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ENVIRONMENTAL MANAGEMENT PROGRAMME REPORT

FOR SOUTH AFRICAN SEA AREAS 2C, 3C, 4C AND 5C

Applicant:

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EXPERTISE AND DECLARATION OF INDEPENDENCE

This report was prepared by Dr Andrea Pulfrich of Pisces Environmental Services (Pty) Ltd. Andrea has a PhD in Fisheries Biology from the Institute for Marine Science at the Christian-Albrechts University, Kiel, Germany.

As Director of Pisces since 1998, Andrea has considerable experience in undertaking specialist environmental impact assessments, baseline and monitoring studies, and Environmental Management Programmes relating to marine diamond mining and dredging, hydrocarbon exploration and thermal/hypersaline effluents. She is a registered Environmental Assessment Practitioner and member of the South African Council for Natural Scientific Professions, South African Institute of Ecologists and Environmental Scientists, and International Association of Impact Assessment (South Africa).

This Environmental Management Programme Report was compiled on behalf of Belton Park Trading 127 (Pty) Ltd as part of their applications for Prospecting Rights in the South African Sea Areas 2 - 5C off the West Coast of South Africa. I do hereby declare that Pisces Environmental Services (Pty) Ltd is financially and otherwise independent of the Applicants.

Andrea Pulfrich

Dr Andrea Pulfrich

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PART 1: GENERAL INFORMATION

1.1 DETAILS OF THE CURRENT MINERAL RIGHTS HOLDER

De Beers Consolidated Mines Ltd

PO Box 616

Kimberley 8300

Responsible Persons:	Mining and Property Titles Administrator
	Tel: Kimberley (053) 8394248
	Fax: Kimberley (053) 8394210

1.2 DETAILS OF THE PROSPECTING PERMIT APPLICANT

Belton Park Trading 127 (Pty) Ltd

36 Silverstone Road, Killarney Gardens

7441 Cape Town, South Africa

Tel: +27 21 5575941 Fax: +27 21 5567594

Responsible Persons:	Peter Looijen	+27 (0)83 3752217
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1.3 DETAILS OF THE OFFSHORE OPERATOR

International Mining and Dredging Holding Limited

36 Silverstone Road, Killarney Gardens

7441 Cape Town, South Africa

Tel: +27 21 5575941 Fax: +27 21 5567594

1.4 DETAILS OF PROSPECTING APPLICATIONS

Belton Park Trading 127 (Pty) Ltd, a company of the International Mining and Dredging Holding Limited group (IMDH), have submitted applications to the Department of Mineral Resources (DMR) for Prospecting Rights for marine diamonds in the South African Sea Areas concessions 2C, 3C, 4C and 5C. The DMR Reference Numbers for the various applications are:

- 2C: NC30/5/1/1/2/10951PR
- 3C: NC30/5/1/1/2/10950PR

- 4C: NC30/5/1/1/2/10949PR
- 5C: NC30/5/1/1/2/10948PR

As part of the application process it is necessary to prepare Environmental Management Programme Reports (EMPRs) in terms of Section 39 of the Mineral and Petroleum Resources Development Act (28/2002) and in terms of Regulations 3 and 48 - 55 of GN R 527 of the MPRDA, to be submitted to the DMR for approval.

1.5 Regional Setting

1.5.1 Details of the Concession Areas

The concession areas are situated some 500 km north of Cape Town, with the inshore boundary 5 km seaward of the coastal towns of Kleinzee in the south and Alexander Bay in the north (Figure 1). The C-concessions extend offshore to approximately the 200 m depth contour

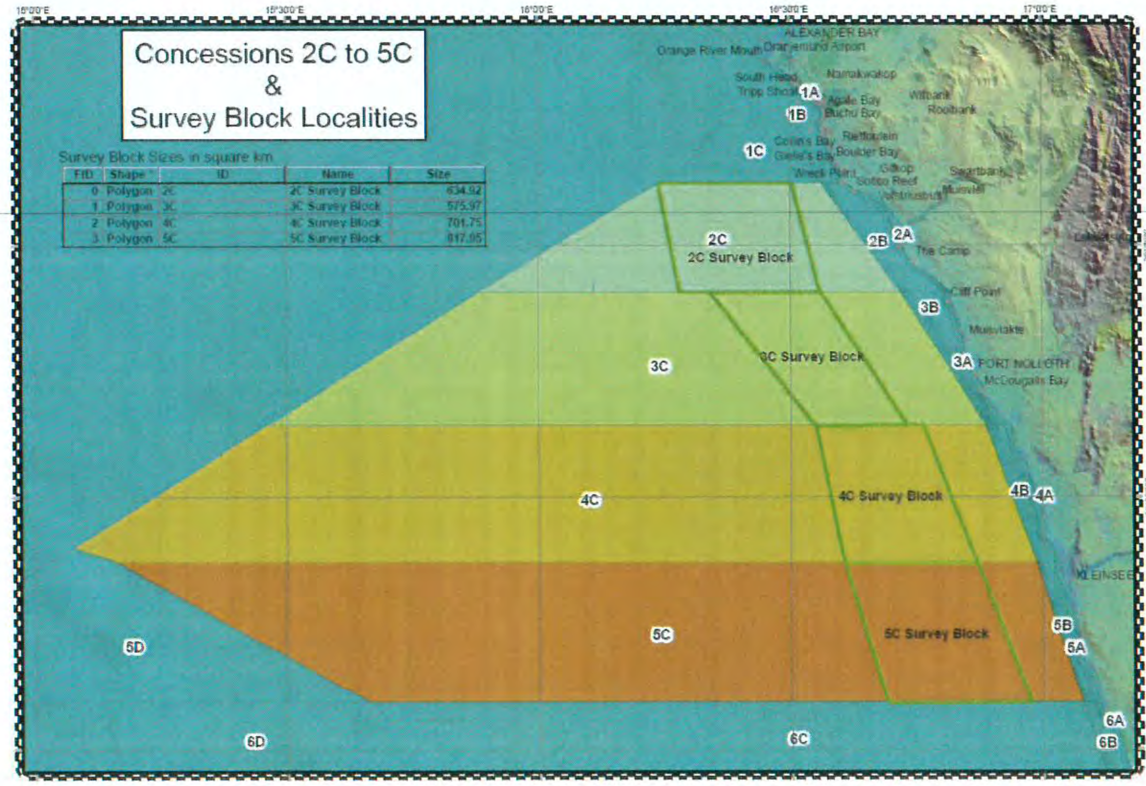

Figure 1: Location of the SASA concessions 2C- 5C, showing proposed geophysical survey blocks (green polygons).

The x- and y-coordinates of the boundary points, expressed in UTM zone 33S and WGS84 chart datum, are provided in Table 1. The total area for each concession is also given.

Table 1: **Co-ordinates (in UTM 33S and WGS 84) of the boundary points of the four concessions to which applications for prospecting permits have been lodged.**

Concession	x-coord.	y-coord.	Latitude	Longitude	Total Area (km²)
2C	620783.18	6805246.41	28.875°S	16.239°E	1 369.6
	652218.31	6804921.90	28.874°S	16.561°E	
	667385.75	6780664.00	29.091°S	16.720°E	
	585438.65	6781567.53	29.091°S	15.878°E	
3C	585438.75	6781567.51	29.091°S	15.878°E	3 253.6
	667385.75	6780664.00	29.091°S	16.720°E	
	683369.25	6751082.00	29.356°S	16.889°E	
	544603.81	6752468.50	29.356°S	15.460°E	
4C	544603.81	6752468.50	29.356°S	15.460°E	4 962.1
	683369.25	6751082.00	29.356°S	16.889°E	
	692671.62	6720707.50	29.629°S	16.990°E	
	515865.19	6722386.00	29.628°S	15.164°E	
	507262.56	6725780.50	29.598°S	15.075°E	
5C	515865.19	6722386.00	29.628°S	15.164°E	4 790.4
	692671.62	6720707.50	29.629°S	16.990°E	
	701038.75	6689901.50	29.905°S	17.082°E	
	563904.56	6691557.00	29.905°S	15.662°E	

1.5.2 Name & location of the nearest coastal towns, harbours and airfields

The closest coastal towns are Alexander Bay, Port Nolloth and Kleinzee (Figure 1), and Oranjemund in Namibia. Although both Alexander Bay and Kleinzee have airstrips, no routine commercial flights connect to them. Oranjemund has an airport with routine flights landing from Lüderitz and Windhoek. Port Nolloth and Alexander Bay have small-boat harbours, with the harbour at Port Nolloth likely to be capable of accommodating the survey vessel.

1.5.3 Location of onshore logistic facilities

The head office of Belton Park Trading 127 (Pty) Ltd is in Killarney Gardens, in Cape Town.

The survey vessel will remain at sea for only a few weeks at a time, so there is no necessity to rotate and relieve the crew. Crew joining the vessel will be transported by road to Port Nolloth, where they will board the vessel.

Normal industrial activities for maintaining the seaworthiness of the survey vessel will be done in Cape Town harbour, where quay and dry dock space will be hired from the port authorities as required.

1.5.4 Location of other projects/activities in the concession areas and in adjacent areas

The inshore portions of Concessions 2C, 3C, 4C and 5C constitute Mining Licence MPT 25/2011, which is currently held by De Beers Consolidated Mines (Pty) Ltd (DBCM) (Figure 1.1).

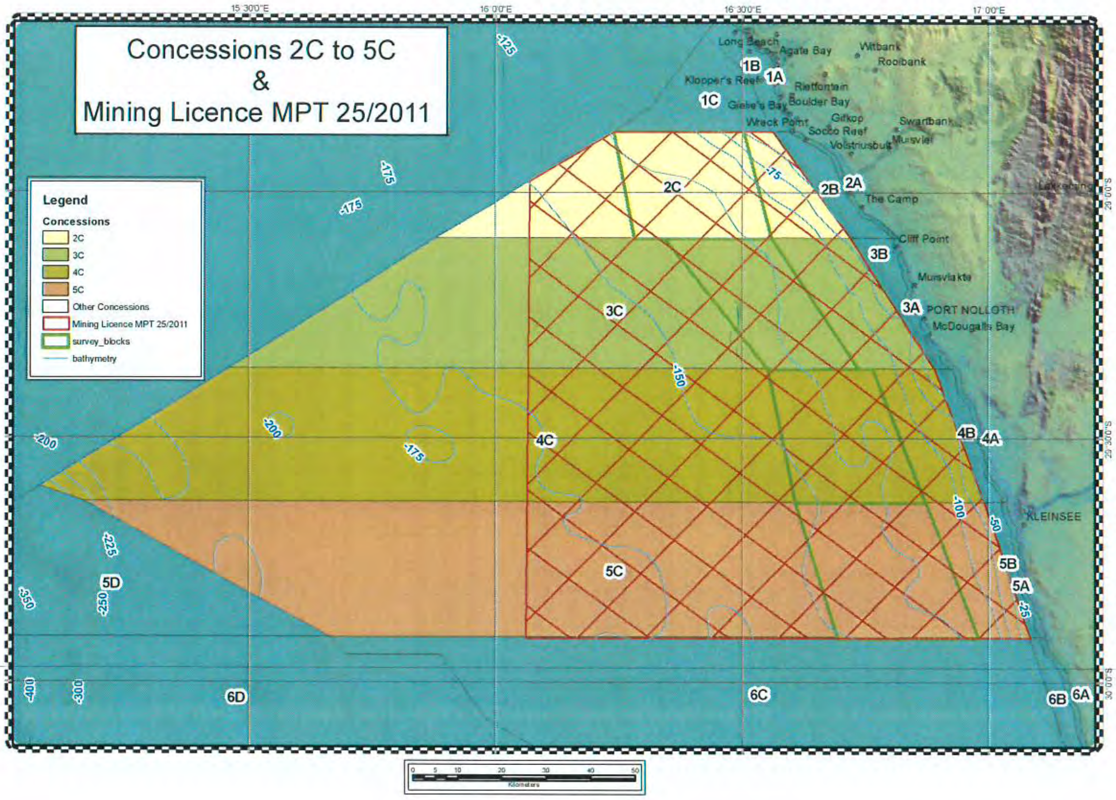

Figure 1.1 Localion and Extent of Mining Licence MPT 25/2011

De Beers Marine (Pty) Ltd, under contract to the right holder, has since 1984 been prospecting extensively in this area. Following mining between 2007 and 2010 by De Beers Marine, a decision was, however, taken by DBCM to relinquish the mining right. Other marine resource users in the area include the rights holders and operators of adjacent marine diamond concessions. The adjacent rights holders are provided in Table 2.

