attached to the bottom line at regular intervals (1 to 1.5 m) by means of a snood. Gear is usually set at night at a speed of between five and nine knots. Once deployed the line is left for up to eight hours before it is retrieved. A line hauler is used to retrieve gear (at a speed of approximately one knot) and can take six to ten hours to complete. During hauling operations a demersal long-line vessel would be severely restricted in manoeuvrability.

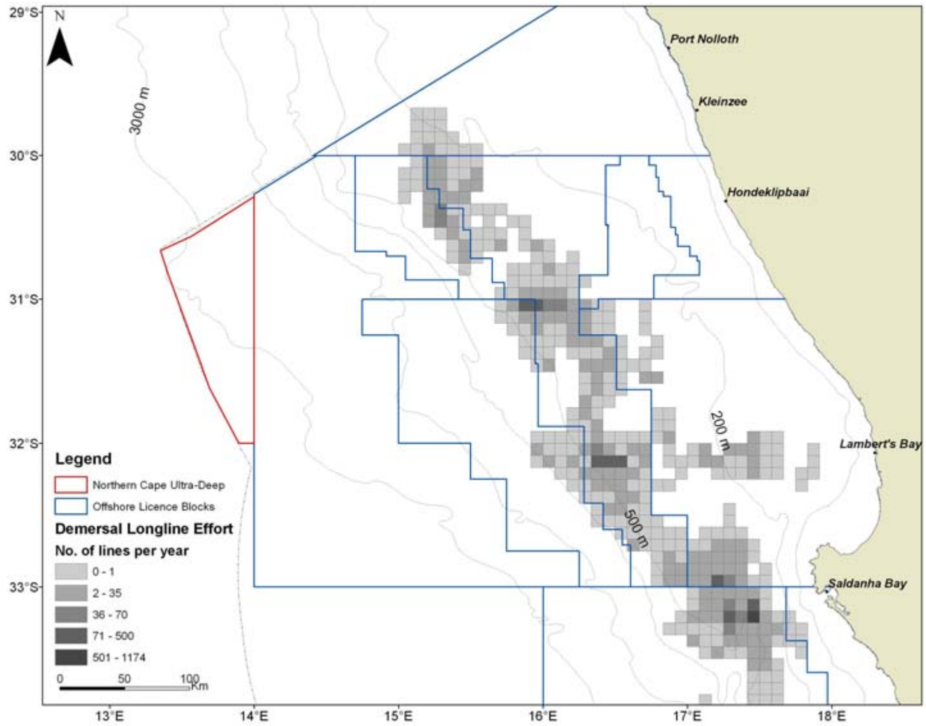

Figure 4.18: **Effort (2000 to 2012) expended by the hake-directed demersal long-line fishing sector on the West Coast of South Africa in relation to the licence area.**

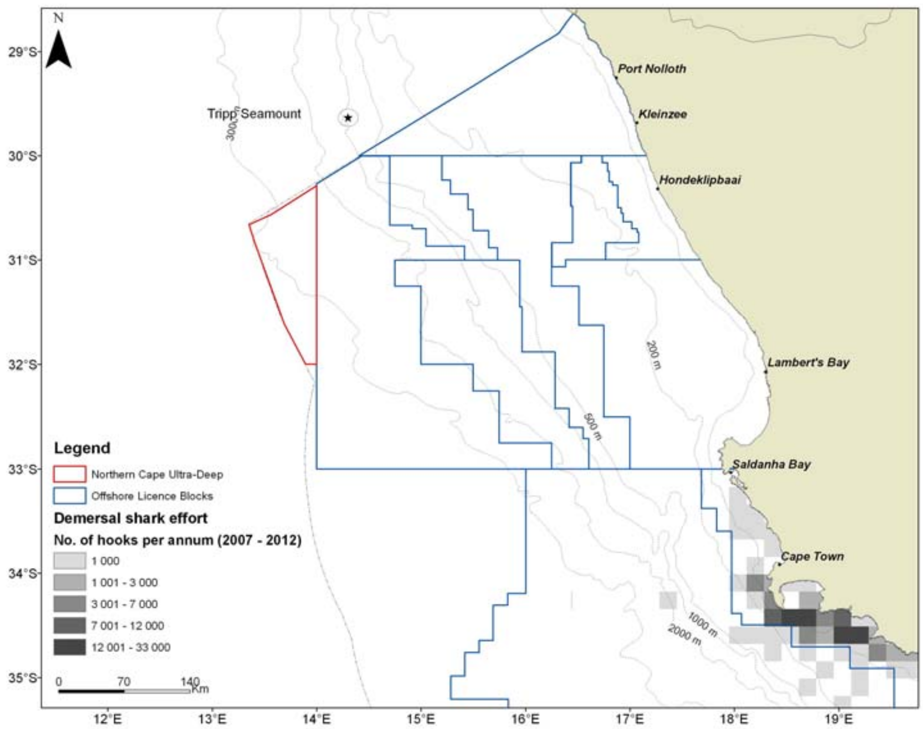

Figure 4.19: **Effort (2007 to 2012) expended by the shark-directed demersal long-line fishing sector on the West Coast of South Africa in relation to the licence area.**

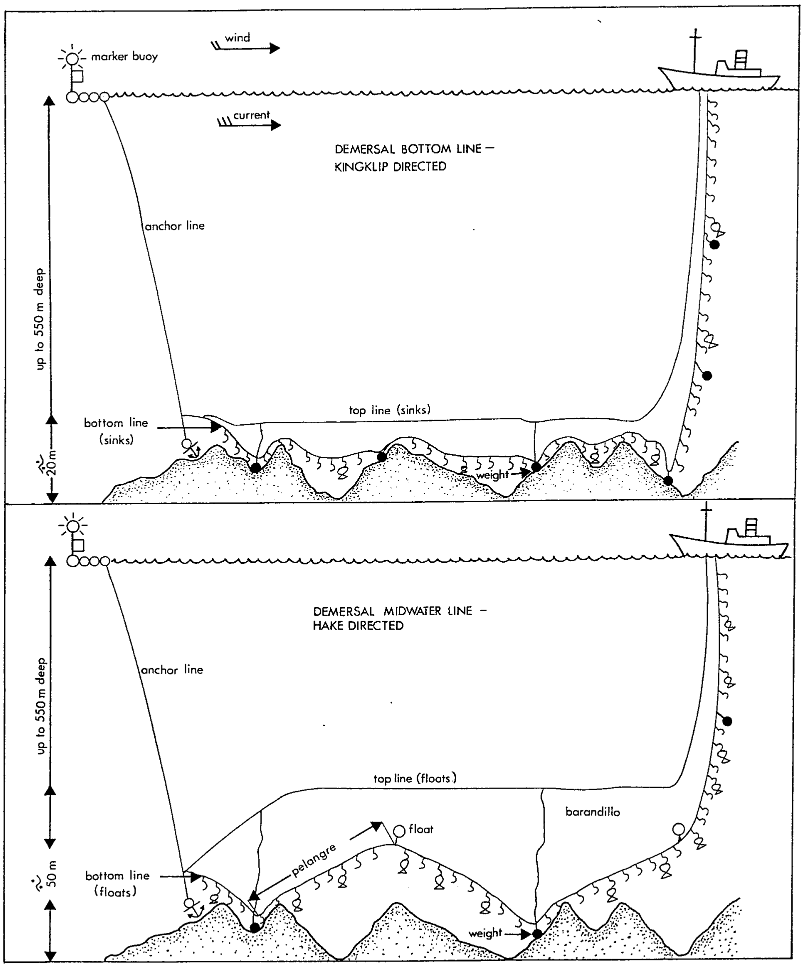

Figure 4.20: Typical configuration of demersal (bottom-set) hake long-line gear used in South African waters.

(d) Large pelagic long-line

The large pelagic long-line fishery operates year-round, extensively within the South African EEZ targeting primarily tuna and swordfish. Due to the highly migratory nature of these species, stocks straddle the EEZ of a number of countries and international waters. As such they are managed as a “shared resource” amongst various countries. There are currently 30 commercial large pelagic fishing rights issued for South African waters and there are 31 vessels active in the fishery.

The fishery operates extensively from the continental shelf break into deeper waters, year-round. Pelagic long-line vessels are primarily concentrated seawards of the 500 m depth contour where the continental slope is steepest (see Figure 4.21). During the period from 2000 to 2012, the national catch and effort recorded in the large pelagic longline fishery amounted to an average of 2 510 tons per year and 3.5 million hooks. Within a 20 nautical mile radius of the licence area, 33 sets amounting to 44 577 hooks were set per annum (1.3% of the total national effort). The corresponding catch within the area was 38.5 tons per annum (1.5% of the total catch landed nationally).

Pelagic long-line vessels set a drifting mainline, which are up to 100 km in length. The mainline is kept near the surface or at a certain depth (20 m below) by means of buoys connected via “buoy-lines”, which are spaced approximately 500 m apart along the length of the mainline (see Figure 4.22). Hooks are attached to the mainline via 20 m long trace lines, which are clipped to the mainline at intervals of approximately 50 m. There can be up to 3 500 hooks per line. A single main line consists of twisted rope (6 to 8 mm diameter) or a thick nylon monofilament (5 to 7.5 mm diameter). Various types of buoys are used in combinations to keep the mainline near the surface and locate it should the line be cut or break for any reason. Each end of the line is marked by a Dahn Buoy and Radar reflector, which marks it's position for later retrieval by the fishing vessel. A line may be left drifting for up to 18 hours before retrieval by means of a powered hauler at a speed of approximately 1 knot. During hauling a vessel's manoeuvrability is severely restricted and, in the event of an emergency, the line may be dropped to be hauled in at a later stage. The presence of long-lines would present a potential threat to the seismic survey operations in terms of entanglements with towed seismic gear. Extreme vigilance would be needed to avoid any drifting lines and regular communications with vessels in the area would be essential.

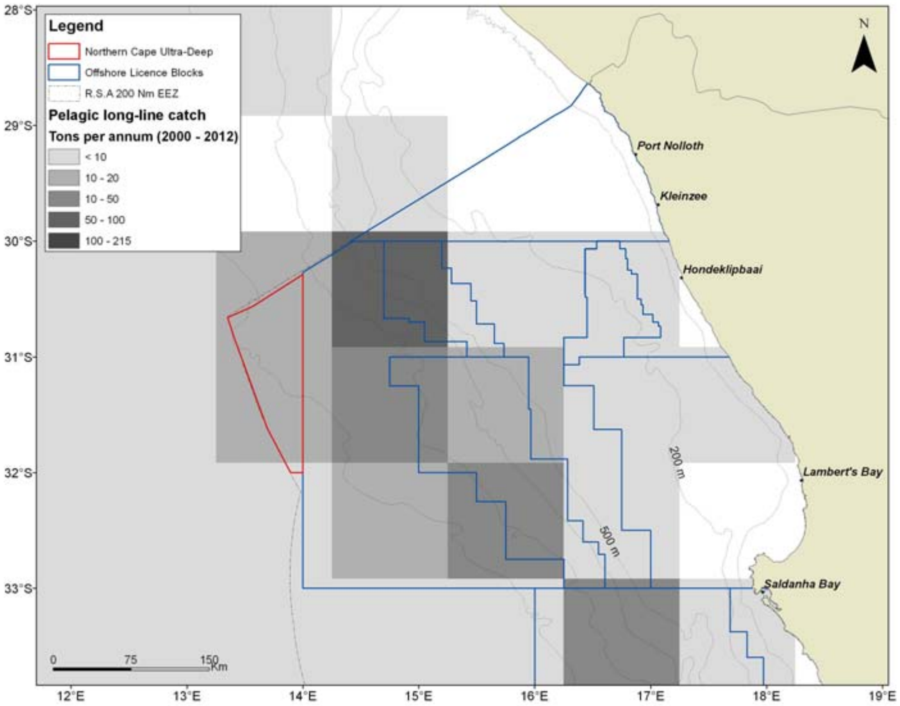

Figure 4.21: Spatial distribution of large pelagic species caught by the pelagic long-line sector from 2000 to 2012 in relation to the licence area.

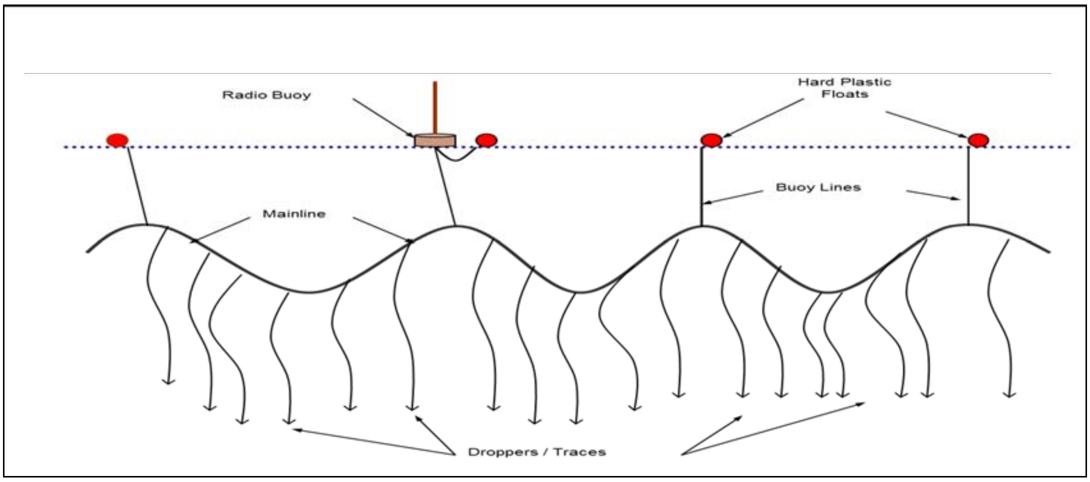

Figure 4.22: Typical pelagic long-line configuration targeting tuna, swordfish and shark species.

(e) Tuna pole

The tuna pole fishery is based on migratory species of tuna, predominantly Atlantic longfin tuna stock (*T. alalunga*) and a very small amount of skipjack tuna (*Katsumonus pelamis*), yellowfin tuna and bigeye tuna. The South African fleet consists of approximately 130 pole-and-line vessels, 119 of which are based at the ports of Cape Town and Hout Bay.

Fishing activity occurs along the entire West Coast beyond the 200 m bathymetric contour. The available records (provided by the International Commission for the Conservation of Atlantic Tunas – ICCAT) are reported for the whole EEZ and no detailed spatial catch and effort data is therefore available. The fishery is seasonal with vessel activity mostly between December and May and peak catches in February and March. The total recorded catch landed by the tuna pole sector was 4 221.4 tons per annum over the period 2008 to 2012. The tuna pole fishing grounds do not overlap with the licence area, with the closest fishing area located at Tripp Seamount, 40 nautical miles northeast in Namibian waters (see Figure 4.23).

Vessels drift whilst attracting and catching shoals of pelagic tunas. Sonars and echo sounders are used to locate schools of tuna. Once a school is located, water is sprayed outwards from high-pressure nozzles to simulate small baitfish aggregating near the water surface. Live bait is then used to entice the tuna to the surface (chumming). Tuna swimming near the surface are caught with hand-held fishing poles. The ends of the 2 to 3 m poles are fitted with a short length of fishing line leading to a hook. In order to land heavier fish, lines may be strung from the ends of the poles to overhead blocks to increase lifting power. Vessels are relatively small (less than 25 m in length) and store catch on ice, thus staying at sea for short periods (approximately five days).

The nature of the fishery and communication between vessels often results in a large number of vessels operating in close proximity to each other at a time. The vessels fish predominantly during daylight hours and are highly manoeuvrable. However, at night in fair weather conditions the fleet of vessels may drift or deploy drogues to remain within an area and would be less responsive during these periods.

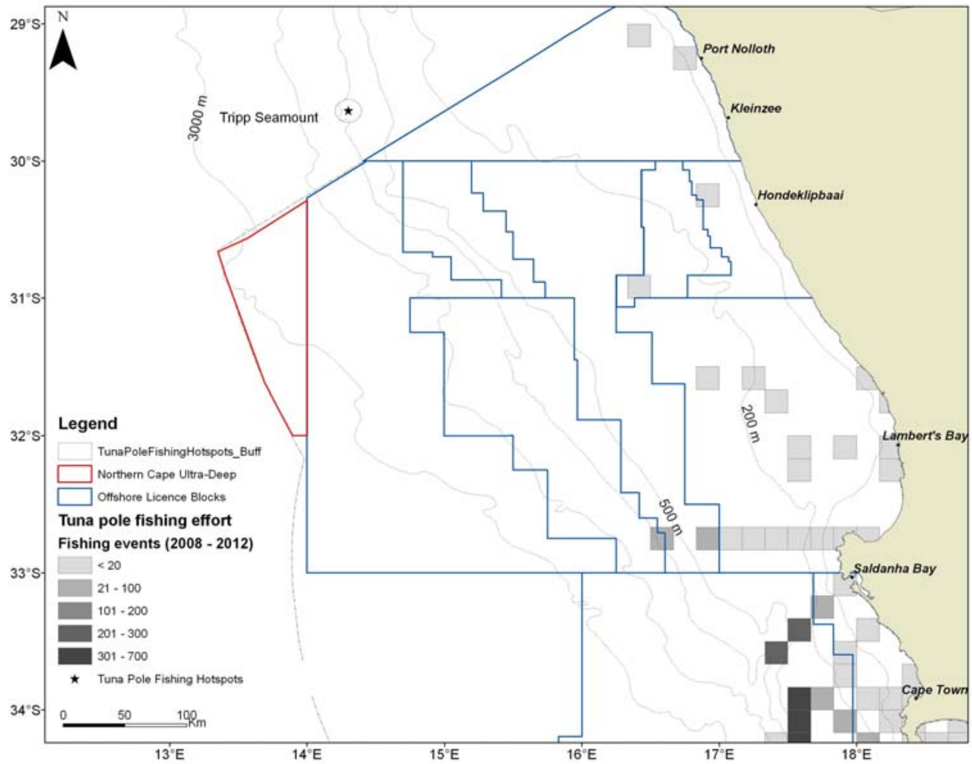

Figure 4.23: Spatial distribution of tuna pole fishing effort (2008 – 2012) in relation to the licence area.

(f) Traditional line fish

This fishery includes commercial, subsistence and recreational sectors. The South African commercial line fishery is the country's third most important fishery in terms of total tons landed and economic value. The bulk of the fishery catch is made up of approximately 35 species. Different assemblages of species are targeted according to the region in which they are being fished and include tuna species, sparidae, serranidae, caragidae, scombridae and sciaenidae. In South Africa effort is managed geographically with the spatial effort of the fishery divided into three zones. The majority of the catch (up to 95%) is landed by the Cape commercial fishery, which operates on the continental shelf up to a maximum depth of 200 m from the Namibian border on the West Coast to the Kei River in the Eastern Cape. Fishing vessels range up to a maximum of 20 nm (35 km) offshore, although fishing at the outer limit of this range would be sporadic. Up to 3 000 boats are involved in the fishery on the national level, 450 of which are involved in the commercial fishery. There have been no records of fishing effort by the traditional linefish sector in the vicinity of the proposed Exploration Right area.

Line fishing techniques consist of hook and line deployments (up to 10 hooks per line) and differ from the pelagic long-line fishing technique in that the use of set long-lines is not permitted.

(g) West Coast rock lobster

The West Coast rock lobster (*J. lalandii*) occurs inside the 200 m depth contour along the West Coast from Namibia to East London on the East Coast of South Africa.

In South Africa the fishery is divided into the offshore fishery and the near-shore fishery, both directed inshore of the 100 m bathymetric contour. The offshore sector operates in a water depth range of 30 m to 100 m whilst the inshore fishery is restricted by the type of gear used to waters shallower than 30 m in depth. The offshore sector makes use of traps consisting of rectangular metal frames covered by netting, which are deployed from trap boats, whilst the inshore fishery makes use of hoop nets deployed from small dinghy's. Traps are set at dusk and retrieved during the early morning. Vessels using traps will leave up to 30 traps per vessel in the fishing grounds overnight during the week. Fishing grounds are divided into Zones stretching from the Orange River mouth to east of Cape Hangklip in the South-Eastern Cape. Effort is seasonal with boats operating from the shore and coastal harbours. Catch is managed using a TAC, 80% and 20% of which is allocated to the offshore and inshore fisheries respectively. A total national landing of approximately 3 300 tons (whole weight) was recorded for 2011. In the last decade however, the TAC allocated to the Northern Cape has only been fully landed twice and there has been very little commercial effort recorded in this area for the last five seasons.

The proposed exploration area is located 150 nautical miles west of the rock lobster fishing grounds (see Figure 4.24).

4.1.4.2 Shipping transport

The majority of shipping traffic is located on the outer edge of the continental shelf with traffic inshore of the continental shelf along the West Coast largely comprising fishing and mining vessels, especially between Kleinsee and Oranjemund (Figure 4.25). Charted Traffic Separation Schemes, which are International Maritime Organisation (IMO) adapted, and other relevant information are listed in the South African Annual Notice to Mariners No 5.

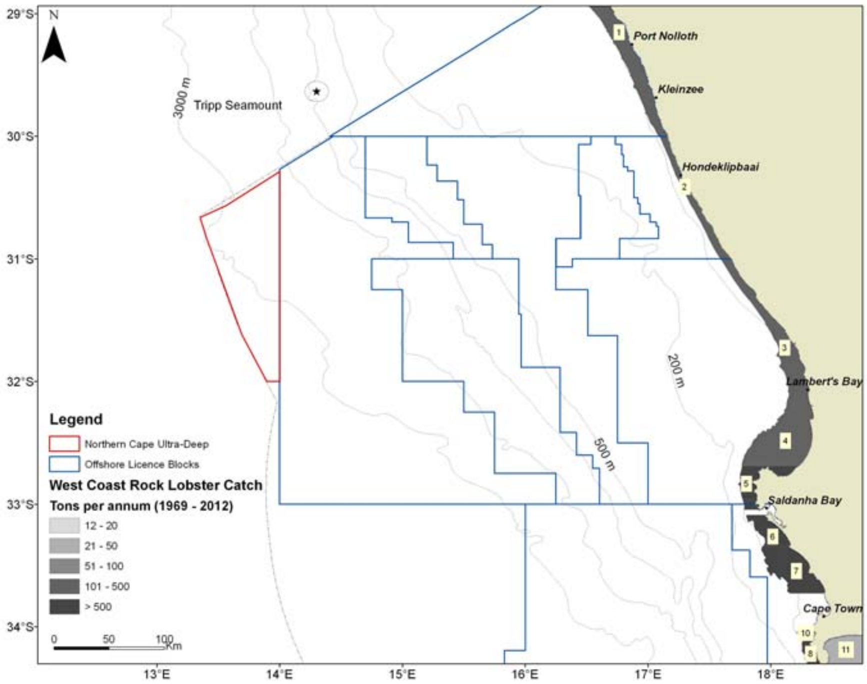

Figure 4.24: Spatial distribution of catches reported by the West Coast Rock Lobster sector ("bakkies") in relation to the licence area (1969 – 2012).

4.1.4.3 Oil and Gas exploration and production

Exploration for oil and gas is currently undertaken in a number of licence blocks off the West, South and East coasts of South Africa (see Figure 4.26). Cairn South Africa (Pty) Ltd conducted a seismic survey over Block 1 during February - March 2014. Spectrum ASA is proposing to undertake a further seismic survey in Block 1 during the second quarter of 2014 which would also cover a portion of the Northern Cape Ultra-deep Licence Area.

There is no current development or production from the South African West Coast offshore. The Ibhubesi Gas Field (Block 2A) and Kudu Gas Field (off the coast of southern Namibia) have been identified for development.

4.1.4.4 Diamond prospecting and mining

Marine diamonds are mined along the West Coast from just south of Lamberts Bay to the Orange River mouth. Twenty diamond mining concessions have been established along the West Coast with each concession divided into four zones from the coat seaward (a, b, c & d) (see Figure 4.27). The majority of concessions worked at present are those closer inshore. The Northern Cape Ultra-deep Licence Area does not overlap with any diamond mining concession areas.

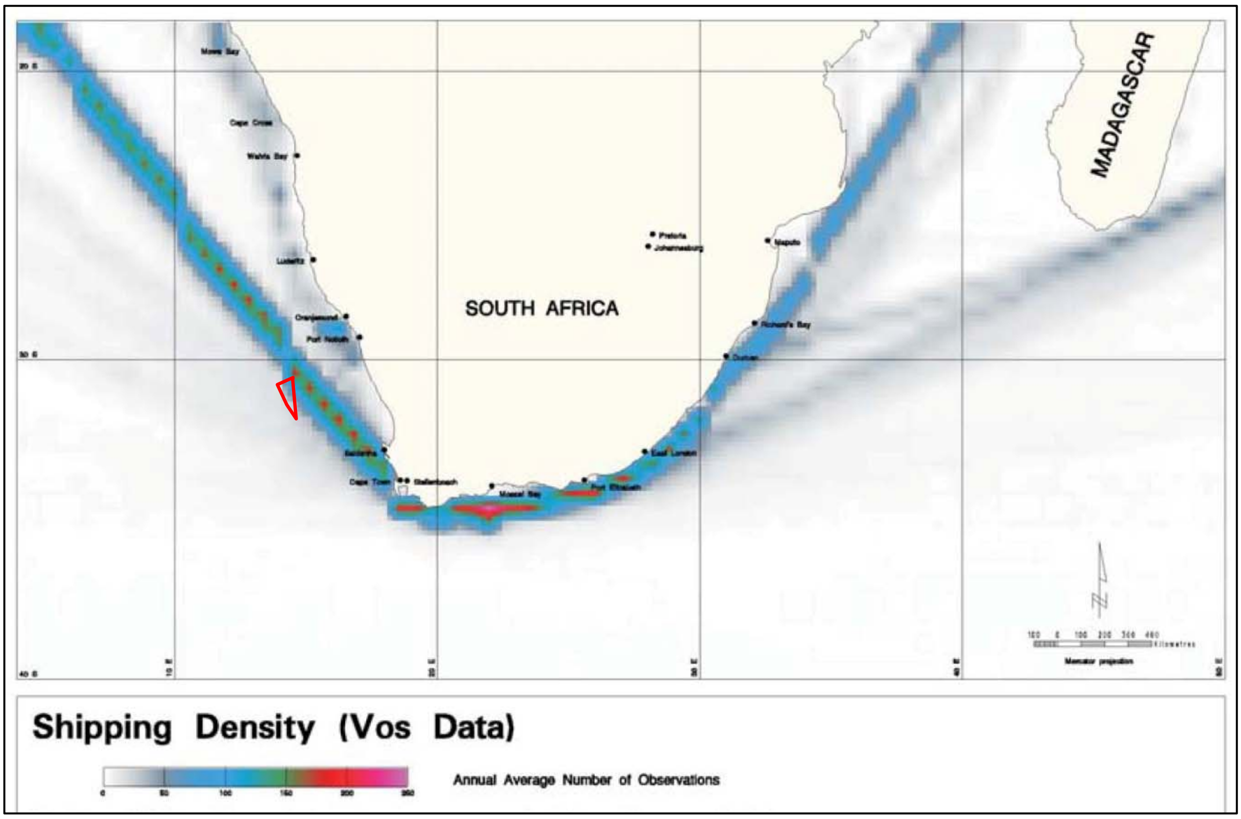

Figure 4.25: Major shipping routes around southern Africa. The approximate location of the Northern Cape Ultra-deep Licence Area is also shown. Data from the South African Data Centre for Oceanography (image source: CSIR).

