MARINE PROSPECTING ACTIVITIES IN VARIOUS AREAS OFF THE WEST COAST OF SOUTH AFRICA

FINAL BASIC ASSESSMENT REPORT

Prepared for:
Department of Environmental Affairs

On behalf of:
De Beers Consolidated Mines Ltd

Prepared by:
CCA Environmental (Pty) Ltd

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Prepared for:
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Reference No: 12/12/20/2254

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PROJECT INFORMATION

TITLE	Final Basic Assessment Report for Marine Prospecting Activities in various areas off the west coast of South Africa
APPLICANT	De Beers Consolidated Mines Ltd
ENVIRONMENTAL CONSULTANTS	CCA Environmental (Pty) Ltd
REPORT REFERENCE	AM01PR/FBAR
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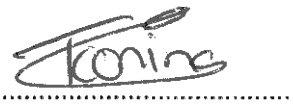
REPORT COMPILED BY: Tamryn Heydenrych



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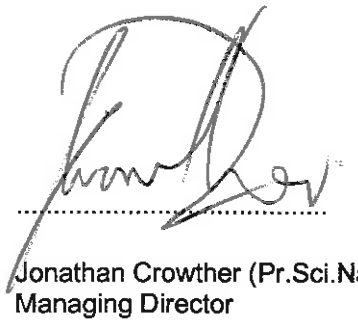
REPORT REVIEW BY: Jonathan Crowther



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

EXPERTISE OF ENVIRONMENTAL ASSESSMENT PRACTITIONER

NAME	Jonathan Crowther
RESPONSIBILITY ON PROJECT	Project leader and quality control.
QUALIFICATIONS	B.Sc. Hons (Geol.), M.Sc. (Env. Sci.)
PROFESSIONAL REGISTRATION	Pr.Sci.Nat., CEAPSA
EXPERIENCE IN YEARS	22
EXPERIENCE	Jonathan Crowther has been involved in environmental consulting since 1988 and is currently the Managing Director of CCA Environmental (Pty) Ltd. He has expertise in a wide range of environmental disciplines, including Environmental Impact Assessments (EIA), Environmental Management Plans / Programmes, Environmental Planning & Review, Environmental Auditing & Monitoring, Environmental Control Officer, Public Consultation & Facilitation. He has project managed a number of offshore oil and gas EIAs for various exploration and production activities in South Africa and Namibia. He also has extensive experience in projects related to roads, property developments and waste landfill sites.

NAME	Tamryn Heydenrych
RESPONSIBILITY ON PROJECT	Project consultant and report writing.
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PROFESSIONAL REGISTRATION	-
EXPERIENCE IN YEARS	4
EXPERIENCE	Tamryn Heydenrych has worked as an environmental assessment practitioner since the beginning of 2007 and has been involved in a number of small-scale projects covering a range of environmental disciplines, including Basic Assessments (BA), Environmental Management Plans (EMP), Environmental Impact Assessments and Environmental Control Work. She has been exposed to a range of projects relating to infrastructure projects (e.g. bulk sewer pipelines, roads, bulk stormwater), and housing developments.

EXECUTIVE SUMMARY

1 INTRODUCTION

De Beers Consolidated Mines Ltd (De Beers) is the current Prospecting Rights holder for the sea areas: 1c, the inshore portions of 2c, 3c, 4c and 5c, as well as 6c, 7c, 8c, 9c, 10c, 12c, 14c, 15c, 16c, 17c, 18c and 20c.

AuruMar (Pty) Ltd (AuruMar), a joint venture entity created by De Beers Group Exploration Holdings Limited and AngloGold Ashanti Marine Exploration Limited, has been formed to act as the operator to undertake Marine Prospecting Activities in these sea areas (refer to Figure 1). The proposed prospecting activities include the identification of heavy minerals, platinum group metals, gold and sapphire (gemstones).

In terms of the Mineral and Petroleum Resources Development Act (No. 28 of 2002) (MPRDA), De Beers submitted four Environmental Management Plans (now Programmes) (EMP's) to the Department of Mineral Resources (DMR) for the above-mentioned sea areas between December 2008 and February 2010. DMR subsequently approved these EMP's on the following dates: 8 October 2009 for portions 2c to 5c and 7c to 10c; 10 September 2009 for portions 12c, 14c to 20c and 1 March 2011 for portions 1c and 6c.

At the time that these EMP's were submitted to DMR, the proposed project did not trigger any listed activities in terms of the National Environmental Management Act (107 of 1998) (NEMA). However, with the amendment to the Environmental Impact Assessment (EIA) Regulations in 2010 the proposed project now triggers listed activities in terms of Government Notice (GN) R 544. Thus a Basic Assessment Process is required to be undertaken in terms of GN R 543 and Environmental Authorisation obtained from the Department of Environmental Affairs (DEA) before the project can proceed.

AuruMar has appointed CCA Environmental (Pty) Ltd (CCA) as the independent Environmental Assessment Practitioner to undertake a Basic Assessment process for the proposed Marine Prospecting Activities in accordance with the requirements of NEMA and the EIA Regulations 2010.

This Final Basic Assessment Report (BAR) summarises the process followed and provides a description of the proposed project and affected environment. It also provides an assessment of the impacts of the proposed project. It should be noted that DEA's standard BAR template has also been completed as an Appendix.

1.1 ASSUMPTIONS AND LIMITATIONS

The study assumptions and limitations are listed below:

- The study assumes that CCA has been provided with all relevant project description information by AuruMar and that it was correct and valid at the time it was provided;
- There will be no significant changes to the project description or surrounding environment between the completion of the report and implementation of the proposed project that could substantially influence findings, recommendations with respect to mitigation and management, etc;
- Certain details regarding the proposed Marine Prospecting Activities were not available at the time of report writing, e.g. the actual specific locations of the sample sites, vessels to be used, etc.); and
- The study assumes that all mitigatory measures incorporated into the project description would be implemented as proposed.

1.2 COMMENT ON THE FINAL BAR

This Final BAR has been distributed for a 30-day comment period from **Thursday 9 June 2011 to Monday 11 July 2011**. It should be noted that all changes to the report are underlined and in a different font. No substantial changes have been made to the report. Copies of the full report have been made available at the following locations:

1. Offices of CCA; and
2. On the CCA website www.ccaenvironmental.co.za.

Electronic copies (disk) of the report can be requested from CCA, at the contact details provided below. Any comments should be forwarded directly to DEA and copied to CCA at the address, telephone/fax numbers or e-mail address shown below by **no later than Monday 11 July 2011**.

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2 BASIC ASSESSMENT PROCESS

2.1 KEY LEGISLATION

Key legislative requirements that the proposed prospecting activities must comply with, include the following:

- National Environmental Management Act (No. 107 of 1998); and
- Minerals and Petroleum Resources Development Act (No. 28 of 2002).

2.2 PROCESS FOLLOWED TO DATE

The Basic Assessment process undertaken to date is summarised below.

- An Application Form and Declaration of Interest were submitted to DEA on 31 March 2011).
- Specialist input was provided on the likely impact on the benthic environment and fishing industry by the proposed prospecting activities.
- The specialist input and other relevant information have been integrated into this Draft BAR.
- A preliminary interested and affected party (I&AP) database has been compiled. To date 62 I&APs have been registered on the project database.
- The Draft BAR was made available to I&APs for a 40-day comment period.
- A notification letter was sent to all I&APs registered on the project database. A copy of the Draft BAR Executive Summary was enclosed with the letter.

- Advertisements were placed in Die Weslander and Ons Kontrei on 18 April 2011 and in the Cape Times and Die Burger on 22 April 2011.
- A total of five comments were received, three of which were from commenting authorities.
- A Comments and Responses Report was compiled.
- The Draft BAR was updated to a Final BAR and has been made available for a further 30-day comment period.
- A notification letter was sent to all I&APs registered on the project database.

It should be noted that I&APs have previously been consulted as part of the MPRDA Prospecting Rights application for proposed Marine Prospecting Activities. During this process, comments received did not raise any significant issues of concern.

2.3 WAY FORWARD

The following steps will be undertaken in the remainder of the Basic Assessment process:

- The Final BAR and any comments received from I&APs on the Final BAR, will be submitted to DEA for consideration and decision-making.
- After DEA has reached a decision, all I&APs on the project database will be notified of the outcome of the application and the reasons for the decision; and
- A statutory appeal period in terms of Chapter 7 of the EIA Regulations 2010 will follow the issuing of the decision.

3 PROJECT DESCRIPTION

3.1 GENERAL INFORMATION

The proposed core sampling and geophysical survey would be undertaken within the sea areas 1c, 2c, 3c, 4c, 5c, 6c, 7c, 8c, 9c, 10c, 12c, 14c, 15c, 16c, 17c, 18c and 20c off the west coast of South Africa. The proposed prospecting activities include the sourcing of heavy minerals, platinum group metals, gold and sapphire (gemstones). Sea areas 1c, 2c, 3c, 4c, 5c, 6c, 7c, 8c, 9c and 10c are located off the Northern Cape coast, while the remaining sea areas are located off the Western Cape coast. The entire prospecting area covers 27 600 km² and is located between the 50 m and 200 m depth contours. Sampling would occur in water depths ranging from 90 m to 200 m.

3.2 NEED AND DESIRABILITY

When considering the need and desirability of this project it is important to consider the role that mining plays within the South African economy. The Minister's statement in the Department of Minerals Resources Strategic Plan 2008/09 - 2010/11 refers "*the growth of the mining industry is historically intertwined with the growth of our economy*" and states further that "*Mining has and will continue to be the mainstay of our economy*."

In order for mining to continue to be a core contributor to the South African economy and in the pursuance of the sustainable development of the nation's mineral resources it is necessary to identify new resources through prospecting. A key intent of the Minerals and Mining Policy of South Africa states that Government will: "*promote exploration and investment leading to increased mining output and employment*" (Minerals and Mining Policy of South Africa, 1998). The Policy states further that:

- *"The South African mining industry, one of the country's few world-class industries, has the capacity to continue to generate wealth and employment opportunities on a large scale.*

- *Mining is an international business and South Africa has to compete against developed and developing countries to attract both foreign and local investment. Many mining projects in South Africa have tended to be unusually large and long term, requiring massive capital and entailing a high degree of risk.*
- *South Africa has an exceptional minerals endowment, and in several major commodities has the potential to supply far more than the world markets can consume."*

If one looks at gold in particular, the Chamber of Mines' explains that *"With the stabilisation in world mine production and central bank sales, the prospect of any major sources of new supply of gold have diminished. The continued focus on productivity and consolidation in the South African gold mining industry will result in a decline in production - although replacement tonnage from new mines will slow the rate of decline.* "

This project aims to establish whether economically viable heavy mineral deposits, including gold, occur on the continental shelf off the west coast of South Africa.