Table 2: Neighbouring mineral rights holders.

Area	Rights Holder	Valid until
1(a)	Alexkor Bpk	
1(b)	Alexkor Bpk	
1(c)	Alexkor Bpk	
2(a)	Alexkor Bpk	
2(b)	Trans Hex Operations (Pty) Ltd	

3(a)	Alexkor Bpk	
3(b)	Trans Hex Operations (Pty) Ltd	
4(a)	Alexkor Bpk	
4(b)	Alexkor Bpk	
5(a)	Trans Hex Operations (Pty) Ltd	
5(b)	Trans Hex Operations (Pty) Ltd	
5(d)	Vacant	
6(a)	Trans Hex Operations (Pty) Ltd	
6(b)	Trans Hex Operations (Pty) Ltd	
6(c)	Ocean Diamond Mining 6c Pty Ltd	
6(d)	Vacant	

Other users of the offshore areas include ships in transit, the commercial fishing industry and hydrocarbon (oil and gas) licence block holders. Concessions 2C, 3C, 4C and 5C fall within the Block 1 offshore petroleum lease area, currently held by PetroSA. Recreational use of the survey area is negligible due to its location offshore.

1.6 Brief Description of the Proposed Project

1.6.1 Prospecting Target Mineral

Target Mineral : Diamond

1.6.2 Extent of Prospecting Target Area

2C: 634.9 km^2

3C: 576.0 km^2

4C: 701.8 km^2

5C: 817.1 km^2

1.6.3 Proposed Prospecting Method

Geophysical Surveys using:

- a multibeam echosounder; and
- a parametric sub-bottom profiler.

1.6.4 Planned Prospecting Duration

Geophysical surveying will be conducted over a total period of four months for all four of the concessions.

PART 2: MOTIVATION FOR THE PROJECT

2.1 BENEFITS OF THE PROJECT

2.1.1 Estimate of Expenditure

The estimated expenditure required to realise the proposed geophysical surveys and conduct the subsequent analysis of data is R1.6 million. This will cover Phase I , which is anticipated to run over a period of 12 months (see Section 4.2 for details).

2.1.3 Estimate of the employee strength at full production

Employment will escalate as the project progresses, with anticipated employee strength reaching 250 on the vessels and at Headquarters in Cape Town in year five.

2.1.4 Estimate of the multiplier effect on the local, regional and national economy

At this early stage it is not possible to estimate the multipier effect on the economy. Should mining be possible following the exploration work, it is expected to bring considerable revenue to the local and national fiscus through royalties and taxes.

2.2 CONSIDERATION OF PROJECT ALTERNATIVES

The following alternative aspects have been considered for the proposed geophysical surveying:

- Process / operation - what technology is most suitable;
- Scheduling - what time of year should the geophysical surveying take place; and
- The "no-project" alternative.

2.2.1 AlternativeTechnology

The multibeam echosounding and sub-bottom profiling equipment fitted to the survey vessel is state-of-the-art technology and no feasible alternatives exist. The only possible alternative would be to use a towfish to collect the "Chirp" seismic data. Towed equipment, however, poses a potential antanglement hazard to marine mammals and turtles. Hull-mounted systems are therefore the preferred alternative.

2.2.2 Scheduling

Consideration should be given to scheduling the geophysical surveys during the period December to May, thereby avoiding the period when migratory whales can be expected in the area. This is particularly important considering the potential cumulative impacts of acoustic disturbance to marine mammals

2.2.3 "No-Project" Alternative

The "No-Project" alternative is the non-occurrence of the proposed project. Whereas this option would cause no negative impacts on the natural environment (e.g. disturbance of marine fauna), it would imply a loss of opportunity to establish whether further viable offshore diamond resources exist, prevent any socio-economic benefits, and would result in substantial loss in revenue, and employment opportunities.

PART 3: DESCRIPTION OF THE BASELINE ENVIRONMENT

The descriptions of the physical and biological marine environments along the South African West Coast focus primarily on the study area between the Orange River mouth and Hondeklipbaai. The purpose of this environmental description is to provide the marine baseline environmental context within which the proposed prospecting operations will take place. The summaries presented below are based on information gleaned from Lane & Carter (1999), Morant (2006), and Penney *et al.* (2007).

3.1 GEOPHYSICAL CHARACTERISTICS

3.1.1 Bathymetry

The continental shelf along the West Coast is generally wide and deep, although large variations in both depth and width occur. The shelf maintains a general NNW trend, widening north of Cape Columbine and reaching its widest off the Orange River (180 km) (Figure 2). Between Cape Columbine and the Orange River, there is usually a double shelf break, with the distinct inner and outer slopes, separated by a gently sloping ledge. The immediate nearshore area consists mainly of a narrow (about 8 km wide) rugged rocky zone, sloping steeply seawards to a depth of around 80 m. The middle and outer shelf typically lacks relief, sloping gently seawards before reaching the shelf break at a depth of ~300 m.

Banks on the continental shelf include the Orange Bank (Shelf or Cone), a shallow (160 - 190 m) zone that reaches maximal widths (180 km) offshore of the Orange River, and Child's Bank, situated ~150 km offshore at about 31°S. Tripp Seamount is a geological feature to the west of the western extent of Concession 5C (Figure 2), which rises from ~1,000 m to a depth of 150 m.

3.1.2 Coastal and Inner-shelf Geology and Seabed Geomorphology

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 surface 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 (Figure 3). An ~500-km long mud belt (up to 40 km wide, and of 15 m average thickness) is situated over the inner edge of the middle shelf between the Orange River and St Helena Bay (Birch *et al.* 1976). Further offshore, sediment is dominated by muddy sands, sandy muds, mud and some sand. 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. As these sediments are generally transported northward, most of the sediment in the project area is 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 South African West Coast coastal plain.

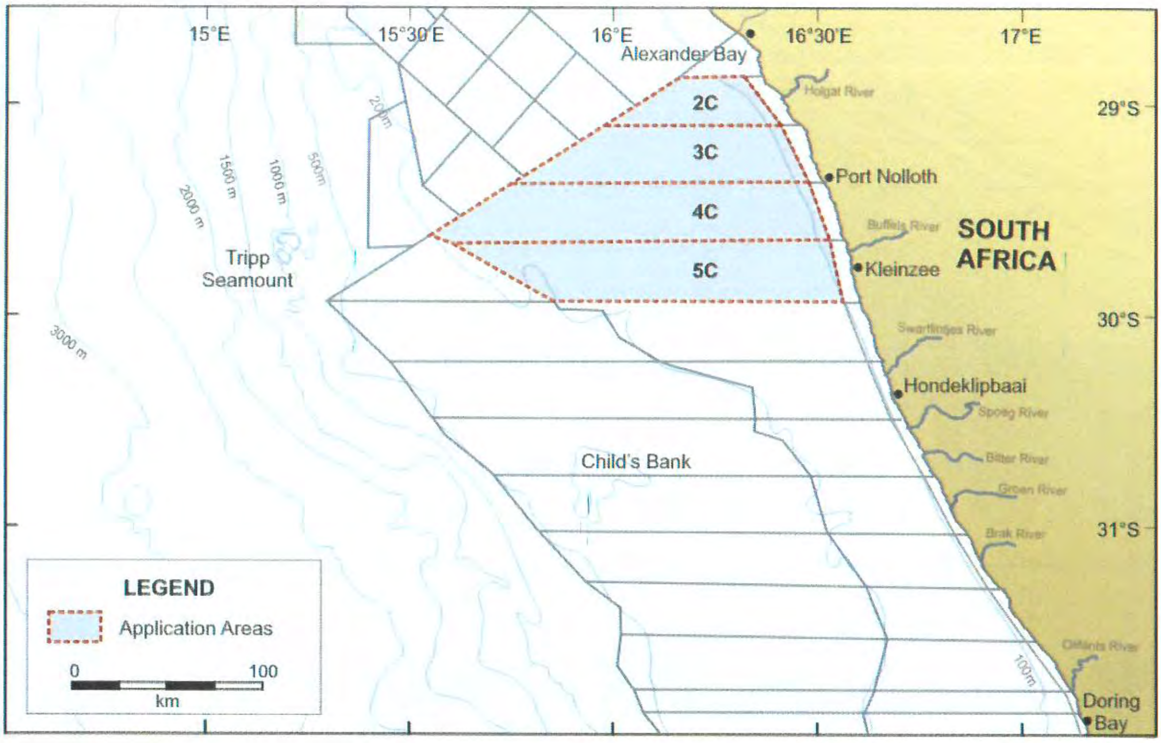

Figure 2: **Bathymetry in the general project area showing proximity of prominent seabed features, and the application areas in relation to other SASA concessions.**

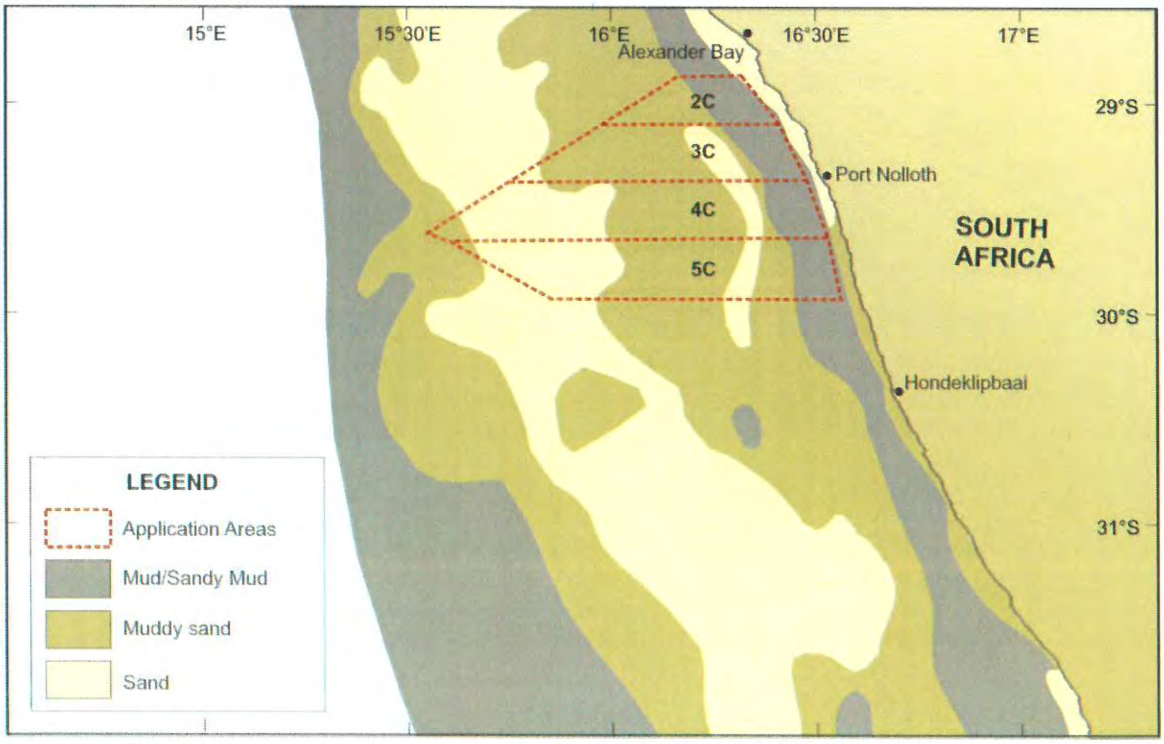

Figure 3: **Sediment distribution on the continental shelf in the general project area (Adapted from Rogers 1977).**

3.2 BIOPHYSICAL CHARACTERISTICS

3.2.1 Wind Patterns

Winds are one of the main physical drivers of the nearshore Benguela region, both on an oceanic scale, generating the heavy and consistent south-westerly swells that impact this coast, and locally, contributing to the northward-flowing longshore currents, and being the prime mover of sediments in the terrestrial environment. Physical processes are characterised by the average seasonal wind patterns, and substantial episodic changes in these wind patterns have strong effects on the entire Benguela region.