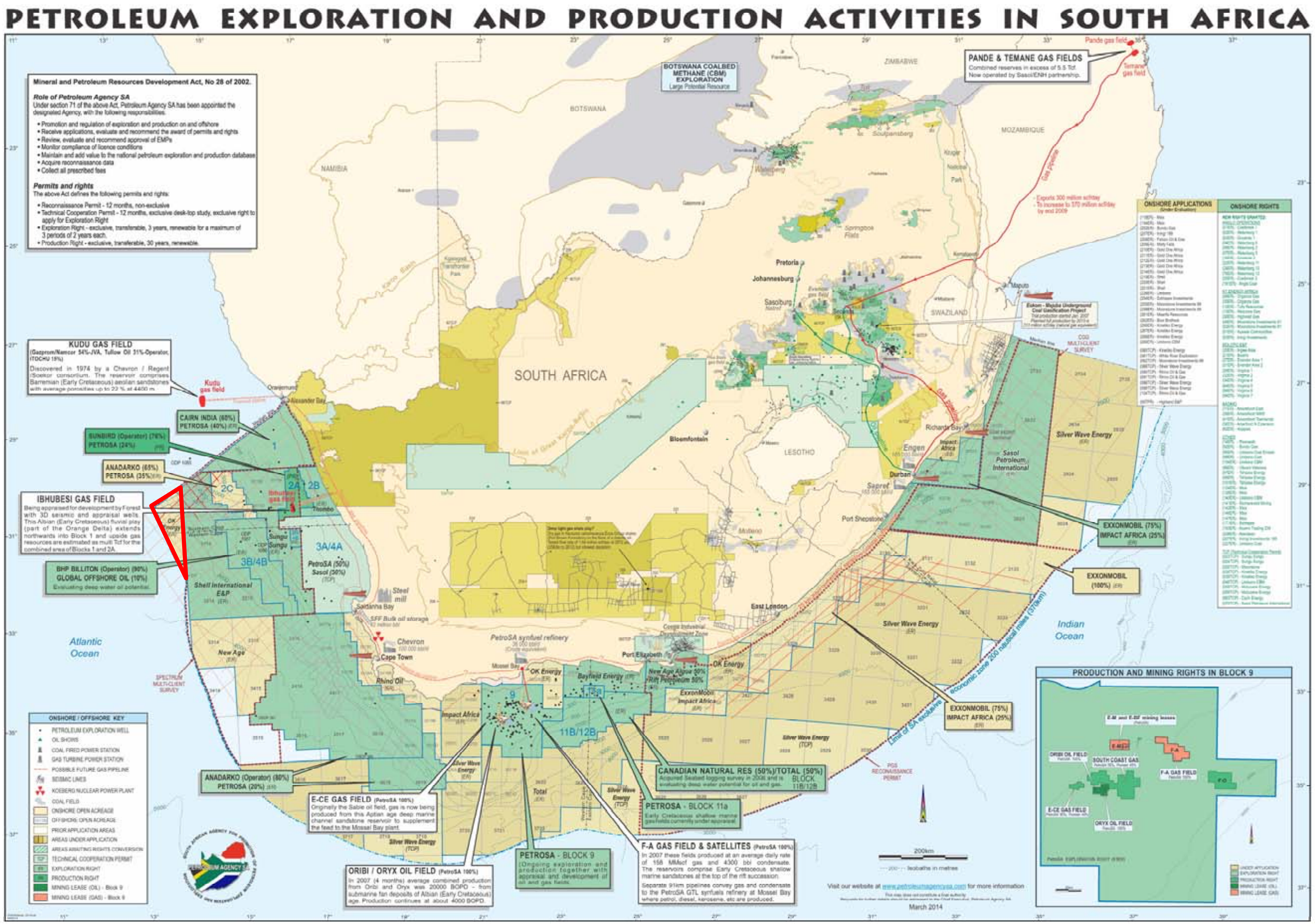

Figure 4.26: Petroleum licence blocks off the West, South and East coasts of South Africa (after PASA, 2014). The Northern Cape Ultra-deep Licence Area is highlighted in red.

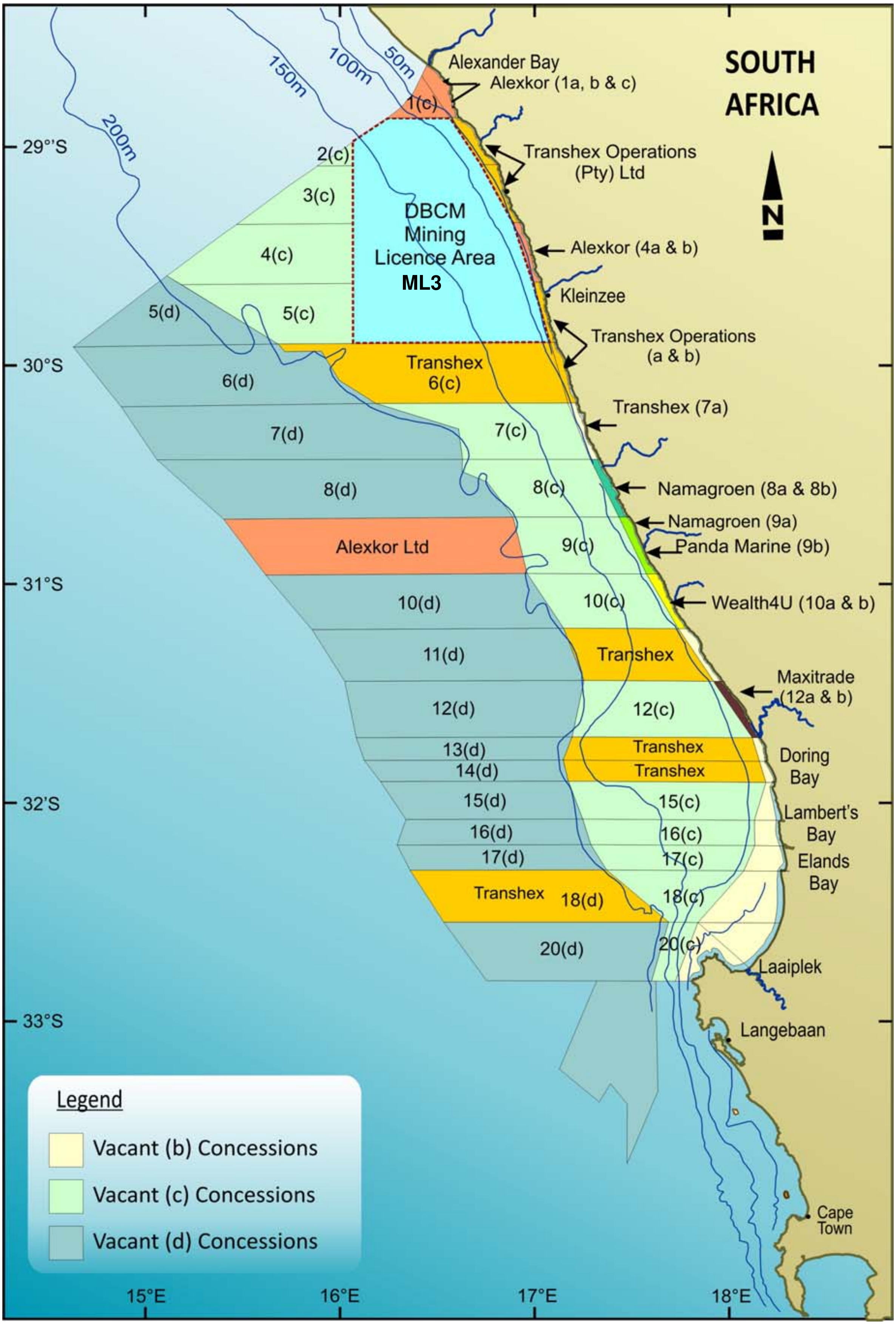

Figure 4.27: South African Diamond Rights Holders off the West Coast (compiled by De Beers, 2011). The far offshore location of the licence area places it outside of the map extent.

4.1.4.5 Prospecting and mining of other minerals

(a) Heavy minerals

Heavy mineral sands containing, amongst other minerals, zircon, ilmenite, garnet and rutile may be found offshore of the West Coast. Exxaro's Namakwa Sands is currently exploiting heavy minerals from onshore deposits near Brand-se-Baai (approximately 385 km north of Cape Town). In October 2009, De Beers secured a Prospecting Right for platinum group metals, gold and sapphires in the DMBC licence area (see Figure 4.28). Between December 2008 and March 2011, AuruMar (Pty) Ltd, a joint venture entity created by De Beers Group Exploration Holdings Limited and AngloGold Ashanti Marine Exploration Limited, secured Prospecting Rights (including heavy minerals, platinum group metals, gold and sapphire) for sea areas: 1c, inshore portions of 2c, 3c, 4c and 5c, as well as 6c, 7c, 8c, 9c, 10c, 12c, 14c, 15c, 16c, 17c, 18c and 20c (see Figure 4.28). None of the Prospecting Right areas overlap with the Northern Cape Ultra-deep Licence Area.

(b) Glauconite and phosphate

Glauconite pellets (an iron and magnesium rich clay mineral) and bedded and peletal phosphorite occur on the seafloor over large areas of the continental shelf on the West Coast. These represent potentially commercial resources that could be considered for mining as a source of agricultural phosphate and potassium (Birch 1979a & b; Dingle *et al.* 1987; Rogers and Bremner 1991).

A number of prospecting areas for glauconite and phosphorite / phosphate are located off the West Coast (see Figure 4.29). None of these overlap with the licence area.

(c) Manganese nodules in ultra-deep water

Rogers (1995) and Rogers and Bremner (1991) report that manganese nodules enriched in valuable metals occur in deep water areas (>3 000 m) off the West Coast (see Figure 4.30). The nickel, copper and cobalt contents of the nodules fall below the current mining economic cut-off grade of 2% over most of the area, but the possibility exists for mineral grade nodules in the areas north of 33°S in the Cape Basin and off northern Namaqualand. None of these areas overlap with the licence area.

4.1.4.6 Other

(a) Anthropogenic marine hazards

Human use of the marine environment has resulted in the addition of numerous hazards on the seafloor. The Annual Summary of South African Notices to Mariners No. 5 and charts from the South African Navy or Hydrographic Office provide detailed information on the location of different underwater hazards along the West Coast.

(b) Undersea cables

There is a submarine telecommunications cable system across the Atlantic and the Indian Ocean (see Figure 4.31). This system is called "SAT3/WASC/SAFE" (South Atlantic Telecommunications cable no.3 / West African Submarine Cable / South Africa Far East). The cable system is divided into two sub-systems, SAT3/WASC in the Atlantic Ocean and SAFE in the Indian Ocean. The SAT3/WASC sub-system connects

Portugal (Sesimbra) with South Africa (Melkbosstrand). From Melkbosstrand the SAT-3/WASC sub-system is extended via the SAFE sub-system to Malaysia (Penang) and has intermediate landing points at Mtunzini South Africa, Saint Paul Reunion, Bale Jacot Mauritius and Cochin India (www.safe-sat3.co.za).

There is also a high bandwidth fibre optic cable system, Eastern Africa Submarine Cable System (EASSy), which connects countries of eastern Africa to the rest of the world (see Figure 4.31). EASSy runs from Mtunzini in South Africa to Port Sudan in Sudan, with landing points in nine countries, and connected to at least ten landlocked countries.

In addition to the new 14 000 km long West Africa Cable System (WACS), which links South Africa to London, and the 17 000 km long Africa Coast to Europe (ACE) cable system to link Africa to France, three new cable systems to link South America and Africa (SAex, WASACE and BRICS) are also being proposed for 2014 (see Figure 4.31).

Three of the undersea cable systems pass through the Northern Cape Ultra-deep Licence Area (see Figure 4.32). There is an exclusion zone applicable to the telecommunication cables one nautical mile each side of the cable in which no anchoring is permitted.

(c) Marine archaeological sites

Over 2 000 shipwrecks are present along the South African coastline. The majority of known wrecks along the West Coast are located in relatively shallow water close inshore (within the 100 m isobath). Wrecks older than 50 years old have National Monument status. All known shipwrecks off the coast of South Africa occur in waters shallower than 100 m within 50 km of the coast.

(d) Ammunition dump sites

Ammunition and explosive dumpsites off the South-West Coast are presented on SAN Chart 56. Such sites are well to the south of the licence area.

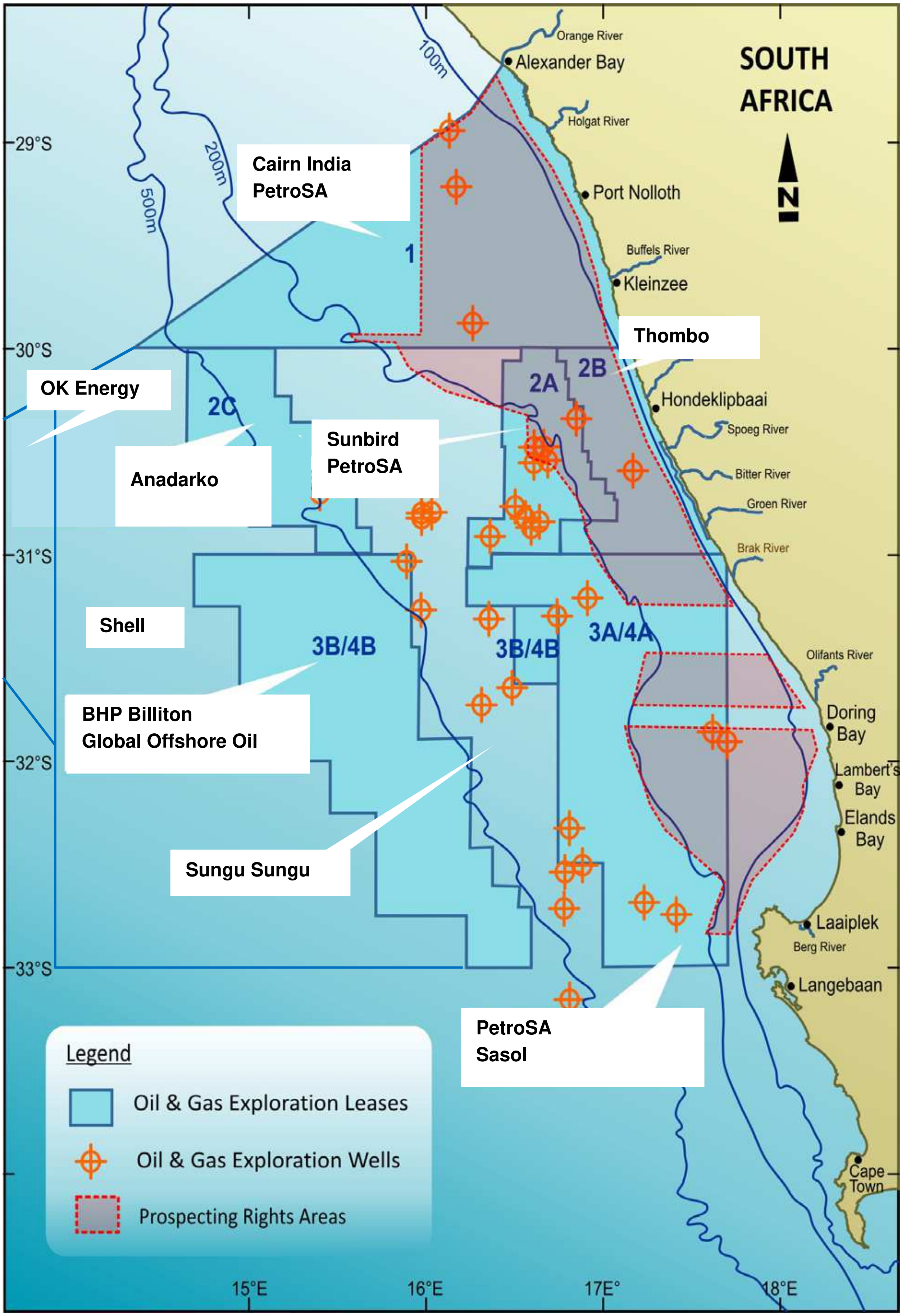

Figure 4.28: AuruMar's prospecting rights area in relation to Petroleum Licence Blocks off the West Coast of South Africa (adapted from De Beers, 2012).

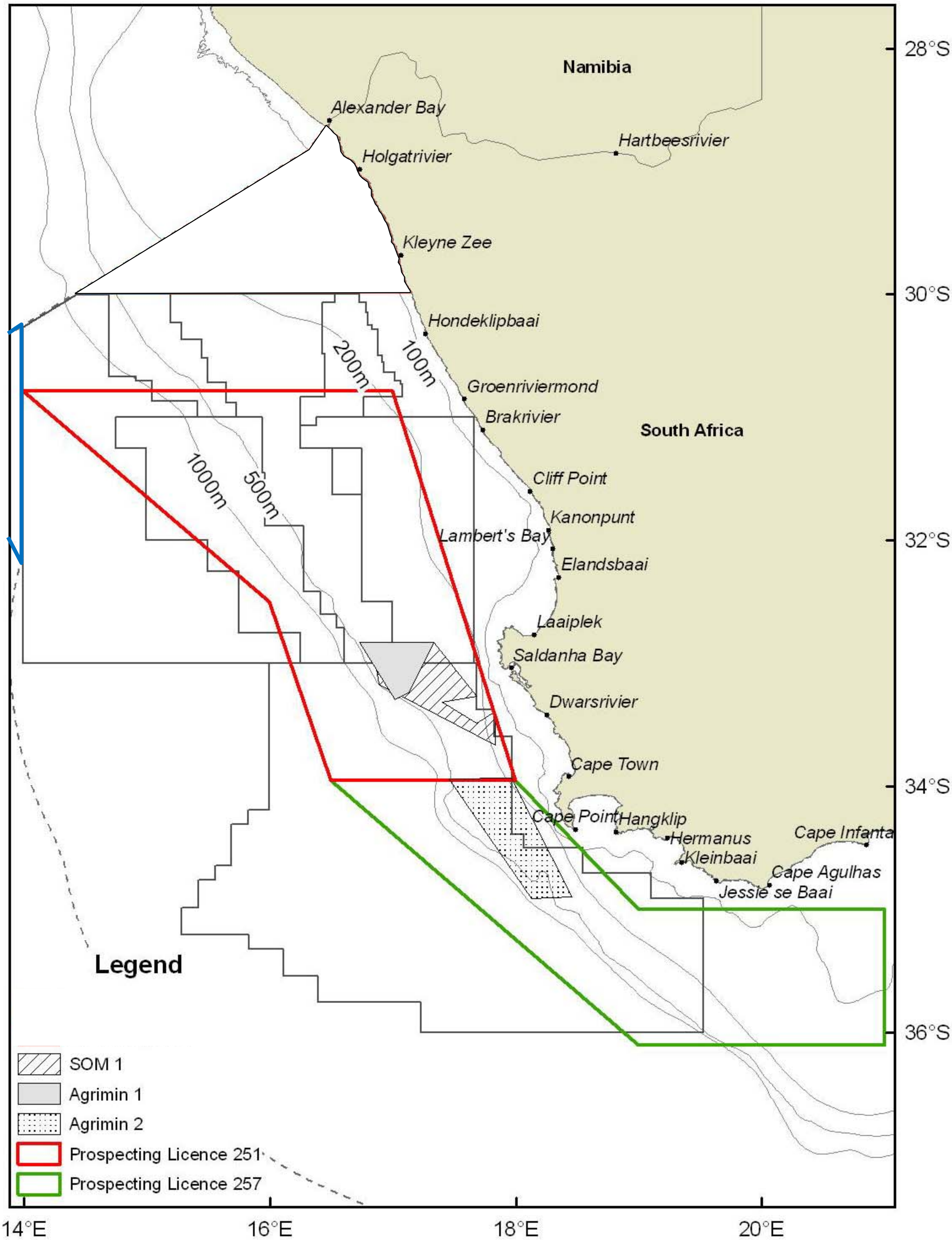

Figure 4.29: Location of glauconite and phosphorite / phosphate prospecting areas in relation to the licence area (eastern extent shown in blue).

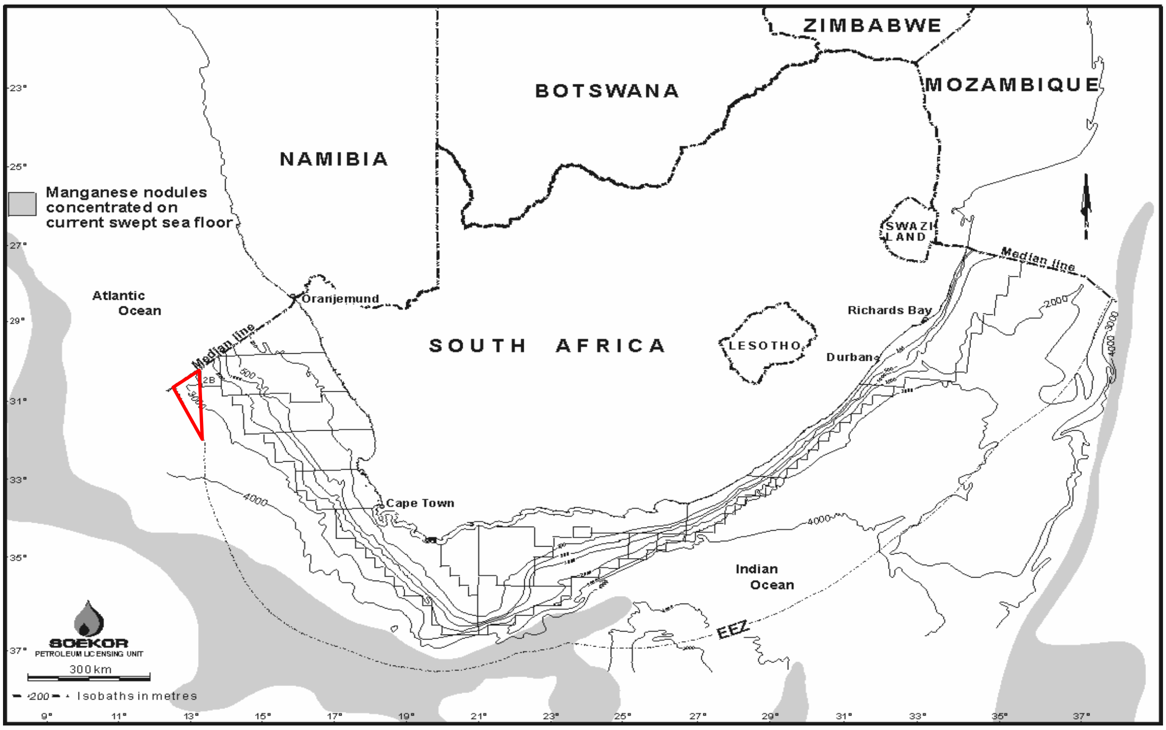

Figure 4.30: **Schematic of location of manganese nodules off Southern Africa in relation to the licence area (red) (Modified from Rogers 1995).**

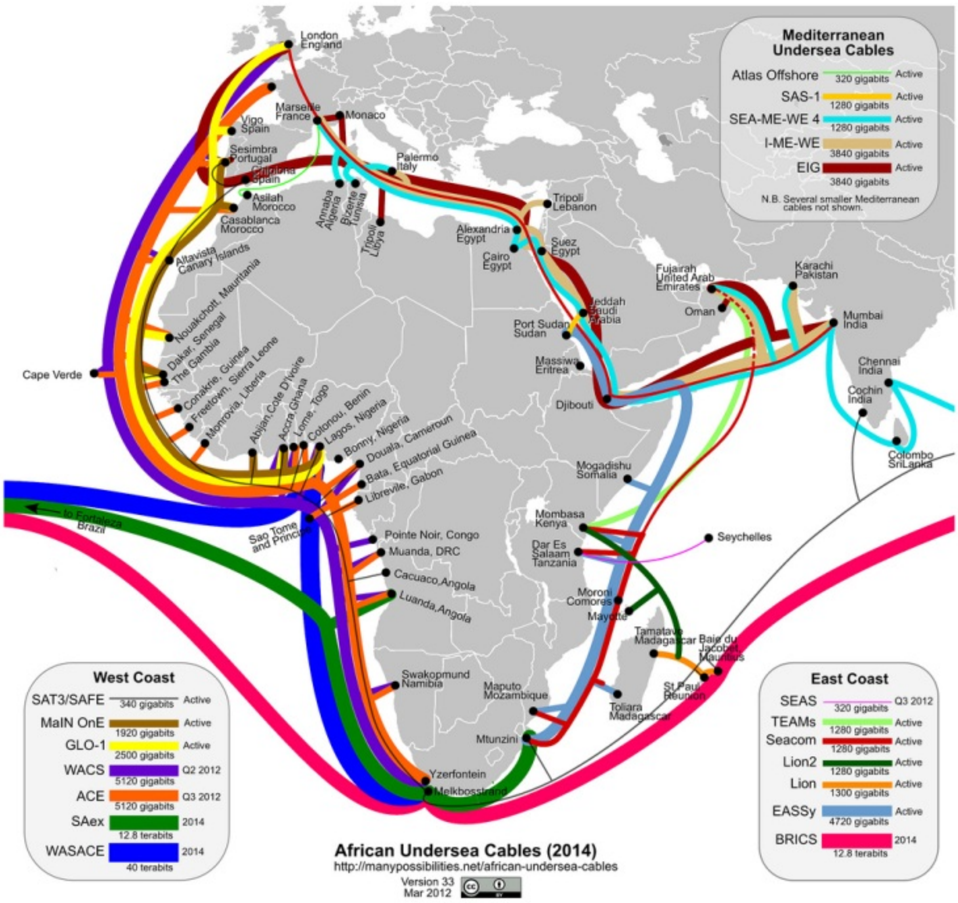

Figure 4.31: **Configuration of the current African undersea cable systems as well as cables proposed for 2013 and 2014 (From http://www.manypossibilities.net).**