3.3 MARINE PROSPECTING OVERVIEW

The prospecting activities would be conducted in a phased approach, with each phase dependant on the results of the previous phase. The two phases planned are as follows and it is proposed that they would run from October 2010 to November 2013:

- Phase I: Initial Deposit Assessment Programme
- Phase II: Resource Delineation Programme

3.3.1.1 Exploration sampling

The proposed prospecting activities would utilise AuruMar's Sonic VibroCorer (SVC) in order to collect the required samples. The system deploys a vibratory head, which has been adapted from land based technology, where the vibration energy is transferred into the drill string and enables the drill-string to penetrate into the seabed down to 10 m with a radius of 75 mm. The system can penetrate through most unconsolidated seabed lithologies, to produce a discrete high integrity core, which can then be analysed in detail. The sampling system is mounted in a frame, which is lowered to the seabed from a purpose built Launch and Recovery System (LARS) on a suitable vessel of opportunity.

Noise measurements have been taken for the SVC and at a distance of 25 m from the tool the noise was measured at 160 – 180 dB re 1µPa. At a distance of 110 m from the tool the noise is typically 155 dB re 1µPa and 164dB re 1µPa. The 1/3 octave analysis showed there was a 1/3 octave tone at 100 Hz and 125 Hz with harmonics at 200Hz and 250Hz.

SVC core samples would be logged and stored onboard the vessel and transferred ashore at regular intervals for further analysis. Once the cores are logged they would then be analysed onshore for heavy mineral content. This would entail initial sizing, screening and sub-sampling, followed by an evaluation of a sub-sample at an appropriately accredited onshore laboratory. Results from the sample treatment and the evaluation process would provide inputs into the geological model.

<u>Initial Deposit Assessment Programme</u>
The aim of Initial Deposit Assessment Programme would be to groundtruth the geological model compiled during the desktop study and to identify the possible presence of mineralisation for further resource delineation (i.e. Phase II).
It is proposed that approximately 300 cores would be collected within identified areas in the prospecting rights areas. Up to 60 target areas would be selected over the 27 600 km² prospecting area based on the results of an ongoing desktop study. Clusters of up to five cores would be collected in each target area with

individual core spacing of approximately 70 metres. The 300 core sampling activities would result in a total disturbance area of 53 m³.

Resource Delineation Programme
Phase II is split into a detailed geophysical survey as well as further exploration sampling activities.

Geophysical Surveying
It is proposed that the Focus towfish could be used to collect side scan sonar as well as Chirp seismic data. Hull mounted swath bathymetry and towed magnetometers would be deployed to gather additional data. In addition, the Autonomous Underwater Vehicle (AUV) could be used to survey in areas where the survey line spacing is less than 50 m apart. Sound levels from the acoustic equipment would range from 190 to 220 dB re 1 µPa at 1m.

Resource Delineation Programme
Once the detailed geophysical surveying has been completed and the results further analysed, it is assumed that these results would yield at least one deposit that would justify further sampling in the Resource Delineation Programme. The proposed method of sampling would be the same as the process undertaken in Phase I. Phase II is intended to increase the level of confidence regarding the presence of a mineral resource in the deposit area. This confidence level would ultimately determine whether it is viable to apply for commercial mining rights.

It is assumed that the potential deposit area to be sampled would be approximately 56 km² in extent. It is estimated that up to 4 500 core samples would be required within this deposit area. The core spacings would be between 50 and 200 m apart. The total volume of disturbance would be approximately 799 m³.

3.4 NO-GO ALTERNATIVE

The No-Go alternative is the non-occurrence of the proposed project. The negative implications of not going ahead with the proposed project are as follows:

- Loss of opportunity to establish whether a viable offshore heavy mineral resource exists off the west coast of South Africa; and
- Lost economic opportunities related to costs already incurred in the initial prospecting phase.

4 EMISSIONS AND DISCHARGES

The types of emissions and discharges that are expected from prospecting activities include the following:

- Discharges such as deck drainage, machinery space wastewater, sewage, etc; and
- Disposal of solid waste such as foodwaste.

5 AFFECTED ENVIRONMENT

The proposed prospecting activities fall within the offshore area of the west coast region of South Africa. It lies within the southern zone of the Benguela Current region and is characterised by the cool Benguela upwelling system. The description of the offshore environment in the Draft BAR contains a general overview of the oceanography and ecology of the west coast offshore region with specific reference to the prospecting area. The human utilisation, such as fishing, marine diamond mining / prospecting and petroleum exploration, of the area is also described.

6 ENVIRONMENTAL IMPACT ASSESSMENT

Table 1 (overleaf) provides a summary of the significance ratings assigned to each potential impact of prospecting.

Table 6.1: Summary of the significance of the potential impacts associated with the proposed prospecting activities and No-Go Alternative.

Potential impact		Significance	
		Without mitigation	With mitigation
Vessels and helicopter operation:			
Deck drainage into the sea		VL	**VL**
Machinery space drainage into the sea		VL	**VL**
Sewage effluent into the sea		VL	**VL**
Galley waste disposal into the sea		VL	**VL**
Solid waste disposal into the sea		N/A	**N/A**
Impact on marine fauna:			
Sediment removal		VL	**VL**
Physical crushing of benthic biota		VL	**VL**
Noise associated with sampling activities		VL	**VL**
Noise associated with geophysical surveying		L	**VL**
Impact on other users of the sea:			
Fishing industry	Pelagic purse-seine	L	**L**
	Demersal long-line	L	**L**
	Tuna pole	VL	**VL**
	Pelagic long-line	VL	**VL**
Marine mining and prospecting	Diamond mining	VL	**VL**
	Other mining	VL	**VL**
Petroleum exploration		VL-L	**VL**
Marine transport routes		VL	**VL**
Impact on cultural heritage material:			
Impact on historical shipwrecks		M	**VL**
No-Go Alternative:			
Lost opportunity to establish whether or not a viable offshore heavy mineral resource exists off the West Coast and the lost economic opportunities related to costs already incurred in the initial prospecting phase.		L-M	**-**

VH=Very High	H=High	M=Medium	L=Low	VL=Very low	Insig = insignificant	N/A= Not applicable

7 CONCLUSIONS

All of the impacts associated with the prospecting activities would occur in the immediate vicinity of the vessel, would be of short term duration and of low to high intensity, and are considered to be of **VERY LOW** to **LOW** significance after mitigation.

8 RECOMMENDATIONS

8.1 GENERAL

8.1.1 Compliance with the Environmental Management Programme

All phases of the proposed project must comply with the Environmental Management Programme presented in Chapter 7. In addition, vessels must ensure compliance with MARPOL 73/78 standards.

8.1.2 Notification and communication with key stakeholders

- Notify PetroSA, Forest Exploration International, Thombo Petroleum, BHP Billiton and Transhex and its contractors, as well as any other operators, prior to the commencement of activities.
- AuruMar should liaise with all petroleum exploration operators to ensure that there is no overlapping of activities in the same area over the same time period.
- Prior to the commencement of activities, AuruMar must notify relevant bodies including: DMR, South African Maritime Safety Authority (SAMSA), the South African Navy (SAN) Hydrographic Office, relevant Port Captains and DAFF: MRM. These bodies must be notified of the navigational co-ordinates of any location prior to commencement of such activities.
- Communication channels should be set up with I&APs. This would involve pre-sampling and survey notifications and regular updates on the sampling and survey progress via email (see bullet below). Key stakeholders should include:
  - > Fishing industry (Association of Small Hake Industries, South African Deep Sea Trawling Industry Association, South African Pelagic Fishing Industry Association, South African Commercial Linefish Association, South African Tuna Association, Fresh Tuna Exporters Association, South African West Coast Rock Lobster Association, and Shark Long-line Association);
  - > Marine mining / prospecting industry (Transhex); and
  - > Authorities (SAN Hydrographic office, DAFF: MRM, DMR, SAMSA and relevant Port Captains).
- Appropriate notices should be distributed timeously to mariners (including the fishing and diamond mining industries). A Notice to Mariners should provide:
  1. the co-ordinates of the sampling and survey activities;
  2. an indication of the sampling and survey timeframes; and
  3. reports on the location of prospecting vessels.

8.1.3 Discharges and emissions

- Provide training and awareness to crew members of the need for thorough cleaning up of any spillages immediately after they occur in order to minimise the volume of contaminants washing off decks.
- Use low toxicity, biodegradable detergents and reusable absorbent cloths during deck cleaning to further minimise the potential impact of deck drainage on the marine environment.
- Machinery spaces must drain into bilge tanks in compliance with MARPOL Annex I.
- Save-alls must be utilised around specific equipment, bunkering points and vents on open deck areas to prevent release of contaminated water overboard.
- Undertake adequate maintenance of all hydraulic systems.
- Minimise the discharge of waste material should obvious attraction of marine fauna be observed.
- Contractors would be required to comply with the MARPOL 73/78 Annex IV requirements, wherever possible.

8.1.4 Vessel sea worthiness

- The vessels must be certified for seaworthiness through an appropriate internationally recognised marine certification programme (e.g. Lloyds Register, Det Norske Veritas).
- Vessels should be equipped with collision prevention equipment including radar, multi-frequency radio, foghorns, etc. The law also requires equipment and training to ensure the safety and survival of the crew in the event of an accident.

8.1.5 Geophysical surveying

- Carry out visual scans around the survey vessel prior to the initiation of any acoustic impulses;
- Pre-survey scans should be limited to 15 minutes prior to the start of survey equipment.
- Terminate the survey if any marine mammals show affected behaviour within 500 m of the survey vessel or equipment until the mammal has vacated the area.
- "Soft starts" should be carried out for any equipment of source levels greater than 210 dB re 1 µPa at 1 m over a period of 20 minutes.
- The geophysical surveying should largely be undertaken between December and May, however, during the transition periods in June and November, surveying would be possible with stricter mitigation measures.
- Ensure that PAM (passive acoustic monitoring) is incorporated into any surveying taking place in June and / or November.
- Geophysical surveying should not be undertaken in the southern concession areas between October and January, when there is a likelihood of Southern Right whales being in the area.
- A Marine Mammal Observer would be appointed to ensure compliance with mitigation measures during seismic geophysical surveying.