The prevailing winds in the Benguela region are controlled by the perennial South Atlantic subtropical anticyclone, the eastward moving mid-latitude cyclones south of southern Africa, and the seasonal atmospheric pressure field over the subcontinent. The south Atlantic anticyclone undergoes seasonal variations, being strongest in the austral summer, when it also attains its southernmost extension, lying south west and south of the subcontinent. In winter, the south Atlantic anticyclone weakens and migrates north-westwards.

These seasonal changes result in substantial differences between the typical summer and winter wind patterns in the region, as the southern hemisphere anti-cyclonic high-pressures system, and the associated series of cold fronts, moves northwards in winter, and southwards in summer. The strongest winds occur in summer, during which winds blow 99% of the time Virtually all winds in summer come from the southeast to south-west (Figure 4; supplied by CSIR), strongly dominated by southerlies which occur over 40% of the time, averaging 20 - 30 kts and reaching speeds in excess of 100 km/h (60 kts). South-easterlies are almost as common, blowing about one-third of the time, and also averaging 20 - 30 kts. The combination of these southerly/south-easterly winds drives the offshore movements of surface water, and the resultant strong upwelling of nutrient-rich bottom waters, which characterise this region.

Winter remains dominated by southerly to south-easterly winds, but the closer proximity of the winter cold-front systems results in a significant south-westerly to north-westerly component (Figure 4). This 'reversal' from the summer condition results in cessation of upwelling, movement of warmer mid-Atlantic water shorewards and breakdown of the strong thermoclines which develop in summer. There are more calms in winter, occurring about 3% of the time, and wind speeds generally do not reach the maximum speeds of summer. However, the westerlies winds blow in synchrony with the prevailing south-westerly swell direction, resulting in heavier swell conditions in winter.

3.2.2 Large-Scale Circulation and Coastal Currents

The West Coast is strongly influenced by the Benguela Current, with current velocities in continental shelf areas ranging between 10-30 cm/s (Boyd & Oberholster 1994). On its western side, flow is more transient and characterised by large eddies shed from the retroflection of the Agulhas Current. The Benguela current widens northwards to 750 km, with flows being predominantly wind-forced, barotropic and fluctuating between poleward and equatorward flow (Shillington *et al.* 1990; Nelson & Hutchings 1983). The long-term mean current residual is in an approximate northwest (alongshore) direction, whereas near-bottom shelf flow is mainly poleward (Nelson 1989) with low velocities of typically 5 cm/s.

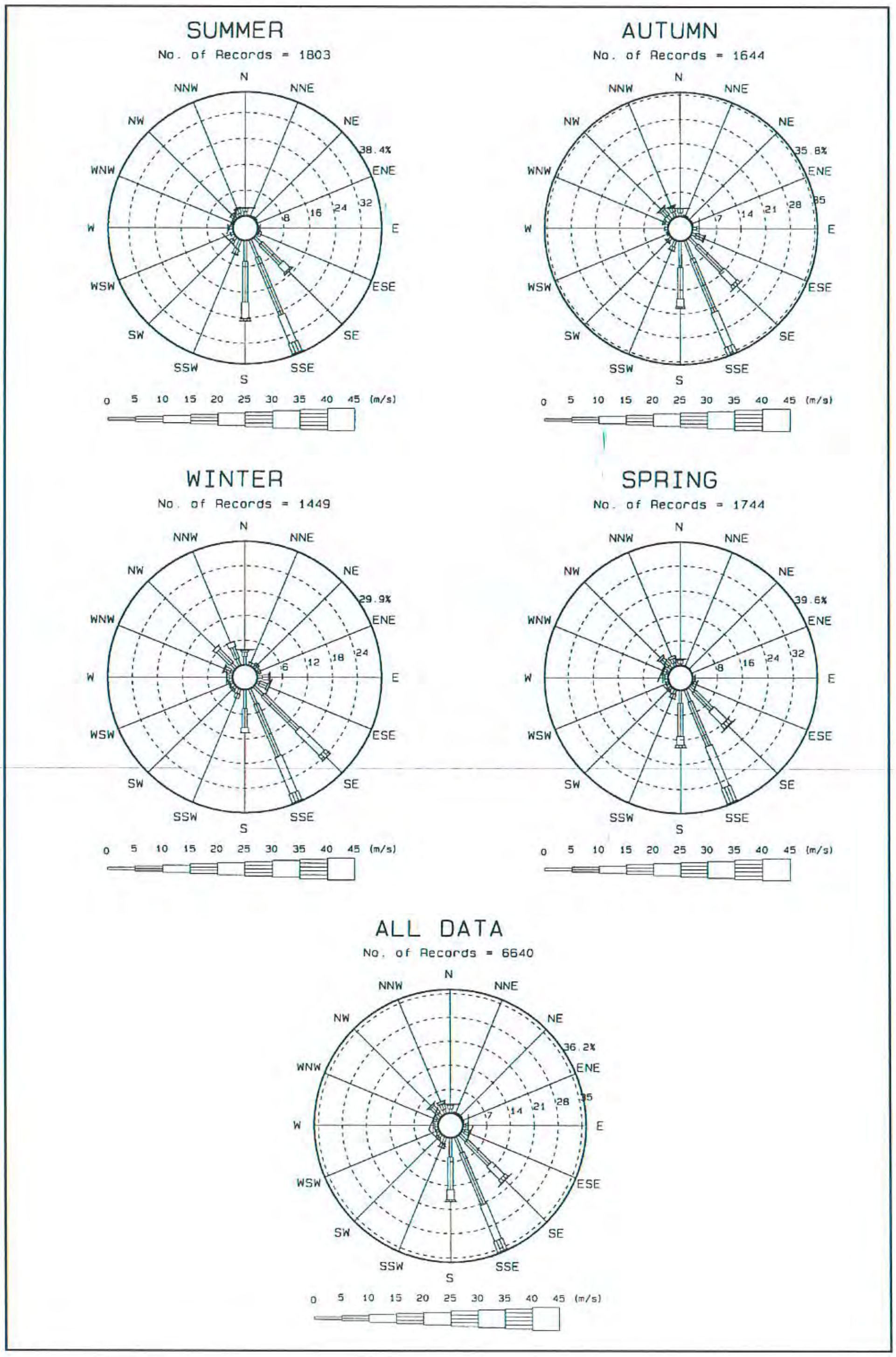

Figure 4: VOS Wind Speed vs Wind Direction data for the offshore area 28°-29°S; 15°-16°E (Oranjemund) (Source: Voluntary Observing Ship (VOS) data from the Southern Africa Data Centre for Oceanography (SADCO)).

The major feature of the Benguela Current Coastal is upwelling and the consequent high nutrient supply to surface waters leads to high biological production and large fish stocks. The prevailing longshore, equatorward winds move nearshore surface water northwards and offshore. To balance the displaced water, cold, deeper water wells up inshore. Although the rate and intensity of upwelling fluctuates with seasonal variations in wind patterns, the most intense upwelling tends to occur where the shelf is narrowest and the wind strongest. There are three upwelling centres in the southern Benguela, namely the Namaqua (30°S), Cape Columbine (33°S) and Cape Point (34°S) upwelling cells (Taunton-Clark 1985) (Figure 7; bottom left). Upwelling in these cells is seasonal, with maximum upwelling occurring between September and March. An example of one such strong upwelling event in December 1996, followed by relaxation of upwelling and intrusion of warm Agulhas waters from the south, is shown in the satellite images in Figure 5.

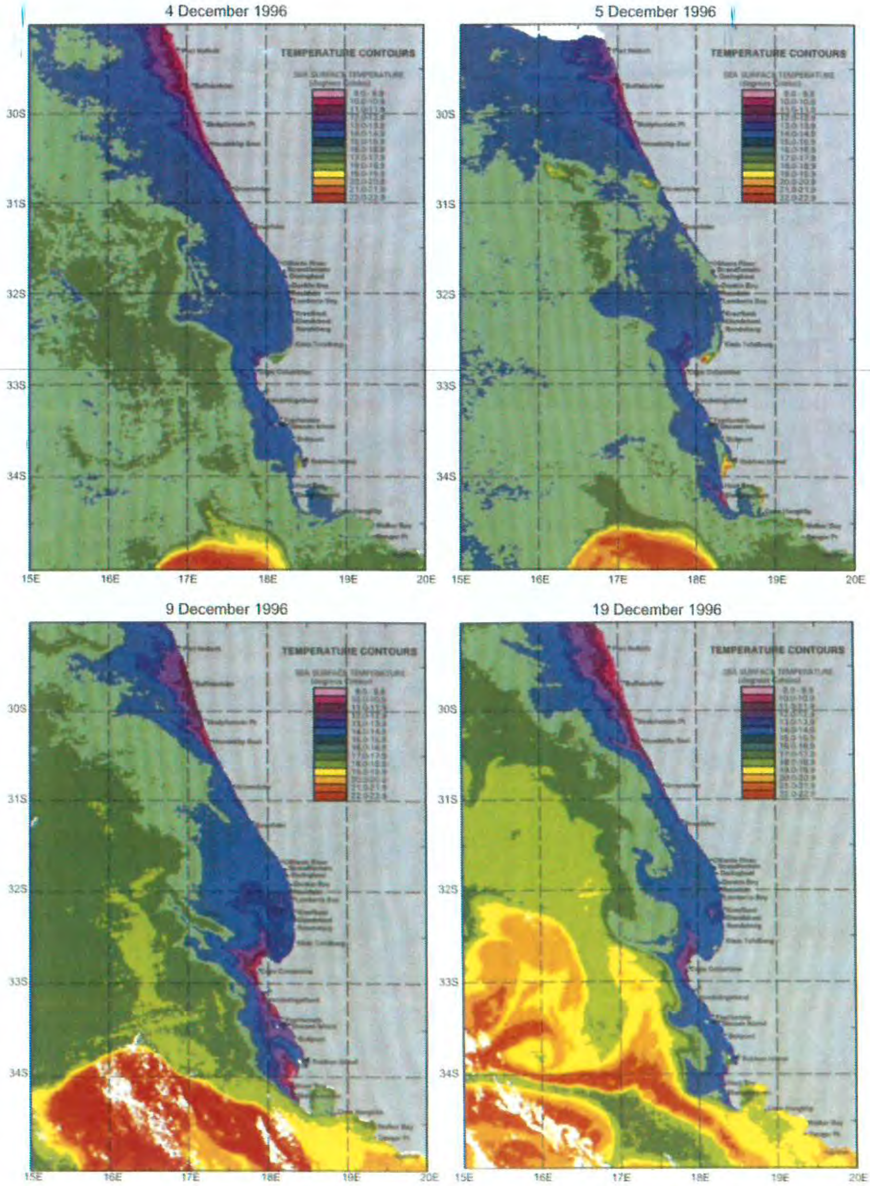

Figure 5: Satellite sea-surface temperature images showing upwelling intensity along the South African west coast on four days in December 1996 (from Lane & Carter 1999).

3.2.3 Waves and Tides

Most of the west coast of southern Africa is classified as exposed, experiencing strong wave action, rating between 13-17 on the 20 point exposure scale (McLachlan 1980). Much of the coastline is therefore impacted by heavy south-westerly swells generated in the roaring forties, as well as significant sea waves generated locally by the prevailing southerly winds. The peak wave energy periods fall in the range 9.7 - 15.5 seconds.