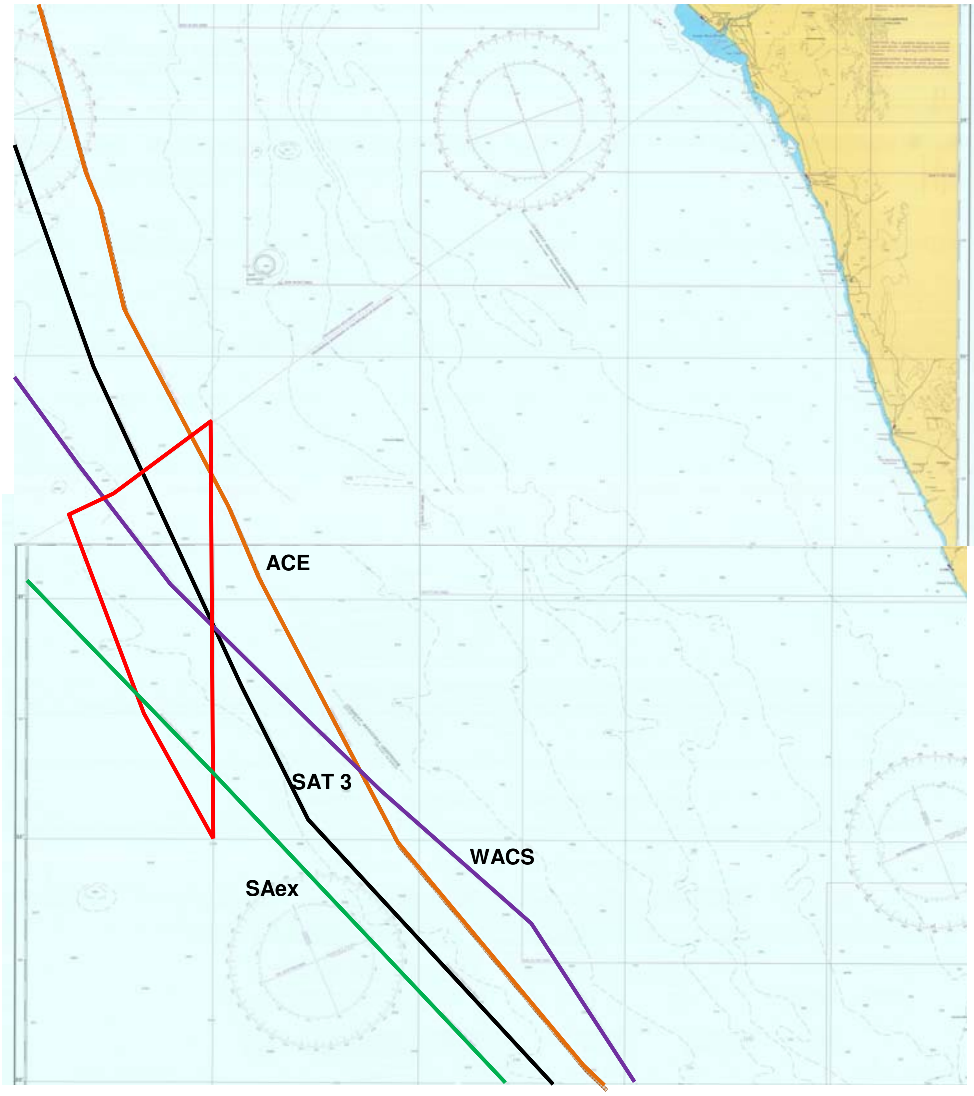

Figure 4.32: Location of undersea cables in relation to the licence area (red outline) (after SAN Hydrographer, Charts SAN54 and SAN55).

(e) Conservation areas

A number of reserves and MPAs are located along the West Coast (Figure 4.33). The only reserve in close proximity to the proposed survey area is a small rock lobster sanctuary off the coast of McDougall's Bay. The proposed Namaqualand Marine Protected Area (MPA), which is located between the Groen and Spoeg rivers and extends to the edge of the EEZ lies to the south of the proposed survey area. The proposed Namaqualand MPA was opposed due to a lack of consultation with oil/gas and mining industry.

Through systematic biodiversity planning to identify a potential offshore Marine Protected Areas network, Sink, *et al*. (2012) identified a number of priority areas off the South African coastline for the protection of benthic and pelagic habitats (see Figure 4.34). The licence area does not overlap with any of the proposed protection areas.

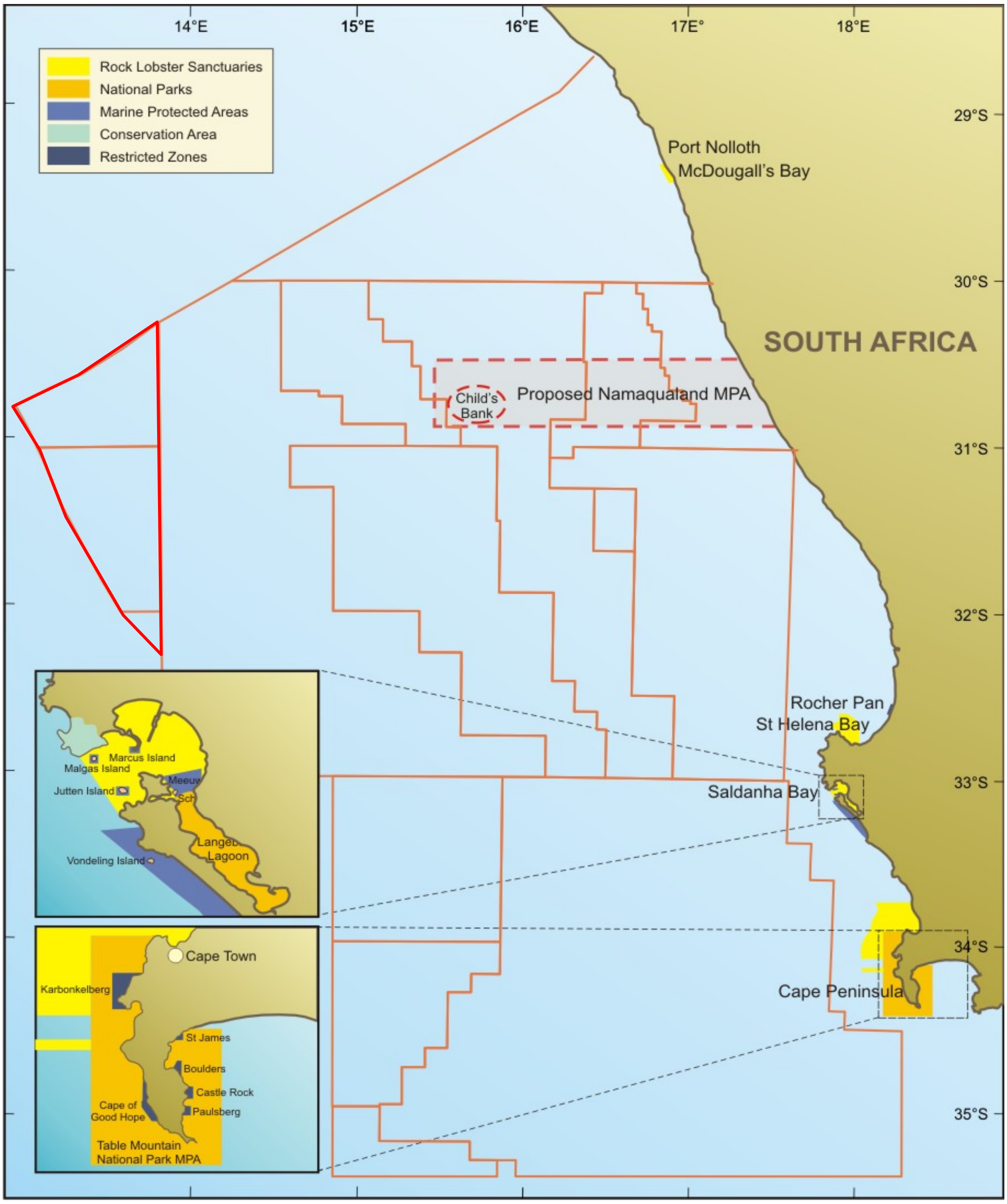

Figure 4.33: Reserves and Marine Protected Areas on the West Coast in relation to the licence area.

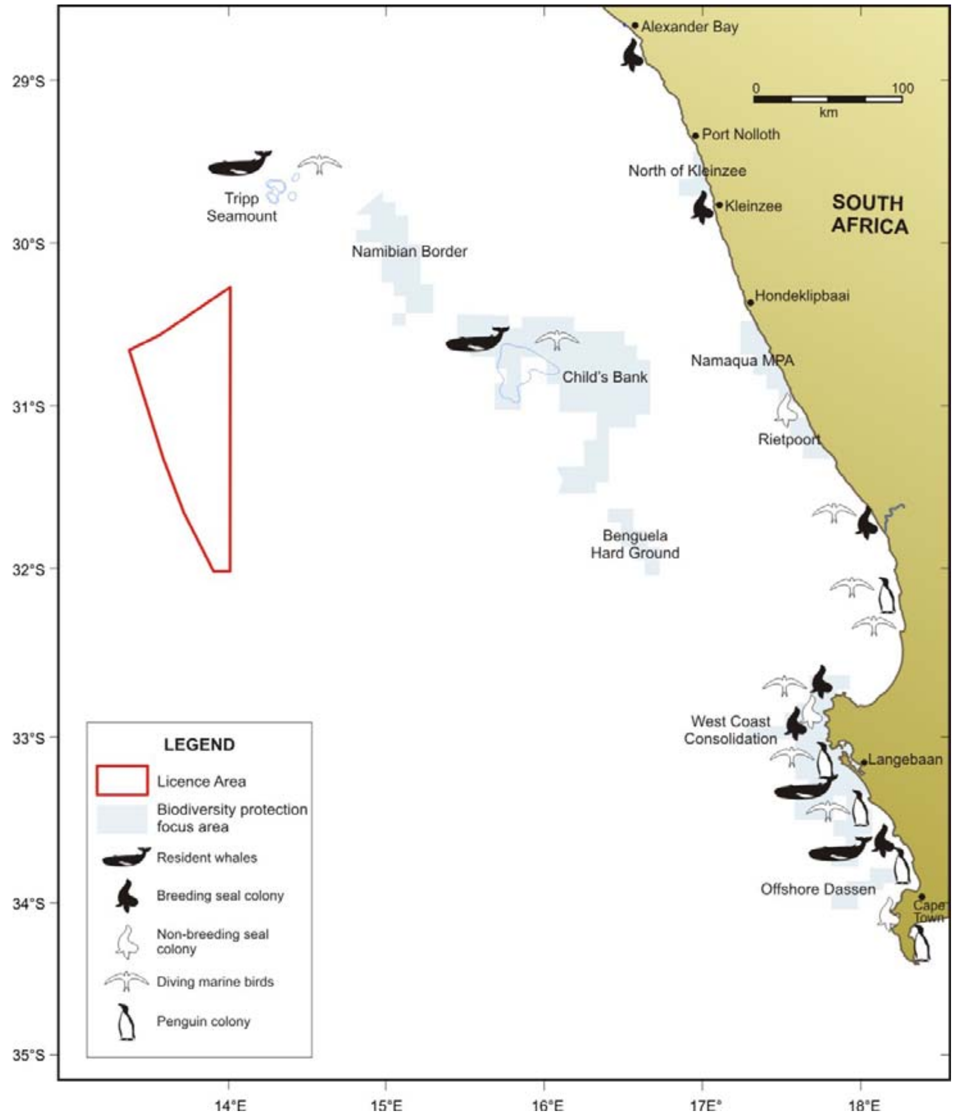

Figure 4.34: Potential priority areas for seabed protection (shaded in blue) in relation to the licence area (as identified by Majiedt *et al.* (2013).

4.2 NEARSHORE REGION AND SHORELINE

4.2.1 INTRODUCTION

The National Biodiversity Spatial Assessment (NBSA) (Lombard and Strauss, 2004) study analysed available data on rocky shores, mixed shores, sandy beaches, pebble beaches and boulder beaches and identified areas of high value / irreplaceability (see Figure 4.35). There is an area mapped as Totally Irreplaceable Habitat along the shoreline area of the proposed survey area in the vicinity of McDougall's Bay.

Two coastal habitat types that dominate the Namaqua bioregion are rocky shores (approximately 53% of the coastline) and sandy shores (about 37%). Mixed shores make up a further 9%. Pebble or boulder beaches are very rare in the Namaqua bioregion, making up less than 1% of the coastline (Lombard & Strauss 2004).

4.2.2 OCEANOGRAPHY

This section briefly describes the oceanography of the coastal region of the West Coast of South Africa, which comprises rocky shores, sandy shores and kelp beds.

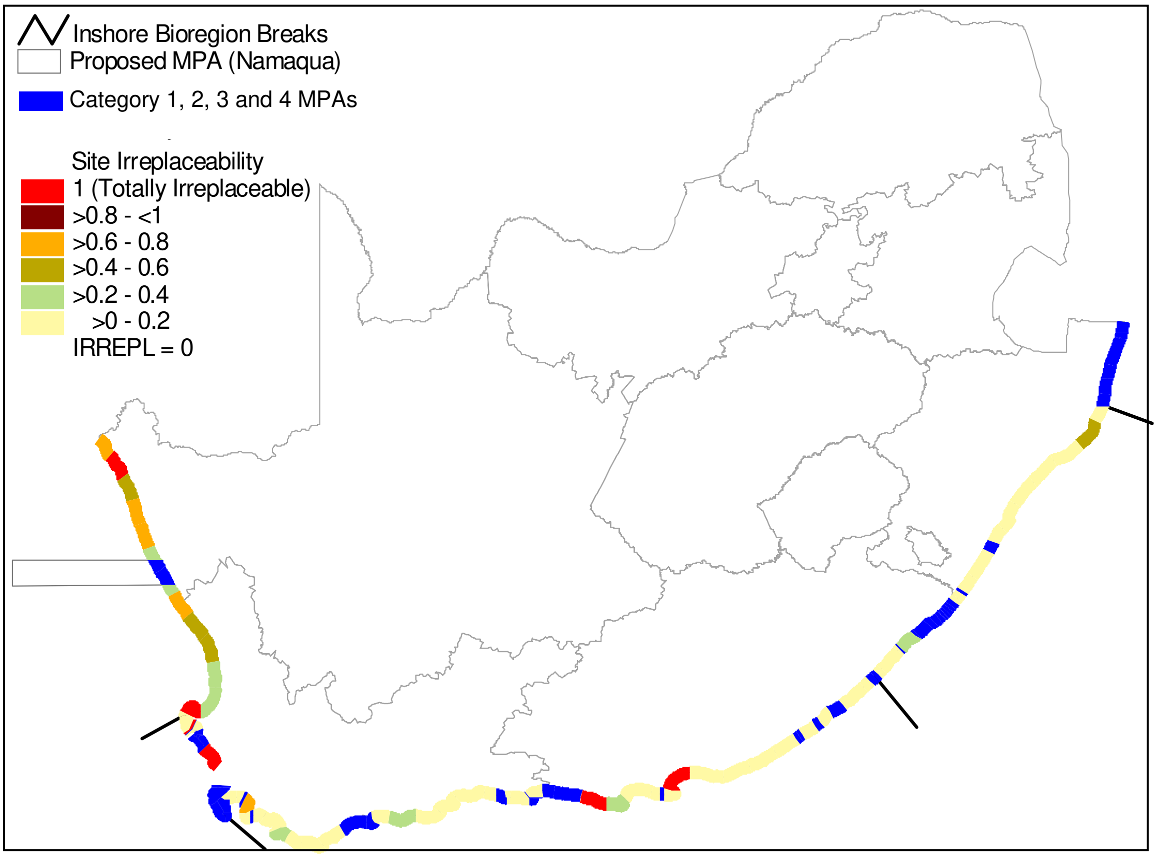

Figure 4.35: Irreplaceability analyses for intertidal habitats, in 50 km strips around South Africa, per bioregion (Lombard and Strauss, 2004).

4.2.2.1 Rocky shores

Approximately 54% of the West Coast (west of Cape Agulhas) is rocky shore. Over 80% of this rocky shore comprises exposed rocky headlands, the balance being wave cut platforms (Jackson and Lipschitz 1984). The biota of the rocky shores of the study area is classified as cool temperate and forms one of the four main biogeographic provinces of southern Africa. Rocky shore faunal diversity is low although biomass may be high (Branch and Griffiths 1988), while floral diversity and biomass are high (Bolton 1986).

The fauna of rocky shores of the West Coast show distinct up/down-shore zonation into five zones including:

1. The *littorina zone* (also known as the supralittoral or splash zone) extends from the highest reaches of spring high tide to the normal high tide level. This area is dry much of the time, but is sprayed with salt water during high tides. It is only flooded during storms and extremely high tides. It is so named because of the dominance of small periwinkles of the genus *Littorina*. On the west coast the dominant periwinkle is *Littorina africana*. The red algae *Porphyra capensis* is the only notable floral representative of this zone.
2. The *upper balanoid zone* (also known as the upper-eulittoral, high tide or high intertidal zone) is flooded only during high tides. This zone is usually dominated by large numbers of barnacles. However, although barnacles such as *Tetraclita serrata* and *Chthamalus dentatus* are present in the Namaqualand bioregion, the limpet *Patella granularis* (and to some extent *P. granatina*) is by far the most common

animal species. The green alga called “sea lettuce” (*Ulva* spp.) is the most common floral representative found in this zone.

3. The *lower balanoid zone* (also known as the mid-eulittoral zone) is flooded twice a day. It is the first zone in which algae is well represented (Branch & Griffiths 1988). The red algae *Gigartina radula, Gigartina stiriata, Aeodes orbitosa* and *Champia lumbricalis* as well as the brown alga *Splachnidium rugosum* occur in this zone, whilst the limpet *P. granatina* is the most common faunal species. The tubeworm *Gunnarea capensis* may form distinctive colonies in this zone along the southern parts of the Namaqua bioregion.
4. The *cochlear / argenvillei zone* (also known as the lower-eulittoral zone) is covered and uncovered twice a day with salt water from the tides. Along the Namaqualand coast, the zone is dominated by very dense aggregations of the limpet *P. cochlear* in the south and *P. argenvillei* in the north. Depending on the local conditions, the black mussel, *Choromytilus meridionalis* is also present, and can completely displace the limpets along rocky shores exposed to strong wave action. The Mediterranean mussel (*Mytilus galloprovincialis*) appears to be displacing the black mussel along the Namaqualand coast, in turn. The definitive flora in this zone is coralline encrusting algae.
5. The *intertidal zone* can be divided into the sublittoral fringe, infratidal zone and sublittoral zone. In the study area the region stretching from the low tide level to, and including, the kelp beds is considered to be the sublittoral zone. Along the central Namaqualand coast this zone is dominated by the Mediterranean mussels, rock lobsters, sea urchins and various red algae.

A number of predatory species are associated with the fauna found along the rocky shores of the central parts of the Namaqualand coast. These include the whelks such as *Natica tecta*, *Nucella cinulata* and *N. dubia*; the starfish (*Marthasterias glacialis)*; tidal pool fish such as the klipvis (*Clinus superciliosus)*; the common octopus (*Octopus vulgaris)* and seabirds, primarily the African oyster catcher (*Haemaptopus moquini)*. The African oyster catcher is listed in the South African Red Data Book as "Near-threatened". Scavengers such as the shore crab (*Cyclograpsus puncatus)* and the kelp gull (*Larus dominicanus)* are also common along these shores.

4.2.2.2 Sandy shores

Approximately 46% of the West Coast comprises sandy beaches. Apart from the larger bays such as St Helena Bay, the sandy shores within the study area are exposed to strong wave action.

There has been little work on sandy beach ecology between Walvis Bay and St Helena Bay (Branch and Griffiths 1988). The invertebrate fauna is cool temperate and relatively consistent throughout the region (Field and Griffiths 1988). Sandy beaches have no stable substrate for plant attachment and consequently have little or no primary production. Major nutrient input into Benguela beaches arise from beach cast kelp wrack and upwelling-related coastal phytoplankton in the nearshore region. Macrofaunal species are generally primary or secondary consumers and can be divided into four major trophic groups, including air breathing scavengers, aquatic particle feeders, aquatic scavengers and predators.

The South African sandy beach up/down-shore environment can be divided into a number of zones (Brown and MacLachlan 1990) (Figure 4.36) including:

1. The *supralittoral zone* runs from the foredunes to the high water drift line. The sand remains mostly dry. The dominant force disturbing the substrate in this zone is the wind. The zone is populated by insects and air-breathing crustaceans.
2. The *littoral or intertidal zone* extends from the high tide drift line down to the low tide mark. This zone is flushed periodically by the changing tide, and the sand is generally damp. The dominant force in this zone comes from the swash. No macro-flora grows in this zone, especially on an exposed beach. Near the drift line, air-breathing crustaceans such as the pill bug isopod (*Tylos granulatus)* or the beach hopper amphipod (*Talorchestia capensis)* are common, as well as some oligochaete worms,

usually found under rotting beach cast seaweed. Further down the beach, isopods such as the right-angle beach louse (*Eurydice longicornis)* and the wide-foot beach louse (*Pontogeloides laticeps)* typify the mid-shore region. Also common to this region of the zone are polychaete worms such as *Scolelepis squamata.* While the white sand mussel (*Donex serra)* occurs in certain instances, it apparently is not found in the Port Nolloth region. In the lower reaches of the intertidal zone, including the sublittoral fringe, the common organisms are the surf mysid shrimp (*Gastrosaccus psammodytes*) and a ubiquitous gastropod scavenger, the finger ploughshell (*Bullia digitalis)*.

3. The *surf zone* starts below the low water level. In the surf zone the sand substrate is always saturated, and experiences strong wave action and currents. The sand bed is generally in a state of mobility in this zone. The macro-fauna found in this zone are much the same as that which occurs in the sublittoral fringe, with some species of amphipods present. Micro-flora in the form of diatoms can be an important component in this zone, migrating between the water column during the day and the sandy substrate at night. High densities of these diatoms can result in semi-stable formations of foam in the inner surf zone.
4. The *transition zone* occurs between the turbulence of the surf zone and the more stable outer turbulent zone. This is the region across which the wave break line will range, depending on the prevailing weather conditions.
5. The *outer turbulent zone* is typified by a return to stability after the turbulence of the surf zone. The currents are weak compared to the surf zone, and although the effects of wave surge are apparent, the sandy substrate is stable enough to be colonised by macro-fauna including amphipods and other small crustaceans, tube-building polychaetes such as *Nephys* spp., delicate cnidarians and anemones such as *Anthopleura michaelseni.*

The three-spot swimming crab (*Ovalipes trimaculatus)* is probably the only resident predator on the sandy shores along the West Coast. The rest of the organisms that predate on the intertidal macro-fauna originate from outside of the sandy beaches. Birds are the most important predators when the shores are exposed during low tides; fish are most important when the shores are submerged during high tides. On exposed beaches the migratory sanderlings (*Calidris alba)* and white-fronted plovers (*Charadrius marginatus)* are the most common bird species, but African black oystercatchers (*Haematopus moquini)*, kelp gulls (*Larus dominicanus)*, Hartlaubs gulls (*Larus hartlaubii)*, turnstones (*Arenaria interpres)* and curlew sandpipers also visit the sandy shores of the West Coast. The galjoen (*Dichristius capensis)* and white steenbras (*Lithognathus lithognathus)* are representatives of the predatory teleost fishes in the region, as is the blue stingray (*Dasyatis chrysonota)* for elasmobranch fishes. There have also been reports of the west coast sole (*Austroglossus microlepis)* occurring in the sheltered embayment during periods of warmer water temperatures.