9 ENVIRONMENTAL MANAGEMENT PROGRAMME

The EMP has been compiled for prospecting activities, which consolidates management activities required to address the issues and mitigation measures identified in the Draft Basic Assessment Report.

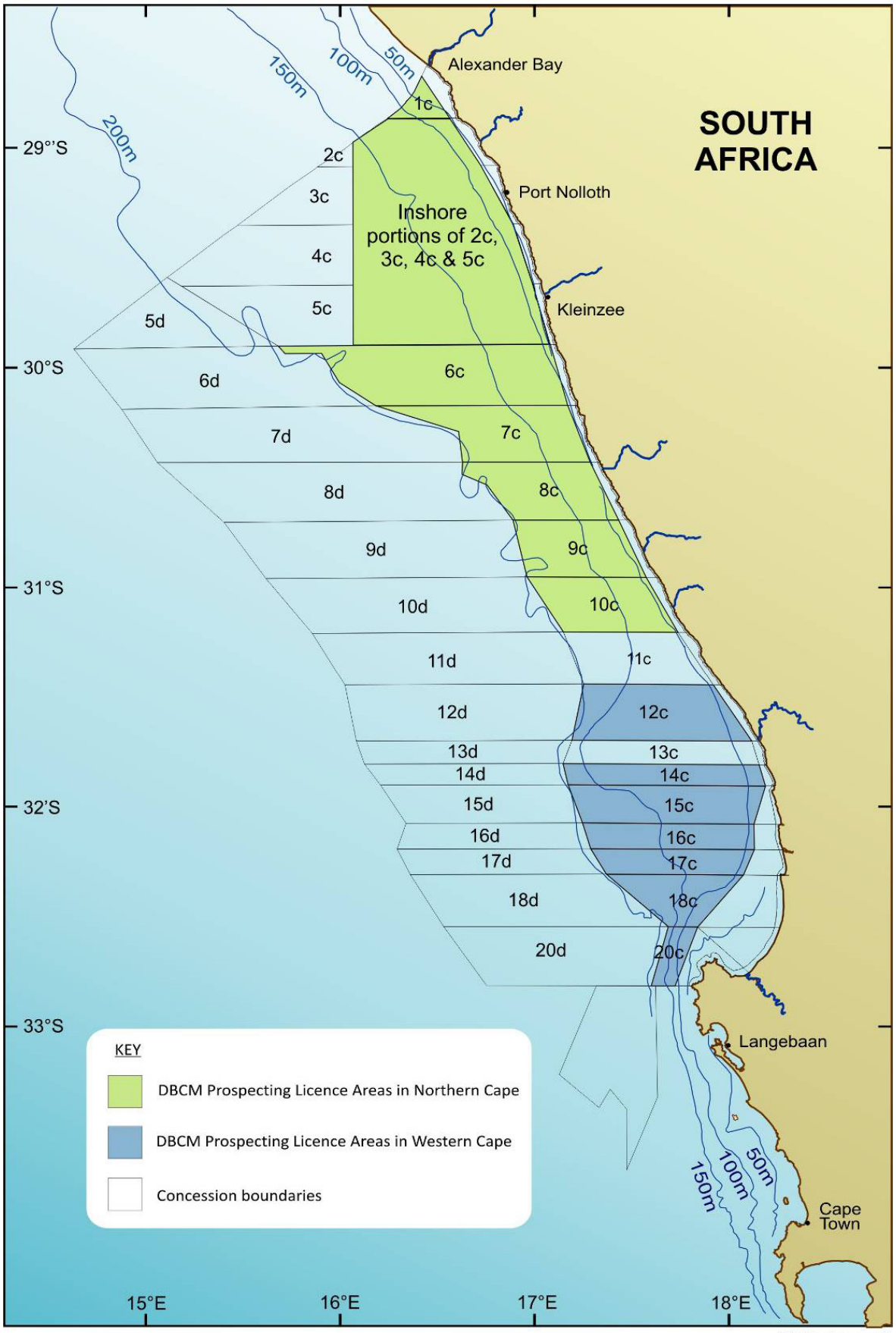

Figure 1: Location of the Prospecting Rights Areas, off the west coast of South Africa.

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List of acronyms and abbreviations

3D	Three-dimensional
AABW	Antarctic Bottom Water
AAIW	Antarctic Intermediate Water
BAR	Basic Assessment Report
CCA	CCA Environmental (Pty) Ltd
DEA	Department of Environmental Affairs
EAP	Environmental Assessment Practitioner
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EMP	Environmental Management Programme
GN	Government Notice
HWC	Heritage Western Cape
I&APs	Interested & Affected Parties
IMO	International Maritime Organisation
LOSC	United Nations Convention on Law of the Sea, 1982
MARPOL	International Convention for the Prevention of Pollution from Ships, 1973/1978
MPA	Marine Protected Area
MPRDA	Mineral and Petroleum Resources Development Act (No. 28 of 2002)
NBSA	National Biodiversity Spatial Assessment Report
NEMA	National Environmental Management Act (No. 107 of 1998)
NHRA	National Heritage Resources Act (No. 25 of 1998)
OPRC	International Convention on Oil Pollution Preparedness, Response and Co-operation, 1990
PASA	Petroleum Agency SA
SAHRA	South African Heritage Resources Agency
SAMSA	South African Maritime Safety Authority
SAN	South African Navy

1. INTRODUCTION

This chapter provides background to the proposed project, describes the purpose of this report, presents the assumptions and limitations of the study and describes the structure of the report. It also invites Interested and Affected Parties (I&APs) to submit comments on the Final Basic Assessment Report (BAR).

1.1 BACKGROUND TO THE PROPOSED PROJECT AND BASIC ASSESSMENT PROCESS

De Beers Consolidated Mines Ltd (De Beers) is the current Prospecting Rights holder for the sea areas: 1c, the inshore portions of 2c, 3c, 4c and 5c, as well as 6c, 7c, 8c, 9c, 10c, 12c, 14c, 15c, 16c, 17c, 18c and 20c.

AuruMar (Pty) Ltd (AuruMar), a joint venture entity created by De Beers Group Exploration Holdings Limited and AngloGold Ashanti Marine Exploration Limited, has been formed to act as the operator to undertake Marine Prospecting Activities in these sea areas (refer to Figure 1.1). The proposed prospecting activities include the identification of heavy minerals, platinum group metals, gold and sapphire (gemstones).

In terms of the Mineral and Petroleum Resources Development Act (No. 28 of 2002) (MPRDA), De Beers submitted four Environmental Management Plans (now Programmes) (EMP's) to the Department of Mineral Resources (DMR) for the above-mentioned sea areas between December 2008 and February 2010. DMR subsequently approved these EMP's on the following dates: 8 October 2009 for portions 2c to 5c and 7c to 10c; 10 September 2009 for portions 12c, 14c to 20c and 1 March 2011 for portions 1c and 6c.

At the time that these EMP's were submitted to DMR, the proposed project did not trigger any listed activities in terms of the National Environmental Management Act (107 of 1998) (NEMA). However, with the amendment to the Environmental Impact Assessment (EIA) Regulations in 2010 the proposed project now triggers listed activities in terms of Government Notice (GN) R 544. Thus a Basic Assessment Process is required to be undertaken in terms of GN R 543 and Environmental Authorisation obtained from the Department of Environmental Affairs (DEA) before the project can proceed.

AuruMar has appointed CCA Environmental (Pty) Ltd (CCA) as the independent Environmental Assessment Practitioner to undertake a Basic Assessment process for the proposed Marine Prospecting Activities in accordance with the requirements of NEMA and the EIA Regulations 2010.

1.2 PURPOSE OF THIS REPORT

This Final BAR has been compiled as part of the Basic Assessment process that is being undertaken for the proposed Marine Prospecting Activities in various sea areas off the west coast of South Africa (see Figure 1.1). This Final BAR summarises the process followed to date and provides a description of the proposed project and affected environment. It also provides an assessment of the impacts of the proposed project. It should be noted that DEA's standard BAR template has also been completed and is presented in Appendix 1.

It should be noted that all changes to the report are underlined and in a different font. This report has been made available for public comment (see Section 1.4). Comments received will be submitted directly to DEA for decision-making.