The wave regime along the southern African west coast shows only moderate seasonal variation in direction, with virtually all swells throughout the year coming from the SW - S direction (Figure 6). Winter swells are strongly dominated by those from the SW - 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.

Summer swells tend to be smaller on average (~2 m), with a more pronounced southerly component. These southerly swells tend to be wind-induced, with shorter wave periods (~8 seconds), and are generally steeper than swell waves (CSIR 1996).

In common with the rest of the southern African coast, tides are semi-diurnal, with a total range of some 1.5 m at spring tide, but only 0.6 m during neap tide periods.

3.2.4 Water

South Atlantic Central Water (SACW) comprises the bulk of the seawater in the project area, either in its pure form in the deeper regions, or mixed with previously upwelled water of the same origin on the continental shelf (Nelson & Hutchings 1983). Salinities range between 34.5‰ and 35.5‰ (Shannon 1985).

Seawater temperatures on the continental shelf typically vary between 6°C and 16°C. Well-developed thermal fronts exist, demarcating the seaward boundary of the upwelled water. Upwelling filaments are characteristic of these offshore thermal fronts, occurring as surface streamers of cold water, typically 50 km wide and extending beyond the normal offshore extent of the upwelling cell. Such fronts typically have a lifespan of a few days to a few weeks, with the filamentous mixing area extending up to 625 km offshore.

The continental shelf waters of the Benguela system are characterised by low oxygen concentrations, especially on the bottom. SACW itself has depressed oxygen concentrations (~80% saturation value), but lower oxygen concentrations (<40% saturation) frequently occur (Bailey *et al.* 1985; Chapman & Shannon 1985).

Nutrient concentrations of upwelled water attain 20 µm nitrate-nitrogen, 1.5 µm phosphate and 15-20 µm silicate, indicating nutrient enrichment (Chapman & Shannon 1985). This is mediated by nutrient regeneration from biogenic material in the sediments (Bailey *et al.* 1985). Modification of these peak concentrations depends upon phytoplankton uptake which varies according to phytoplankton biomass and production rate. The range of nutrient concentrations can thus be large but, in general, concentrations are high.

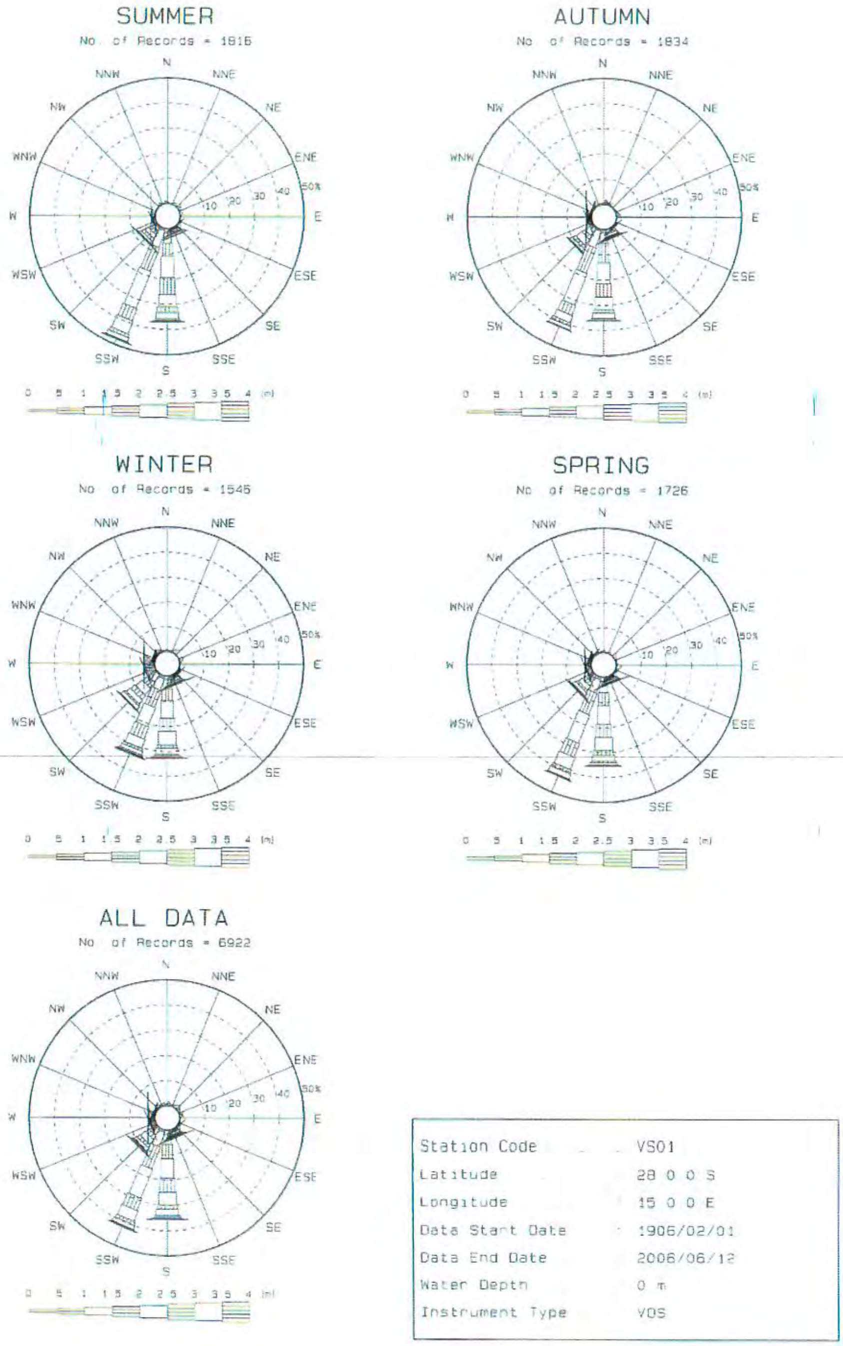

Figure 6: VOS Wave Height vs Wave Direction data for the offshore area (28°-29°S; 15°-16°E recorded during the period 1 February 1906 and 12 June 2006)) (Source: Voluntary Observing Ship (VOS) data from the Southern African Data Centre for Oceanography (SADCO)).

3.2.5 Upwelling & Plankton Production

The cold, upwelled water is rich in inorganic nutrients, the major contributors being various forms of nitrates, phosphates and silicates (Chapman & Shannon 1985). During upwelling the comparatively nutrient-poor surface waters are displaced by enriched deep water, supporting substantial seasonal primary phytoplankton production. This, in turn, serves as the basis for a rich food chain up through zooplankton, pelagic baitfish (anchovy, pilchard, round-herring and others), to predatory fish (hake and snoek), mammals (primarily seals and dolphins) and seabirds (jackass penguins, cormorants, pelicans, terns and others). High phytoplankton productivity in the upper layers again depletes the nutrients in these surface waters. This results in a wind-related cycle of plankton production, mortality, sinking of plankton detritus and eventual nutrient re-enrichment occurring below the thermocline as the phytoplankton decays.

3.2.6 Organic Inputs

The Benguela upwelling region is an area of particularly high natural productivity, with extremely high seasonal production of phytoplankton and zooplankton. These plankton blooms in turn serve as the basis for a rich food chain up through pelagic baitfish (anchovy, pilchard, round-herring and others), to predatory fish (snoek), mammals (primarily seals and dolphins) and seabirds (jackass penguins, cormorants, pelicans, terns and others). All of these species are subject to natural mortality, and a proportion of the annual production of all these trophic levels, particularly the plankton communities, die naturally and sink to the seabed.

The Benguela region can support substantial biomasses of phytoplankton (76.9 tons/km^2) and zooplankton (31.5 tons/km^2) (Shannon *et al.* 2003), much of which is lost to the seabed annually. This natural annual input onto the seabed of millions of tons of organic material provides most of the food requirements of the particulate and filter-feeding benthic communities that inhabit the sandy-muds of this area, and results in the high organic content of the muds in the region. As most of the organic detritus is not directly consumed, it enters the seabed decomposition cycle, resulting in subsequent depletion of oxygen in deeper waters.

An associated phenomenon ubiquitous to the Benguela system are red tides or Harmful Algal Blooms (HABs) (dinoflagellate and/or ciliate blooms) (see Shannon & Pillar 1985; Pitcher 1998), which can reach very large proportions. Toxic dinoflagellate species can cause extensive mortalities of fish and shellfish through direct poisoning, while degradation of organic-rich material derived from both toxic and non-toxic blooms results in oxygen depletion of subsurface water.

3.2.7 Low Oxygen Events

The continental shelf waters of the Benguela system are characterised by low oxygen concentrations with <40% saturation occurring frequently (e.g. 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 3), there are corresponding preferential areas for the formation of oxygen-poor water. The two main areas of low-oxygen water formation in the southern Benguela region are in the Orange River

Bight and St Helena Bay (Chapman & Shannon 1985; Bailey 1991; Shannon & O'Toole 1998; Bailey 1999; Fossing *et al.* 2000). 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. Subsequent upwelling processes can move this low-oxygen water up onto the inner shelf, and into nearshore waters, often with devastating effects on marine communities.

Periodic low oxygen events in the nearshore region can have catastrophic effects on the marine communities leading to large-scale stranding of rock lobsters, and mass mortalities of marine biota and fish (Newman & Pollock 1974; 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. The blooms develop over a period of unusually calm wind conditions when sea surface temperatures where high. 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.

3.2.8 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. Seasonal microphyte production associated with upwelling events will play an important role in determining the concentrations of POM in coastal waters. 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 and terriginous inputs during 'Berg' wind events, which 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; Zoutendyk 1992, 1995; Shannon & O'Toole 1998; Lane & Carter 1999).

Concentrations of suspended particulate matter in 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 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.

The major source of turbidity in the swell-influenced nearshore areas is the redistribution of fine inner shelf sediments by long-period Southern Ocean swells. The current velocities typical of the Benguela (10-30 cm/s) are capable of resuspending and transporting considerable quantities of sediment equatorwards. Under relatively calm wind conditions, however, much of the suspended fraction (silt and clay) that remains in suspension for longer periods becomes entrained in the slow poleward undercurrent (Shillington *et al.* 1990; Rogers & Bremner 1991).

Superimposed on the suspended fine fraction, is the northward littoral drift of coarser bedload sediments, parallel to the coastline. This littoral transport is generated by the predominantly south-westerly swell and wind-induced waves. 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).

3.3 THE BIOLOGICAL ENVIRONMENT

Biogeographically, the project area falls into the cold temperate Namaqua Bioregion, which extend from Sylvia Hill, north of Lüderitz in Namibia to Cape Columbine (Emanuel *et al.* 1992; Lombard *et al.* 2004). The coastal, wind-induced upwelling characterising the western Cape coastline, is the principle physical process which shapes the marine ecology of the southern Benguela region. The Benguela system is characterised by the presence of cold surface water, high biological productivity, and highly variable physical, chemical and biological conditions.

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 majority of the proposed survey area is located beyond the 50 m depth contour. The near- and offshore marine ecosystems comprise a limited range of habitats, namely unconsolidated seabed sediments, deep water reefs 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 or sensitive species, which may be affected by the proposed prospecting activities.

3.3.1 Demersal Communities

3.3.1.1 Benthic Invertebrate Macrofauna

The benthic biota of unconsolidated marine sediments constitute invertebrates that live on (epifauna) or burrow within (infauna) the sediments, and are generally divided into macrofauna (animals >1 mm) and meiofauna (<1 mm). Numerous studies have been conducted on southern African West Coast continental shelf benthos, mostly focused on mining, pollution or demersal trawling impacts (Christie & Moldan 1977; Moldan 1978; Jackson & McGibbon 1991; Environmental Evaluation Unit 1996; Parkins & Field 1997; 1998; Pulfrich & Penney 1999; Goosen *et al.* 2000; Savage *et al.* 2001; Steffani & Pulfrich 2004a, 2004b; 2007; Steffani 2007a; 2007b; Steffani 2009, 2010; Atkinson *et al.* 2011; Steffani 2012). The description below is drawn from recent surveys by Karenyi (unpublished data), De Beers Marine Ltd surveys in 2008 and 2010 (unpublished data), and Atkinson *et al.* (2011).