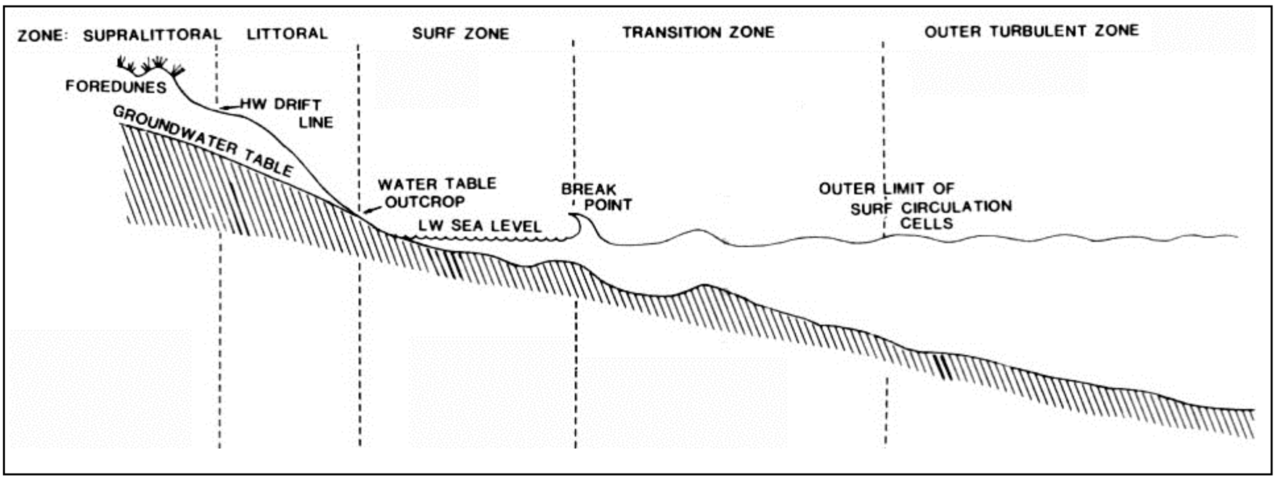

Figure 4.36: Generalised scheme of zonation on sandy shores (Modified from Brown & MacLachlan 1990).

4.2.2.3 Kelp beds

Kelp beds along the West coast of South Africa are characterised by four species, *Ecklonia maxima* reaching up to 12 m in length, *Laminaria pallida* and *Laminaria schintzei* reaching 5 m in length and the smaller species *Macrocystis angustifolia*. These kelp beds occur in shallow waters and extend from the shore to as much as 3 km offshore. Because of the clearer waters around Cape Point, kelp extends out to the 30 m depth contour (Branch 1981).

The shallow kelp beds are colonised by relatively few faunal species, with diversity increasing on their deeper, seaward fringes (Branch and Griffiths, 1988). The faunal species include grazers such as the sea urchin (*Parechinus angulosus)*, limpet (*Patella compressa)*, kelp louse (*Paridotea reticulate)* and amphipods; and filter feeders including mussels, sponges, ascidians and barnacles. Carnivorous species are also represented, including anemones, whelks, starfish, fish and crustaceans (including the most important predator in the ecosystem, the West Coast rock lobster).

4.2.3 ANTHROPOGENIC ACTIVITIES

4.2.3.1 Mariculture industries

The following mariculture facilities can be found along the West Coast of South Africa (O'Sullivan 1998; after MCM - http://www.mcm-deat.gov.za/):

- Alexkor Diamond Mines has an oyster (*Crassostrea gigax*) growout system in the seawater reservoirs employed by diamond processing plants south of Alexander Bay, while a similar facility for oysters, perlemoen and the red seaweed *Gracilaria gracilis* can be found at Kleinsee.
- A permit has been granted for perlemoen (*Haliotis midae*) ranching within a 100 km long 0 to 20 m deep zone north and south of Port Nolloth. Oysters are also grown at Port Nolloth.
- Oysters and perlemoen are grown in Kleinsee.
- A perlemoen aquaculture operation at Hondeklip Bay.
- Abalone, oysters and finfish are grown in Jacobs Bay.
- Abalone, mussels, seaweed, oysters, clams and scallops are grown in Paternoster.
- Oysters and seaweed are grown in St Helena Bay.
- Mussels and oysters are grown within Saldanha Bay.

4.2.3.2 Recreational utilisation

Coastal recreation along the West Coast may be either consumptive or non-consumptive.

Consumptive recreational uses involve people collecting material from the sea for their own use. Recreational anglers (Brouwer, Mann, Lamberth, Sauer and Erasmus 1997) and divers (Mann, Scott, Mann-Lang, Brouwer, Lamberth, Sauer and Erasmus 1997) target linefish from either a boat or the shore, while shore-based divers also target perlemoen and West Coast rock lobsters. Rock lobsters are also exploited recreationally from boats with the use of hoop nets. The majority of recreational exploitation of marine resources occurs from inshore waters, and is not substantial compared to activities along the South and East Coasts.

Non-consumptive recreational uses of the marine environment include watersports, nature watching and beach recreation. Recreational practices are mostly undertaken near coastal settlements, and are largely practised for their aesthetic value. Recreational sites are listed by Jackson and Lipshitz (1984).

Although few resource economic studies exist for South African marine recreational use, the value of recreational coastal use and tourism should not be underestimated.

4.2.3.3 Marine outfall/intake pipes

Thirty-four outfalls, of which the majority are sewerage outfalls, and 17 intakes are located along the West Coast of South Africa. An important pipeline intake/outfall is the Koeberg Nuclear Power Station; a thermal outfall, discharging warmed cooling water into the cooler coastal waters rather than a chemical effluent. A two nautical mile marine exclusion zone exists offshore of the nuclear power station.

4.2.3.4 Marine Protected Areas

A number of MPAs are located along the West Coast (see Table 4.8). The proposed exploration area is, however, located well offshore of any proclaimed MPAs (see Figure 4.32).

Table 4.8: List of marine conservation areas along the West Coast of South Africa.

Bioregion	Marine Protected Area	Protection	Location
Namaqualand	McDougall's Bay Rock Lobster Sanctuary: 2.5 km of coastline, 3 km south of Port Nolloth	No rock lobsters may be caught.	29°14' S 16°52' E
	Robeiland / Kleinzee Seal Colony Robeiland: 15 km north of Kleinzee	Island reserve for seabirds and seals, no access	29°33' S 16°59' E
	Elephant Rocks (Olifant's River Mouth)	Island reserve for seabirds and seals, no access	31°38' S 18°07' E
	Penguin / Bird Island (Lambert's Bay)	Island reserve for seabirds and seals, no access	32°05' S 18°18' E
	Rocherpan Marine Reserve: Adjacent to the Rocherpan Nature Reserve extending 500 m seaward, 2.75 km of coastline (in process of being registered as a declared reserve)	Exploitation limited to shore-based angling.	32°35'-37' S 18°07' E
	St Helena Bay Rock Lobster Sanctuary From Shelly Bay Point to Stompneus Point, extending three nautical miles seaward of the high-water mark; From Stompneus Point to SHBE/DR beacon, extending six nautical miles seaward of the high-water mark	No rock lobster may be caught	32°43' S 18°00'-07' E

5. ENVIRONMENTAL IMPACT ASSESSMENT

This chapter describes and assesses the significance of potential impacts associated with the proposed exploration programme in the Northern Cape Ultra-deep Licence Area off the West Coast of South Africa. The assessment is based, to a large extent, on a generic description of the proposed exploration activities and the specialist studies undertaken as part of this EMP process.

5.1 INTRODUCTION

The potential impacts of the proposed activities are addressed in three categories, namely:

1. Impacts of normal vessel (including helicopter) operations;
2. Impacts of seismic noise on marine fauna;
3. Impacts of multi-beam bathymetry survey on marine fauna;
4. Impacts of seabed sampling programme on marine fauna; and
5. Impacts of exploration activities on other users of the sea.

All impacts are systematically assessed and presented according to predefined rating scales (see Appendix 2). For each potential impact a table is provided that summarises the significance level assessment for that impact. Mitigation or optimisation measures are proposed which could ameliorate the negative impacts or enhance potential benefits, respectively. The status of all impacts should be considered to be negative unless otherwise indicated. The significance of impacts with and without mitigation is also assessed.

Unless otherwise indicated, all potential impacts discussed below would only be for the duration of the exploration programme, i.e. short term (up to one month per exploration activity), due to the transient nature of survey activities.

5.2 IMPACT OF NORMAL SURVEY / SUPPORT VESSELS AND HELICOPTER OPERATION

5.2.1 EMISSIONS TO THE ATMOSPHERE

Description of impact

Emissions to the atmosphere during the surveys may include exhaust gases from the use of diesel as fuel for generators and motors, and the burning of wastes.

Diesel exhaust gas comprises mainly carbon dioxide (CO_2) as well as several toxic gases such as nitrogen oxides (NO_X), sulphur oxides (SO_X) and carbon monoxide (CO). In addition, diesel combustion can produce hydrocarbons (Total Hydrocarbons and Volatile Organic Compounds). Smoke and particulate matter (soot) are also produced during diesel combustion.

Incineration of waste on board would also release soot as well as CO, CO_2 and dioxins (depending on the composition of waste). However, many vessels do not have an incinerator on board. In these circumstances solid waste would be stored separately on board for later onshore disposal.

Assessment

The atmospheric emissions from the seismic and support vessels are expected to be similar to those from similar diesel-powered vessels of comparable tonnage (approximately 3 000 tonnes), with the addition of the emissions from the airgun compressors. The volumes of solid waste incinerated on board, and hence also the volumes of atmospheric emissions, would be minimal and incineration would comply with the relevant MARPOL 73/78[1] standards.

The potential impact of emissions to the atmosphere during exploration operations would be limited to the survey area, of low intensity and is considered to be of **VERY LOW** significance with or without the implementation of mitigation measures (see Table 5.1).

Mitigation

No mitigation is deemed necessary, but it is recommended that all diesel motors and generators receive adequate maintenance to minimise soot and un-burnt diesel released to the atmosphere.

Table 5.1: Impact of atmospheric emissions from the survey and support vessels, and helicopter operation.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Low to Medium	Definite	**Very Low**	High
With mitigation	Local	Short-term	Low	Definite	**VERY LOW**	High

5.2.2 DISCHARGES/DISPOSAL TO THE SEA

Discharges from the survey and support vessels to the marine environment include deck drainage, machinery space drainage, sewage, galley wastes, solid wastes and accidental hydrocarbon spills.

5.2.2.1 Deck drainage

Description of impact

Drainage of deck areas may result in small volumes of oils, solvents or cleaners being introduced into the marine environment.

Assessment

Oils, solvents and cleaners could be introduced into the marine environment in very small volumes through spillage and drainage of deck areas. Due to the small volumes lost overboard, the potential impact of deck drainage on the marine environment would be of low intensity across the survey area over the short-term, and is considered to be of **VERY LOW** significance with or without mitigation (see Table 5.2).

Mitigation

The following measures are recommended for mitigation of deck drainage discharges from the seismic and support vessels:

- Deck drainage should be collected in oily water separator systems. Discharged water must meet MARPOL 73/78 standards;
- Low-toxicity biodegradable detergents should be used in cleaning of all deck spillage;
- Training and awareness of crew in spill management could minimise contamination; and
- All hydraulic systems should be adequately maintained and hydraulic hoses should be frequently inspected.

[1] MARPOL 73/78 is an International Convention for the Prevention of Pollution from Ships 1973, as modified by the Protocol of 1978 relating thereto. All vessels operating within the South African EEZ are required to conform to legal requirements for waste management and pollution control, including the Marine Pollution Act (No. 2 of 1986 – which incorporate MARPOL 73/78 standards) and the Dumping at Sea Control Act (No. 73 of 1965). These Acts make provision for the discharge of sewage, plastics, oil, galley wastes, hazardous liquids and packaged hazardous material.

Table 5.2: Impact of deck drainage from the survey and support vessels.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Low	Highly Probable	**Very Low**	High
With mitigation	Local	Short-term	Low	Highly Probable	**VERY LOW**	High

5.2.2.2 Machinery space drainage

Description of impact

Small volumes of oil such as diesel fuel, lubricants, grease, etc. used within the machinery space of survey and support vessels could enter the marine environment.

Assessment

All operations would comply fully with international agreed standards regulated under MARPOL 73/78. All machinery space drainage would pass through an oil/water filter to reduce the oil in water concentration to less than 15 ppm, in accordance with Regulation 21 of MARPOL (Annex 1). If no such equipment is available oily water would be retained on board and disposed of at an appropriate facility at port.

Concentrations of oil reaching the marine environment through drainage of machinery spaces are, therefore, expected to be low. Based on the distance offshore, the potential impact of such low concentrations would be of low intensity and limited to the survey area over the short-term. The potential impact of machinery space drainage on the marine environment is therefore considered to be of **VERY LOW** significance with or without mitigation (see Table 5.3).

Mitigation

Mitigation is as for deck drainage (see Section 5.2.2.1).

Table 5.3: Impact of machinery space drainage from the survey and support vessels.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Low	Highly Probable	**Very Low**	High
With mitigation	Local	Short-term	Low	Highly Probable	**VERY LOW**	High

5.2.2.3 Sewage

Description of impact

Sewage poses an organic and bacterial loading on the natural degradation processes of the sea, resulting in an increased biological oxygen demand (BOD). This could result in anaerobic conditions in the marine environment. Although treated sewage would also increase BOD, it does not pose a bacterial load.

Assessment

The proposed exploration activities are expected to take up to one month per activity to complete, depending on, amongst other things, weather conditions. The volumes of sewage wastes released from the survey and support vessels would be small and comparable to volumes produced by vessels of similar crew compliment (up to 50 people). All sewage would be treated to the required MARPOL 73/78 standard prior to release into the marine environment, where the high wind and wave energy is expected to result in rapid dispersal. Discharges of sewage, according to MARPOL 73/78 standards, would be comminuted and disinfected prior to disposal to the marine environment if between 4 nm (± 7.5 km) and 12 nm (± 22 km) from the coast, and no disposal would occur within 4 nm of the coast. Disposal beyond 12 nm requires no treatment. Sewage would not be discharged instantaneously but at a moderate rate when the vessel is *en route* and travelling at no less than 4 knots.

The potential impact of sewage effluent from the survey and support vessels on the marine environment is expected to be limited to the survey area over the short-term, and is therefore considered to be of **VERY LOW** significance with or without mitigation (see Table 5.4).

Mitigation
Ensure compliance with the MARPOL 73/78 standards.

Table 5.4: Impact of sewage effluent discharge from the survey and support vessels.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Low	Highly Probable	**Very Low**	High
With mitigation	Local	Short-term	Low	Highly Probable	**VERY LOW**	High

5.2.2.4 Galley waste

Description of impact
Galley wastes, comprising mostly of biodegradable food waste, would place a small organic and bacterial loading on the marine environment.

Assessment
The volume of galley waste from a survey and support vessel would be small and comparable to wastes from any vessel of a similar crew compliment (up to 50 people). Discharges of galley wastes, according to MARPOL 73/78 standards, would be comminuted to particle sizes smaller than 25 mm prior to disposal to the marine environment if less than 12 nm (± 22 km) from the coast and with no disposal within 3 nm (± 5.5 km) of the coast. The potential impact of galley waste disposal on the marine environment would be of low intensity and limited to the survey area over the short-term. The potential impact of galley waste on the marine environment is therefore considered to be of **VERY LOW** significance with or without mitigation (see Table 5.5).

Mitigation
Ensure compliance with the MARPOL 73/78 standards.

Table 5.5: Impact of galley waste disposal from the survey and support vessels.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Low	Highly Probable	**Very Low**	High
With mitigation	Local	Short-term	Low	Highly Probable	**VERY LOW**	High

5.2.2.5 Solid waste

Description of impact

The disposal of solid waste comprising non-biodegradable domestic waste, packaging and operational industrial waste into the sea could pose a hazard to marine fauna, may contain contaminant chemicals and could end up as visual pollution at sea, on the seashore or on the seabed.

Assessment

Solid waste would be incinerated on-board or transported ashore for disposal on land, and consequently would have no impact on the marine environment. However, a spill may result in a small amount of waste entering the marine environment (e.g. blown by wind, spill during transfer to support vessel, etc.). Hazardous waste would be disposed of by specialist waste disposal contractors. The potential impact of the disposal of solid waste on the marine environment is therefore **INSIGNIFICANT** (see Table 5.6).

Mitigation

The following measures are recommended for the mitigation of waste:

- Initiate an on-board waste minimisation system;
- Ensure on-board solid waste storage is secure; and
- Co-operate with the relevant local authority to ensure solid and hazardous waste disposal is carried out in accordance with the appropriate laws and ordinances.

Table 5.6: Impact of solid waste disposal from the survey and support vessels.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short- term	Zero	Improbable	**Insignificant**	Medium
With mitigation	Local	Short- term	Zero	Improbable	**INSIGNIFICANT**	Medium

5.2.3 NOISE FROM VESSEL AND HELICOPTER OPERATIONS

5.2.3.1 Noise from survey and support vessel operations

Impact description

The noise from survey and support vessels could result in localised disturbance of marine fauna.

Assessment

Noise from survey and support vessels is likely to be no higher than that from other small shipping vessels in the region. The potential impact of noise from survey and support vessel operations on marine fauna is considered to be localised and of low intensity in the short-term. The significance of this impact is therefore assessed to be **VERY LOW** with and without mitigation (Table 5.7).

Mitigation measures

No measures are deemed necessary to mitigate noise impacts from survey and support vessel operations.

Table 5.7: Impact of noise from survey and support vessel operations.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Low	Probable	**Very Low**	Medium
With mitigation	Local	Short-term	Low	Probable	**VERY LOW**	Medium

5.2.3.2 Noise from helicopter operations

Impact description

Helicopters could be used for crew / supply transfers between the survey and support vessels and the mainland, which could result in localised disturbance of fauna.

Assessment

Low altitude flight paths over bird breeding colonies could result in temporary abandonment of nests and exposure of eggs and chicks leading to increased predation risk. There are 14 species of seabirds that breed in southern Africa, including Cape Gannet, African Penguin, four species of Cormorant, White Pelican, three Gull and four Tern species. Although breeding areas are distributed along the whole coast, islands are especially important, particularly those between Dyer Island and Lamberts Bay. Cape Gannets breed only on islands and Lamberts Bay and Malgas Island are important colonies. Cape cormorants breed mainly on offshore islands (Dyer, Jutten, Seal, Dassen, Bird (Lamberts Bay), Malgas and Vondeling Islands), although the large colonies may associate with estuaries, lagoons or sewerage works. The bank and crowned cormorants both breed between Namibia and just to the west of Cape Agulhas. Although white-breasted cormorants occur between northern Namibia and the Eastern Cape in southern Africa, the majority of the population is concentrated between Swakopmund and Cape Agulhas. African penguin colonies occur at 27 localities around the coast of South Africa and Namibia (see Figure 4.12).

In addition, low altitude flight paths over seal colonies can cause stampedes of animals to sea resulting in trampling of pups and nesting seabirds within seal colonies. There are two Cape fur seal breeding colonies within the study area: at Kleinzee (incorporating Robeiland; 300 km north-east of the licence area) and at Bucchu Twins near Alexander Bay (320 km north-east of the licence area; see Figure 4.13). Non-breeding colonies occur south of Hondeklip Bay at Strandfontein Point and on Bird Island at Lamberts Bay, with the McDougalls Bay islands and Wedge Point being haul-out sites only and not permanently occupied by seals.

In terms of the Marine Living Resources Act, 1998 (No 18 of 1998) it is illegal for any vessel, including aircraft, to approach to within 300 m of whales within South African waters. Disturbance of cetaceans by helicopter would depend on the distance and altitude of the aircraft from the animals (particularly the angle of incidence of helicopter noise to the water surface) and the prevailing sea conditions. It is an offence in terms of the Sea Birds and Seals Protection Act, 1973 (No. 46 of 1973) to wilfully disturb seals on the coast or on offshore islands.

Indiscriminate or direct flying over seabird or seal colonies (or flying low level parallel to the coast) and cetaceans could have a significant disturbance impact on breeding success or mortalities of juveniles. Although such impacts would be local in the area of the colony, they may have wider ramifications over the range of affected species and are deemed to range from low to high intensity. The significance of the potential impact is considered to range from **low to medium** significance (see Table 5.8), if helicopter flight paths cross any of these areas at an altitude of less than 500 m.

Mitigation

- All flight paths must be planned to avoid seal and seabird colonies, coastal reserves and marine islands;
- Extensive coastal flights (parallel to the coast within 1 nm of the shore) should be avoided;
- Aircrafts may not approach to within 300 m of whales without a permit in terms of the Marine Living Resources Act, 1998;
- The contractor must comply with the Seabirds and Seals Protection Act, 1973, which prohibits the wilful disturbance of seals on the coast or on offshore islands;
- The contractor should comply fully with aviation and authority guidelines and rules; and
- All pilots must be briefed on ecological risks associated with flying at a low level parallel to the coast.

If the suggested mitigation measures are implemented, this impact is expected to be **VERY LOW** (see Table 5.8).

Table 5.8: Impact of noise from helicopter operations.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Low to High	Probable	**Low to Medium**	Medium
With mitigation	Local	Short-term	Low	Improbable	**VERY LOW**	Medium

5.3 IMPACTS OF SEISMIC NOISE ON MARINE FAUNA

5.3.1 POTENTIAL IMPACTS ON PLANKTON SPECIES

Plankton, which are species that are unable to determine their direction of travel within the water column, comprise bacterioplankton (bacterial component of plankton), phytoplankton (floral plankton) and zooplankton (faunal plankton). Zooplankton includes meroplankton[1] (planktonic larval stages of fish and invertebrates and eggs) as well as holoplankton (species that spend their entire life-cycle as plankton).

Description of impact

Potential impacts of seismic pulses on plankton could include physiological injury and/or mortality. No behavioural avoidance of the seismic survey area by plankton or invertebrates would occur. Limited indirect impacts may arise from effects on predators or prey.

Assessment

Review of the literature suggests that mortality or injury to plankton would occur in the immediate vicinity of the airgun sound source within metres of the firing airgun sound sources. Impacts would thus be of high intensity at very close range (< 5 m from the airguns), but this would be no more significant than the effect of the wash from ships propellers and bow waves. As plankton distribution is naturally temporally and spatially variable and natural mortality rates are high, any impacts would thus be of low to negligible intensity across the proposed survey area and for the duration of the survey (short-term).

The intensity is further reduced as the proposed seismic survey area lies in the Orange River Cone (LUCORC) area, which is characterised by powerful upwelling, high turbulence and deep mixing in the water column. Areas of intense upwelling are characterised by diminished phytoplankton biomass, and a deficiency of phytoplankton results in poor feeding conditions for micro-, meso- and macrozooplankton and for

[1] Also termed “ichthyoplankton”.

ichthyoplankton. Thus, phytoplankton, zooplankton and ichthyoplankton abundances in the proposed seismic survey area are thus expected to be comparatively low.

The proposed exploration area is also located well offshore of the spring to early summer spawning areas for a number of commercially important species, including anchovy, pilchard, round herring and chub mackerel. There is also no overlap with the northward egg and larval drift for anchovy. Ichthyoplankton abundance are thus expected to be negligible.

The overall potential impact of seismic noise on plankton is consequently deemed to be of **VERY LOW** significance both with and without mitigation (see Table 5.9).

<u>Mitigation</u>
No measures to mitigate the impacts of seismic sounds on plankton are deemed necessary or practical.

Table 5.9: Impact of seismic noise on plankton.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Low	Probable	**Very Low**	Medium
With mitigation	Local	Short-term	Low	Probable	**VERY LOW**	Medium

5.3.2 POTENTIAL IMPACTS TO MARINE INVERTEBRATES

<u>Description of impact</u>
Most marine invertebrates do not possess hearing organs that perceive sound pressure, although many have mechanoreceptors or statocyst organs that are sensitive to hydroacoustic disturbances. Potential impacts of seismic pulses on invertebrates could include physiological injury and behavioural avoidance of seismic survey areas. Masking of environmental sounds and indirect impacts due to effects on predators or prey have not been documented and are highly unlikely.

<u>Assessment</u>
Physiological injury and mortality
Although there is little published information on the effects of seismic surveys on invertebrate fauna, lethal and sub-lethal effects have been observed under experimental conditions. It has been postulated that shellfish, crustaceans and most other invertebrates can only hear seismic survey sounds at very close range (< 15 m away). This implies that only surveys conducted in very shallow water would have any detrimental effects. As the proposed survey would be conducted in excess of 2 000 m water depth, the received noise at the seabed would be within the far-field range and outside of distances at which physiological injury of benthic invertebrates would be expected.

The potential impact of seismic noise on physiological injury or mortality of invertebrates is consequently deemed of low to negligible intensity across the proposed survey area and for the survey duration and is considered to be of **VERY LOW** significance both with and without mitigation (see Table 5.10).

Behavioural avoidance of seismic survey area
Similarly, there is little published information on the effects of seismic surveys on the response of invertebrate fauna to seismic impulses. Limited avoidance of airgun sounds may occur in mobile neritic and pelagic invertebrates and is deemed to be of low intensity. Of the marine invertebrates only cephalopods are receptive to the far-field sounds of seismic airgun arrays. Although consistent avoidance has not been reported, behavioural changes have been observed at 2 to 5 km from an approaching large seismic source.

The received noise at the seabed would be within the far-field range and outside of distances at which avoidance of benthic invertebrates would be expected, but potentially within the response range of cephalopods.

The potential impact of seismic noise on invertebrate behaviour is consequently deemed of low to negligible intensity across the survey areas and for the survey duration and is considered to be of **VERY LOW** significance both with and without mitigation (see Table 5.10).

Mitigation

No mitigation measures for potential impacts on marine invertebrates are feasible or deemed necessary.

Table 5.10: Impact of seismic noise on marine invertebrates

	Extent	Duration	Intensity	Probability	Significance	Confidence
Physiological injury						
Without mitigation	Local	Short-term	Low	Probable	**Very Low**	Medium
With mitigation	Local	Short-term	Low	Probable	**VERY LOW**	Medium
Behavioural avoidance						
Without mitigation	Local	Short-term	Low	Probable	**Very Low**	Medium
With mitigation	Local	Short-term	Low	Probable	**VERY LOW**	Medium

5.3.3 POTENTIAL IMPACTS ON FISH

The potential impact of seismic noise on fish larvae is discussed under Section 5.3.1 above and this section discusses the impact on adult fish only.

Description of impact

A review of the available literature suggests that potential impacts of seismic pulses to fish species (including sharks) could include physiological injury and mortality, behavioural avoidance of seismic survey areas, masking of environmental sounds and communication, and indirect impacts due to effects on predators or prey.