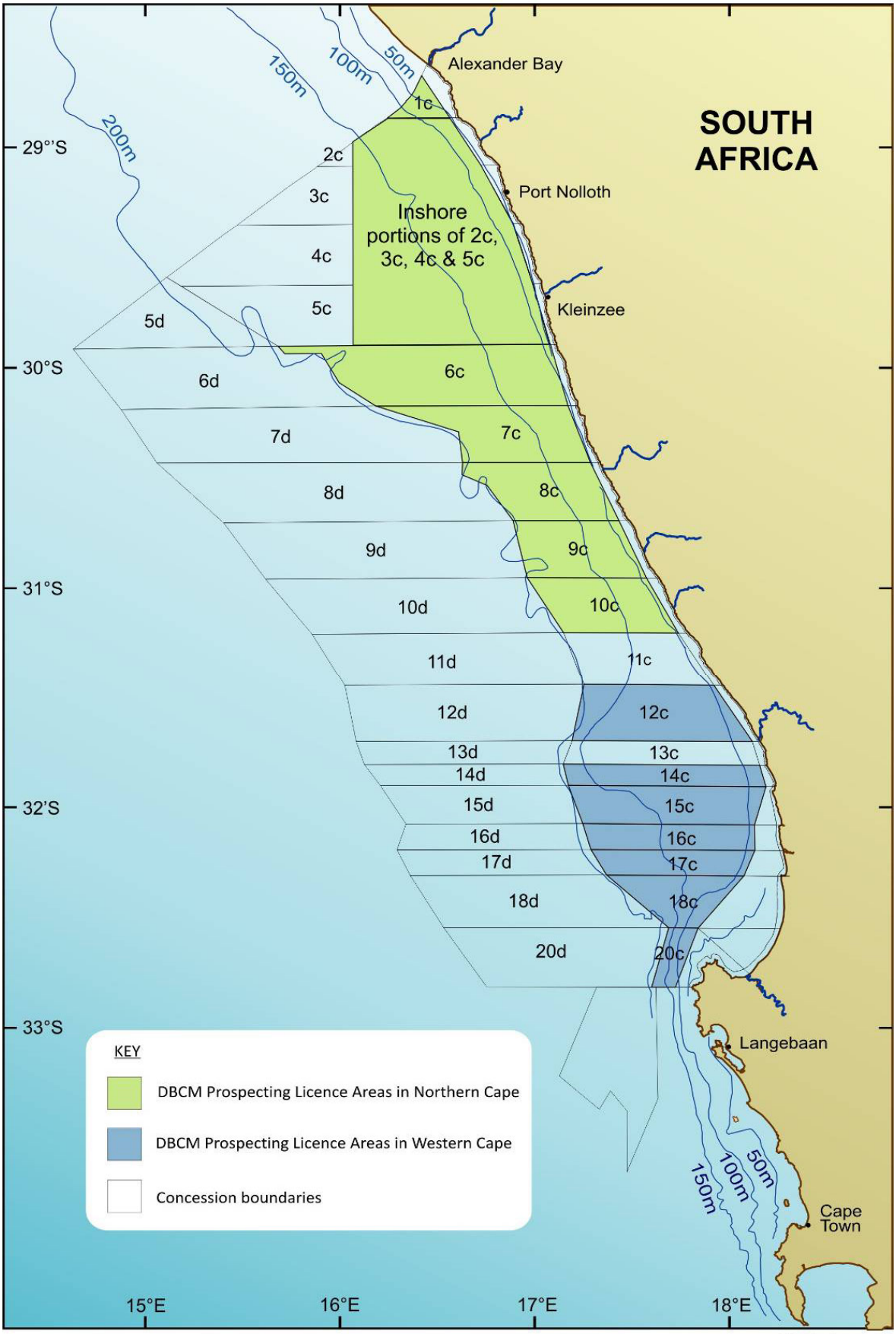

Figure 1.1: Location of the Prospecting Rights Areas, off the west coast of South Africa.

1.3 ASSUMPTIONS AND LIMITATIONS

The study assumptions and limitations are listed below:

- The study assumes that CCA has been provided with all relevant project description information by AuruMar and that it was correct and valid at the time it was provided;
- There will be no significant changes to the project description or surrounding environment between the completion of the report and implementation of the proposed project that could substantially influence findings, recommendations with respect to mitigation and management, etc;
- Certain details regarding the proposed Marine Prospecting Activities were not available at the time of report writing, e.g. the actual specific locations of the sample sites, vessels to be used, etc.); and
- The study assumes that all mitigatory measures incorporated into the project description would be implemented as proposed.

1.4 STRUCTURE OF THIS REPORT

This report consists of eight chapters and five appendices, the contents of which are outlined below.

Section	Contents
Executive Summary	Provides an overview of the main findings of the BAR.
Chapter 1	**Introduction** Provides background to the proposed project, describes the purpose of this report, presents the assumptions and limitations of the study, and describes the structure of the report. It also invites I&APs to submit comments on the Draft BAR.
Chapter 2	**Basic Assessment approach and methodology** Covers the legislative requirements of the Basic Assessment process, presents the process undertaken and presents the way forward in the Basic Assessment process.
Chapter 3	**Project description** Provides a description of the proposed Marine Prospecting Activities.
Chapter 4	**Description of the affected environment** Describes the existing biophysical and social environment that could be affected by the proposed project.
Chapter 5	**Impact description and assessment** Describes and assesses the potential impacts of the proposed project on the affected environment. It also presents mitigation or optimisation measures that could be used to reduce the significance of any negative impacts or enhance any benefits, respectively.
Chapter 6	**Conclusion and recommendations** Provides conclusions to the BAR and summarises the recommendations for the proposed project.
Chapter 7	**Environmental Management Programme for Marine Prospecting Activities** Provides an Environmental Management Programme for the proposed Marine Prospecting Activities.
Chapter 8	**References** Provides a list of the references used in compiling this report.
Appendices	Appendix 1: DEA's standard BAR template Appendix 2: Application Form, DEA correspondence and I&AP letters Appendix 3: Marine Benthic Input Appendix 4: Fishing Input Appendix 5: Convention for assigning significance ratings to impacts Appendix 6: I&AP database Appendix 7: Advertisements Appendix 8: Comments and Responses Report Appendix 9: Previous Heritage Assessment

1.5 COMMENT ON THE FINAL BAR

This Final BAR has been distributed for a 30-day comment period from **Thursday 9 June 2011 to Monday 11 July 2011** in order to provide I&APs with an opportunity to comment on any aspect of the Basic Assessment process and the proposed project. Copies of the full report have been made available at the following locations:

3. Offices of CCA; and
4. On the CCA website www.ccaenvironmental.co.za.

Electronic copies (disk) of the report can be requested from CCA, at the contact details provided below.

Any comments should be forwarded directly to DEA and copied to CCA at the address, telephone/fax numbers or e-mail address shown below by **no later than Monday 11 July 2011**.

COMMENTS SUBMITTED TO:
Babalwa Xalipi
Department of Environmental Affairs
Private Bag X447, Pretoria, 0001
Fedsure Building 315 Pretorius Street, Pretoria, 0001

Tel: 012 395 1771 Fax: 012 320 7539
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Tamryn Heydenrych
CCA Environmental (Pty) Ltd
Unit 35 Roeland Square, 30 Drury Lane, Cape Town, 8001
PO Box 10145, Caledon Square, 7905

Tel: (021) 461 1118 / 9 Fax: 021) 461 1120
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2. EIA APPROACH AND METHODOLOGY

This chapter outlines the key legislative requirements for the proposed study and outlines the methodology and I&AP consultation process followed in the study.

2.1 LEGISLATIVE REQUIREMENTS

2.1.1 NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 1998

Section 2 of NEMA, as amended, sets out a range of environmental principles that are to be applied by all organs of state when taking decisions that significantly affect the environment. Included amongst the key principles is that all development must be socially, economically and environmentally sustainable and that environmental management must place people and their needs at the forefront of its concern, and serve their physical, psychological, developmental, cultural and social interests equitably. NEMA also provides for the participation of I&APs and stipulates that decisions must take into account the interests, needs and values of all I&APs.

Chapter 5 of NEMA, as amended, outlines the general objectives and implementation of Integrated Environmental Management, which provides a framework for the integration of environmental issues into the planning, design, decision-making and implementation of plans and development proposals. Section 24(4) provides the minimum requirements for procedures for the investigation, assessment and communication of the potential impact of activities.

The EIA Regulations 2010 promulgated in terms of Chapter 5 of NEMA provide for the control of certain activities that are listed in Government Notices (GNs) R544, R545 and R546 of 18 June 2010. Activities listed in these notices must comply with the regulatory requirements listed in GN R543, which prohibits such activities until written authorisation is obtained from the competent authority. Such environmental authorisation, which may be granted subject to conditions, will only be considered once there has been compliance with the EIA Regulations 2010. GN R543 sets out the procedures and documentation that need to be complied with in undertaking an EIA. In terms of GN R544, the following two activities are applicable to the proposed project (see Table 2.1).

Table 2.1: Activities listed in GN R544 triggered by the proposed project.

Activity No.	Activity description and brief description of proposed project triggering the activity
16(vi)	*Construction or earth moving activities in the sea …, in respect of infrastructure covering 50 m^2 or more.* The two proposed sampling phases would cover more than 50 m² (accumulatively and never at one time) and would include the following: <u>Initial deposit assessment phase</u> During the initial deposit assessment phase, it is proposed that a minimum of 300 core samples would be obtained. <u>Resource delineation phase</u> During the resource delineation phase a maximum of 4 500 cores would be obtained. Sampling for the above two phases would be undertaken utilising a vibracoring tool, mounted in a frame which is lowered to the seabed during the coring operation to provide stability. The frame has a footprint of 6 m x 6 m. It is not fixed to the seabed in any way and is only positioned on the seabed during the coring process, which takes approximately 1.5 hours. The tool is then recovered to the deck of the sampling vessel where the sediment core is removed. The vessel would then move to the next

Activity No.	Activity description and brief description of proposed project triggering the activity
	sampling location.
18(ii)	*The infilling or depositing of any material of more than 5 m^3 into, or the dredging, excavation, removal or moving soil, sand, shells, shell grit, pebbles or rock from the sea.* Initial deposit assessment phase The volume of each core sample would be approximately 0.178m^3 at each core site and therefore the total volume of seabed sediment that would be removed for 300 cores would be approximately 53 m^3 over the total prospecting area. The core samples would be collected in up to 60 target areas over the 27 600 km^2 prospecting area. Clusters of up to five cores would be collected at each target area with individual core spacing of approximately 70 m. Resource delineation phase The total volume of seabed sediment that would be removed during the sampling of the estimated 4 500 cores would be approximately 799 m^3 over the total prospecting area. The cores would be collected at a core spacing of 50 m to 200 m apart. There would be no infilling or depositing of material during either of the two sampling phases.

2.1.2 MINERAL AND PETROLEUM RESOURCES DEVELOPMENT ACT, 2002

In terms of the MPRDA a Prospecting Right must be granted by DMR prior to the commencement of any sampling activities. A requirement of obtaining a Prospecting Right is that an EMP must be compiled in terms of Section 39 of the MPRDA and Section 52 of the MPRDA Regulations (GN 7949) and submitted to DMR for approval.

As noted earlier, in terms of the MPRDA, DMR has granted Prospecting Rights to De Beers for the Marine Prospecting Activities in the applied sea areas.