The macro-infauna in the project area is representative of the typical mid-shelf community (50-180 m) occurring on the West Coast. In the region of the mudbelt, the macrofauna is characterised by the mud prawns *Callianassa* sp. and *Calocaris barnardi*. Further offshore in sandy sediments, the macrofauna is characterised by various polychaetes including deposit-feeding *Spiophanes soederstromi* and *Paraprionospio pinnata*. Polychaetes, crustaceans and molluscs make up the largest proportion of individuals, biomass and species on the west coast.

The distribution of species within these communities are inherently patchy reflecting the high natural spatial and temporal variability associated with macro-infauna of unconsolidated sediments (e.g. Kenny *et al.* 1998; Kendall & Widdicombe 1999; van Dalfsen *et al.* 2000; Zajac *et al.* 2000; Parry *et al.* 2003), with evidence of mass mortalities and substantial recruitments recorded on the South African West Ciast (Steffani & Pulfrich 2004). Given the state of our current knowledge of South African macro-infauna it is not possible to determine the threat status or endemicity of macro-infauna species on the west coast, although such research is currently underway (pers. comm. Ms N. Karenyi, SANBI and NMMU).

Figure 7: Benthic macrofaunal genera commonly found in nearshore sediments include: (top: left to right) *Ampelisca*, *Prionospio*, *Nassarius*; (middle: left to right) *Callianassa*, *Orbinia*, *Tellina*; (bottom: left to right) *Nephtys*, hermit crab, *Bathyporeia*.

Generally species richness increases from the inner shelf (0-50 m depth) across the mid-shelf and is influenced by sediment type (Karenyi unpublished data). The highest total abundance and species diversity was measured in sandy sediments of the mid-shelf. Biomass is highest in the inshore (± 50 g/m^2 wet weight) and decreases across the mid-shelf averaging around 30 g/m^2 wet weight. This is contrary to Christie (1974) who found that biomass was greatest in the mudbelt at 80 m depth off Lamberts Bay, south of the application area, where the sediment characteristics and the the impact of environmental stressors (such as low oxygen events) are likely to differ.

Surveys recently conducted between 180 m and 480 m depth in the vicinity of the project area revealed high proportions of hard ground rather than unconsolidated sediment on the outer shelf (Karenyi unpublished data). The benthic fauna of the outer shelf and continental slope (beyond ~450 m depth) are very poorly known largely due to limited opportunities for sampling. To date very few areas of the continental slope off the West Coast have been biologically surveyed. Such offshore areas of unconsolidated sediments 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.

Benthic communities are structured by the complex interplay of a large array of environmental factors. Water depth and sediment grain size are considered the two major factors that determine benthic community structure and distribution on the South African west coast (Christie 1974, 1976; Steffani & Pulfrich 2004a, 2004b; 2007; Steffani 2007a; 2007b) and elsewhere in the world (e.g. Gray 1981; Ellingsen 2002; Bergen *et al.* 2001; Post *et al.* 2006). However, studies have shown that shear bed stress - a measure of the impact of current velocity on sediment - oxygen concentration (Post *et al.* 2006; Currie *et al.* 2009; Zettler *et al.* 2009), productivity (Escaravage *et al.* 2009), organic carbon and seafloor temperature (Day *et al.* 1971) may also strongly influence the structure of benthic communities. There are clearly other natural processes operating in the deepwater shelf areas of the West Coast that can over-ride the suitability of sediments in determining benthic community structure, and it is likely that periodic intrusion of low oxygen water masses is a major cause of this variability (Monteiro & van der Plas 2006; Pulfrich *et al.* 2006). In areas of frequent oxygen deficiency, benthic communities will be characterised either by species able to survive chronic low oxygen conditions, or colonising and fast-growing species able to rapidly recruit into areas that have suffered oxygen depletion. The combination of local, episodic hydrodynamic conditions and patchy settlement of larvae will tend to generate the observed small-scale variability in benthic community structure.

The invertebrate macrofauna are important in the marine benthic environment as they influence major ecological processes (e.g. remineralisation and flux of organic matter deposited on the sea floor, pollutant metabolism, sediment stability) and serve as important food source for commercially valuable fish species and other higher order consumers. As a result of their comparatively limited mobility and permanence over seasons, these animals provide an indication of historical environmental conditions and provide useful indices with which to measure environmental impacts (Gray 1974; Warwick 1993; Salas *et al.* 2006).

Also associated with soft-bottom substrates are demersal communities that comprise epifauna and bottom-dwelling vertebrate species, many of which are dependent on the invertebrate benthic macrofauna as a food source. According to Lange (2012) Block 1 contained a single epifaunal community between the depths of 100 m and 250 m characterised by the hermit crabs Sympagurus dimorphus and Parapaguris pilosimanus, the prawn Funchalia woodwardi and the sea urchin Brisaster capensis. Atkinson (2009) also reported numerous species of urchins and burrowing anemones beyond 300 m depth off the West Coast.

3.3.1.2 Deep-water coral communities

There has been increasing interest in deep-water corals in recent years because of their likely sensitivity to disturbance and their long generation times. These benthic filter-feeders generally occur at depths exceeding 150 m. 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.

Evidence from video footage taken on hard-substrate habitats in 100 - 120 m depth off southern Namibia and to the south-east of Child's Bank (De Beers Marine, unpublished data) (Figure 8) suggest that vulnerable communities including gorgonians, octocorals and reef-building sponges occur on the continental shelf, and similar communities may thus be expected in the proposed project area.

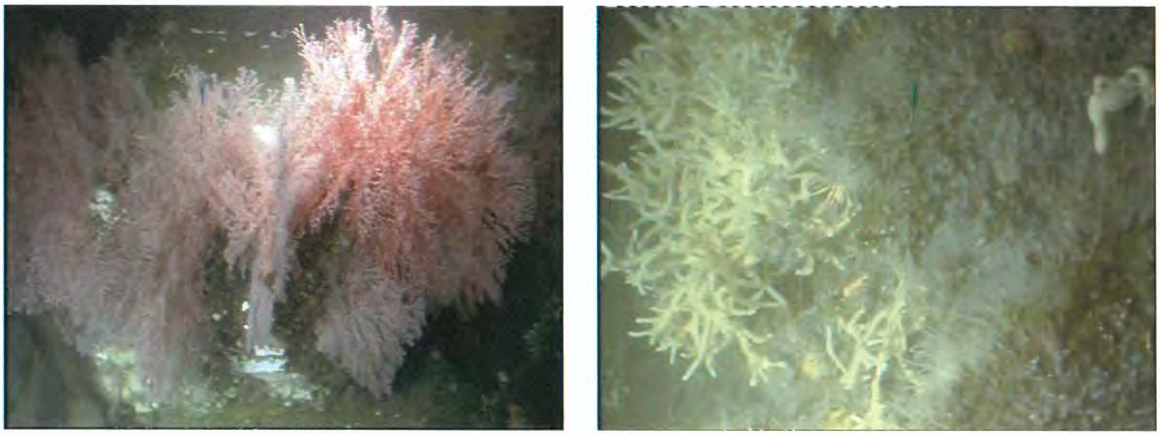

Figure 8: Gorgonian and bryozoan communities recorded on deep-water reefs (100-120 m) off the southern African West Coast (Photos: De Beers Marine).

3.3.1.3 Demersal Fish Species

Common commercial demersal species found mostly on the continental shelf but also extending beyond 500 m water depth include both the shallow-water hake, *Merluccuis capensis* and the deep-water hake (*Merluccius paradoxus*), monkfish (*Lophius vomerinus*), and kingklip (*Genypterus capensis*). There are also many other demersal "bycatch" species that include jacopever (*Helicolenus dactylopterus*), angelfish/pomfret (*Brama brama*), kingklip (*Genypterus capensis*) and gurnard (*Chelidonichtyes* sp), as well as several cephalopod species (such as squid and cuttlefishes) and many elasmobranch (sharks and rays) species. The project area includes four demersal fish communities (Shine 2006) based broadly on depth bands and related to a shift in abundance of the shallow-water and deep-water hake species. *Merluccius capensis* dominates the shallowest community (30-130 m depths). The shallow and deep-water hake species have similar abundances in the community found mainly between 130 m and 200 m depths. The two deeper communities are dominated by *M. paradoxus* but include monkfish *Lophius vomerinus*, kingklip *Genypterus capensis*, bronze whiptail *Lucigadus ori* and hairy conger *Bassanago albescens* and various squalid shark species (Lane & Carter 1999; Hampton *et al.* 1999).

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). 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 the greatest change in species composition occurring in the region between 300 m and 400 m depth (Roel 1987; Atkinson 2009).

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. In a more recent study, 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.* 2008).

The diversity and distribution of demersal cartilagenous fishes on the West Coast is discussed by Compagno *et al.* (1991). The species likely to occur in the proposed survey area, and their approximate depth range, are listed in Table 3.

Table 3: Demersal cartilaginous species found on the mid-shelf along the West Coast, with approximate depth range at which the species occurs (adapted from Compagno *et al.* 1991).

Common Name	Scientific name	Depth Range
Six gill cowshark	*Hexanchus griseus*	150-600
Bramble shark	*Echinorhinus brucus*	55-285
Spotted spiny dogfish	*Squalus acanthias*	100-400
Shortnose spiny dogfish	*Squalus megalops*	75-460
Shortspine spiny dogfish	*Squalus mitsukurii*	150-600
Sixgill sawshark	*Pliotrema warreni*	60-500
Tigar catshark	*Halaelurus natalensis*	50-100
Izak catshark	*Holohalaelurus regani*	100-500
Yellowspotted catshark	*Scyliorhinus capensis*	150-500
Soupfin shark/Vaalhaai	*Galeorhinus galeus*	<10-300
Houndshark	*Mustelus mustelus*	<100
Whitespotted houndshark	*Mustelus palumbes*	>350
Little guitarfish	*Rhinobatos annulatus*	>100
Atlantic electric ray	*Torpedo nobiliana*	120-450
Roughnose legskate	*Crurirajaparcomaculata*	150-620
Thorny skate	*Raja radiata*	50-600
Slime skate	*Raja pullopunctatus*	15-460
Rough-belly skate	*Raja springeri*	85-500
Yellowspot skate	*Raja wallacei*	70-500
Biscuit skate	*Raja clavata*	25-500
Bigthorn skate	*Raja confundens*	100-800
Spearnose skate	*Raja alba*	75-260
St Joseph	*Callorhinchus capensis*	30-380

3.3.2 Seamount Communities

Two geological features of note in the vicinity of the proposed survey area are Child's Bank, situated ~150 km offshore at about 31°S approximately 90 km south of concession 5c, and Tripp Seamount situated ~250 km offshore at about 29°40'S and 80 km west of concession 4c (see Figure 2). Child's Bank was described by Dingle *et al.* (1987) to be a carbonate mound (bioherm). Composed of sediments and the calcareous deposits from an accumulation of carbonate skeletons of sessile organisms (e.g. cold-water coral, foraminifera or marl), such features typically have topographic relief, forming isolated seabed knolls in otherwise low profile homogenous seabed habitats (Kopaska-Merkel & Haywick 2001; Kenyon *et al.* 2003, Wheeler *et al.* 2005, Colman *et al.* 2005). 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 up-welling 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 influences 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. Seamounts provide an important habitat for commercial deepwater fish stocks such as orange roughy, oreos, alfonsino and Patagonian toothfish, which aggregate around these features for either spawning or feeding (Koslow 1996).

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).