Assessment

Physiological injury and mortality

The greatest risk of physiological injury or mortality from seismic sound sources is for species that establish home ranges on shallow-water reefs or congregate in inshore waters to spawn or feed, and those displaying an instinctive alarm response to hide on the seabed or in the reef rather than flee. In addition, large demersal or reef-fish species with swim-bladders are also more susceptible than those without this organ. Such species may suffer pathological injury or severe hearing damage and adverse effects may intensify and last for a considerable time after the termination of the sound source. However, as the proposed survey would be located in water depths greater than 2 000 m, the received noise by demersal species at the seabed would be within the far-field range, and outside of distances at which physiological injury or avoidance would be expected.

The most likely fish species to be encountered in the proposed survey area would be the large pelagic species, such as the highly migratory tuna and billfish, which occur offshore of the 100 m isobath. These species show seasonal association with Child's Bank (approximately 200 km inshore of the proposed survey area) and Tripp Seamount (situated approximately 50 km north-east of the proposed survey area at about 29°40'S) between October and June, with commercial catches often peaking in March and April. As the proposed survey programme is scheduled to commence over the summer months (to avoid the winter migration of humpback and southern right whales) there is thus a high likelihood that the survey vessel would encounter tuna and billfish *en route* to their seasonal aggregation around Tripp Seamount. However, given the high mobility of most large pelagic species, it is assumed that the majority of fish species would avoid seismic noise at levels below those where physiological injury or mortality would result. Furthermore, in many of the large pelagic species, the swim-bladders are either underdeveloped or absent, and the risk of physiological injury through damage of this organ is therefore lower.

Possible injury or mortality in pelagic species could occur on initiation of a sound source at full pressure in the immediate vicinity of fish, or where reproductive or feeding behaviour override a flight response to seismic survey sounds. The potential physiological impact on pelagic species would be of high intensity. The potential physiological impact on demersal species would, however, be insignificant as they would only be affected in the far-field range, if at all. The duration of the impact on the population would be limited to the short-term. The impact is therefore considered to be of **low** significance without the implementation of mitigation and of **VERY LOW** significance with mitigation measures.

Behavioural avoidance of seismic survey area

Behavioural responses are varied and include avoidance of seismic survey areas, changes in depth distribution and schooling behaviour, startle response and changes in feeding behaviours of some fish. Behavioural responses such as avoidance of the seismic survey area and changes in feeding behaviours of some fish to seismic sounds have been documented at received levels of about 160 dB re 1 μPa. Behavioural effects are generally short-term with duration of the effect being less than or equal to the duration of exposure, although these vary between species and individuals, and are dependent on the properties of the received sound. There are, however, currently concerns that seismic survey activities in southern Namibia, just to the north of the proposed survey area, are linked to reductions in tuna catches. This is currently being investigated by the Namibian Ministry of Mines and Energy (MME). A briefing paper prepared by Dr Gabi Schneider of the Geological Survey of Namibia (Schneider & Muyongo, 2013) states that a simple correlation between seismic survey acquisition in Namibian waters and reduced tuna catches cannot be inferred and more in-depth research is required. It must, however, also be noted that according to the Commission for the Conservation of Atlantic Tunas (ICCAT) data, there has been a significant increase in fishing effort on albacore tuna by Namibia and South Africa in the last ten years and considering all scenarios, there is a 57% probability that the fish stock is overfished. Overfishing, improved fish finding technology (e.g. use of sonar) and environmental variability (e.g. Benguela "nino" effect) are factors that also need to be taken into account when investigating the cause of the decline in catches (see Appendix 3 for Fisheries Assessment).

The potential impact on fish behaviour could be of high intensity (particularly in the near-field of the airgun array), over the short term (with duration of the effect being less than or equal to the duration of exposure, although these vary between species and individuals and are dependent on the properties of the received sound), but limited to the survey area. Any observed effects are unlikely to persist for more than a few days after termination of airgun use. Consequently it is considered to be of **medium** significance without mitigation and **LOW** significance with mitigation.

Spawning and recruitment

Fish populations could be further impacted if behavioural responses result in deflection from migration paths or disturbance of spawning. If fish on their migration paths or spawning grounds are exposed to powerful external forces, they may be disturbed or even cease spawning altogether thereby affecting recruitment to fish stocks.

The magnitude of effect in these cases would depend on the biology of the species and the extent of the dispersion or deflection. Studies undertaken experimentally exposing the eggs and larvae of various fish species to airgun sources, however, identified mortalities and physiological injuries at very close range (< 5 m) only. The survey exploration activities would be conducted at depths in excess of 2 000 m, well outside of the major spawning areas. Considering this, together with the wide range over which the potentially affected species occur, the relatively short duration of the exploration programme and that the migration routes do not constitute narrow restricted paths, the impact is considered to be of **VERY LOW** significance both with and without mitigation.

Masking of environmental sounds and communication

Fish deliberately produce sounds by three processes, including by stridulation (caused by friction of adjacent skeletal components), by vibration of the swimbladder, or by rapid head movement. Chorus sounds range across frequencies higher than the majority of produced seismic survey energy, but some frequency overlap may occur.

Communication and the use of environmental sounds by fish in the offshore environment off the West Coast of South Africa are unknown. Impacts arising from masking of sounds are expected to be of low intensity due to the duty cycle of seismic surveys in relation to the more continuous biological noise. Such impacts would occur across the survey area and for the duration of the survey and are consequently considered of **VERY LOW** significance both with and without mitigation.

Indirect impacts due to effects on predators or prey

The assessment of indirect effects of seismic surveys on fish is limited by the complexity of trophic pathways in the marine environment. The impacts are difficult to determine and would depend on the diet make-up of the fish species concerned and the effect of the exploration activities on the diet species. Indirect impacts of seismic surveying could include attraction of predatory species such as sharks and tuna to pelagic fish species stunned by seismic noise. Little information is available on the feeding success of large migratory species in association with seismic survey noise. Although large pelagic species are known to aggregate around seamounts (e.g. Tripp Seamount) to feed, considering the extensive range over which large pelagic fish species feed in relation to the survey area and the low abundance of pelagic shoaling species that constitute their main prey, the impact is likely to be of **VERY LOW** significance both with and without mitigation.

Impacts are summarised in Table 5.11.

<u>Mitigation</u>

- Implement a “soft-start” procedure of a minimum of 20 minutes’ duration when initiating seismic surveying. This requires that the sound source be ramped from low to full power rather than initiated at full power, thus allowing a flight response to outside the zone of injury or avoidance. Such a “soft-start” procedure would allow fish to move out of the survey area and thus avoid potential physiological injury as a result of seismic noise;
- All breaks in airgun firing of longer than 20 minutes must be followed by a “soft-start” procedure of at least 20 minutes prior to the survey operation continuing. Breaks of shorter than 20 minutes should be followed by a “soft-start” of similar duration; and
- Airgun firing should be terminated in the unlikely event that mass mortalities of fish are observed as a direct result of shooting.

Table 5.11: Impact of seismic noise on fish.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Physiological injury						
Without mitigation	Local	Short-term	High	Probable	**Low**	Medium
With mitigation	Local	Short-term	Low to Medium	Improbable	**VERY LOW**	Medium
Behavioural avoidance						
Without mitigation	Local	Short-term	High	Probable	**Medium**	Medium
With mitigation	Local	Short-term	Medium	Improbable	**LOW**	Medium
Spawning and recruitment						
Without mitigation	Local	Short-term	Low to Medium	Improbable	**Very Low**	Medium
With mitigation	Local	Short-term	Low to Medium	Improbable	**VERY LOW**	Medium
Masking sounds and communication						
Without mitigation	Local	Short-term	Low	Improbable	**Very Low**	Low
With mitigation	Local	Short-term	Low	Improbable	**VERY LOW**	Low
Indirect impacts						
Without mitigation	Local	Short-term	Low	Improbable	**Very Low**	Low
With mitigation	Local	Short-term	Low	Improbable	**VERY LOW**	Low

5.3.4 POTENTIAL IMPACTS ON SEABIRDS

Description of effect

Among the marine avifauna occurring along the West Coast of South Africa, it is only the species that feed by plunge-diving or that rest on the sea surface (non-diving), which may be affected by the underwater noise of seismic surveys. Potential impacts of seismic pulses to seabirds could include physiological injury, behavioural avoidance of the seismic survey area and indirect impacts due to effects on predators or prey.

Assessment

Impacts on seabirds are summarised in Table 5.12 (diving seabirds) and 5.13 (non-diving seabirds).

Physiological injury and mortality

Diving seabirds are all highly mobile and would be expected to flee from approaching sound sources at distances well beyond those that could cause physiological injury, although initiation of a sound source at full power in the vicinity of diving seabirds could result in injury or mortality where feeding behaviour override a flight response to seismic survey sounds.

Of the plunge diving species that occur along the West Coast, only the Cape gannet regularly feeds as far offshore as 100 km (well inshore of the proposed survey area). African penguins are known to forage as far as 60 km offshore, with the rest foraging in nearshore areas up to 40 km from the coast. Due to the far offshore location of the exploration area (more than 300 km offshore), there are no nesting or roosting grounds in close proximity to the proposed exploration area and it falls beyond the range of most foraging seabirds. There is a very low likelihood of encountering gannets in the proposed survey area, but it is unlikely that any penguins would be encountered. Pelagic seabirds that dive for their prey may, however, be encountered in the vicinity of the survey area around Tripp Seamount, as this feature acts as a mid-ocean focal point for a variety of pelagic species that may migrate large distances in search of food.

The potential for physiological impact of seismic noise on diving bird species is considered to be of high intensity and would be limited to the survey area and survey duration (short-term). The potential physiological impact on diving species is considered to be of **low** significance without mitigation and of **VERY LOW** significance with mitigation.

No physiological injury or mortality impacts would occur in non-diving seabirds, as flying seabirds are highly mobile and would be expected to flee from approaching seismic noise sources at distances well outside of that that could cause physiological injury. The potential physiological impact on non-diving species is considered to be **INSIGNIFICANT**.

Behavioural avoidance of seismic survey area

Diving birds would be expected to hear seismic sounds at considerable distances as they have good hearing at low frequencies (which coincide with seismic shots). Response distances are, however, speculative as no empirical evidence is available. Avoidance behaviour by diving seabirds would only last for the duration of the survey period and would be limited to the vicinity of the operating airguns within the survey area. The impact is likely to be of medium to high intensity. Due to the low likelihood of encountering Cape gannets in the survey area, the potential impact on the behaviour of diving seabirds is considered to be of **low** significance without mitigation and of **VERY LOW** significance with mitigation.

The behavioural impact of seismic noise on non-diving seabirds is considered to be **INSIGNIFICANT**.

Indirect impacts due to effects on predators or prey

The assessment of indirect effects of seismic surveys on diving seabirds is limited by the complexity of trophic pathways in the marine environment and depends on the diet make-up of the bird species concerned and the effect of seismic surveys on the diet species. No information is available on the feeding success of seabirds in association with seismic survey noise. With few exceptions, most plunge-diving birds, however, forage on small shoaling fish prey species relatively close to the shore and are unlikely to feed extensively in the deep offshore waters of the proposed survey area.

The broad ranges of potential fish prey species (in relation to potential avoidance patterns of seismic surveys of such prey species) and extensive ranges over which most seabirds feed suggest that indirect impacts would be of **VERY LOW** significance with and without mitigation.

<u>Mitigation</u>

Recommendations to mitigate the potential impacts on seabirds are the same as recommended for fish (see Section 5.2.3). In addition, the following is recommended:

- It is recommended that an area with a radius of 500 m be scanned (visually during the day) by an independent on-board observer or Marine Mammal Observer (MMO) for the presence of diving seabirds prior to the commencement of "soft-starts". "Soft-start" procedures must only commence once it has been confirmed that there is no significant diving seabird activity within 500 m of the vessel;
- Daylight observations of the survey area should be carried out by an independent on-board observer or MMO. Seabird incidence and behaviour should be recorded. Any attraction of predatory seabirds by mass disorientation and stunning of fish as a result of seismic survey activities, and incidents of feeding behaviour near the hydrophone streamer, should be recorded;

- If obvious mortality or injuries to seabirds are observed, the survey should be terminated temporarily until such time as the MMO confirms that the risk to diving seabirds has been significantly reduced. It is important that the MMO's decisions to terminate firing are made confidently and expediently. In this light it is suggested that MMOs advise when the survey is to be terminated and a log of all termination decisions is kept (for inclusion in both daily and close out reports);
- Lighting on-board the survey vessel should be reduced to minimum safety levels to minimise stranding of pelagic seabirds on the survey vessel at night. All stranded seabirds must be retrieved and released during daylight hours; and
- All data recorded by the MMO should form part of a survey close-out report. Furthermore, daily reports should be forwarded to the necessary stakeholders to ensure compliance with the mitigation measures.

Table 5.12: Impact of seismic noise on diving seabirds.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Physiological injury						
Without mitigation	Local	Short-term	High	Probable	**Low**	Medium
With mitigation	Local	Short-term	Low	Improbable	**VERY LOW**	Medium
Behavioural avoidance						
Without mitigation	Local	Short-term	Medium to High	Probable	**Low**	Medium
With mitigation	Local	Short-term	Low	Improbable	**VERY LOW**	Medium
Indirect impacts						
Without mitigation	Local	Short-term	Low	Improbable	**Very Low**	Low
With mitigation	Local	Short-term	Low	Improbable	**VERY LOW**	Low

Table 5.13: Impact of seismic noise on non-diving seabirds.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Physiological injury						
Without mitigation	Local	Short-term	Zero	Improbable	**Insignificant**	High
With mitigation	Local	Short-term	Zero	Improbable	**INSIGNIFICANT**	High
Behavioural avoidance						
Without mitigation	Local	Short-term	Zero	Improbable	**Insignificant**	High
With mitigation	Local	Short-term	Zero	Improbable	**INSIGNIFICANT**	High

5.3.5 POTENTIAL IMPACTS ON TURTLES

Description of impact

The most likely impacts to turtles from seismic survey operations include physiological injury (including disorientation) or mortality from seismic noise and collision with or entanglement in towed seismic apparatus, behavioural avoidance of the seismic survey area and indirect effects due to the effects of seismic sounds on prey species.

<u>Assessment</u>
Although three species of turtles occur along the West Coast, it is only the leatherback turtle that is likely to be encountered in deeper waters. However, abundances are likely to be extremely low comprising occasional migrants. Impacts on turtles are summarised in Table 5.14.

Physiological injury and mortality
The overlap of turtle hearing sensitivity with the higher frequencies produced by airguns suggest that turtles may be considerably affected by seismic noise. Recent evidence, however, suggests that turtles only detect airguns at close range (<10 m) or are not sufficiently mobile to move away from approaching airgun arrays (particularly if basking). Initiation of a sound source at full power in the immediate vicinity of a swimming or basking turtle would be expected to result in physiological injury. The potential impact could therefore be of high intensity, but remain within the short-term.

There is also the potential for collision between adult turtles and the seismic vessel or entanglement of turtles in the towed seismic equipment and surface floats. The potential impact on turtles is highly dependent on the abundance and behaviour of turtles in the survey area at the time of the survey. The abundance of turtles in the area is low. Thus, the likelihood of encountering turtles during the proposed exploration activities is also expected to be low. Since the breeding areas for Leatherback turtles are located over 3 000 km north of the survey area in the Congo and Gabon, turtles encountered during the survey are likely to be migrating vagrants and impacts through collision or entanglement would be of low intensity and short-term.

The potential physiological impact on turtles and the potential for mortality through collision or entanglement is considered to be of **low** significance without mitigation and of **VERY LOW** significance with mitigation.

Behavioural avoidance of seismic survey area
Behavioural changes by turtles in response to seismic sounds range from startle response and avoidance by fleeing an operating sound source, through to apparent lack of movement away from active airgun arrays. The impact of seismic sounds on turtle behaviour is considered to be of high intensity, but would persist only for the duration of the survey, and be restricted to the survey area.

Given the general extent of turtle migrations relative to exploration area and low abundance, the impact of seismic noise on turtle migrations is deemed to be of **low** significance without mitigation and **VERY LOW** with mitigation.

Masking of environmental sounds and communication
Breeding adults of sea turtles undertake large migrations between distant foraging areas and their nesting sites (over 3 000 km north of the exploration area). Although it is speculated that turtles may use acoustic cues for navigation during migrations, information on turtle communication is lacking. There is no information available in the literature on the effect of seismic noise in masking environmental cues and communication in turtles, but their low abundance in the survey area would suggest that the potential significance of this impact would be **INSIGNIFICANT**.

Indirect impacts due to effects on prey species
Leatherback turtles feed on jellyfish, which are pelagic and therefore have a naturally temporally and spatially variable distribution. Adverse modification of such pelagic food sources would thus be insignificant, and the effect of a seismic survey on the feeding behaviour of turtles is thus expected to be **VERY LOW** both with and without mitigation.

Mitigation

Recommendations to mitigate the potential impacts on turtles are the same as recommended for seabirds (see Section 5.3.4). In addition, the following is recommended:

- The MMO should record incidence of turtles and their responses to seismic shooting, including position, distance from the vessel, swimming speed and direction and obvious changes in behaviour (e.g. startle responses or changes in surfacing/diving frequencies, breathing patterns, etc.). It is important that the identification and behaviour of the animals are recorded accurately along with sound levels. MMOs should, therefore, have experience in identification and differentiation of marine species, as well as observation techniques. The observer should also record (1) all "soft-starts" and pre-firing observation regimes, (2) incidence of feeding behaviour of predators within the hydrophone streamers, and (3) sightings of any injured or dead protected species, regardless of whether the injury or death was caused by the seismic vessel itself. If the injury or death was caused by a collision with the seismic vessel, the date and location (coordinates) of the strike and the species or a description of the animal should be recorded;
- Seismic shooting must be temporarily terminated when obvious negative changes to turtle behaviour is observed, if animals are observed within 500 m of the operating airguns and appear to be approaching the firing airguns or there is mortality or injuries to turtles as a direct result of the survey; and
- 'Turtle-friendly' tail buoys should be used by the survey contractor or existing tail buoys should be fitted with either exclusion or deflector 'turtle guards'.

Table 5.14: Impact of seismic noise on turtles.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Physiological injury and mortality						
Without mitigation	Local	Short-term	High	Probable to Highly probable	**Low**	Medium
With mitigation	Local	Short-term	Low	Probable	**VERY LOW**	Medium
Behavioural avoidance of seismic survey area						
Without mitigation	Local	Short-term	High	Highly probable	**Low**	High
With mitigation	Local	Short-term	Low	Probable	**VERY LOW**	High
Masking sounds and communication						
Without mitigation	Local	Short-term	Very Low	Improbable	**Insignificant**	Low
With mitigation	Local	Short-term	Very Low	Improbable	**INSIGNIFICANT**	Low
Indirect impacts						
Without mitigation	Local	Short-term	Low	Improbable	**Very Low**	Low
With mitigation	Local	Short-term	Low	Improbable	**VERY LOW**	Low

5.3.6 POTENTIAL IMPACTS ON SEALS

Description of impact

Review of the available literature suggests that potential impacts of seismic pulses on Cape fur seals could include physiological injury, behavioural avoidance of the proposed survey area, masking of environmental sounds and underwater communication and indirect impacts due to effects on predators or prey.

Assessment

The Cape fur seal is the only seal species that has breeding colonies along the West Coast. The nearest breeding colonies are located at Buchu Twins near Alexander Bay (320 km north-east of the licence area) and Robeiland at Kleinzee (300 km north-east of the licence area), with a further breeding colony at Elephant Rocks near the Olifants River mouth. There are non-breeding colonies located at Strandfontein Point near the mouth of the Groen River (approximately 450 km to the east) and Bird Island at Lambert's Bay (approximately 450 km south-east of the licence area). Seals are highly mobile with a general foraging range covering the continental shelf up to 120 nm (approximately 190 km) offshore. As the proposed survey area is located more than 300 km offshore and thus well offshore of the foraging range of seals, encounters are highly unlikely. All potential impacts on seals are thus rates as **INSIGNIFICANT** (see Table 5.).

Mitigation

Recommendations to mitigate the potential impacts on seals are similar to that recommended for turtles (see Section 5.3.5), except that:

- "Soft-start" procedures should be allowed to commence for at least a 20 minute duration, if after a period of 30 minutes seals are still within 500 m of the airguns;
- Airgun firing should be terminated temporarily if any obvious negative changes to seal behaviour is observed or there is any obvious mortality or injuries to seals as a direct result of the survey; and
- The MMO's daily report should record general seal activity, numbers and any noticeable change in behaviour.

Table 5.15: Impact of seismic noise on seals.

	Extent	Duration	Intensity	Probability	Significance	Confidence
All impacts						
Without mitigation	Local	Short-term	Low - Medium	Improbable	**Insignificant**	High
With mitigation	Local	Short-term	Low	Improbable	**INSIGNIFICANT**	High

5.3.7 POTENTIAL IMPACT ON CETACEANS (WHALES AND DOLPHINS)

Description of impact

Review of the available literature suggests that potential impacts of seismic pulses on whales and dolphins could include physiological injury, behavioural avoidance of the seismic survey area, masking of environmental sounds and communication, and indirect impacts due to effects on prey species.

Assessment

A wide diversity of cetaceans (whales and dolphins) occurs off the West Coast of South Africa. The terms "whales" and "dolphins" relate to the size of cetacean species, but the group can best be divided into odontocete (toothed whales and dolphins) that are resident or migratory and mysticete (baleen whales) that are largely migratory. Marked differences occur in the hearing capabilities of odontocete cetaceans and mysticete cetaceans. Mysticete hearing is centred at below 1 kHz, overlapping the highest peaks of the power spectrum of airgun sounds and consequently these animals may be more affect by disturbance form seismic surveys. Odontocete hearing is centred at frequencies of between 10 and 100 kHz. These species may react to seismic shots at long ranges, but hearing damage from seismic shots is only likely to occur at close range.

Impacts on mysticete cetaceans and odontocete cetaceans are summarised in Tables 5.16 and 5.17, respectively.

Physiological injury and mortality

Physiological injury to cetaceans can result from exposure to high sound levels through a number of avenues, including trauma to both auditory and non-auditory tissues as shifts of hearing threshold (as permanent (PTS) or temporary threshold shifts (TTS)), direct tissue damage, acoustically induced decompression sickness or other non-auditory physiological effects.

There is little information available on the levels of noise that would result in physiological injury to whales and dolphins. No PTS have been recorded in cetaceans. TTS have been induced in captive dolphin species at received levels higher than 190 dB, although it should be noted that the limited duration of seismic survey pulses would limit the onset of TTS to far higher levels. Available information suggests that the animal would need to be in close proximity to operating airguns to suffer physiological injury, and being highly mobile it is assumed that they would avoid sound sources at distances well beyond those at which injury is likely to occur. Deep-diving cetacean species may, however, be more susceptible to acoustic injury, particularly in the case of seafloor-focussed seismic surveys, where the downward focussed impulses could trap deep diving cetaceans within the survey pulse, as escaping towards the surface would result in exposure to higher sound level pulses.

The majority of the toothed whales that occur in inshore and offshore waters are resident, and interaction with the proposed survey would thus occur throughout the year. As the proposed survey area is located in water depths of more than 2 000 m, there is a likelihood of encounters with sperm whales.

The majority of baleen whales migrate to the southern African subcontinent to breed during winter months. The main winter concentration areas for humpback whales are to the north of Namibia in Angola, Republic of Congo and Gabon. The migration route follows the West Coast of southern Africa although it has been speculated that only a small proportion of the main migration chooses to come close inshore, the majority choosing the shortest route to the central West African breeding grounds and thus following the edge of the continental shelf (200 m to 500 m depth) and thus passing through the proposed survey area. Most humpback whales reach southern African waters around April, continuing through to September/October when the southern migration begins and continues through to December.

Southern right whales arrive in coastal waters off the southern African West Coast in June, building up to a maximum in September/October and departing again in late November (although animals may be sighted as early as April and as late as February). On the West Coast southern right whales are most common south of Lambert's Bay (and thus well to the south of the proposed survey area), although a number of the bays between Chameis Bay (27°56'S) and Conception Bay (23°55'S) in Namibia have in recent years become popular calving sites, with sightings reported as far north as the Kunene and Möwe Bay. Thus, southern right whales may also migrate through the proposed survey area.

High abundances of both southern right and humpback whales along the southern portions of the West Coast around the Cape Columbine – Yzerfontein area during spring and summer (September-February), however, suggests that the upwelling zones off Saldanha and St Helena Bay may serve as an important summer feeding area and that these populations maybe localised resident populations.

The initial survey is planned outside of peak humpback and southern right whale migration periods, but resident whales and those making exploratory trips northwards may still be encountered. The potential impact of physiological injury to both mysticete and odontocete cetaceans as a result of high-amplitude seismic sounds is deemed to be of high intensity, but would be limited to the immediate vicinity of operating airguns within the proposed survey area. The impact is, therefore, considered to be of **medium** significance without mitigation and **LOW** significance with mitigation.

Behavioural avoidance of seismic survey area

Avoidance of seismic survey activity by cetaceans, particularly mysticete species, begins at distances where levels of approximately 150 to 180 dB are received, while subtle behavioural responses have been noted at levels of 110 dB. Behavioural avoidance of seismic noise by baleen whales is therefore highly likely, but such avoidance is likely to be of minimal impact in relation to the distances of migrations of the majority of mysticete cetaceans. The survey location overlaps with the migration route of humpback and other baleen whale species. However, as the initial survey is planned outside of the main winter migration period (June – November) interactions with migrating whales should be minimal.

Of greater concern than general avoidance of resident or migrating whales is avoidance of critical breeding habitat or areas where mating, calving or nursing occurs. Displacement from critical habitats is particularly important if the sound source is located at an optimal feeding or breeding ground or areas where mating, calving or nursing occurs. The proposed survey area is located outside the main breeding areas for humpback and southern right whales. The majority of humpback whales passing through the area are migrating to breeding grounds off tropical West Africa, between Angola and the Gulf of Guinea.