2.1.3 OTHER RELEVANT LEGISLATION

In addition to the foregoing, AuruMar must also comply with the provisions of other relevant international and national legislation and conventions, which includes, amongst others, the following:

International Marine Pollution Conventions

- International Convention for the Prevention of Pollution from Ships, 1973/1978 (MARPOL);
- Amendment of the International Convention for the Prevention of Pollution from Ships, 1973/1978 (MARPOL) (Bulletin 567 – 2/08);
- International Convention on Oil Pollution Preparedness, Response and Co-operation, 1990 (OPRC Convention);
- United Nations Convention on Law of the Sea, 1982 (LOSC);
- Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (the London Convention) and the 1996 Protocol (the Protocol);

Other South African legislation

- Carriage of Goods by Sea Act, 1986 (No. 1 of 1986);
- Dumping at Sea Control Act, 1980(No. 73 of 1980);
- Hazardous Substances Act, 1983 and Regulations (No. 85 of 1983);
- Marine Living Resources Act, 1998 (No. 18 of 1998);
- Marine Traffic Act, 1981 (No. 2 of 1981);
- Marine Pollution (Control and Civil Liability) Act, 1981 (No. 6 of 1981);

- Marine Pollution (Prevention of Pollution from Ships) Act, 1986 (No. 2 of 1986);
- Marine Pollution (Intervention) Act, 1987 (No. 65 of 1987);
- Maritime Safety Authority Act, 1998 (No. 5 of 1998);
- Maritime Safety Authority Levies Act, 1998 (No. 6 of 1998);
- Maritime Zones Act 1994 (No. 15 of 1994);
- Merchant Shipping Act, 1951 (No. 57 of 1951);
- National Environmental Management: Air Quality Act, 2004 (No. 39 of 2004);
- National Environmental Management: Integrated Coastal Management Act, 2008 (No. 24 of 2008);
- National Heritage Resources Act, 1999 (No. 25 of 1999);
- Occupational Health and Safety Act, 1993 (No. 85 of 1993);
- Sea-Shore Act, 1935 (No. 21 of 1935);
- Sea Birds and Seals Protection Act, 1973 (No. 46 of 1973);
- Ship Registration Act, 1998 (No. 58 of 1998);
- Water Act, 1998 (No. 36 of 1998); and
- Wreck and Salvage Act, 1995 (No. 94 of 1995).

2.2 BASIC ASSESSMENT PROCESS

The Basic Assessment has the following important objectives:

- To provide a reasonable opportunity for I&APs to be involved in the study;
- To ensure that all potential key environmental issues and impacts that would result from the proposed project are identified;
- To assess potential impacts of the proposed project alternatives during the different phases of project development;
- To present appropriate mitigation or optimisation measures to minimise potential impacts or enhance potential benefits, respectively; and
- Through the above, to ensure informed, transparent and accountable decision-making by the relevant authorities.

The Basic Assessment process consists of a series of steps to ensure that the objectives are achieved and that it complies with the EIA Regulations 2010 as set out in GN R543. A flowchart indicating the Basic Assessment process is presented in Figure 2.1. The process involves an open, participatory approach to the study and full involvement of I&APs to ensure that all impacts are identified and that planning and decision-making takes place in an informed, transparent and accountable manner.

2.2.1 PROCESS UNDERTAKEN TO DATE

The Basic Assessment process undertaken is summarised below.

- An Application Form and Declaration of Interest were submitted to DEA on 31 March 2011 (see Appendix 2).
- Specialist input was provided on the likely impact on the benthic environment and fishing industry by the proposed prospecting activities (see Appendices 3 and 4, respectively). Impacts were assessed according to pre-defined rating scales (see Appendix 5).
- The specialist input and other relevant information was integrated into the Draft BAR.
- A preliminary interested and affected party (I&AP) database has been compiled which consists of authorities (local and regional), Non-Governmental Organisations, Community-based Organisations and other key stakeholders. This database was compiled using databases of previous studies in the area. To date 59 I&APs have been registered on the project database (see Appendix 6).

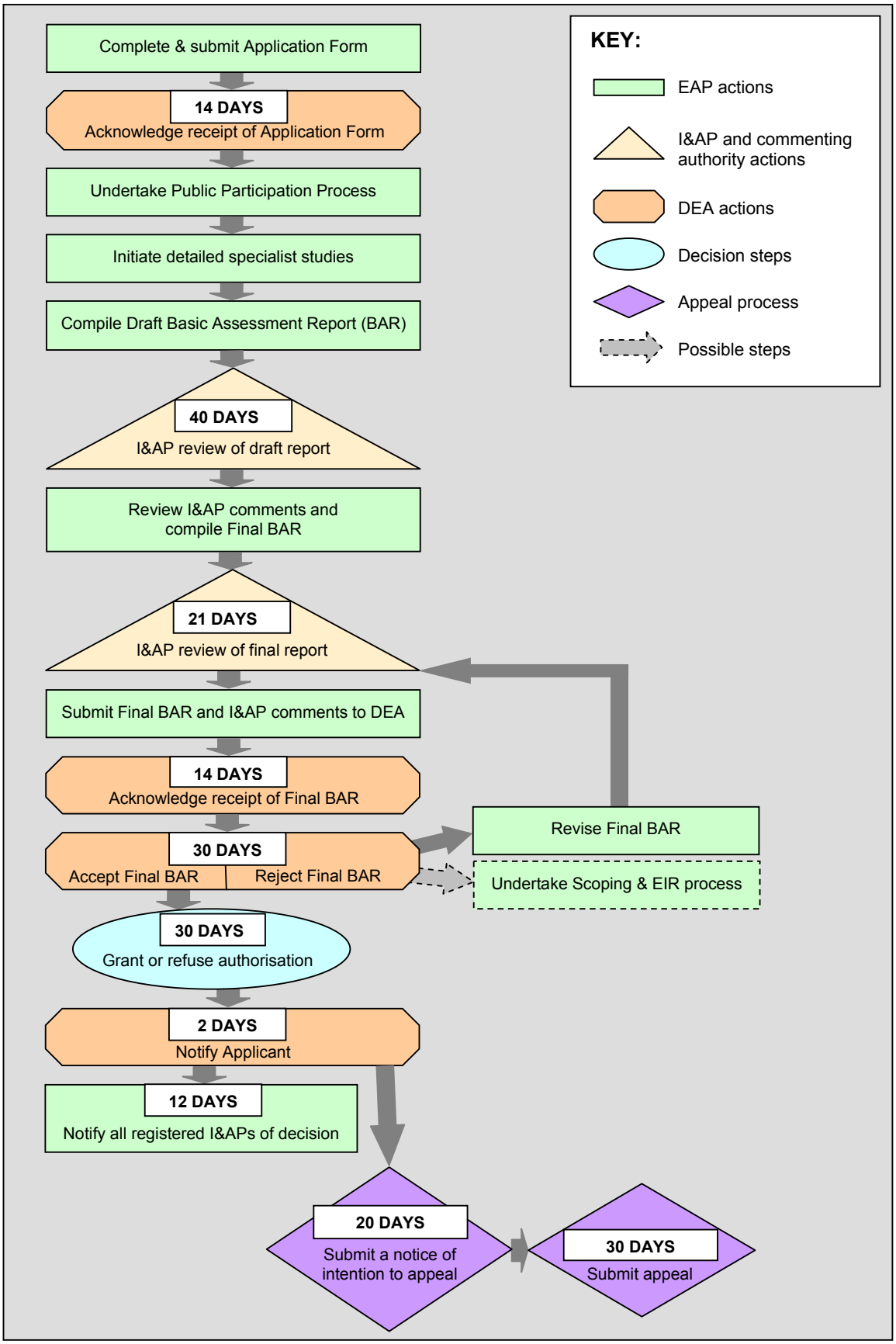

Figure 2.1: Basic Assessment process.

- The Draft BAR was made available to I&APs for a 40-day comment period.
- A notification letter was sent to all I&APs registered on the project database (see Appendix 2). A copy of the Draft BAR Executive Summary was enclosed with the letter.
- Advertisements were placed in Die Weslander and Ons Kontrei on 18 April 2011 and in the Cape Times and Die Burger on 22 April 2011 (see Appendix 7).
- A total of five comments were received, three of which were from commenting authorities (see Appendix 8).
- A Comments and Responses Report was compiled (see Appendix 8).
- The Draft BAR was updated to a Final BAR and has been made available for a further 30-day comment period (see Section 1.4).
- A notification letter was sent to all I&APs registered on the project database.

It should be noted that I&APs have previously been consulted as part of the MPRDA Prospecting Rights application for proposed Marine Prospecting Activities. During this process, comments received did not raise any significant issues of concern.

2.2.2 WAY FORWARD IN THE BASIC ASSESSMENT PROCESS

The following steps will be undertaken in the remainder of the Basic Assessment process (see Figure 2.1):

- The Final BAR and any comments received from I&APs on the Final BAR, will be submitted to DEA for consideration and decision-making.
- After DEA has reached a decision, all I&APs on the project database will be notified of the outcome of the application and the reasons for the decision; and
- A statutory appeal period in terms of Chapter 7 of the EIA Regulations 2010 will follow the issuing of the decision.

3. PROPOSED PROJECT DESCRIPTION

This chapter provides general information on the proposed project, the need and desirability of the proposed project, description of alternatives, and information on the proposed sampling activities.

3.1 GENERAL INFORMATION

3.1.1 PROSPECTING RIGHT APPLICANT

De Beers is the applicant for the Marine Prospecting Activities; however, AuruMar would be the operator representing the applicant for the proposed project.

Address: **De Beers Consolidated Mines Ltd**
PO Box 616,
KIMBERLEY
8300

Operator: **AuruMar (Pty) Ltd**
Project Manager: Mr Neil Fraser, Venture Manager, AuruMar (Pty) Ltd
Telephone: +27 (0)21 658 3213
Facsimile: +27 (0)21 658 3354
Cell: +27 (0)83 388 8788
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3.1.2 PROSPECTING SEA AREA DETAILS

The proposed core sampling and geophysical survey would be undertaken within the sea areas 1c, 2c, 3c, 4c, 5c, 6c, 7c, 8c, 9c, 10c, 12c, 14c, 15c, 16c, 17c, 18c and 20c off the west coast of South Africa (refer to Figure 1.1). The proposed prospecting activities include the sourcing of heavy minerals, platinum group metals, gold and sapphire (gemstones). Sea areas 1c, 2c, 3c, 4c, 5c, 6c, 7c, 8c, 9c and 10c are located off the Northern Cape coast, while the remaining sea areas are located off the Western Cape coast. The entire prospecting area covers 27 600 km^2 and is located between the 50 m and 200 m depth contours. Sampling would occur in water depths ranging from 90 m to 200 m. The co-ordinates of the proposed prospecting area boundary are provided Table 3.1 and refer to Figure 3.1.