Enhanced currents, steep slopes and volcanic rocky substrata, in combination with locally generated detritus, favour the development of suspension feeders in the benthic communities characterising seamounts (Rogers 1994). 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 (reviewed in Rogers 2004). There is also associated mobile benthic fauna that includes echinoderms (sea urchins and sea cucumbers) and crustaceans (crabs and lobsters) (reviewed by Rogers 1994; Kenyon *et al.* 2003). Some of the smaller cnidarians species remain solitary while others form reefs thereby adding structural complexity to otherwise uniform seabed habitats. The coral frameworks offer refugia for a great variety of invertebrates and fish (including commercially important species) within, or in association with, the living and dead coral framework thereby creating spatially fragmented areas of high biological diversity. Compared to the surrounding unconsolidated sediments typified by low topography, seamounts typically form biological hotspots with a distinct, abundant and diverse fauna, many species of which remain unidentified. Consequently, the fauna of seamounts is usually highly unique and may have a limited distribution restricted to a single geographic region, a seamount chain or even a single seamount location (Rogers *et al.* 2008). Levels of endemism on seamounts are also relatively high compared to the deep sea. As a result of conservative life histories (*i.e.* very slow growing, slow to mature, high longevity, low levels of recruitment) and sensitivity to changes in environmental conditions, such biological communities have been identified as Vulnerable Marine Ecosystems (VMEs). They are recognised as being particularly sensitive to anthropogenic disturbance (primarily deep-water trawl fisheries and mining), and once damaged are very slow to recover, or may never recover (FAO 2008).

It is not always the case that seamount habitats are VMEs, as some seamounts may not host communities of fragile animals or be associated with high levels of endemism. South Africa's seamounts and their associated benthic communities have not been sampled by either geologists or biologists (Sink & Samaai 2009) and the same is most likely true for Tripp Seamount. There is reference to decapods 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.

3.3.3 Pelagic Communities

The pelagic communities are typically divided into plankton and fish, and their main predators, marine mammals (seals, dolphins and whales), seabirds and turtles.

3.3.3.1 Plankton

Plankton is particularly abundant in the shelf waters off the West Coast, being associated with the upwelling characteristic of the area. Plankton range from single-celled bacteria to jellyfish of 2-m diameter, and include bacterio-plankton, phytoplankton, zooplankton, and ichthyoplankton.

Phytoplankton are the principle primary producers with mean productivity ranging from 2.5 - 3.5 g C/m^2/day for the midshelf region and decreasing to 1 g C/m^2/day inshore of 130 m (Shannon & Field 1985; Mitchell-Innes & Walker 1991; Walker & Peterson 1991). The phytoplankton is dominated by large-celled organisms, which are adapted to the turbulent sea conditions. The most common diatom genera are *Chaetoceros*, *Nitschia*, *Thalassiosira*, *Skeletonema*, *Rhizosolenia*, *Coscinodiscus* and *Asterionella* (Shannon & Pillar 1985). Diatom blooms occur after upwelling events, whereas dinoflagellates (e.g. *Prorocentrum*, *Ceratium* and *Peridinium*) are more common in blooms that occur during quiescent periods, since they can grow rapidly at low nutrient concentrations. In the surf zone, diatoms and dinoflagellates are nearly equally important members of the phytoplankton, and some silicoflagellates are also present.

Red-tides are ubiquitous features of the Benguela system (see Shannon & Pillar, 1986). The most common species associated with red tides (dinoflagellate and/or ciliate blooms) are *Noctiluca scintillans*, *Gonyaulax tamarensis*, *G. polygramma* and the ciliate *Mesodinium rubrum*. *Gonyaulax* and *Mesodinium* have been linked with toxic red tides. Most of these red-tide events occur quite close inshore, although Hutchings *et al.* (1983) have recorded red-tides 30 km offshore. They are unlikley to occur frequently in the project area.

The mesozooplankton (≥200 µm) is dominated by copepods, which are overall the most dominant and diverse group in southern African zooplankton. Important species are *Centropages brachiatus*, *Calanoides carinatus*, *Metridia lucens*, *Nannocalanus minor*, *Clausocalanus arcuicornis*, *Paracalanus parvus*, *P. crassirostris* and *Ctenocalanus vanus*. All of the above species typically occur in the phytoplankton rich upper mixed layer of the water column, with the exception of *M. lucens* which undertakes considerable vertical migration.

The macrozooplankton (≥1,600 µm) are dominated by euphausiids of which 18 species occur in the area. The dominant species occurring in the nearshore are *Euphausia lucens* and *Nyctiphanes capensis*, although neither species appears to survive well in waters seaward of oceanic fronts over the continental shelf (Pillar *et al.* 1991).

Standing stock estimates of mesozooplankton for the southern Benguela area range from 0.2 - 2.0 g C/m^2, with maximum values recorded during upwelling periods. Macrozooplankton biomass ranges from 0.1-1.0 g C/m^2, with production increasing north of Cape Columbine (Pillar 1986). Although it shows no appreciable onshore-offshore gradients, standing stock is highest over the shelf, with accumulation of some mobile zooplanktors (euphausiids) known to occur at oceanographic fronts. Beyond the continental slope biomass decreases markedly.

Zooplankton biomass varies with phytoplankton abundance and, accordingly, seasonal minima will exist during non-upwelling periods when primary production is lower (Brown 1984; Brown & Henry 1985), and during winter when predation by recruiting anchovy is high. More intense variation will occur in relation to the upwelling cycle; newly upwelled water supporting low zooplankton biomass due to paucity of food, whilst high biomasses develop in aged upwelled water subsequent to significant development of phytoplankton. Irregular pulsing of the upwelling system, combined with seasonal recruitment of pelagic fish species into West Coast shelf waters during winter, thus results in a highly variable and dynamic balance between plankton replenishment and food availability for pelagic fish species.

Although ichthyoplankton (fish eggs and larvae) comprise a minor component of the overall plankton, it remains significant due to the commercial importance of the overall fishery in the region. Various pelagic and demersal fish species are known to spawn in the inshore regions of the southern Benguela, (including pilchard, round herring, chub mackerel lanternfish and hakes (Crawford *et al.* 1987), and their eggs and larvae form an important contribution to the ichthyoplankton in the region. Ichthyoplankton abundance in the project area is, however, expected to be low.

3.3.3.2 Cephalopods

The major cephalopod resource in the southern Benguela are sepiods/cuttlefish, of which around 14 species have been reported (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 was 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.

3.3.3.3 Fish

Small pelagic species include the sardine/pilchard (*Sadinops ocellatus*) (Figure 9, left), anchovy (*Engraulis capensis*), chub mackerel (*Scomber japonicus*), horse mackerel (*Trachurus capensis*) (Figure 9, right) and round herring (*Etrumeus whiteheadi*). These species typically occur in mixed shoals of various sizes (Crawford *et al.* 1987), and generally occur within the 200 m contour. 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.


Figure 9: Cape fur seal preying on a shoal of pilchards (left). School of horse mackerel (right) (photos: www.underwatervideo.co.za; www.delivery.superstock.com).

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 recruit in the pelagic stage, across broad stretches of the shelf, to 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 coast is highly seasonal. Snoek migrating along the 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). They are voracious predators occurring throughout the water column, feeding on both demersal and pelagic invertebrates and fish. Chub mackerel similarly migrate along the 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* (Figure 10, right), yellowfin *T. albacares*, bigeye *T. obesus*, and skipjack *Katsuwonus pelamis tunas*, as well as the Atlantic blue marlin *Makaira nigricans* (Figure 10, left), the white marlin *Tetrapturus albidus* and the broadbill swordfish *Xiphias gladius* (Payne & Crawford 1989). The distributions 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 feature such as canyons and seamounts as well as meteorologically induced oceanic fronts (Penney *et al.* 1992).

Figure 10: Large migratory pelagic fish such as blue marlin (left) and longfin tuna (right) occur in offshore waters (photos: www.samathatours.com; www.osfimages.com).

A number of species of pelagic sharks are also known to occur on the West and South-West Coast, including blue *Prionace glauca*, short-fin mako *Isurus oxyrinchus* and oceanic whitetip sharks *Carcharhinus longimanus*. Occurring throughout the world in warm temperate waters, these species are usually found further offshore on the West Coast. 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" on the International Union for Conservation of Nature (IUCN).

2.3.3.4 Turtles

Three species of turtle occur along the West Coast, namely the Leatherback (*Dermochelys coriacea*) (Figure 11, left), and occasionally the Loggerhead (*Caretta caretta*) (Figure 11, right) and the Green (*Chelonia mydas*) turtle. Loggerhead and Green turtles are expected to occur only as occasional visitors along the West Coast.

The Leatherback is the only turtle likely to be encountered in the offshore waters of west South Africa. The Benguela ecosystem, especially the northern Benguela where jelly fish numbers are high, is increasingly being recognized 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 from the east South Africa population have been satellite tracked swimming around the west coast of South Africa and remaining in the warmer waters west of the Benguela ecosystem (Lambardi *et al.* 2008).

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). Their abundance in the project area is unknown but expected to be low 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. South Africa is thus committed to conserve these species at an international level.

Figure 11: Leatherback (left) and loggerhead turtles (right) occur along the West Coast of Southern Africa (Photos: Ketos Ecology 2009; www.aquaworld-crete.com).

3.3.3.5 Seabirds

Large numbers of pelagic seabirds exploit the pelagic fish stocks of the Benguela system. Of the 49 species of seabirds that occur in the Benguela region, 14 are defined as resident, 10 are visitors from the northern hemisphere and 25 are migrants from the southern Ocean. The 18 species classified as being common in the southern Benguela are listed in Table 4. 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 - 500 m depth) with highest population levels during their non-breeding season (winter). Pintado petrels and Prion spp. show the most marked variation here.

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

14 species of seabirds breed in southern Africa; Cape Gannet (Figure 12, left), African Penguin (Figure 12, right), four species of Cormorant, White Pelican, three Gull and four Tern species (Table 5). The breeding areas are distributed around the coast with islands being especially important. The number of successfully breeding birds at the particular breeding sites varies with food abundance. Most of these 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 2003; Ludynia 2007), and African Penguins have been recorded as far as 60 km offshore.

Figure 12: Cape Gannets *Morus capensis* (left) (Photo: NACOMA) and African Penguins *Spheniscus demersus* (right) (Photo: Klaus Jost) breed primarily on the offshore Islands.

Table 4: 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
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

[1]. May move to Critically Endangered if mortality from long-lining does not decrease.

Table 5: Breeding resident seabirds present along the West Coast (CCA & CMS 2001).

Common name	Species name	Global IUCN Status
African Penguin	Spheniscus demersus	Vulnerable
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

3.3.3.6 Marine Mammals

The marine mammal fauna occurring off the west coast of South Africa, north of Cape Columbine, include whales, dolphins and seals. The description below focusses on those species associated with the continental shelf of the Benguela ecosystem proper.

The cetacean fauna of the West Coast comprises **28 species** of whales and dolphins known (historic sightings or strandings) or likely (habitat projections based on known species parameters) to occur here (Table 6). The most common species within the proposed survey area (in terms of likely encounter rate not total population sizes) are likely to be the dusky dolphin, long finned pilot whale, southern right whale and humpback whale.

Cetaceans comprised two basic taxonomic groups: the mysticetes (filter-feeding baleen whales) and the odontocetes (toothed predatory whales and dolphins). Due to large differences in their size, sociality, communication abilities, ranging behaviour and acoustic behaviour, these two groups are considered separately.

The majority of baleen whales fall into the family Balaenidae. Those occurring in pelagic waters offshore of the project area, but which may make occasional visits into shelf waters, include the blue, fin, sei, minke, dwarf minke and two populations of Bryde's whale. 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, those species possibly encountered in the project area are discussed in further detail below.

Two types of Bryde's whales are recorded from South African waters - a smaller neritic form (of which the taxonomic status is uncertain) and a larger pelagic form described as *Balaenoptera brydei*. 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, sightings are very rare as the distribution of this population appears to have shifted eastwards (Best 2001, 2007; Best *et al.* 1984). This is a very small population and its current distribution implies that it is unlikely to be encountered in the project area (Penry 2010).