Southern right whales mostly remain in the coastal area (<3 km from shore) south of Lambert's Bay, but are seen regularly along the northern Namaqualand coast and off southern Namibia, and are increasingly expanding their range as the population grows (see Section 4.1.3.10 on cetacean distributions). The proposed survey area is located well offshore of Lambert's Bay and therefore does not overlap with nearshore West Coast regions typically utilised by southern right whales for mating, calving and nursing. The exploration area is similarly located well northwest of the West Coast feeding ground around the Cape Columbine – Yzerfontein area, where local abundances of temporary resident humpbacks and southern rights whales occur during summer months. Interaction between the proposed exploration activities and the summer feeding aggregations is thus unlikely. Although encounter rates peak in migration periods, humpback and southern right whales are found in South African West Coast waters year round.

The potential impact of behavioural avoidance of the exploration area by mysticete cetaceans is considered to be of high intensity across the exploration area and for the duration of the activities. However, the likelihood of the exploration activities encountering humpback and southern right whales is low, as the initial seismic survey is scheduled to commence outside of their migration periods. Resident whales and those making exploratory trips northwards from summer feeding grounds may, however, still be encountered. The proposed schedule would minimise, but not eliminate, encounter rates with large whales, thus reducing the intensity of the impact. The impact of behavioural avoidance by mysticete cetaceans is thus considered of **medium** significance without mitigation and of **LOW** significance with mitigation.

There is very limited information on the response of odontocete cetaceans to seismic surveys. No seasonal patterns of abundance are known for odontocetes occupying the proposed exploration area, but serveral species are considered to be resident year round. A number of toothed whale species have a more pelagic distribution thus occurring further offshore and potentially overlapping with the exploration area, with species diversity and encounter rates likely to be highest on the shelf slope. Consequently, the impact on the behaviour of odontocete cetaceans is considered to be of medium intensity over the survey area and for duration of the activities. The overall significance will therefore vary between species, and consequently ranges between **very low** and **low** before mitigation and **VERY LOW** with mitigation.

Masking of environmental sounds and communication

Mysticete cetaceans appear to vocalise almost exclusively within the frequency range of the maximum energy of seismic survey noise, while odontocete cetaceans vocalise at frequencies higher than these. As the by-product noise in the mid-frequency range can travel far, masking of communication sounds produced by whistling dolphins and blackfish[2] is likely. In the migratory baleen whale species, vocalisation increases once they reach the breeding grounds and on the return journey in December to January when accompanied by calves. Additionally, the effect of masking may be reduced by the intermittent nature of seismic pulses (one pulse every approximately 25 m). Consequent, the intensity of impact on baleen whales is likely to be

[2] The term blackfish refers to the delphinids: melon-headed whale, killer whale, pygmy killer whale, false killer whale, long-finned pilot whale and short-finned pilot whale.

low over the exploration area and of short duration, but high in the case of odontocetes. The significance for mysticetes is rated as **VERY LOW,** both with and without mitigation, and the significance for odontocetes is considered to be **medium** without mitigation and **LOW** with mitigation.

Indirect impacts due to effects on prey species

Although the majority of baleen whales undertake little feeding while on breeding migrations (relying on blubber reservers), there is recent evidence that certain upwelling centres may be utilised as low latitude feeding ground by both southern right and humpback whales during summer.

The assessment of indirect effects of seismic surveys on resident odontocete cetaceans is limited by the complexity of trophic pathways in the marine environment and depends on the diet make-up of the species (and their flexibility in their diet) and the effect of the exploration activities on the diet species. However, it is expected that both fish and cephalopod prey of toothed whales and dolphins may be affected over a limited area. The broad ranges of prey species (in relation to the avoidance patterns of seismic surveys of such prey species) suggest that indirect impacts due to effects on prey would be of **VERY LOW** significance before and after mitigation.

Mitigation

Recommendations to mitigate the potential impacts on cetaceans are similar to that recommended for turtles (see Section 5.3.5). In addition, the following is recommended:

- The exploration activities should be planned to avoid the key cetacean migration and breeding periods which extend form the beginning of June to the end of November (i.e. survey period is from December to May);
- All survey vessels must be fitted with Passive Acoustic Monitoring (PAM) technology which detects animals through their vocalisations. PAM technology must be used during the 30-minute pre-watch period and when surveying at night or during adverse weather conditions and thick fog. It is also recommended that PAM be used 24-hours a day for the duration of the survey since the proposed survey would be undertaken in water depths beyond 3 000 m where sperm whales are likely to be encountered. The PAM hydrophone streamer should ideally be towed behind the airgun array to minimise the interference of vessel noise, and be fitted with two hydrophones to allow directional detection of cetaceans. In order to avoid unnecessary delays to the survey programme, it is recommended that a spare PAM cable and sensor are kept on-board should there be any technical problems with the system. However, if there is a technical problem with PAM during surveying, visual watches must be maintained by the MMO during the day and night-vision/infra-red binoculars must be used at night while PAM is being repaired.
- "Soft-start" procedures must only commence once it has been confirmed (visually and using PAM technology during the day and using only PAM technology at night or during periods of poor visibility) that there is no large cetacean activity within 500 m of the vessel. The period of confirmation should be for at least 30 minutes prior to the commencement of the "soft-start" procedures, so that deep or long diving species can be detected;
- All breaks in airgun firing of longer than 20 minutes must be followed by a 30-minute pre-shoot watch and a "soft-start" procedure of at least 20 minutes prior to the survey operation continuing. Breaks of shorter than 20 minutes should be followed by a visual assessment for marine mammals within the 500 m mitigation zone (not a 30-minute pre-shoot watch) and a "soft-start" of similar duration;
- The use of the lowest practicable airgun volume should be defined by the operator and enforced;
- Airgun use should be prohibited outside of the licence area;
- In terms of the Marine Living Resources Act, 1998 (No. 18 of 1998) it is illegal for any vessel to approach to or remain within 300 m of whales within South African waters without a permit or exemption. The Department of Environmental Affairs (DEA) has recommended that, if necessary, the operator should apply for exemption ; and

- Marine mammal incidence data and seismic source output data arising from the survey should be made available, if requested, to the Marine Mammal Institute, DEA: Branch Oceans and Coasts, Department of Agriculture, Forestry and Fisheries (DAFF) and PASA for analyses of survey impacts in local waters.

Table 5.16: Impact of seismic noise on mysticete cetaceans (baleen whales).

	Extent	Duration	Intensity	Probability	Significance	Confidence
Physiological injury						
Without mitigation	Local	Short-term	High	Probable	**Medium**	Medium
With mitigation	Local	Short-term	Low to Medium	Probable	**LOW**	Medium
Behavioural avoidance						
Without mitigation	Local	Short-term	High	Probable	**Medium**	High
With mitigation	Local	Short-term	Low	Probable	**LOW**	High
Masking sounds and communication						
Without mitigation	Local	Short-term	Low	Probable	**Very Low**	Medium
With mitigation	Local	Short-term	Low	Probable	**VERY LOW**	Medium
Indirect impacts						
Without mitigation	Local	Short-term	Low	Probable	**Very Low**	High
With mitigation	Local	Short-term	Low	Probable	**VERY LOW**	High

Table 5.17: Impact of seismic noise on odontocete cetaceans (toothed whales and dolphins).

	Extent	Duration	Intensity	Probability	Significance	Confidence
Physiological injury						
Without mitigation	Local	Short-term	High	Probable	**Medium**	Medium
With mitigation	Local	Short-term	Low to Medium	Probable	**LOW**	Medium
Behavioural avoidance						
Without mitigation	Local	Short-term	Medium	Probable	**Very Low to Low**	High
With mitigation	Local	Short-term	Low to Medium	Probable	**VERY LOW**	High
Masking sounds and communication						
Without mitigation	Local	Short-term	High	Probable	**Medium**	Medium
With mitigation	Local	Short-term	Low	Probable	**LOW**	Medium
Indirect impacts						
Without mitigation	Local	Short-term	Low	Probable	**Very Low**	Medium
With mitigation	Local	Short-term	Low	Probable	**VERY LOW**	Medium

5.4 IMPACTS OF A MULTI-BEAM BATHYMETRY SURVEY ON MARINE FAUNA

Description of impact

Potential impacts of a multi-beam bathymetry survey on marine fauna (mainly cetaceans) could include physiological injury and behavioural avoidance of the survey area.

Assessment

There are significant differences in the effects of seismic and multi-beam/side-scan surveys. A typical multi-beam echo sounder emits a fan of acoustic beams from a transducer at frequencies ranging from 10 kHz to 200 kHz and typically produces sound levels in the order of 207 db re 1μPa at 1m, which is approximately 1 000 times less than a seismic survey. The higher frequency emissions utilised in normal multi-beam and sub-bottom profiling operations tend to be dissipated to safe levels over a relatively short distance. The anticipated radius of influence of multi-beam sonar would thus be significantly less than that for an airgun array. Hence the most likely scenario for injury to an animal by acoustic equipment would be if the equipment were turned on full power while the animal was close to it.

Although both baleen and toothed whales would thus be expected to hear sonar signals at frequencies within their functional hearing range, the animals would only be affected if they were within the sonar beam below the survey vessel. The statistical probability of crossing a cetacean with the narrow multi-beam fan several times, or even once, is very small. It is thus generally understood that in open coastal waters the effects of multi-beam sonars on marine fauna are negligible.

The potential physiological impact on marine fauna (mainly cetaceans) would be of low intensity across the proposed exploration area (within sonar beam below the survey vessel). The duration of the impact would be limited to the short-term. The impact is therefore considered to be of **VERY LOW** significance with and without mitigation (see Table 5.18).

Mitigation

Despite the very low significance of potential impacts, the following mitigation measures, which are based on the Joint Nature Conservation Committee (JNCC) guidelines, are recommended for the proposed multi-beam bathymetry survey:

- The multi-beam bathymetry survey should, as far as possible, be planned to avoid cetacean migration period from their southern feeding grounds into low latitude waters (beginning of June to end of November);
- An onboard Independent Observer must be appointed for the duration of the survey to act as the MMO;
- Surveying must only commence once it has been confirmed by the MMO (visually during the day) that there is no large cetacean activity within 500 m of the vessel for a 15-minute period;
- If source level is greater than 210 dB re 1 μPa at 1 m the following is recommended:
    - > Where equipment allows, a “soft-start” procedure shall be implemented for a period of 20 minutes. Where this is not possible, the equipment should be turned on and off over a 20 minute period to act as a warning signal and allow cetaceans to move away from the sound source;
    - > “Soft-starts” should, as far as possible, be planned to commence within daylight hours;
    - > “Soft-start” procedures must only commence once it has been confirmed by the MMO (visually during the day) that there is no large cetacean activity within 500 m of the vessel for a 15-minute period. However, if after a period of 15 minutes small cetaceans (particularly dolphins) are still within 500 m of the vessel, the normal “soft-start” procedure should be allowed to commence;

> "Soft-start" procedures must also be implemented after breaks in surveying (for whatever reason) of longer than 20 minutes. Breaks of shorter than 20 minutes should be followed by a "soft-start" of similar duration; and
> Should surveying in the sensitive cetacean period be unavoidable, PAM technology must be implemented 24 hours a day from beginning of June to end of November. A PAM operator must be appointed during this period.

- Terminate the survey if cetaceans show obvious negative behavioural changes within 500 m of the survey vessel or equipment until the animal/s has vacated the area; and
- In terms of the Marine Living Resources Act, 1998 (No. 18 of 1998) it is illegal for any vessel to approach to or remain within 300 m of whales within South African waters without a permit or exemption. Therefore, if necessary, apply to DEA for an exemption from the regulations.

Table 5.18: Impact of multi-beam bathymetry surveying on marine fauna.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Low	Improbable	**Very Low**	High
With mitigation	Local	Short-term	Low	Improbable	**VERY LOW**	High

5.5 IMPACTS OF SEAFLOOR SAMPLING PROGRAMME

Description of impact

During the seafloor sampling programme sediment cores / samples would be removed from the seafloor. As benthic fauna typically inhabit the top 20 to 30 cm of sediment, removal of the sediment samples would result in the disturbance and loss of benthic macrofauna, which would result in a loss of some benthic biodiversity.

Some disturbance or loss of adjacent benthic biota can also be expected as a result of the placement on the seafloor of the trigger weight. Epifauna and infauna beneath the footprint of the weight may be smothered or crushed resulting in a reduction in benthic biodiversity. Crushing is likely to primarily affect soft-bodied species as some molluscs and crustaceans may be robust enough to survive. In addition, the discarding overboard of excess sediment may result in limited smothering effects on the seafloor.

Assessment

Sediment removal

It is proposed to remove up to five piston core samples from the seafloor, which would amount to the removal of approximately 0.1 m^3 of sediment (i.e. 0.02 m^3 per sample). Considering the available area of similar habitat off the edge of the continental shelf in the vicinity of the proposed exploration area, this reduction in benthic biodiversity can be considered negligible.

Depending on the texture of the sediments at the target sites, slumping of adjacent unconsolidated sediments into the excavation can be expected over the very short-term. Although this may result in localised disturbance (i.e. confined to the sample footprints) of macrofauna associated with these sediments and alteration of sediment structure, it also serves as a means of natural recovery of the excavations. Studies have shown that some mobile benthic animals are capable of actively migrating vertically through overlying sediment thereby significantly affecting the recolonisation of impacted areas and the subsequent recovery of disturbed areas of seafloor.

Natural rehabilitation of the seafloor following sampling or dredging operations, through a process involving influx of sediments and recruitment of invertebrates, has been demonstrated on the southern African continental shelf. Recovery rates of impacted communities are variable and dependent on the sampling method, sediment influx rates and the influence of natural disturbances on succession communities. Recovery rates have been found to range from one year for fine grained sediments to five years for coarse grained sediments.

Any change in sediment composition is expected to be minimal and would not affect recovery. Impacts on the offshore benthos as a result of sediment removal are considered to be of very low intensity at an extremely local scale (i.e. confined to the sample footprints). Full recovery is expected to take place within 1 to 5 years (i.e. short term), as the excavations would be refilled through sediment influx and recolonisation would occur through recruitment and immigration from adjacent areas. Therefore, this impact is rated as being **INSIGNIFICANT** (see Table 5.19).

Crushing and smothering

The piston core sampling would impact a very small surface area at any one core sample site (footprint of approximately 0.0035 m^2) resulting in a cumulative footprint of 0.0175 m^2 across the proposed exploration area. Most of the discarded material would be dispersed as it settles through the water column. Thus crushing and smothering effects are considered negligible.

The impacts would be of very low intensity, but highly localised, and short-term as recolonisation would occur rapidly from adjacent undisturbed sediments. The potential impact is consequently deemed to **INSIGNIFICANT** (see Table 5.19).

Mitigation

- Sampling sites must avoid existing submarine telecommunications cables within the proposed exploration area (see Figure 4.31).

Table 5.19: Impacts of seafloor sampling programme on benthic fauna.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Sediment removal						
Without mitigation	Local (highly)	Short-term	Very Low	Definite	**Insignificant**	High
With mitigation	Local (highly)	Short-term	Very Low	Definite	**INSIGNIFICANT**	High
Crushing and smothering						
Without mitigation	Local (highly)	Short-term	Very Low	Definite	**Insignificant**	High
With mitigation	Local (highly)	Short-term	Very Low	Definite	**INSIGNIFICANT**	High

5.6 IMPACT ON OTHER USERS OF THE SEA

5.6.1 POTENTIAL IMPACT ON FISHING INDUSTRY

Description of impact

The proposed exploration programme could result in impacts on fishing as a result of the 500 m safety zones around the survey vessels (in terms of the Marine Traffic Act (No. 2 of 1981)). In addition to the statutory 500 m safety zone, a seismic contractor would request a safe operational limit (that is greater than the 500 m safety zone) that it would like other vessels to stay beyond. Typical safe operational limits for 2D and 3D surveys are illustrated in Figure 3.3. The operator would commission a chase vessel equipped with appropriate radar and communications to patrol the area during the seismic survey to ensure that other vessels adhere to the safe operational limits.

The impact on the fishing industry includes the likely disruption to fishing operations, loss of access to fishing grounds in the proposed survey area over the survey period, fish avoidance of the survey area and changes in feeding behaviour (with duration of the effect being less than or equal to the duration of the survey). Due to the far offshore location of the exploration area, it is anticipated that only the large pelagic long-line sector could potentially be impacted by the proposed exploration activities (see Section 4.1.4.1).

<u>Assessment</u>

The large pelagic long-line fishery operates year-round, extensively within the South African EEZ targeting primarily tuna and swordfish. The fishery operates extensively from the continental shelf break into deeper waters, year-round. Pelagic long-line vessels are primarily concentrated seawards of the 500 m depth contour where the continental slope is steepest (see Figure 4.21). During the period from 2000 to 2012, the national catch and effort recorded in the large pelagic long-line fishery amounted to an average of 2 510 tons per year and 3.5 million hooks. Within a 20 nautical mile radius of the exploration area, 33 sets amounting to 44 577 hooks were set per annum (1.3% of the total national effort). The corresponding catch within the area was 38.5 tons per annum (1.5% of the total catch landed nationally).

The presence of long-lines would present a potential threat to seismic survey operations in terms of entanglements with towed seismic gear. Extreme vigilance would be needed to avoid any drifting lines and regular communications with vessels in the area would be essential. As long-line fishing vessels are also restricted in their manoeuvrability, clear communications and cooperation with the fishing industry would ensure that the impact on each other’s operations due to the required safety zones is minimised.

The potential impact on the pelagic long-line fishery is considered to be local and of medium intensity over the short-term. This impact is assessed to be of **VERY LOW** significance with and without mitigation (see Table 5.20).

<u>Mitigation</u>

The mitigation measures listed below are unlikely to reduce the significance of potential impacts, but they would minimise disruptions to survey and fishing operations.

- Prior to survey commencement the following key stakeholders should be consulted and informed of the proposed survey activity (including navigational coordinates of the survey area, timing and duration the proposed activities) and the likely implications thereof:
  - Fishing industry / associations (these include South African Tuna Association, South African Tuna Long-Line Association, Fresh Tuna Exporters Association, South African Deep-Sea Trawling Industry Association, South African Hake Long-Line Association, South African Pelagic Fishing Industry Association, Namibian Large Pelagic Association); and
  - Other key stakeholders include: DEA, DAFF, Port Captains, South African Maritime Safety Authority (SAMSA), South African Navy Hydrographic office.
- OK Energy must request, in writing, the South African Navy Hydrographic office to release Radio Navigation Warnings and Notices to Mariners throughout the seismic survey period. The Notice to Mariners should give notice of (1) the co-ordinates of the proposed survey area, (2) an indication of the proposed survey timeframes and day-to-day location of the survey vessel, and (3) an indication of the 500 m safety zones and the proposed safe operational limits of the survey vessel. These Notices to Mariners should be distributed timeously to fishing companies and directly onto vessels where possible;
- An independent onboard Fisheries Liaison Officer (FLO) that is familiar with fisheries operational in the area must be appointed for the duration of the survey (seismic only). The FLO should provide a

fisheries facilitation role to identify and communicate with fishing vessels in the area to reduce the risk of gear interaction between fishing and survey activities. The FLO should:
> Report on vessel activity daily;
> Advise on actions to be taken in the event of encountering fishing gear; and
> Set up a daily electronic reporting routine to keep key stakeholders informed of survey activity and progress and fisheries and environmental issues.

- The seismic survey vessels should be accompanied by a chase boat;
- In order to facilitate research into the effect on tuna catches, it is recommended that a record should be kept of the hourly positioning of the survey vessel for the duration of the seismic survey. Positioning data should be provided to the Namibian government task force for use in their current research into the potential impact of seismic survey activities on migration routes of albacore tuna along the southwest coast of Africa.

Table 5.20: Assessment of the potential impact on the large pelagic long-line fishery in the proposed survey area.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Medium	Probable	**Very Low**	High
With mitigation	Local	Short-term	Medium	Probable	**VERY LOW**	High

5.6.2 POTENTIAL IMPACT ON MARINE TRANSPORT ROUTES

Description of impact

The acquisition of high quality seismic data requires that the position of the seismic vessel is accurately known and that the vessel would need to travel in uninterrupted lines. For this reason the survey vessel, together with its towed arrays and hydrophone streamer is defined as a “vessel restricted in its ability to manoeuvre” which requires that power-driven and sailing vessels give way to it (COLREGS, 1972 Part B, Rule 10). Although the bathymetry survey typically does not require the vessel to tow any cables, it also has restricted manoeuvrability due to the operational nature of this work. In addition, any vessel used for the purpose of exploration or exploitation of the seabed (including seafloor sampling vessel) falls under the definition of an “offshore installation and is thus protected by a 500 m safety zone (Marine Traffic Act, 1981).

Furthermore, a vessel (including array of airguns and hydrophones) used for the purpose of exploiting the seabed falls under the definition of an “offshore installation” and as such it is protected by a 500 m safety zone. In addition to the statutory 500 m safety zone, the seismic contractor would request a safe operational limit (that is greater than the 500 m safety zone) that it would like other vessels to stay beyond. The presence of the survey vessels could thus interfere with shipping in the area.

Assessment

The majority of shipping traffic off the West Coast is located on the outer edge of the continental shelf (see Figure 4.25) with traffic inshore of the shelf largely comprising fishing and mining vessels, especially between Kleinsee and Oranjemund. Therefore, shipping traffic is expected to pass through the licence area.

Although the safety zone around the survey vessels would be relatively small all vessels would be prohibited from entering this area. The displacement of shipping would be limited to within the extreme near vicinity of the survey vessels. Although survey vessels are protected by a 500 m safety zone, there could be some interaction with marine traffic during surveying, resulting in disruptions and/or delays. This is normally mitigated by a notice to mariners and regular communication through daily notifications.

The impact on shipping traffic in the proposed exploration area is considered to be localised and of medium intensity in the short-term. The significance of this impact is therefore assessed to be **VERY LOW** with and without mitigation (see Table 5.21).

Mitigation

Recommendations to mitigate the potential impacts on marine transport routes are similar to that recommended for fishing (refer to Section 5.6.1). In addition, the following is recommended:

- The survey and support vessels must be certified for seaworthiness through an appropriate internationally recognised marine certification programme (e.g. Lloyds Register, Det Norske Veritas). The certification, as well as existing safety standards, requires that safety precautions would be taken to minimise the possibility of an offshore accident;
- Collision prevention equipment on the vessels should include radar, multi-frequency radio, foghorns, etc. Additional precautions include: chase boat (for seismic survey only), the existence of an internationally agreed safety zone around the survey vessels, cautionary notices to mariners and access to current weather service information. The vessels are required to fly standard flags, lights (three all-round lights in a vertical line, with the highest and lowest lights being red and the middle light being white) or shapes (three shapes in a vertical line, with the highest and lowest lights being balls and the middle light being a diamond) to indicate that the seismic vessel is engaged in towing surveys and is restricted in manoeuvrability, and must be fully illuminated during twilight and night; and
- Report any emergencies to SAMSA.

Table 5.21: Assessment of interference with marine transport routes.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Medium	Probable	**Very Low**	Medium
With mitigation	Local	Short-term	Low	Probable	**VERY LOW**	Medium

5.6.3 POTENTIAL IMPACT ON MARINE PROSPECTING, MINING, EXPLORATION AND PRODUCTION ACTIVITIES

Description of impact

The presence of the survey vessels with the associated 500 m safety zones could interfere with other prospecting, mining, exploration and production activities in the area.

Assessment

Prospecting and mining

The majority of diamond mining concessions worked at present are those close inshore. The proposed survey area does not overlap with any mining licence areas and not impact is expected on the inshore diamond mining areas (see Figure 4.27).

AuruMar (Pty) Ltd, a joint venture entity created by De Beers Group Exploration Holdings Limited and AngloGold Ashanti Marine Exploration Limited, secured Prospecting Rights for heavy minerals, platinum group metals, gold and sapphire for an area off the West Coast (see Figure 4.28). The proposed survey area does not overlap with this prospecting area.

A number of prospecting areas for glauconite and phosphorite / phosphate are located off the West Coast (see Figure 4.29). The proposed survey area does not overlap with any of these areas.

Manganese nodules enriched with valuable metals occur in water depths of over 3 000 m on the West Coast (see Figure 4.30). The proposed survey area does not overlap with these areas, thus no impact is expected.

The potential impact on prospecting and mining in the proposed survey area is considered to be localised and of very low intensity in the short-term. The significance of this potential impact is thus assessed to be **INSIGNIFICANT** with and without mitigation (see Table 5.22).

Exploration and production

Exploration for oil and gas is currently undertaken in a number of licence blocks off the West Coast of South Africa (see Figure 4.26). Cairn South Africa (Pty) Ltd conducted a seismic survey over Block 1 in February – March 2014 with Spectrum ASA proposing to undertake a further speculative seismic survey over Block 1 and into the Northern Cape Ultra-deep Licence Area during the second quarter of 2014. Should any of the other adjacent operators, however, undertake any exploration activities (mainly seismic surveys) at a similar time there could be a localised impact, of high intensity in the short-term. There are currently no production activities off the West Coast of South Africa. The significance of this impact is therefore assessed to be **low** without mitigation and **VERY LOW** with mitigation (see Table 5.22).

Mitigation

- OK Energy should engage timeously with other exploration right holders and applicants to discuss the scheduling of proposed survey activities in order to reduce the risk of delay to or interference with the proposed seismic survey; and
- Any dispute arising should be referred to the Department of Mineral Resources or PASA for resolution.

Table 5.22: Impact on marine prospecting, mining, exploration and production activities.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Prospecting and mining						
Without mitigation	Local	Short-term	Very Low	Improbable	**Insignificant**	Medium
With mitigation	Local	Short-term	Very Low	Improbable	**INSIGNIFICANT**	Medium
Exploration and production						
Without mitigation	Local	Short-term	High	Improbable	**Low**	Medium
With mitigation	Local	Short-term	Low	Improbable	**VERY LOW**	Medium

6. CONCLUSIONS AND RECOMMENDATIONS

OK Energy Limited is proposing to undertake an exploration programme in the Northern Cape Ultra-deep Licence Area (Licence Blocks 3013 and 3113) off the West Coast of South Africa. The licence area is located in the Orange Basin beyond the continental shelf in depths from roughly 2 500 m to beyond 3 000 m and is approximately 6 930 km^2 in extent.