Table 3.1: Coordinates of the Proposed Prospecting Area Boundary

Point	Latitude	Longitude
Prospecting Right Areas 1c -10c		
1	16° 25.094' E	28° 41.056' S
2	16° 33.595' E	28° 52.491' S
3	16° 43.129' E	29° 5.490' S
4	16° 53.281' E	29° 21.372' S
5	16° 59.347' E	29° 37.885' S
6	17° 4.881' E	29° 54.322' S
7	17° 10.278' E	30° 10.890' S
8	17° 17.461' E	30° 26.489' S
9	17° 26.495' E	30° 42.271' S
10	17° 35.211' E	30° 57.871' S
11	17° 45.478' E	31° 12.853' S
12	17° 9.077' E	31° 12.852' S

13	16° 57.543' E	30° 57.870' S
14	16° 53.077' E	30° 42.271' S
15	16° 44.910' E	30° 32.655' S
16	16° 37.076' E	30° 29.789' S
17	16° 37.226' E	30° 26.489' S
18	16° 36.043' E	30° 18.039' S
19	16° 10.112' E	30° 10.939' S
20	15° 58.742' E	30° 4.407' S
21	15° 53.175' E	29° 56.441' S
22	15° 41.725' E	29° 56.441' S
23	15° 39.674' E	29° 54.274' S
24	16° 3.567' E	29° 54.394' S
25	16° 3.722' E	29° 37.724' S
26	16° 3.872' E	29° 21.374' S
27	16° 4.016' E	29° 5.492' S
28	16° 4.078' E	28° 58.528' S
29	16° 14.298' E	28° 52.491' S
30	16° 18.653' E	28° 49.603' S
Prospecting Right Area 12c		
31	17° 56.745' E	31° 27.269' S
32	18° 9.296' E	31° 42.584' S
33	17° 11.860' E	31° 42.584' S
34	17° 15.577' E	31° 27.268' S
Prospecting Right Areas 14c – 20c		
35	18° 11.612' E	31° 48.951' S
36	18° 13.712' E	31° 54.734' S
37	18° 10.212' E	32° 5.166' S
38	18° 10.495' E	32° 12.182' S
39	18° 6.928' E	32° 19.165' S
40	17° 52.461' E	32° 33.464' S
41	17° 45.261' E	32° 49.613' S
42	17° 37.660' E	32° 49.615' S
43	17° 42.928' E	32° 33.464' S
44	17° 23.010' E	32° 19.165' S
45	17° 17.910' E	32° 12.182' S
46	17° 15.277' E	32° 5.166' S
47	17° 10.677' E	31° 54.733' S
48	17° 9.027' E	31° 48.950' S

3.1.3 PROPOSED WORK PROGRAMME

AuruMar's proposed timeframes to complete the prospecting work is provided in Table 3.2.

Table 3.2: Proposed work programme.

Activity	Timeframe
Initial Deposit Assessment Programme	4th Quarter 2011
Evaluation of results	1st Half 2012
Detailed geophysical survey	Mid 2012
Resource Delineation Programme	4th Quarter 2012 – Nov 2013

Due to the dynamic nature of prospecting and evaluation the work programme may have to be modified, extended or curtailed as results and data become available.

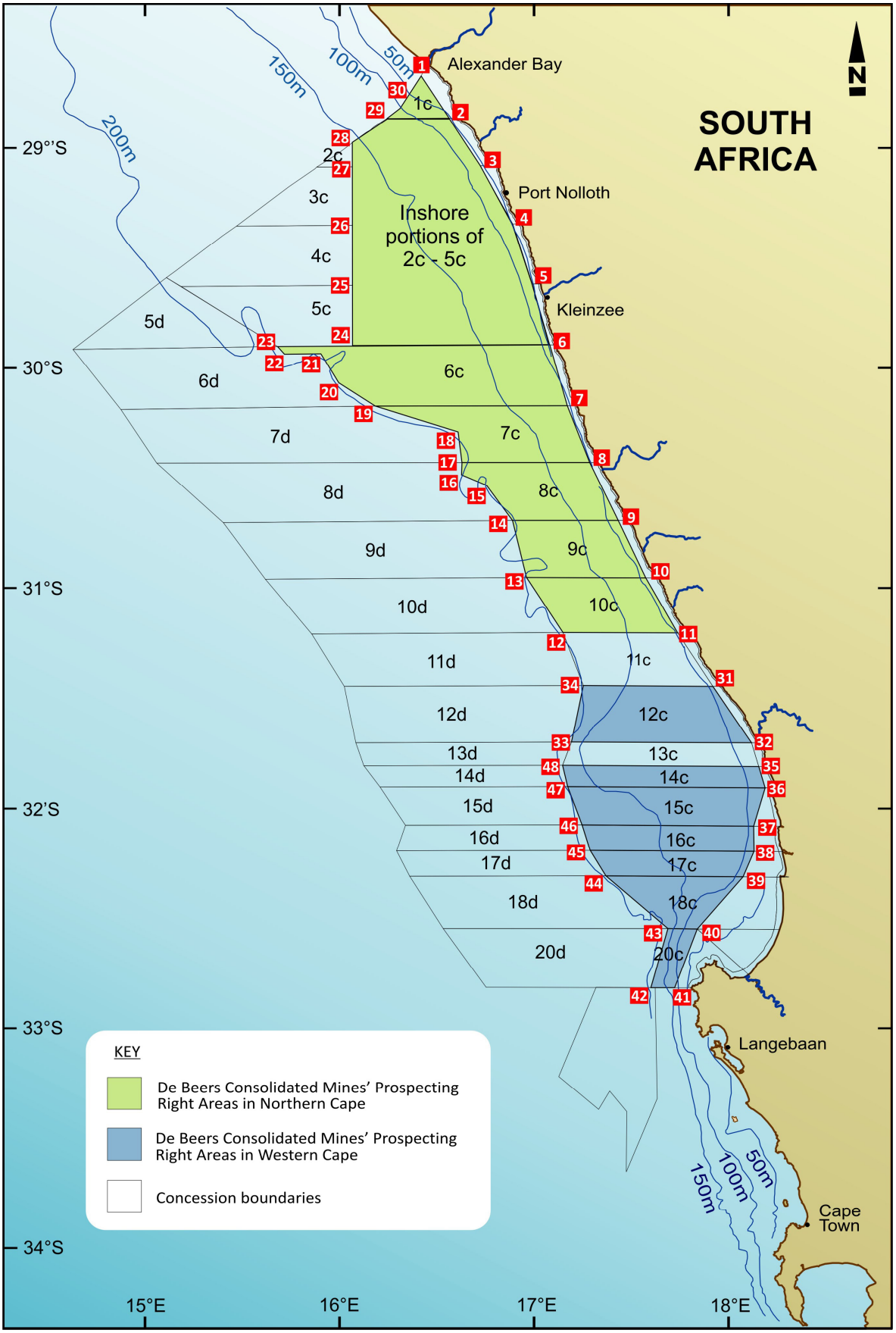

Figure 3.1: **Map showing location of the prospecting area, as well as the position of coordinates, as per table 3.1**

3.2 NEED AND DESIRABILITY OF THE PROPOSED PROJECT

3.2.1 BACKGROUND

When considering the need and desirability of this project it is important to consider the role that mining plays within the South African economy. The Minister's statement in the Department of Minerals Resources Strategic Plan 2008/09 - 2010/11 refers "*the growth of the mining industry is historically intertwined with the growth of our economy*" and states further that "*Mining has and will continue to be the mainstay of our economy*."

In order for mining to continue to be a core contributor to the South African economy and in the pursuance of the sustainable development of the nation's mineral resources it is necessary to identify new resources through prospecting. A key intent of the Minerals and Mining Policy of South Africa states that Government will: "*promote exploration and investment leading to increased mining output and employment*" (Minerals and Mining Policy of South Africa, 1998). The Policy states further that:

- *"The South African mining industry, one of the country's few world-class industries, has the capacity to continue to generate wealth and employment opportunities on a large scale.*
- *Mining is an international business and South Africa has to compete against developed and developing countries to attract both foreign and local investment. Many mining projects in South Africa have tended to be unusually large and long term, requiring massive capital and entailing a high degree of risk.*
- *South Africa has an exceptional minerals endowment, and in several major commodities has the potential to supply far more than the world markets can consume."*

If one looks at gold in particular, the Chamber of Mines' explains that *"With the stabilisation in world mine production and central bank sales, the prospect of any major sources of new supply of gold have diminished. The continued focus on productivity and consolidation in the South African gold mining industry will result in a decline in production - although replacement tonnage from new mines will slow the rate of decline.* "

This project aims to establish whether economically viable heavy mineral deposits, including gold, occur on the continental shelf off the west coast of South Africa.

3.2.2 RATIONALE FOR THE PROPOSED PROJECT

The principal objective of this project is to use the best available technology to ground-truth the geological model for the existence and regional distribution of potentially economic and accessible placer deposits within the prospecting rights areas, to determine the mineralogical content of such deposits and to determine the regional distribution of grades in technologically and economically assessable shelf sediments.

3.3 CONSIDERATION OF ALTERNATIVES

This section presents the various alternatives considered in this Basic Assessment.

3.3.1 MARINE PROSPECTING ALTERNATIVES

A number of alternatives specifically related to the proposed Marine Prospecting Activities are discussed further in Section 3.4 and assessed in Chapter 5. These include:

- Number of sample sites;
- Sampling techniques;
- Choice of survey tools; and
- Choice of sampling platform.

3.3.2 THE NO-GO ALTERNATIVE

The No-Go alternative is the non-occurrence of the proposed project. The negative implications of not going ahead with the proposed project are as follows:

- Loss of opportunity to establish whether a viable offshore heavy mineral resource exists off the west coast of South Africa; and
- Lost economic opportunities related to costs already incurred in the initial prospecting phase.

3.4 MARINE PROSPECTING OVERVIEW

The prospecting activities would be conducted in a phased approach, with each phase dependant on the results of the previous phase. The two phases planned are as follows and it is proposed that they would run from October 2010 to November 2013:

- Phase I: Initial Deposit Assessment Programme
- Phase II: Resource Delineation Programme

It should be noted that AuruMar has already undertaken a desktop study and developed a geological model and an associated mineralisation model, based on existing information. The desktop study included the review of published geophysical, geotechnical and sampling data as well as the review of data that De Beers has collected from existing and adjacent concession areas. Geophysical surveys and follow up ground-truthing was also undertaken in areas highlighted as potential targets by the desktop studies and where there was insufficient detail to guide further exploration.