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 balaenopterids, with abundance offshore of the proposed survey area likely to be highest in January-February. Information on the number of animals in this population is lacking.

The most abundant baleen whales off the coast of South Africa are southern right and humpback whales (Figure 13). Southern rights 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, building up to a maximum in September/October, with most departing again in December (although animals may be sighted as early as April and as late as February). On the South African 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.

The majority of humpback whales on the west coast of South Africa are migrating past the southern African continent to breeding grounds off Angola, Republic of Congo and Gabon (Rosenbaum *et al.* 2009, Barendse *et al.* 2010). On the West Coast it is thought that only a small proportion of the main migration comes close inshore, the majority choosing the shortest route to the central West African breeding grounds by following the edge of the continental shelf (Best 2007; Best & Allison 2010). Most Humpbacks reach southern African waters around April, continuing through to September/October when the southern migration begins and continues through to December. The calving season for Humpbacks extends from July to October, peaking in early August (Best 2007). Cow-calf pairs are typically the last to leave southern African waters on the return southward migration, although considerable variation in the departure time from breeding areas has been recorded (Barendse *et al.* 2010).

Table 6: Cetaceans occurrence off the West Coast of South Africa, their seasonality and likely encounter frequency with proposed prospecting operations.

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 truncatus*	No	Yes	Year round	Monthly
Common (short beaked) dolphin	*Delphinus delphis*	Yes	Yes	Year round	Monthly
Long-finned pilot whale	*Globicephala melas*		Yes	Year round	<Weekly
Killer whale	*Orcinus orca*	Occasional	Yes	Year round	Occasional
False killer whale	*Pseudorca crassidens*	Occasional	Yes	Year round	Monthly
Risso's dolphin	*Grampus griseus*	Yes (edge)	Yes	Year round	Occasional
Pygmy killer whale	*Feresa attenuata*		Yes	Year round	Occasional
Sperm whales					
Pygmy sperm whale	*Kogia breviceps*		Yes	Year round	Occasional
Sperm whale	*Physeter macrocephalus*		Yes	Year round	Occasional
Beaked whales					
Cuvier's	*Ziphius cavirostris*		Yes	Year round	Occasional
Arnoux's	*Beradius arnouxii*		Yes	Year round	Occasional
Southern bottlenose	*Hyperoodon planifrons*		Yes	Year round	Occasional
Layard's	*Mesoplodon layardii*		Yes	Year round	Occasional
True's	*M. mirus*		Yes	Year round	
Gray's	*M. grayi*		Yes	Year round	Occasional
Blainville's	*M. densirostris*		Yes	Year round	

Common Name	Species	Shelf	Offshore	Seasonality	Likely encounter freq.
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*

* Barendse *et al.* (2010, 2011) and Mate *et al.* (2011) reported sightings of both individuals and groups on a daily basis in the nearshore feeding areas off Cape Columbine during the summer months.

In the last decade, deviations from the predictable and seasonal migration patterns of these two species have been reported from the Cape Columbine - Yzerfontein area (Best 2007; Barendse *et al.* 2010). High abundances of both Southern Right and Humpback whales in this area during spring and summer (September-February), indicates that the upwelling zones off Saldanha and St Helena Bay may serve as an important summer feeding area (Barendse *et al.* 2011, Mate *et al.* 2011). Individual whales have been recorded using the area for up to 90 consecutive days (Mate *et al.* 2011), but also make exploratory trips northwards along the west coast, with regular sightings in southern Namibia as late as February (S. Elwen unpublished data). 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.

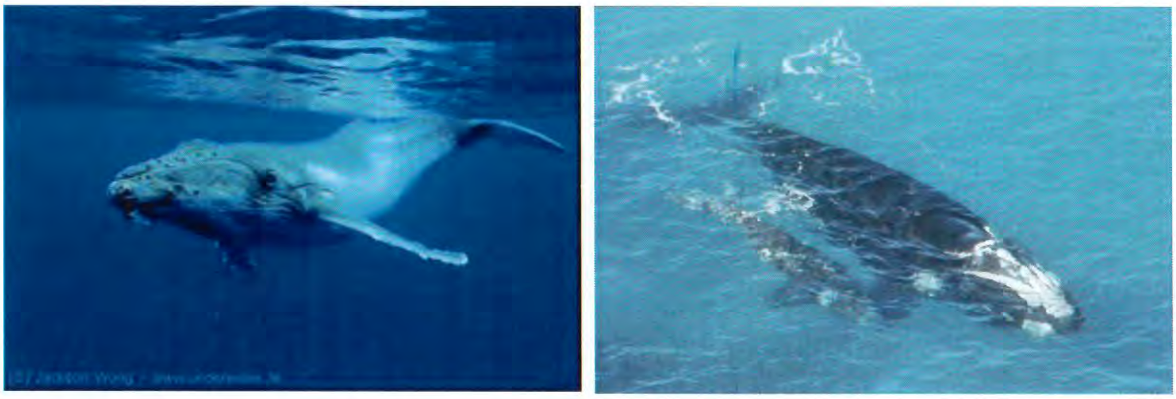

Figure 13: The Humpback whale Megaptera novaeangliae (left) and the Southern Right whale Eubalaena australis (right) are the most abundant large cetaceans occurring along the southern African West Coast (Photos: www.divephotoguide.com; www.aad.gov.au).

Best (2000) estimated that southern right population was increasing at approximately 7% per annum. The most recent abundance estimate for the South African Southern right whale population (2008) puts 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). At least one third of the total South African population (between 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.

Humpback whales off the west coast of South Africa fall into two main groups; those passing through the area on their northward and southward migrations to equatorial breeding grounds, and those showing temporary residence on the feeding ground in the Cape Columbine area. There is considerable overlap between migrating and non-migrating animals in nearshore waters and uncertainty exists about the relationship between animals (population structure) using the South African west coast and other aggregation sites further north off West Africa (Barendse *et al.* 2010). Humpback whales from all west African populations are considered likely to pass through the proposed survey area. Recent abundance estimates put the number of animals using the west coast feeding area, over the period 2001-2007, at around 500 animals (Barendse *et al.* 2011). In contrast, in 2005 those on the Gabon breeding ground were estimated at between 5,000-6,000 animals (Collins *et al.* 2008). Both populations are likely to have increased in size since these estimates were undertaken. Furthermore, the estimates were made from geographically restricted areas, and should thus be considered as minima. Humpback whales migrate at various distances from the coast including pelagic waters (Barendse *et al.* 2002), and as they are likely to regularly cross the proposed survey area, will probably be the most abundant large whale encountered. As in the case of southern right whales, of humpback seasonality off the West Coast is highest in spring and summer (September-February), and not during the traditional winter 'whale season'.

Of the smaller odontocetes known to occur on the continental shelf, the long-finned pilot whale is likely to be the most commonly encountered in the proposed survey area, as it is usually associated with the shelf edge and is regularly reported by Marine Mammal Observers, fishermen and other observers (S. Elwen pers commn). 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 (Figure 14, right) are likely to be the most frequently encountered small cetacean. 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. The species is very boat-friendly and will often approach vessels to bowride.

Heaviside's dolphins (Figure 14, left) are abundant in the southern Benguela, extending from the coat to at least 200 m depth (Elwen *et al.* 2006; Best 2007). This species 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.* 2006, Elwen *et al.* 2009). In the proposed survey areas they are thus likely to be most encountered throughout the day. Their small group sizes and inconspicuous behaviour when offshore, will make monitoring their presence at night very difficult.

Figure 14: The endemic Benguela Dolphin Cephalorhynchus heavisidii (left) (Photo: De Beers Marine Namibia), and Dusky dolphin Lagenorhynchus obscurus (right) (Photo: scottelowitzphotography.com).

Of the migratory cetaceans, the Blue, Sei and Humpback whales are listed as "Endangered" and the Southern Right and Fin whale as "Vulnerable" in the IUCN Red Data book. All whales and dolphins are given protection under the South African Law. The Marine Living Resources

Act, 1998 (No. 18 of 1998) states that no whales or dolphins may be harassed, killed or fished. No vessel or aircraft may approach closer than 300 m to any whale and a vessel should move to a minimum distance of 300 m from any whales if a whale surfaces closer than 300 m from a vessel or aircraft.

The Cape fur seal (*Arctocephalus pusillus pusillus*) (Figure 15) is the only species of seal resident along the west coast of Africa, occurring at numerous breeding and non-breeding sites on the mainland and on nearshore islands and reefs (see Figure 18). Vagrant records from four other species of seal more usually associated with the subantarctic environment have also been recorded: southern elephant seal (*Mirounga leoninas*), subantarctic fur seal (*Arctocephalus tropicalis*), crabeater (*Lobodon carcinophagus*) and leopard seals (*Hydrurga leptonyx*) (David 1989).

There are two Cape fur seal colonies within the broad project area: at Kleinzee (incorporating Robeiland), and at Bucchu Twins near Alexander Bay. 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).

Figure 15: Colony of Cape fur seals Arctocephalus pusillus pusillus (Photo: Dirk Heinrich).

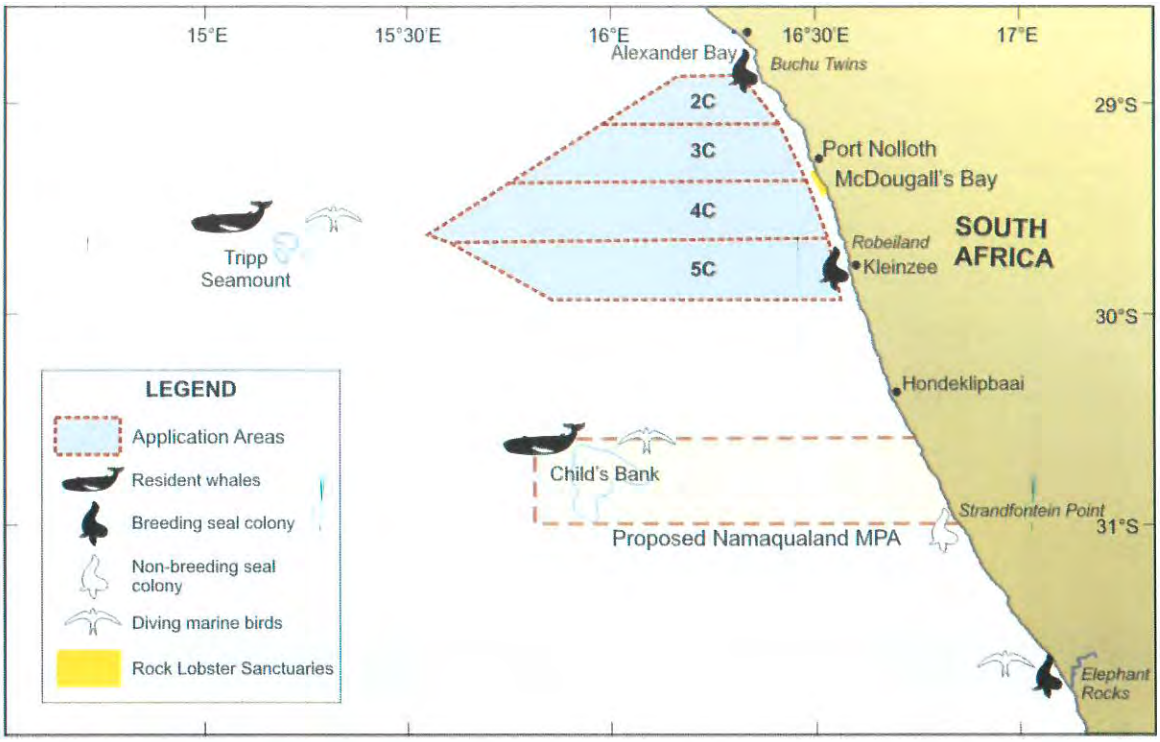

Figure 16: Project - environment interaction points on the West Coast, illustrating the location of seabird and seal colonies, resident whale populations, rock lobster sanctuaries and the proposed Namaqualand Marine Protected Area (MPA) in relation to the proposed application areas.