OK Energy appointed CCA to compile this EMP and undertake the associated public participation process to meet the requirements of the MPRDA and the Regulations thereto. Specialists were appointed to address the two key issues, namely the effect on the fishing industry and effects on marine fauna. The findings of the specialist studies and other relevant information have been integrated and synthesised into this EMP.

This chapter summarises the key findings of the study and presents mitigation measures that should be implemented if the proposed survey goes ahead.

6.1 CONCLUSIONS

A summary of the assessment of potential environmental impacts associated with the proposed exploration programme is provided in Table 6.1.

The majority of the impacts associated with the various exploration activities would be of short-term duration and limited to the immediate survey area. As a result, the majority of the impacts are considered to be of **VERY LOW** to **LOW** significance after mitigation.

The two key issues identified in this study relate to:

- The potential impact on marine mammals (physiological injury and behavioural avoidance) as a result of seismic noise; and
- The potential impact on the fishing industry (vessel interaction, disruption to fishing operations and reduced catch) due to the presence of the various survey vessels, potential fish avoidance of the survey area and changes in feeding behaviour.

Although most of the impacts on cetaceans are assessed to have **VERY LOW** to **LOW** significance with mitigation, the impact could be of much higher significance due to the limited understanding of how short-term effects of seismic surveys relate to longer term impacts. For example, if a sound source displaces a species from an important feeding or breeding area for a prolonged period, impacts at the population level could be more significant. In order to mitigate the potential impact on cetaceans it is recommended that the proposed seismic survey programme be planned to avoid key cetacean migration and breeding periods (the key period stretches from the beginning of June to the end of November). Various other measures are recommended to further mitigate the potential impact on marine fauna, including a 30-minute pre-watch period (visually and using PAM technology), a 20-minute “soft-start” procedure, temporary termination of survey, etc. It is also recommended that PAM be used 24-hours a day for the duration of the survey since the proposed survey would be undertaken in water depths beyond 3 000 m where sperm whales are likely to be encountered.

Due to the far offshore location of the survey area, the only fishing sector likely to be affected would be the large pelagic long-line sector. Due to the limited fishing effort taking place in the survey area, the impact is assessed to be of **VERY LOW** significance with and without mitigation. However, if fish avoid the survey area and / or change their feeding behaviour it could have a more significant impact on the fishing industry. Research has, however, shown that behavioural effects are generally short-term with duration of the effect being less than or equal to the duration of exposure, although these vary between species and individuals, and are dependent on the properties of the received sound. Similarly, if there was any interaction between the survey vessels and a fishery the significance of the impact could be higher. Thus it is important that OK Energy engage timeously with the fishing industry prior to and during the survey. Regular communication with fishing vessels in the vicinity during surveying would minimise the potential disruption to fishing operations and risk of gear entanglements.

Table 6.1: Summary of the significance of potential impacts of the proposed exploration programme in the Orange Basin off the West Coast of South Africa.

Potential impact		Significance	
		Without mitigation	With mitigation
Normal seismic / support vessels and helicopter operation:			
Emissions to the atmosphere		VL	**VL**
Deck drainage into the sea		VL	**VL**
Machinery space drainage into the sea		VL	**VL**
Sewage effluent into the sea		VL	**VL**
Galley waste disposal into the sea		VL	**VL**
Solid waste disposal into the sea		Insignificant	**INSIGNIFICANT**
Noise from seismic and support vessel operation		VL	**VL**
Noise from helicopter operation		L-M	**VL**
Impact of seismic noise on marine fauna:			
Plankton		VL	**VL**
Invertebrates	Physiological injury	VL	**VL**
	Behavioural avoidance	VL	**VL**
Fish	Physiological injury	L	**VL**
	Behavioural avoidance	M	**L**
	Spawning and reproductive success	VL	**VL**
	Masking sound and communication	VL	**VL**
	Indirect impacts	VL	**VL**
Non-diving seabirds	Physiological injury	Insignificant	**INSIGNIFICANT**
	Behavioural avoidance	Insignificant	**INSIGNIFICANT**
Diving seabirds	Physiological injury	L	**VL**
	Behavioural avoidance	L	**VL**
	Indirect impacts	VL	**VL**
Turtles	Physiological injury	L	**VL**
	Behavioural avoidance	L	**VL**
	Masking sound and communication	Insignificant	**INSIGNIFICANT**
	Indirect impacts	VL	**VL**
Seals	All impacts	Insignificant	**INSIGNIFICANT**
Mysticete Cetaceans	Physiological injury	M	**L**
	Behavioural avoidance	M	**L**
	Masking sound and communication	VL	**VL**
	Indirect impacts	VL	**VL**
Odontocete Cetaceans	Physiological injury	L	**VL**
	Behavioural avoidance	VL-L	**VL**
	Masking sound and communication	M	**L**
	Indirect impacts	VL	**VL**
Impact of multi-beam noise on marine fauna:		VL	**VL**

Potential impact		Significance	
		Without mitigation	With mitigation
Impact of seafloor sampling on benthic biota:		Insignificant	**INSIGNIFICANT**
Impact on other users of the sea:			
Fishing industry	Large pelagic long-line fishery	VL	**VL**
Marine transport routes		VL	**VL**
Marine prospecting and mining		Insignificant	**INSIGNIFICANT**
Exploration and production		L	**VL**
H=High M=Medium	L=Low VL=Very low	N/A=Not applicable	All impacts are negative

6.2 RECOMMENDATIONS

6.2.1. COMPLIANCE WITH ACTION PLAN, PROCEDURES AND MARPOL STANDARDS

All phases of the proposed project (including pre-establishment phase, establishment phase, operational phase, and decommissioning and closure phase) must comply with the Action Plan and Procedures presented in Chapter 7. In addition, all vessels must ensure compliance with the MARPOL 73/78 standards (see Appendix 6 for selected Annexures of MARPOL).

6.2.2 RECOMMENDATIONS SPECIFIC TO SEISMIC SURVEY PROCEDURES

6.2.2.1 Survey timing, scheduling and equipment

The exploration activities should be undertaken outside of the key cetacean migration and breeding periods (the key period stretches from the beginning of June to the end of November).

'Turtle-friendly' tail buoys should be used by the survey contractor or existing tail buoys should be fitted with either exclusion or deflector 'turtle guards'.

6.2.2.2 PAM technology

All survey vessels must be fitted with PAM technology, which detects cetaceans through their vocalisations. PAM technology must be used during the 30-minute pre-watch period and when surveying at night or during adverse weather conditions and thick fog. It is also recommended that PAM be used 24-hours a day for the duration of the survey since the proposed survey would be undertaken in water depths beyond 3 000 m where sperm whales are likely to be encountered. The PAM hydrophone streamer should ideally be towed behind the airgun array to minimise the interference of vessel noise, and be fitted with two hydrophones to allow directional detection of cetaceans.

In order to avoid unnecessary delays to the survey programme, it is recommended that a spare PAM cable and sensor are kept on-board should there be any technical problems with the system. However, if there is a technical problem with PAM during surveying, visual watches must be maintained by the MMO during the day and night-vision/infra-red binoculars must be used at night while PAM is being repaired.

6.2.2.3 "Soft-start" procedure and airgun firing

All initiations of seismic surveys must be carried out as "soft-starts" for a minimum of 20 minutes. This requires that the sound source be ramped from low to full power rather than initiated at full power, thus allowing a flight response by marine fauna to outside the zone of injury or avoidance. Where possible, "soft-starts" should be planned so that they commence within daylight hours.

"Soft-start" procedures must only commence once it has been confirmed (visually and using PAM technology during the day and using only PAM technology at night or during periods of poor visibility) that there are no seabirds (diving), turtles or marine mammal activity within 500 m of the vessel. For cetaceans, the period of confirmation should be for at least 30 minutes prior to the commencement of the "soft-start" procedures, so that deep or long diving species can be detected. However, in the case of seals, which are often attracted to survey vessels, the normal "soft-start" procedures should be allowed to commence, if after a period of 30 minutes seals are still within 500 m of the airguns.

All breaks in airgun firing of longer than 20 minutes must be followed by a 30-minute pre-shoot watch and a "soft-start" procedure of at least 20 minutes prior to the survey operation continuing. Breaks of shorter than 20 minutes should be followed by a visual assessment for marine mammals within the 500 m mitigation zone (not a 30-minute pre-shoot watch) and a "soft-start" of similar duration.

Airgun use should be prohibited outside of the licence area.

The use of the lowest practicable airgun volume, as defined by the operator, should be defined and enforced.

During surveying, airgun firing should be terminated when:

- obvious negative changes to turtle, seal and cetacean behaviour is observed;
- turtles or cetaceans are observed within 500 m of the operating airgun and appear to be approaching the firing airgun; or
- there is mass mortality of fish or mortality / injuries to seabirds, turtles, seals or cetaceans as a direct result of the survey.

The survey should remain terminated until such time the time MMO confirms that:

- Turtles or cetaceans have moved to a point that is more than 500 m from the source;
- Despite continuous observation, 30 minutes has elapsed since the last sighting of the turtles or cetaceans within 500 m of the source; and
- Risks to seabirds, turtles, seals or cetaceans have been significantly reduced.

A log of all termination decisions must be kept (for inclusion in both daily and "close-out" reports).

6.2.2.4 MMO and PAM operator

An independent onboard MMO and PAM operator must be appointed for the duration of the seismic survey. The MMO and PAM operator must have experience in seabird, turtle and marine mammal identification and observation techniques. The duties of the MMO would be to:

<u>Marine fauna:</u>

- Observe and record responses of marine fauna to the seismic survey, including seabird, turtle and cetacean incidence and behaviour and any mortality of marine fauna as a result of the seismic survey. Data captured should include species identification, position (latitude/longitude), distance from the vessel, swimming speed and direction (if applicable) and any obvious changes in behaviour (e.g. startle responses or changes in surfacing/diving frequencies, breathing patterns) as a result of the survey activities;
- Record airgun activities, including sound levels, "soft-start" procedures and pre-firing regimes;

- Request the temporary termination of the seismic survey, as appropriate. It is important that the MMOs' decisions to terminate firing are made confidently and expediently;

Other:

- Monitor compliance with international marine pollution regulations (MARPOL 73/78 standards); and
- Prepare daily reports of all observations. These reports should be forwarded to the key stakeholders.

The duties of the PAM operator would be to:

- Confirm that there is no marine mammal activity within 500 m of the vessel prior to commencing with the "soft-start" procedures;
- Record species identification, position (latitude/longitude) and distance from the vessel, where possible;
- Record airgun activities, including sound levels, "soft-start" procedures and pre-firing regimes; and
- Request the temporary termination of the seismic survey, as appropriate.

All data recorded by MMO and PAM operator should form part of the survey "close-out" report.

6.2.2.5 Onboard FLO

An independent onboard FLO that is familiar with fisheries operational in the area must be appointed for the duration of the seismic survey. The duties of the FLO would be to:

- Identify fishing vessels active in the area and associated fishing gear;
- Advise on actions to be taken in the event of encountering fishing gear;
- Provide back-up on-board facilitation with the fishing industry and other users of the sea. This would include communication with fishing and shipping / sailing vessels in the area in order to reduce the risk of interaction between the proposed survey and other existing or proposed activities; and
- Provide daily electronic reporting on vessel activity and recording of any communication and/or interaction should be undertaken in order to keep key stakeholders informed of survey activity and progress.

6.2.2.6 Record of positioning data

A record should be kept of the hourly positioning of the survey vessel for the duration of the seismic survey. Positioning data should be provided to the Namibian government task force for use in their current research into the potential impact of seismic survey activities on migration routes of albacore tuna along the southwest coast of Africa.

6.2.3 RECOMMENDATIONS SPECIFIC TO THE MULTI-BEAM BATHYMETRY SURVEY

6.2.3.1 Survey timing

The multi-beam bathymetry survey should, as far as possible, be planned to avoid cetacean migration periods which stretch from the beginning of June to the end of November.

6.2.3.2 Multi-beam survey procedures

- An onboard Independent Observer(s) must be appointed for the duration of the multi-beam survey to act as the and MMO. The duties of the MMO are detailed in Section 6.2.2.4.

- Surveying must only commence once it has been confirmed by the MMO (visually during the day) that there is no large cetacean activity within 500 m of the vessel for a 15-minute period.
- If the source level is greater than 210 dB re 1 µPa at 1 m the following is recommended:
  - > Where equipment allows, a "soft-start" procedure shall be implemented for a period of 20 minutes. Where this is not possible, the equipment should be turned on and off over a 20 minute period to act as a warning signal and allow cetaceans to move away from the sound source;
  - > "Soft-starts" should, as far as possible, be planned to commence within daylight hours;
  - > "Soft-start" procedures must only commence once it has been confirmed by the MMO (visually during the day) that there is no large cetacean activity within 500 m of the vessel for a 15-minute period.
  - > "Soft-start" procedures must also be implemented after breaks in surveying (for whatever reason) of longer than 20 minutes. Breaks of shorter than 20 minutes should be followed by a "soft-start" of similar duration; and
  - > Should surveying in the sensitive cetacean period be unavoidable, PAM technology must be implemented 24 hours a day from beginning of June to end of November. If there is a technical problem with PAM during surveying, visual watches must be maintained by the MMO during the day and night-vision/infra-red binoculars must be used at night while PAM is being repaired. A PAM operator must be appointed during this period. The duties of the PAM operator are detailed in Section 6.2.2.4.
- Surveying should be terminated temporarily if cetaceans show obvious negative behavioural changes within 500 m of the survey vessel or equipment; and
- The survey should be terminated until such time the MMO confirms that cetaceans have moved to a point that is more than 500 m from the source or despite continuous observation, 15 minutes has elapsed since the last sighting of the cetaceans within 500 m of the source.

6.2.4 SEAFLOOR SAMPLING PROGRAMME

- Sampling sites must avoid existing submarine telecommunications cables within the proposed exploration area.

6.2.5 HELICOPTER OPERATIONS

Mitigation relating to helicopter operations includes:

- Flight paths must be pre-planned to ensure that no flying occurs over seal and seabird colonies, coastal reserves or marine islands;
- Extensive coastal flights (parallel to the coast within 1 nautical mile of the shore) should be avoided;
- Aircraft may not approach to within 300 m of whales without a permit or exemption in terms of the Marine Living Resources Act, 1998;
- The contractor should comply fully with aviation and authority guidelines and rules; and
- All pilots must be briefed on ecological risks associated with flying at a low level parallel to the coast.

6.2.6 OTHER MITIGATION MEASURES COMMON TO ALL EXPLORATION ACTIVITIES

Other mitigation measures that should also be implemented during the survey in order to ensure that any potential impacts are minimised include the following:

<u>Permit / exemption requirement</u>

An exemption is required from DEA to approach or remain within 300 m of whales;

Vessel safety

- The survey vessel must be certified for seaworthiness through an appropriate internationally recognised marine certification programme (e.g. Lloyds Register, Det Norske Veritas). The certification, as well as existing safety standards, requires that safety precautions would be taken to minimise the possibility of an offshore accident;
- Collision prevention equipment should include radar, multi-frequency radio, foghorns, etc. Additional precautions include:
  - > A support / chase vessel with FLO familiar with the fisheries expected in the area (for seismic survey only);
  - > The existence of an internationally agreed 500 m safety zone around the survey vessel;
  - > Cautionary notices to mariners; and
  - > Access to current weather service information.
- The vessels are required to fly standard flags, lights (three all-round lights in a vertical line, with the highest and lowest lights being red and the middle light being white) or shapes (three shapes in a vertical line, with the highest and lowest lights being balls and the middle light being a diamond) to indicate that they are engaged in towing surveys and are restricted in manoeuvrability, and must be fully illuminated during twilight and night;
- Report any emergency situation to SAMSA;

Vessel lighting

- Lighting on board survey vessels should be reduced to the minimum safety levels to minimise stranding of pelagic seabirds on the survey vessels at night. All stranded seabirds must be retrieved and released during daylight hours;

Emissions, discharges into the sea and solid waste

- Ensure adequate maintenance of diesel motors and generators to minimise the volume of soot and unburned diesel released to the atmosphere;
- Ensure adequate maintenance of all hydraulic systems and frequent inspection of hydraulic hoses;
- Undertake training and awareness of crew members of the need for thorough cleaning up of any spillages immediately after they occur, as this would minimise the volume of contaminants washing off decks;
- Use of low toxicity, biodegradable detergents during deck cleaning to further minimise the potential impact of deck drainage on the marine environment;
- Collect deck drainage in oily water catchment systems;
- Discharge effluent (e.g. sewage and galley waste as per MARPOL requirements) into the sea as far as possible from the coast;
- Initiate an on-board waste minimisation system;
- Ensure on-board solid waste storage is secure;
- Ensure that contractors co-operate with the relevant local authority to ensure that solid and hazardous waste disposal is carried out in accordance with the appropriate laws and ordinances;

Communication and key stakeholders

- Prior to survey commencement the following key stakeholders should be consulted and informed of the proposed survey activity (including navigational coordinates of the survey area, timing and duration the proposed activities) and the likely implications thereof:
  - > Fishing industry/associations: South African Tuna Association, South African Tuna Long-Line Association, Fresh Tuna Exporters Association, South African Deep-Sea Trawling Industry Association, South African Hake Long-Line Association and South African Pelagic Fishing Industry Association; Namibian Large Pelagic Long-Line Association; and
  - > Other key stakeholders include: DAFF, Port Captains, SAMSA and South African Navy Hydrographic office.

- OK Energy must request, in writing, the South African Navy Hydrographic office to release Radio Navigation Warnings and Notices to Mariners throughout the seismic survey period. The Notice to Mariners should give notice of (1) the co-ordinates of the proposed survey area, (2) an indication of the proposed survey timeframes and day-to-day location of the survey vessel, and (3) an indication of the 500 m safety zones and the proposed safe operational limits of the survey vessel. These Notices to Mariners should be distributed timeously to fishing companies and directly onto vessels where possible;
- Ongoing notification is to be undertaken throughout the duration of survey / sampling activities with the submission of daily reports (via email) indicating the vessel's location to key stakeholders; and
- Marine mammal incidence data and data arising from the survey should be made available, if requested, to the Marine Mammal Institute, DEA: Branch Oceans and Coasts, DAFF and PASA.

7. ACTION PLAN AND PROCEDURES

This chapter lists the specific environmental protection activities and procedures required to avoid or minimise impacts on the environment from the proposed exploration programme in the Northern Cape Ultra-deep Licence Area.

The specific environmental protection activities and procedures are addressed under each of the project life cycle phases listed below:

7.1	PLANNING PHASE	7.1.1 Survey timing and scheduling
		7.1.2 Survey equipment
		7.1.3 Survey personnel
		7.1.4 Preparation of subsidiary plans
		7.1.5 Stakeholder consultation and notification
		7.1.6 Approval of EMP
7.2	ESTABLISHMENT PHASE	7.2.1 Compliance with the EMP
		7.2.2 Environmental Awareness Training
		7.2.3 Notifying other users of the sea
7.3	OPERATIONAL PHASE	7.3.1 Adherence to the EMP
		7.3.2 Communication with other users of the sea and resource managers
		7.3.3 Prevention of emergencies
		7.3.4 Dealing with emergencies including major oil spills
		7.3.5 Pollution control and waste management
		7.3.6 Equipment loss
		7.3.7 Use of helicopters
		7.3.8 Vessel lighting
		7.3.9 Seismic survey procedure and monitoring
		7.3.10 Multi-beam bathymetry survey procedure and monitoring
7.4	DECOMMISSIONING AND CLOSURE PHASE	7.4.1 Survey vessels to leave area
		7.4.2 Inform key stakeholders of survey completion
		7.4.3 Final waste disposal
		7.4.4 Information sharing
		7.4.5 Compile survey “close-out” reports

7.1	**PLANNING PHASE**						
PROJECT PHASE AND ACTIVITIES:	**ENVIRONMENTAL OBJECTIVES:**	**AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE ENVIRONMENTAL MANAGEMENT PLAN REPORT OBJECTIVES:**	✓	**RESPONSI-BILITY:**	**CONTROL MEASURES:**	**TIMING:**	**REQUIREMENT FOR "CLOSE-OUT" REPORT:**
7.1.1 SURVEY TIMING AND SCHEDULING	Minimise impact on cetaceans and fishing industry	The seismic and multi-beam bathymetry surveys should be undertaken outside of the key winter cetacean migration and breeding period, which occurs between June and November (inclusive).		OK Energy		Prior to finalisation of survey schedule / timing	
7.1.2 SURVEY EQUIPMENT	Minimise impact on cetaceans and turtles	Use 'turtle-friendly' tail buoys during seismic surveys. Alternatively, the existing tail buoys should be fitted with either exclusion or deflector 'turtle guards' to prevent turtle entrapment. The MMO shall inspect tail buoys prior to the survey to ensure guards are in place. If turtles are observed to be trapped, survey operations will be ceased until the animal can be freed from the towed equipment.		OK Energy and Contractors	MMO record of inspection	Prior to commencement of operation	
		If necessary, apply to DEA for an exemption to approach to or remain within 300 m of whales (see note below). The request for an exemption must be submitted to DEA (Xola Mfeke; email: xmfeke@environment.gov.za). <u>Note:</u> In terms of the Marine Living Resources Act, 1998 (18 of 1998): • No person may approach within 300 metres of a whale by vessel, aircraft or other means without a permit; • A vessel approached by a whale is required to distance itself at 300 m from the whale, unless in possession of a permit; • A vessel may not proceed directly through a school of dolphins or porpoises; and • No person shall attempt to feed, harass, disturb or kill great white sharks, dolphins, seals or turtles.					
		The survey vessel(s) must be fitted with Passive Acoustic Monitoring (PAM) technology, which detects animals through their vocalisations. The PAM hydrophone streamer should ideally be towed behind the airgun array to minimise the interference of vessel noise, and be fitted with two hydrophones to allow directional detection of cetaceans. It is recommended that a spare PAM cable and sensor are kept on-board should there be any technical problems with the system.					PAM operator close-out report

7.1	**PLANNING PHASE**						
PROJECT PHASE AND ACTIVITIES:	**ENVIRONMENTAL OBJECTIVES:**	**AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE ENVIRONMENTAL MANAGEMENT PLAN REPORT OBJECTIVES:**	✓	**RESPONSI-BILITY:**	**CONTROL MEASURES:**	**TIMING:**	**REQUIREMENT FOR "CLOSE-OUT" REPORT:**
7.1.3 SURVEY PERSONNEL	Minimise impact on cetaceans	Appoint an independent on-board Marine Mammal Observer (MMO) and PAM operator for the duration of the seismic surveys. The MMO and PAM operator must have experience in seabird, turtle and marine mammal identification and observation techniques. Only an MMO is required for the multi-beam bathymetry survey.		OK Energy		Prior to commencement of operation	MMO and PAM operator close-out reports
	Minimise impact on other users of the sea	Appoint an independent on-board Fisheries Liaison Officer (FLO) for the duration of the seismic surveys. The FLO must be familiar with fisheries operational in the area.					FLO close-out report
7.1.4 PREPARATION OF SUBSIDIARY PLANS	Preparation for any emergency that could result in an environmental impact	Ensure the following plans are prepared and in place: • Emergency Response Plan (including MEDIVAC plan); • Support vessel and helicopter Emergency Response Plans; • Shipboard Oil Pollution Emergency Plan (SOPEP) as required by MARPOL; and • Waste Management Plan (see contents in Section 7.3.5). In addition to the above, ensure that: • There is adequate protection and indemnity insurance cover for oil pollution incidents; and • There is a record of the vessel's seaworthiness certificate and/or classification stamp.		OK Energy and Contractors		Prior to commencement of operation	Confirm compliance and justify any omissions
7.1.5 STAKEHOLDER CONSULTATION AND NOTIFICATION	PASA notification	Compile the specific details of the exploration activities into a Survey Notification and submit to the Petroleum Agency SA (PASA). The notification should provide details on the following: • Survey lines / sampling target areas; • Number of samples; • Survey timing and duration; • Contractor details; • Vessel specifications (including relevant certification and insurance); • Emergency Response Plan;		OK Energy		14-days prior to commencement of operations	Confirm that notification was sent to PASA

7.1	PLANNING PHASE						
PROJECT PHASE AND ACTIVITIES:	**ENVIRONMENTAL OBJECTIVES:**	**AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE ENVIRONMENTAL MANAGEMENT PLAN REPORT OBJECTIVES:**	✓	**RESPONSI-BILITY:**	**CONTROL MEASURES:**	**TIMING:**	**REQUIREMENT FOR "CLOSE-OUT" REPORT:**
		• Shipboard Oil Pollution Emergency Plan (SOPEP); and • Details of MMO, PAM operator and FLO.					
	Stakeholder notification	• Notify relevant government departments and other key stakeholders of the proposed exploration activities (including navigational co-ordinates of the survey area, and timing and duration of proposed activities) and the likely implications thereof (500 m safety zone and proposed safe operational limits). • The notification must also invite stakeholders to be included on the daily report distribution list (only those included on the daily notification database will receive further notification during the survey). • Stakeholders include: > Fishing industry and associations (South African Tuna Association, South African Tuna Long-Line Association, Fresh Tuna Exporters Association, South African Deep-Sea Trawling Industry Association, South African Hake Long-Line Association and South African Pelagic Fishing Industry Association; Namibian Large Pelagic Long-Line Association); > Overlapping and neighbouring users with delineated boundaries in the oil / gas and mining industries; > SAN Hydrographic Office (Silvermine); > Government departments with jurisdiction over marine activities, particularly DAFF, DEA:BOC and PASA; and > SAMSA and local Port Captains.		OK Energy		14 days prior to commencement of operations	Provide copies of all correspondence
	Compliance with legislative requirements	> Ensure that the EMP has been approved by the Minister or delegated authority.				Prior to commencement of operations	Provide copy of approval letter