AuruMar is currently in the processes of identifying the potential sampling areas for Phase I. However, this information is only likely to be completed towards September 2011.

Phases I and II would utilise the exploration sampling method, detailed below.

3.4.1 EXPLORATION SAMPLING

The proposed prospecting activities would utilise AuruMar's Sonic VibroCorer (SVC) in order to collect the required samples (see Figure 3.2). The system utilises a vibratory head, which has been adapted from land based technology, where the vibration energy is transferred into the drill string and enables the drill-string to penetrate into the seabed down to 10 m with a radius of 75 mm. The system can penetrate through most unconsolidated seabed lithologies, to produce a discrete high integrity core, which can then be analysed in detail. The sampling system is mounted in a frame, which is lowered to the seabed from a purpose built Launch and Recovery System (LARS) on a suitable vessel of opportunity (refer to Section 3.4.3 below).

Noise measurements have been taken for the SVC and at a distance of 25 m from the tool the noise was measured at 160 – 180 dB re 1µPa. At a distance of 110 m from the tool the noise is typically 155 dB re 1µPa and 164dB re 1µPa. The 1/3 octave analysis showed there was a 1/3 octave tone at 100 Hz and 125 Hz with harmonics at 200Hz and 250Hz (Hegley, 2010).

SVC core samples would be logged and stored onboard the vessel and transferred ashore at regular intervals for further analysis. Once the cores are logged they would then be analysed onshore for heavy mineral content. This would entail initial sizing, screening and sub-sampling, followed by an evaluation of a sub-sample at an appropriately accredited onshore laboratory. Results from the sample treatment and the evaluation process would provide inputs into the geological model.

Figure 3.2: AuruMar's Sonic VibroCorer on a vessel.

3.4.2 PHASE I – INITIAL DEPOSIT ASSESSMENT PROGRAMME

The aim of Initial Deposit Assessment Programme would be to groundtruth the geological model compiled during the desktop study and to identify the possible presence of mineralisation for further resource delineation (i.e. Phase II).

It is proposed that approximately 300 cores would be collected within identified areas in the prospecting rights areas. Up to 60 target areas would be selected over the 27 600 km² prospecting area based on the results of an ongoing desktop study. Clusters of up to five cores would be collected in each target area with individual core spacing of approximately 70 metres. The 300 core sampling activities would result in a total disturbance area of 53 m³ (see Table 3.3).

The Initial Deposit Assessment Programme would extend for approximately 80 days.

Table 3.3: Total disturbance area during Phase I.

Total disturbance for Deposit Assessment Programme			
# cores	**Area (m2)**	**Disturbance area as % of total prospecting right area**	**Volume (m3)**
300	5	1.8×10^{-8}	53
Note: Calculations of area and volume disturbed based on a radius of 75.18 mm for each recovered core. Calculated volume per 10m deep sampling hole is 0.1775 m^3 and area of each sampling hole is 0.0178 m^2			

3.4.3 PHASE II - RESOURCE DELINEATION PROGRAMME

Phase II is split into a detailed geophysical survey as well as further exploration sampling activities (as described in Section 3.4.3.2)

3.4.3.1 Geophysical Survey

A detailed geophysical survey would be undertaken, based on the findings of Phase I.

The following geophysical tools are available for prospecting surveys:

- *Swath bathymetry*
  The swath bathymetry system produces a digital terrain model of the seafloor.
- *Shallow (2 to 10 Khz) and medium penetration (0.5 to 2 Khz) "Chirp" seismic systems*:
  Chirp seismic systems generate profiles up to 10 m beneath the seafloor to give a cross section view of the sediment layers.
- *Medium penetration Sleevegun seismic systems*:
  Sleevegun seismic systems generate medium penetration profiles up to 50 m beneath the seafloor to give a cross section view of the sediment layers.
- *100 Khz side scan sonar*:
  Side scan sonar systems produce acoustic intensity images of the seafloor and are used to map the different sediment textures of the seafloor.
- *Magnetometer:*
  The magnetometer measures local variations in the intensity of the Earth's magnetic field, which are caused by differences in composition of the sediment layers beneath the seafloor and help identify where deposits lie in the seabed.

It is proposed that the Focus towfish (see Figure 3.3) could be used to collect side scan sonar as well as Chirp seismic data. Hull mounted swath bathymetry and towed magnetometers would be deployed to gather additional data. In addition, the Autonomous Underwater Vehicle (AUV) (see Figure 3.4) could be used to survey in areas where the survey line spacing is less than 50 m apart. The survey tools are deployed from a vessel of opportunity contracted for the period of the survey programme (see Figure 3.5). Table 3.4 lists the survey equipment (and its source level noise) that is likely to be used for the geophysical survey.

Table 3.4: Specifications of acoustic equipment to be utilised in the proposed survey

Type	Frequency	Cycle (impulses per second)	Source level (dB re 1 µPa at 1m)
Chirp sub - bottom profiler	1.5 to 12.5 kHz	4	202
Klein Side Scan Sonar	100 or 500 kHz	10	210
SRD swath Bathymetry	240 kHz	15	190
AVTRAK acoustic positioning	18 to 35 kHz	0.5	190
RDI Doppler system	1200 kHz		214
RESON 8101 Bathymetry system	240 kHz	up to 30	220
10 inch Sleeve gun system	100-800 Hz	1	about 220

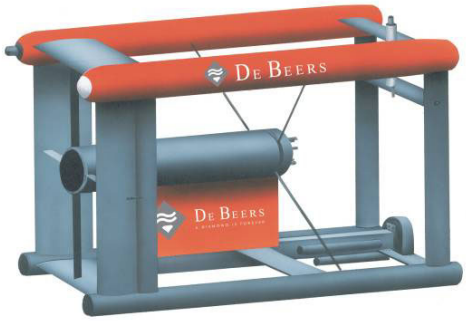

Figure 3.3: Focus Towfish could be used to collect both side scan sonar and Chirp seismic data.

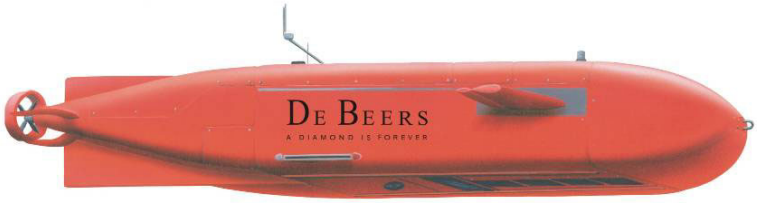

Figure 3.4: An Autonomous Underwater Vehicle (AUV).

Figure 3.5: Photograph of mv Ellen Khuzwayo, a typical vessel of opportunity used as a platform for geophysical survey activities.

3.4.3.2 Resource Delineation Programme

Once the detailed geophysical surveying has been completed and the results further analysed, it is assumed that these results would yield at least one deposit that would justify further sampling in the Resource Delineation Programme. The proposed method of sampling would be the same as the process undertaken in Phase I (see Section 3.4.1 above). Phase II is intended to increase the level of confidence regarding the presence of a mineral resource in the deposit area. This confidence level would ultimately determine whether it is viable to apply for commercial mining rights.

It is assumed that the potential deposit area to be sampled would be approximately 56 km² in extent. It is estimated that up to 4 500 core samples would be required within this deposit area. The core spacings would be between 50 and 200 m apart. The total volume of disturbance would be approximately 799 m³ (see Table 3.5).

Table 3.5: Total disturbance area for the Resource Delineation Programme.

Total disturbance for Resource Delineation Programme			
# cores	**Area (m2)**	**Disturbance area as % of total prospecting right area**	**Volume (m3)**
4500	80	2.9 x e^{-7}	799
Note: Calculations of area and volume disturbed based on a radius of 75.18 mm for each recovered core. Calculated volume per 10 m deep sampling hole is 0.1775 m^3 and area of each sampling hole is 0.0178 m^2.			

3.4.4 VESSELS

It is proposed that a vessel of opportunity would be used for the sampling activities (see Figures 3.6).

Figure 3.6: An example of the type of vessel that could be used for the proposed sampling activities.

3.4.5 ONSHORE CORE AND DATA PROCESSING

Cores would be dispatched onshore from the vessel on a monthly basis. A dedicated processing facility would be established in Cape Town for the initial preparation and selection of the samples. The 10 m cores

would be logged in detail and subdivided into 0.5 m sequential samples. Individual samples would be screened to separate out the coarse (>5 mm) fraction. The remaining fine fraction (<5 mm) would be dried crushed to 2 mm and subdivided for further mineral analysis and assay. Mineral analysis and assay would be conducted by an accredited laboratory, either by fire assay or bottle roll leach extraction.

3.5 EMISSIONS AND DISCHARGES

This section provides a brief description of the types of emissions and discharges that are expected from the activities relating to the sampling activities. These would include:

- Discharges such as deck drainage, machinery space wastewater, sewage, etc; and
- Disposal of solid waste such as foodwaste.

These are discussed in more detail below.

3.5.1 DISCHARGES TO SEA

3.5.1.1 Vessel machinery spaces (bilges), ballast water and deck drainage

The concentration of oil in discharge water from any vessel (bilge and ballast) would comply with the MARPOL Regulation 21 standard of less than 15 ppm oil in water. Any oily water would be processed through a suitable separation and treatment system to meet the MARPOL standard before discharge overboard. Drainage from marine (weather) deck spaces would wash directly overboard.

3.5.1.2 Sewage

Although South Africa is not yet a signatory to MARPOL Annex IV Regulations for the Prevention of Pollution by Sewage from Ships, the contracted vessels would be required to comply, wherever possible, with the requirements of this Annex.

3.5.1.3 Food (galley) wastes

The disposal into the sea of food waste is permitted in terms of MARPOL when it has been comminuted or ground and the vessel is located more than 3 nautical miles (approximately 5.5 km) from land. Such comminuted or ground food wastes shall be capable of passing through a screen with openings no greater than 25 mm. Disposal overboard without macerating can occur greater than 12 nautical miles (approximately 22 km) from the coast. The daily discharge from a sampling vessel is typically about 0.15 m^3.

3.5.1.4 Detergents

Detergents used for washing exposed marine deck spaces would be discharged overboard. The toxicity of detergents varies greatly depending on their composition. Water-based detergents are low in toxicity and are preferred for use. Preferentially biodegradable detergents would be used. Detergents used on work deck space would be collected with the deck drainage and treated as described under deck drainage (see Section 3.5.2.4 above).