3.4 OTHER USES OF THE PROPOSED SURVEY AREAS

3.4.1 Beneficial Uses

The proposed survey area is located offshore beyond the 50 m depth contour. Other users of the offshore areas include the commercial fishing industry and hydrocarbon (oil and gas) licence block holders. Recreational use of the survey area will be negligible due to its location offshore.

The continental shelf is divided into concession areas for hydrocarbon exploration, virtually all of which have been covered by 2D and/or 3D seismic surveys. A number of exploration wells have also been drilled (Figure 17). The proposed prospecting areas overlap with licence Block 1 held by PetroSA, where numerous seismic surveys have recently been undertaken, and the drilling of further exploration wells is currently proposed. Hydrocarbon exploration has implications for marine diamond prospecting and mining operations through the imposition of exclusion zones around seismic survey vessels (short-term: 4-12 weeks) and drilling platforms (long-term: years).

Other industrial uses of the marine environment include the intake of feed-water for mariculture, or diamond-gravel treatment. None of these activities should in any way be affected by offshore prospecting operations.

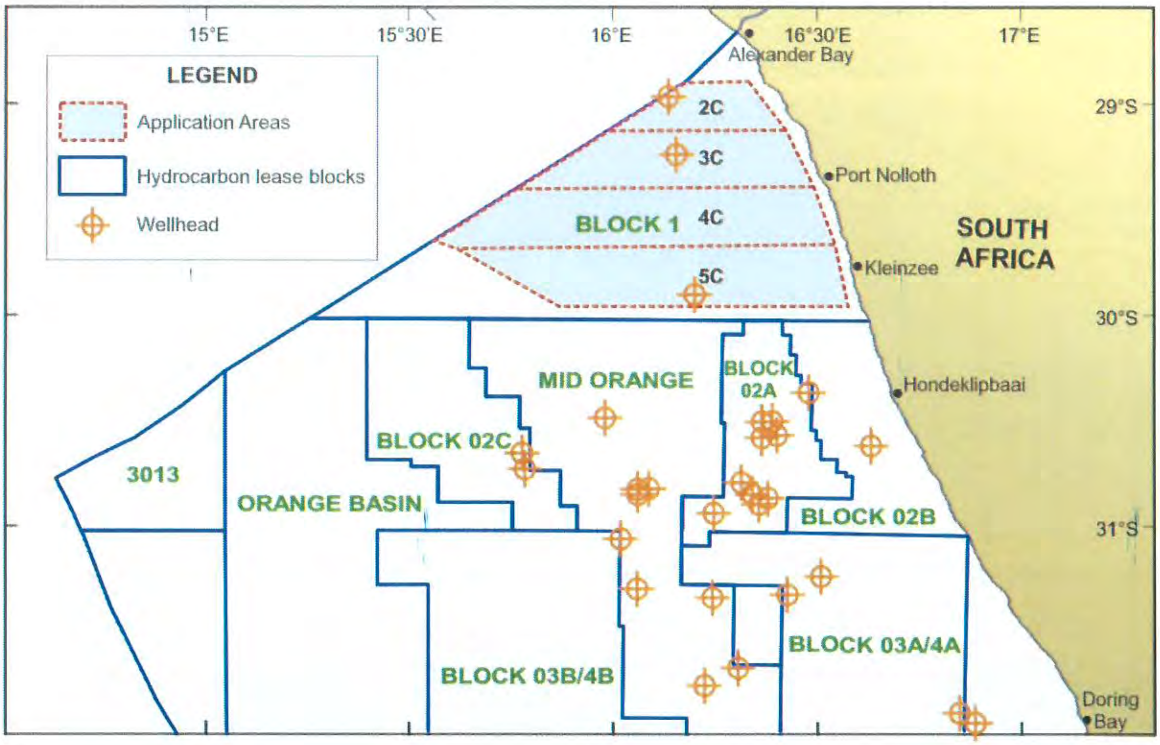

Figure 17: Offshore petroleum licence blocks and wellheads in relation to the proposed application areas.

3.4.2 Conservation Areas and Marine Protected Areas

Numerous conservation areas and a proposed marine protected area (MPA) exist along the coastline of the Western Cape, although none fall directly within the proposed survey area (see Figure 16). The closes conservation area to concessions 2C, 3C, 4C and 5C in which restrictions apply is the McDougall's Bay rock lobster sanctuary near Port Nolloth, which is closed to commercial exploitation of rock lobsters.

As 'no-take' MPAs offering protection of the Namaqua biozones (sub-photic, deep-photic, shallow-photic, intertidal and supratidal zones) are absent northwards from Cape Columbine (Emanuel *et al.* 1992, Lombard *et al.* 2004), marine biodiversity in the area north of Cape Columbine has been rated as 'critically endangered', with commercial fishing and marine mining primarily being held responsible for this status (Lombard *et al.* 2004). Impacts of these activities are predicted to increase over the next decade and immediate conservation intervention has been identified as a priority. To this end, a proposed National Park stretching along 50 km of coast from just north of the Spoeg River to Island Point in the south was gazetted in February 2004. The northern border of the park will extend offshore to the shelf break, whereas the southern border will extend beyond the shelf-break and will include Child's Bank. The proposed Namaqualand MPA was opposed due to a lack of consultation with industry. However, the South African National Biodiversity Institute (SANBI) has partnered with the World Wildlife Fund (WWF) and together have implement an Offshore Marine Protected Areas Project, whose principal objective is to facilitate the development of a representative Offshore MPA network that has broad support from the various offshore marine-use.

PART 4: DESCRIPTION OF THE PROPOSED PROJECT

4.1 Detailed Project Description

The inshore portions of Concessions 2C, 3C, 4C and 5C have undergone extensive geophysical surveys, sampling and test mining programmes over the past 30 years. Based on these investgations and subsequent geological, geotechnical and mineralization models, a patchy, low to medium grade diamond deposit has been identified overlying the Pre-Cambrian and Cretaceous bedrock. The diamonds are concentrated in gravels associated with storm lag beach deposits between 100 - 160 m below current sea level.

As resource generation in the marine environment is an ongoing process, the principal objective of the current proposed prospecting applications is to further delineate and re-estimate the potential diamond resource for further future mining in the area.

The geophysical surveying will be undertaken using the group-owned dedicated survey vessel, the *DP STAR* (Figure 18). With an overall length of 45.15 m and a gross tonnage of 498 t, the vessel is equipped with:

- a multibeam echosounder designed to produce high resolution digital terrain models of the seafloor (Figure 19, left) by transmitting a 30 kHz sounding in a wide swath below the vessel; and
- a parametric sub-bottom profiler, which uses shallow (35 to 45 kHz) and medium penetration (1 to 10 kHz) "Chirp" seismic pulses to generate profiles up to 60 m beneath the seafloor (Figure 19, right), thereby giving a cross section view of the sediment layers.

All the systems are hull-mounted and no towed equipment will be used. Sound levels from the acoustic equipment would range from 190 to 220 dB re 1 μPa at 1 m. The proposed surveys would be undertaken in specific priority areas in each of the four concessions, at water depths between approximately 100 - 150 m and at distances of between 10 - 30 km from the shore (see Figure 1). Only a small proportion of the available concession area would thus be affected by proposed prospecting operations. The areas to be surveyed and the proportion of the available concession areas affected are provided in Table 7.

Initially the surveys will have a line spacing of 1 000 m by 5 000 m. In areas of particular interest this will be reduced to a spacing of 200 m for main lines and 1 000 m for cross lines. The total line kilometres surveyed per concession will be between 750 and 1 500 km.

Figure 18: The proposed survey vessel *DP Star*.

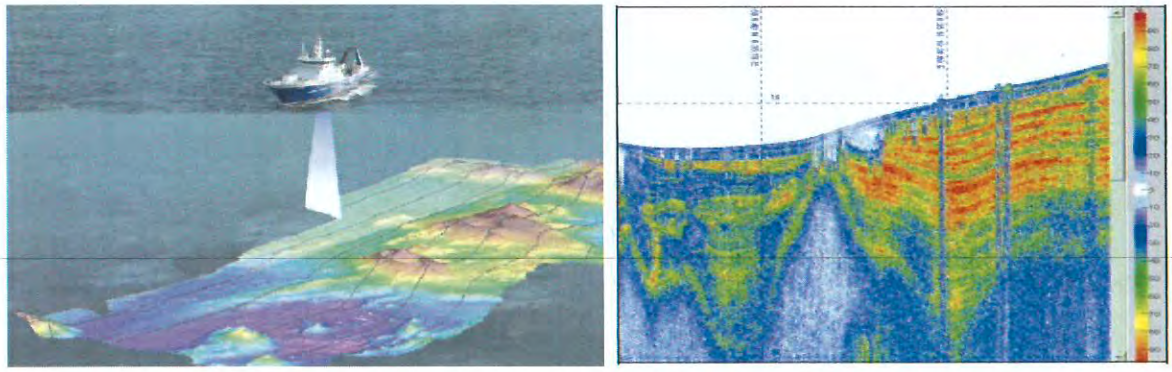

Figure 19: Swath bathymetry (left) and sub-bottom profiling (right) will be the geophysical survey techniques employed during Phase I of the proposed prospecting operations.

Table 7: The proportion of the total concession areas to be surveyed.

Concession	Total Area (km^2)	Survey Area (km^2)	Proportion of Total Area affected
2C	1 369.6	634.9	46.3%
3C	3 253.6	576.0	17.7%
4C	4 962.1	701.8	14.1%
5C	4 790.4	817.1	17.1%

4.2 PROPOSED TIMETABLE, DURATION AND SEQUENCE

The proposed exploration project comprises four phases to be completed over a period of four years, with an additional year possibly required depending on the outcome of the prospecting activities and the subsequent evaluation of the deposit. The phases are outlined in more detail below:

PHASE I: Geophysical surveying (this application) conducted over a total period of four months for all four of the concessions. The data collected during the surveys will be analysed by an exploration geologist to determine the seafloor geology and distribution of potentially mineralised deposits, and the results presented in the form of a report submitted three months after completion of the survey. The objective of this phase is to identify selected areas for subsequent drill and bulk sampling.

PHASE II: Drill sampling to 8 m below the seafloor is proposed for a total of 40 days per annum over a period of four years for all four of the concessions. The sampling will be conducted at intervals of 500 m to 50 m in selected areas. The data collected will be analysesd by an exploration geologist and metallurgist to evaluate the potential resource in areas that are mineralised, to obtain an estimate of the extent and size of the resource present and to make recommendations for a bulk sampling programme. The results will be presented in the form of a report submitted nine months after completion of the drill sampling.

PHASE III: The bulk (trench) sampling programme would be undertaken for a total of 20 days per annum over a period of three years for all four of the concessions. In each concession it is planned to excavate 10 trenches to a depth of between 2 - 8 m, each 60 m long by 22 m wide. The data collected will be analysed by an exploration geologist and metallurgist and form part of the mining pre-feasibility study to be presented six months after the sampling campaign.

PHASE IV: A mining feasibility study for all four concessions will be undertaken over a period of a year. The objective of the study will be to assess the size and extent of the mineable resource and its economic viability.

As part of this application for prospecting rights to undertake geophysical surveying, Belton Park Trading 127 (Pty) Ltd has committed to providing the necessary **amendments to the EMPRs** to include any future drill and bulk sampling campaigns. As these sampling campaigns will also trigger various listed activities in Government Notice (GN) R544 of the Environmental Impact Assessment (EIA) Regulations 2010 promulgated in terms of Chapter 5 of NEMA, a **Basic Assessment or EIA** (whichever is applicable at the time) will have to be conducted, and environmental authorisation obtained before sampling operations can commence. The amendments and environmental requirements as part of Phase II and III of this project will be initiated towards the completion of Phase I.