7.2	ESTABLISHMENT PHASE						
PROJECT PHASE AND ACTIVITIES:	**ENVIRONMENTAL OBJECTIVES:**	**AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE EMP OBJECTIVES:**	✓	**RESPONSI-BILITY:**	**CONTROL MEASURES:**	**TIMING:**	**REQUIREMENT FOR "CLOSE-OUT" REPORT:**
7.2.1 COMPLIANCE WITH EMP	Operator and contractor to commit to adherence to environmental protection activities and procedures	• Verify that a copy of the approved EMP is supplied to all Contractors and is on-board the survey and support vessels during the operation. • Operator to commit organisation and Contractors to meet the requirements of the EMP. • Verify procedures and systems for compliance are in place. • Verify correct equipment and personnel are available to meet the requirements of the EMP.		OK Energy and Contractors	Audit Minutes of meetings	Prior to commencement of operation	Ensure that a copy of the EMP is provided to the Seismic Contractor and that an acknowledgment of receipt form is signed
7.2.2 ENVIRONMENTAL AWARENESS TRAINING	Ensure personnel are appropriately trained	• Undertake Environmental Awareness Training to ensure the vessel's personnel are appropriately informed of the purpose and requirements of the EMP. • Verify responsibilities are allocated to personnel.		OK Energy and Contractors	Training records		Copy of attendance register
7.2.3 NOTIFYING OTHER USERS OF THE SEA	Ensure that other users are aware of the seismic survey	• OK Energy must request, in writing, the SAN Hydrographic Office (Silvermine) to release Radio Navigation Warning and Notices to Mariners throughout the seismic survey period. The Notice to Mariners should give notice of (1) the co-ordinates of the proposed survey area, (2) an indication of the proposed survey timeframes and day-to-day location of the survey vessel(s), and (3) an indication of the 500 m safety zone and the proposed safe operational limits of the survey vessel(s). • These notices should also be distributed directly to: > fishing operators through recognised fishing associations and directly to fishing vessels; and > overlapping and neighbouring users with delineated boundaries in the offshore petroleum and offshore mineral prospecting/mining industries.		OK Energy and Contractors	Copy of notices sent	Notice to mariners to be issued 24 hours prior to start	Confirm that notices were sent to relevant parties Provide copies of notices and list of those to whom these were sent

7.3	OPERATIONAL PHASE						
PROJECT PHASE AND ACTIVITIES:	**ENVIRONMENTAL OBJECTIVES:**	**AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE ENVIRONMENTAL MANAGEMENT PLAN REPORT OBJECTIVES:**	**✓**	**RESPONSI-BILITY:**	**CONTROL MEASURES:**	**TIMING:**	**REQUIREMENT FOR "CLOSE-OUT" REPORT:**
7.3.1 ADHERENCE TO THE EMP	Operate in an environmentally responsible manner	• Comply fully with the EMP (compliance would mean that all activities were undertaken successfully and details recorded); • Subscribe to the principles of an internationally acceptable Environmental Management System on-board the vessels. This includes environmental awareness training, waste management and environmental monitoring, record keeping and continuous improvement; and • Comply with the "Environmental Guidelines for Worldwide Geophysical Operations" issued by the International Association of Geophysical Contractors (IAGC).		Contractors	Self-audits	Throughout programme	Copies of self-audit reports
7.3.2 COMMUNICATION WITH OTHER USERS OF THE SEA AND RESOURCE MANAGERS	Promote cooperation and successful multiple use of the sea, including promotion of safe navigation	Daily reports shall be submitted, via email, to key stakeholders and those stakeholders that request to be notified during the survey (see Section 7.1.5). Daily reports should include, but not limited to, the following: • Survey details (incl. percentage completion & start-up procedure); • Vessel interaction; • Meteorological Conditions; • Observation times and sightings; • Waste management; and • Survey strategy (incl. survey progress and next line / sample to be acquired).		MMO	Copies of written notices and correspondence	During operations as required	Provide copies of written notices and list of those to whom it was sent
		Keep constant watch for approaching vessels during operations. Warn by radio and chase boat if required. The duties of the FLO include: • Identifying fishing vessels active in the area and associated fishing gear; • Advising on actions to be taken in the event of encountering fishing gear; • Providing back-up on-board facilitation with the fishing industry and other users of the sea; and • Daily electronic reporting on vessel activity and recording of any communication and/or interaction. In addition, the following sector-specific procedures shall be followed: • *Large pelagic long-line*: Establish communications with the known operators if drifting buoys (with radar responders) are sighted.		Officer on watch / FLO		Throughout operation	

7.3	OPERATIONAL PHASE						
PROJECT PHASE AND ACTIVITIES:	**ENVIRONMENTAL OBJECTIVES:**	**AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE ENVIRONMENTAL MANAGEMENT PLAN REPORT OBJECTIVES:**	✓	**RESPONSI-BILITY:**	**CONTROL MEASURES:**	**TIMING:**	**REQUIREMENT FOR "CLOSE-OUT" REPORT:**
		Support vessel to patrol the 500 m safety zone in order to minimise the risk of fishing vessels or gear from being entangled with or damaged by the streamers or survey vessels (seismic surveys only).		Seismic Contractor / FLO			Records of encounters with fishing boats
7.3.3 PREVENTION OF EMERGENCIES	Minimise disruption to other legitimate users of the sea by respecting their rights and the chance of emergency occurring and subsequent damage to the environment	• Co-operate with other legitimate users of the sea to minimise disruption to other marine activities. • Vessels are required to fly standard flags, lights (three all-round lights in a vertical line, with the highest and lowest lights being red and the middle light being white) or shapes (three shapes in a vertical line, with the highest and lowest lights being balls and the middle light being a diamond) to indicate that the seismic vessel is engaged in towing surveys and is restricted in manoeuvrability. • Use warning lights during twilight and at night and in periods of low visibility. • Maintain standard visual watch procedures (also see Section 7.3.2). • Maintain 500 m safety zone around survey vessel through Notices to Mariners and Navigation Warnings. • 24 hr chase boat on patrol during seismic surveying. • Radio communication to alert approaching vessels. • Use of radar equipment. • Use flares or fog horn where necessary. • Practice weekly emergency response drills. • Ensure access to current weather information. • Establish lines of communication with the following emergency response agencies/facilities: National Sea Rescue Institute and Port Captain(s).		Contractors / FLO		Throughout operation	Record any incidents outside of normal occurrence
7.3.4 DEALING WITH EMERGENCIES INCLUDING MAJOR OIL SPILLS (owing to collision, vessel break-up, refuelling	Minimise damage to the environment by implementing response procedures efficiently	• Adhere to obligations regarding other vessels in distress. • Notify SAMSA about wrecked vessels (safety and pollution) and the Department of Finance (salvage, customs, royalties). Provide location details to SAN Hydrographer. • In the event of an oil spill immediately implement emergency plans (see Section 7.1.4). In the case of an oil spill to sea with serious potential consequences to marine and human life notify (a) the		OK Energy and Seismic Contractor	Audits, Ships log, Record of Notifications	In the event of accident / spill	Record of all spills (Spill Record Book), including spill reports; emergency exercises and

7.3 OPERATIONAL PHASE

PROJECT PHASE AND ACTIVITIES:	ENVIRONMENTAL OBJECTIVES:	AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE ENVIRONMENTAL MANAGEMENT PLAN REPORT OBJECTIVES:	✓	RESPONSI-BILITY:	CONTROL MEASURES:	TIMING:	REQUIREMENT FOR "CLOSE-OUT" REPORT:
etc.)		Principal Officer of the nearest SAMSA office, (b) the DEA's Chief Directorate of Marine & Coastal Pollution Management in Cape Town and (c) Smit Amandla Marine. Information that should be supplied when reporting a spill includes: > Name and contact details of person reporting the incident; > The type and circumstances of incident, ship type, port of registry, nearest agent representing the ships company; > Date and time of spill; > Location (co-ordinates), source and cause of pollution; > Type and estimated quantity of oil spilled and the potential and probability of further pollution; > Weather and sea conditions; > Action taken or intended to respond to the incident; and > Support vessels must have the necessary spill response capability to deal with accidental spills in a safe, rapid, effective and efficient manner. • Where diesel, which evaporates relatively quickly, has been spilled, the water should be agitated or mixed using a propeller boat/dinghy to aid dispersal and evaporation. • Dispersants should not be used without authorisation of DEA. Dispersants should not be used: > On diesel or light fuel oil. > On heavy fuel oil. > On slicks > 0.5 cm thick. > On any oil spills within 5 nautical miles off-shore or in depths less than 30 metres. > In areas far offshore where there is little likelihood of oil reaching the shore. • Dispersants are most effective: > On fresh crude oils; under turbulent sea conditions (as effective use of dispersants requires mixing). > When applied within 12 hours or at a maximum of 24 hours. • The volume of dispersant application should not exceed 20-30% of the oil volume.					audit records. Incident log

7.3	OPERATIONAL PHASE						
PROJECT PHASE AND ACTIVITIES:	**ENVIRONMENTAL OBJECTIVES:**	**AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE ENVIRONMENTAL MANAGEMENT PLAN REPORT OBJECTIVES:**	✓	**RESPONSI-BILITY:**	**CONTROL MEASURES:**	**TIMING:**	**REQUIREMENT FOR "CLOSE-OUT" REPORT:**
7.3.5 POLLUTION CONTROL AND WASTE MANAGEMENT of products disposed of: into the air (exhausts, cfcs and incinerators), to sea (sewage, food, oils), to land (used oils etc, metals, plastics, glass, etc.)	Minimise pollution and maximise recycling by implementing and maintaining pollution control and waste management procedures at all times	• Implement Waste Management Plan (see Section 7.1.4). The plan must comply with legal requirements for waste management and pollution control (for air and water quality levels at sea) and ensure "good housekeeping" and monitoring practices: > General waste: - Initiate a waste minimisation system. - No disposal overboard. - Ensure on-board solid waste storage is secure. - Incinerate (non-hazardous) or transport ashore for disposal. Retain waste receipts. > Galley (food) waste: - Ensure compliance with MARPOL standards. - No disposal within 3 nm of the coast. - Disposal between 3 nm and 12 nm needs to be comminuted to particle sizes smaller than 25 mm. - Disposal beyond 12 nm requires no treatment. > Deck drainage: - Deck drainage should be collected in oily water separator systems. - Ensure that weather decks are kept free of spillage. - Mop up any spills immediately with biodegradable low toxicity detergents. - Low-toxicity biodegradable detergents should be used in cleaning of all deck spillage. - Maintain hydraulic systems and ensure that hydraulic hoses are frequently inspected. - Ensure compliance with MARPOL standards. > Machinery space drainage: - Vessels must comply with international agreed standards regulated under MARPOL. - All machinery space drainage would pass through an oil/water filter to reduce the oil in water concentration to less than 15 ppm. - Any spills should be cleaned up immediately with low-toxicity biodegradable detergents.		Contractors	Audits Registers Record Books Daily Reports	Throughout operation	Provide summary of waste record book / schedule and receipts. Manifest required for all shipments to shore. Report occurrence of minor oil spills and destination of wastes

7.3	OPERATIONAL PHASE						
PROJECT PHASE AND ACTIVITIES:	**ENVIRONMENTAL OBJECTIVES:**	**AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE ENVIRONMENTAL MANAGEMENT PLAN REPORT OBJECTIVES:**	✓	**RESPONSI-BILITY:**	**CONTROL MEASURES:**	**TIMING:**	**REQUIREMENT FOR "CLOSE-OUT" REPORT:**
		- All hydraulic systems should be adequately maintained and hydraulic hoses regularly inspected. > Sewage: - Use approved treatment plants to the MARPOL standards. - No disposal within 4 nm of the coast. - Disposal between 4 nm and 12 nm needs to be comminuted and disinfected prior to disposal into the sea. - Disposal beyond 12 nm requires no treatment. > Medical waste: Seal in aseptic containers for appropriate disposal onshore. > Metal: Send to shore for recycling or disposal. > Other waste: Incinerate (only non-hazardous waste) or send remaining waste to a licensed waste site. Ensure waste disposal is carried out in accordance with appropriate laws and ordinances. > Waste oil: Return used oil to a port with a registered facility for processing or disposal. > Wastewater: Comply with MARPOL. > Minor oil spill: Use oil absorbent. > Emissions to the atmosphere: Properly tune and maintain all engines, motors, generators and all auxiliary power to contain the minimum of soot and unburned diesel. > Other hazardous waste: Send to designated onshore hazardous disposal site. • Ensure all crew is trained in spill management.					

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7.3.6 EQUIPMENT LOSS	Minimise hazards left on the sea bed or floating in the water column, and inform relevant parties	• Keep a record of lost equipment and all items lost overboard and not recovered. • When any item that constitute a seafloor or navigation hazard is lost on the sea bed, or in the sea, a standard form must be completed which records the date and cause of loss, details of equipment type, vessel Sea Control location, sea state and weather, and the nature of the sea bed. • Submit form to SAMSA, South African Navy Hydrographic Office, relevant mining companies and fishing associations. • Request that the SAN Hydrographic office send out a Notice to Mariners with this information.		Contractosr	Incident records	Throughout operation, in the event of an incident	Provide a list of lost equipment and a copy of record sheet
7.3.7 USE OF HELICOPTERS for crew changes, servicing, etc.	Minimise disturbance / damage to marine and coastal fauna	• Establish, with pilots, flight paths that do not over-pass Ramsar sites, islands, coastal reserves, bird and seal breeding or bird breeding colonies / sanctuaries on the coast (minimum altitudes of 600 m above ground level over nature conservation areas). • Extensive coastal flights (parallel to the coast within 1 nautical mile of the shore) should also be avoided. • Report any deviations from set flight plans. • Brief all pilots on the ecological risks associated with flying over seabird and seal colonies and at a low level parallel to the coast. • Comply with aviation and authority guidelines and rules.		OK Energy and Helicopter contractor		As required	Submit copy of set flight path Copies of reports on deviations from set flight paths
7.3.8 VESSEL LIGHTING	Minimise stranding of pelagic seabirds	Lighting on-board the survey vessel(s) should be reduced to the minimum safety levels to reduce the incidence of stranded pelagic seabirds on the vessel(s) at night. All stranded seabirds shall be retrieved and released during daylight hours.		Contractors			

7.3	OPERATIONAL PHASE						
PROJECT PHASE AND ACTIVITIES:	**ENVIRONMENTAL OBJECTIVES:**	**AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE ENVIRONMENTAL MANAGEMENT PLAN REPORT OBJECTIVES:**	✓	**RESPONSI-BILITY:**	**CONTROL MEASURES:**	**TIMING:**	**REQUIREMENT FOR "CLOSE-OUT" REPORT:**
7.3.9 SEISMIC SURVEY PROCEDURE AND MONITORING	Reduce disturbance of marine life, particularly cetaceans (whales and dolphins), seals, turtles and seabirds	Joint Nature Conservation Commission (JNCC) Guidelines (2010) relative to precautions to be taken to minimise potential impacts to marine mammals and marine turtles during seismic surveys shall be followed, as appropriate. An on-board MMO and PAM operator shall be assigned to perform marine mammal observations and notifications (see Section 7.1.3)		OK Energy and Seismic Contractor			MMO & PAM operator close-out report
		Ensure the lowest practicable seismic source array volume to achieve the geophysical objective is defined and used throughout the survey period.		OK Energy		Prior to survey operations	
		Airgun use should be prohibited outside the survey area.		OK Energy and Seismic Contractor		Prior to survey operations	
		Pre-survey watch: • Undertake pre-survey watch (prior to soft-starts) in order to confirm there is no seal, turtle or cetacean activity within 500 m or no diving seabirds (specifically large flocks consisting of several hundred birds) within 500 m of the seismic source array. This is to be undertaken both visually and with PAM technology during the day and using only PAM technology at night and during periods of poor visibility. Should a technical problem be encountered with PAM during surveying, visual watches shall be maintained during the day and night-vision/infra-red binoculars used at night until such time as PAM is repaired. • For cetaceans, the period of confirmation should be for at least 30 minutes[1] prior to the commencement of the "soft-start" procedures, so that deep or long diving species can be detected. However, in the case of seals, which are often attracted to survey vessels, the normal "soft-start" procedures should be allowed to commence, if after a period of at least 30 minutes seals are still within 500 m of the seismic source array.		MMO/ PAM operator	Records of pre-watches	Prior to "soft-start" procedures	MMO & PAM operator close-out report

[1] The JNCC Guidelines state that this should be extended to 60 minutes for deep-diving species when surveying in deeper water (>200 m). However, as PAM would be operational during the pre-watch period deep diving species would already be identified within the 30 minute period proposed.

7.3	OPERATIONAL PHASE						
PROJECT PHASE AND ACTIVITIES:	**ENVIRONMENTAL OBJECTIVES:**	**AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE ENVIRONMENTAL MANAGEMENT PLAN REPORT OBJECTIVES:**	✓	**RESPONSI-BILITY:**	**CONTROL MEASURES:**	**TIMING:**	**REQUIREMENT FOR "CLOSE-OUT" REPORT:**
		"Soft-start" procedure: • All initiations of seismic surveys must be carried out as "soft-starts" for a minimum of 20 minutes. This requires that the sound source be ramped from low to full power rather than initiated at full power, thus allowing a flight response by marine fauna to outside the zone of injury or avoidance. • Where possible, "soft-starts" should be planned so that they commence within daylight hours.		Seismic Contractor	Records of "soft-start" procedures	Prior to surveying at full power	MMO & PAM operator close-out report
		Break in seismic acquisition: • All breaks in seismic acquisition of longer than 20 minutes must be followed by the 30-minute pre-shoot watch and a "soft-start" procedure of at least 20 minutes prior to the survey operation continuing. • Breaks shorter than 20 minutes should be followed by a visual scan for marine mammals within the 500 m mitigation zone (not a 30 minute pre-shoot watch) and a "soft-start", of similar duration.		Seismic Contractor	Records of pre-watches and "soft-start" procedures	After breaks in seismic acquisition	MMO & PAM operator close-out report
		Monitoring: • MMO is to monitor survey operations visually during the day. Duties include: > Monitoring marine faunal activity during daytime surveying; > Confirm that there is no marine mammal activity within 500 m of the seismic source array prior to commencing with the "soft-start" procedures; > Observing and recording responses of marine fauna to the seismic surveys, including incidence and behaviour, and any mortality as a result of the surveys. Data captured should include species identification, position (latitude/longitude), distance from the vessel, swimming speed and direction (if applicable), any obvious changes in behaviour (e.g. startle responses or changes in surfacing/diving frequencies, breathing patterns) and incidence of feeding behaviour of predators within the hydrophone streamers as a result of the		MMO/ PAM operator	Records of marine fauna observations and "soft-start" procedures	Throughout survey operations	MMO & PAM operator close-out report

7.3	OPERATIONAL PHASE						
PROJECT PHASE AND ACTIVITIES:	**ENVIRONMENTAL OBJECTIVES:**	**AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE ENVIRONMENTAL MANAGEMENT PLAN REPORT OBJECTIVES:**	**✓**	**RESPONSI-BILITY:**	**CONTROL MEASURES:**	**TIMING:**	**REQUIREMENT FOR "CLOSE-OUT" REPORT:**
		survey activities; > Recording survey activities, including sound levels, "soft-start" procedures and survey periods (duration); > Requesting the temporary termination of seismic acquisition, as appropriate; > Recording meteorological conditions; > Monitoring compliance with international marine pollution regulations (MARPOL 73/78 standards); and > Preparing daily reports of all observations. • PAM operator is to monitor at night and during periods of poor visibility. Duties include: > Ensuring that hydrophone streamers are optimally placed within the towed array; > Monitoring marine cetacean activity during night time surveying or during period of poor visibility; > Confirming that there is no marine mammal activity within 500 m of the seismic source array prior to commencing with the "soft-start" procedures; > Recording species identification, position (latitude/longitude) and distance from the vessel, where possible; > Recording survey activities, including sound levels, "soft-start" procedures and survey periods (duration); and > Requesting the temporary termination of seismic acquisition, as appropriate.					

7.3	OPERATIONAL PHASE						
PROJECT PHASE AND ACTIVITIES:	**ENVIRONMENTAL OBJECTIVES:**	**AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE ENVIRONMENTAL MANAGEMENT PLAN REPORT OBJECTIVES:**	✓	**RESPONSI-BILITY:**	**CONTROL MEASURES:**	**TIMING:**	**REQUIREMENT FOR "CLOSE-OUT" REPORT:**
		Temporary termination of seismic acquisition: • During seismic acquisition the sound source should be terminated when: > obvious negative changes to turtle, seal and cetacean behaviour is observed; > turtles or cetaceans are observed within 500 m of the active sound source and appear to be approaching the sound source; or > there is visual evidence of mass mortality of fish or mortality / injuries to seabirds, seals, turtles or cetaceans as a direct result of the seismic survey. • The survey should be terminated until such time as the MMO / PAM operator confirms that: > Turtles or cetaceans have moved to a point that is more than 500 m from the sound source; > Despite continuous observation, 30 minutes has elapsed since the last sighting of the turtles or cetaceans within 500 m of the sound source; and > Risks to seabirds, turtles, seals or cetaceans have been significantly reduced. • A log of all termination decisions must be kept.		Seismic Contractor and MMO / PAM operator	Termination log	Throughout survey operations	MMO & PAM operator close-out report
7.3.10 MULTI-BEAM BATHYMETRY SURVEY PROCEDURE AND MONITORING	Reduce disturbance of marine life, particularly cetaceans (whales and dolphins), seals, turtles and seabirds	• An onboard Independent Observer(s) must be appointed for the duration of the multi-beam survey to act as the FLO and MMO (see Section 7.3.9 for duties). • Surveying must only commence once it has been confirmed by the MMO (visually during the day) that there is no large cetacean activity within 500 m of the vessel for a 15-minute period. • If the source level is greater than 210 dB re 1 μPa at 1 m the following is recommended: ○ Where equipment allows, a "soft-start" procedure shall be implemented for a period of 20 minutes. Where this is not					

7.3	OPERATIONAL PHASE						
PROJECT PHASE AND ACTIVITIES:	**ENVIRONMENTAL OBJECTIVES:**	**AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE ENVIRONMENTAL MANAGEMENT PLAN REPORT OBJECTIVES:**	✓	**RESPONSI-BILITY:**	**CONTROL MEASURES:**	**TIMING:**	**REQUIREMENT FOR "CLOSE-OUT" REPORT:**
		possible, the equipment should be turned on and off over a 20 minute period to act as a warning signal and allow cetaceans to move away from the sound source; o "Soft-starts" should, as far as possible, be planned to commence within daylight hours; o "Soft-start" procedures must only commence once it has been confirmed by the MMO (visually during the day) that there is no large cetacean activity within 500 m of the vessel for a 15-minute period. o "Soft-start" procedures must also be implemented after breaks in surveying (for whatever reason) of longer than 20 minutes. Breaks of shorter than 20 minutes should be followed by a "soft-start" of similar duration; and o Should surveying in the sensitive cetacean period be unavoidable, PAM technology must be implemented 24 hours a day from beginning of June to end of November. If there is a technical problem with PAM during surveying, visual watches must be maintained by the MMO during the day and night-vision/infra-red binoculars must be used at night while PAM is being repaired. A PAM operator must be appointed during this period (see Section 7.3.9 for duties). • Surveying should be terminated temporarily if cetaceans show obvious negative behavioural changes within 500 m of the survey vessel or equipment; and • The survey should be terminated until such time the MMO confirms that cetaceans have moved to a point that is more than 500 m from the source or despite continuous observation, 15 minutes has elapsed since the last sighting of the cetaceans within 500 m of the source.					

7.4	DECOMMISSIONING AND CLOSURE PHASE						
PROJECT PHASE AND ACTIVITIES:	**ENVIRONMENTAL OBJECTIVES:**	**AUDITABLE MANAGEMENT ACTIONS TO BE TAKEN TO MEET THE ENVIRONMENTAL MANAGEMENT PLAN REPORT OBJECTIVES:**	✓	**RESPONSI-BILITY:**	**CONTROL MEASURES:**	**TIMING:**	**REQUIREMENT FOR "CLOSE-OUT" REPORT:**
7.4.1 SURVEY VESSELS TO LEAVE AREA	Leave survey area as it was prior to survey	Ensure that all deployed equipment is retrieved.		Contractors		On completion of survey	
7.4.2 INFORM KEY STAKEHOLDERS OF SURVEY COMPLETION	Ensure that relevant parties are aware that the seismic campaign is complete	Inform all key stakeholders (see Section 7.1.5) that the survey has been completed and the vessels are off location.		OK Energy		Within two weeks after completion of survey	Copies of notification documentation required.
7.4.3 FINAL WASTE DISPOSAL	Minimise pollution and ensure correct disposal of waste	Dispose all waste retained on-board at a licensed waste site using a licensed waste disposal contractor.		Contractors	Waste receipts	When vessel is in port	Receipt required from contractor
7.4.4 INFORMATION SHARING	Information sharing	Take steps to share data collected during the survey (e.g. marine mammal incidence and behaviour), if requested, to resource managers (the Marine Mammal Institute, DEA: BOC, DAFF and PASA). Provide a log of hourly seismic survey vessel positioning data to the Namibian government task force for use in research into the potential impact of seismic survey activities on migration routes of albacore tuna along the southwest coast of Africa.		OK Energy		As requested	
7.4.5 COMPILE SEISMIC SURVEY/EXPLORATION ACTIVITY "CLOSE-OUT" REPORTS	Ensure corrective action and compliance and contribute towards improvement of EMP implementation	• Compile "close-out" reports at the end of the exploration activities. • The "close-out" reports must be based on requirements of the monitoring and EMP. • Provide information / records as indicated in the "close-out" report column of the EMP within 90 days of the end of the survey. • Provide a copy of the report to PASA.		OK Energy		Within 90 days post surveying	

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