3.5.1.5 Other

The sampling vessel would have a certified antifouling coating system that is tin free.

3.5.2 LAND DISPOSAL

A number of other types of wastes generated during the sampling activities would not be discharged at sea but would be transported onshore for ultimate disposal. Waste transported to land would be disposed at a licensed municipal landfill facility or at an alternative approved site. Operators would co-operate with local authorities to ensure that waste disposal is carried out in an environmentally acceptable manner.

A summary of these waste types generated by a vessel used during a typical sampling operation, their expected amounts, environmental properties, and destination is given below. Typical volumes are presented in Table 3.5 (note: these quantities should be viewed as rough estimates based on experience).

Garbage generated on board would be sorted and stored in separate bins e.g. plastic, paper, metals, food stuffs and glass.

Table 3.6: Estimated volume/mass of wastes produced during sampling activities of 100 days.

Waste Type	Volume / Mass produced per day	Total Volume / Mass produced during sampling
Rubbish/trash	120 kg	12 000 kg
Scrap metal	50 kg	5 000 kg
Drums/containers	0-2 units	Up to 200 units
Used oil	0.1 m^3	10 m^3
Chemicals/hazardous water	0.02 m^3	2 m^3
Infectious waste	negligible	negligible
Filters and filter media	5 kg	500 kg

3.5.2.1 Garbage

This includes wastes originating from vessel and sampling operations, including waste paper, plastics, wood, metal, glass, etc. All waste would be disposed of at an onshore landfill site in accordance with legal requirements.

3.5.2.2 Scrap metal

Scrap metal would be stored and recycled / disposed of on land in accordance with legal requirements.

3.5.2.3 Drums and containers

Empty drums containing residues, which may have adverse environmental effects (solvents, lubricating/gear oil, etc.), would be recycled / disposed of in a local landfill site in accordance with legal requirements.

3.5.2.4 Used oil

Examples include used lubricating and gear oil, solvents, hydrocarbon-based detergents and machine oil. Toxicity varies depending on oil type. All non-recycled waste oils would be securely stored, transported to shore and disposed of at a licensed site acceptable to the relevant authorities.

3.5.2.5 Chemicals and hazardous wastes

Disposal of any unexpected chemical and hazardous substance (e.g. fluorescent tubes, toner cartridges, batteries, etc.) would be done on a case-by-case basis and in a manner acceptable to appropriate regulatory authorities.

3.5.2.6 Infectious wastes

Infectious wastes include bandages, dressings, surgical waste, tissues, medical laboratory wastes, needles, and food wastes from persons with infectious diseases. Only minor quantities of medical waste are expected. Prevention of exposure to contaminated materials is essential, requiring co-operation with local medical facilities to ensure proper disposal. All such waste will be stored and brought onshore for disposal via a registered medical waste company.

3.5.2.7 Filters and filter media

This includes air, oil and water filters from machinery. Oily residue and used media in oil filters that may contain metal (e.g. copper) fragments, etc. are possibly toxic. Filters and media would be transported onshore and disposed of at a licensed landfill facility.

3.5.3 DISCHARGES TO AIR

3.5.3.1 Vessel machinery

All vessel engines would comply with the requirements for the prevention of pollution by smoke, as dictated by Marpol (Marpol Annex VI).

4. THE AFFECTED ENVIRONMENT

This chapter provides a description of the biophysical and socio-economic environment likely to be affected by the proposed prospecting activities in the study area. The information provided here is based on previous information compiled for the area (CCA Environmental 2005; CCA Environmental 2007a; CCA Environmental 2007b; and De Beers Marine 2008) and the specialist benthic study undertaken as part of this study. This chapter has been divided into two sections, *viz.* marine environment (offshore) and nearshore region and shoreline environment.

4.1 MARINE ENVIRONMENT (OFFSHORE)

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

The study area lies within the southern zone of the Benguela Current region and is characterised by the cool Benguela upwelling system (Shillington 1998; Shannon 1985). A conceptual model of the Benguela system is shown in Figure 4.1.

4.1.1 METEOROLOGY

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

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

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

Strong north-westerly (NW) to south-westerly (SW) winds result from mid-latitude cyclones passing the southern Cape at a frequency of 3 to 6 days. Associated with the approach of mid-latitude cyclones is the appearance of low-pressure cells, which originate from near Lüderitz on the Namibian coast and quickly travel around the subcontinent (Reason and Jury 1990; Jury, Macarthur and Reason 1990).

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

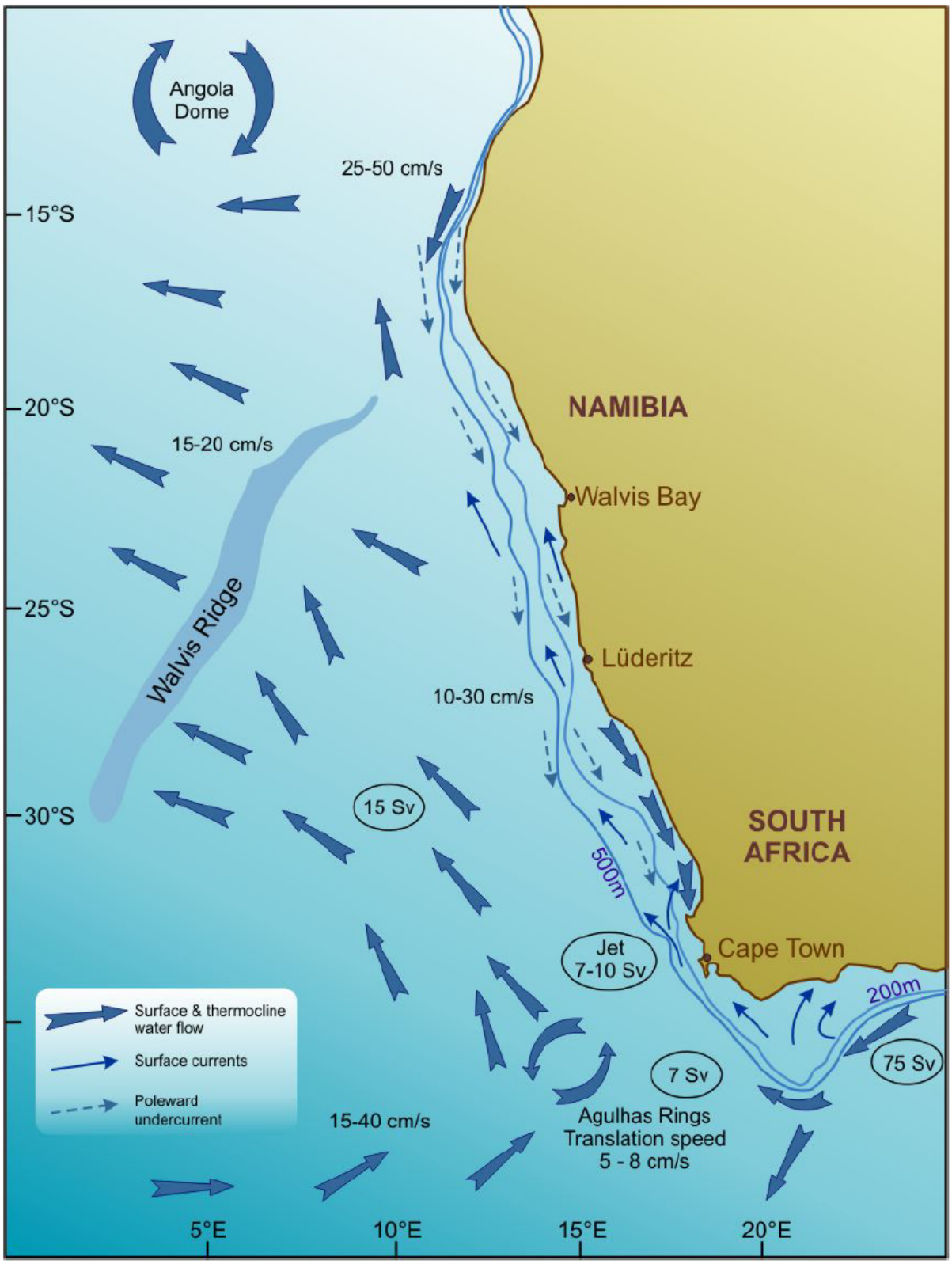

Figure 4.1: Circulation and volume flows of the Benguela current (after Shannon & Nelson, 1996).

4.1.2 PHYSICAL OCEANOGRAPHY

4.1.2.1 Waves

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

Wave patterns along the West Coast are strongly influenced by the seasonal meteorology. The majority of swells are generated by mid-latitude cyclones to the south of the country, and thus originate from the SW.

Wave period is similar and unimodal along the West Coast to the north of Cape Point. Peak energy periods range from 9.7 to 15.5 seconds and reach the coast from the west-south-west (WSW) to south-south-west (SSW) in the south (indicating that large swells originate from mid-latitude cyclones).

Wave height decreases with both distance north along the West Coast and with distance offshore. There is little seasonal variation in the wave regime along the West Coast, although a slight increase in swells from the WSW-west direction occurs in winter. The largest waves (6 to 8 m) originate from the SSW sector. Large wave events usually last for 2 to 4 days, although they may last for as long as a week.

4.1.2.2 Tides

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

4.1.2.3 Topography

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

The continental shelf along the West Coast is generally both wide and deep, although large variations in both depth and width occur (Figure 4.2). The shelf maintains a general north-north-west (NNW) trend north of Cape Point, being narrowest in the south between Cape Columbine and Cape Point (40 km) and widening to the north of Cape Columbine to its widest of the Orange River (180 km).

The immediate nearshore area consists mainly of a narrow (to about 8 km wide) rugged rocky zone which initially slopes steeply seawards to a depth of about 30 m and then gradually to about 80 m. The middle and outer shelf normally lacks relief and slope gently seawards reaching the shelf break (where the slope becomes significantly steeper) at a depth of approximately 500 m. Banks on the continental shelf include the Orange Bank (Shelf or Cone), a shallow (160 to 190 m) zone that reaches maximal widths (180 km) offshore of the Orange River, and Childs Bank, situated about 150 km offshore at about 31°S. A number of submarine canyons cut into the shelf between 31° and 35°S, the most prominent being the Cape Canyon and the Cape Point Valley.

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

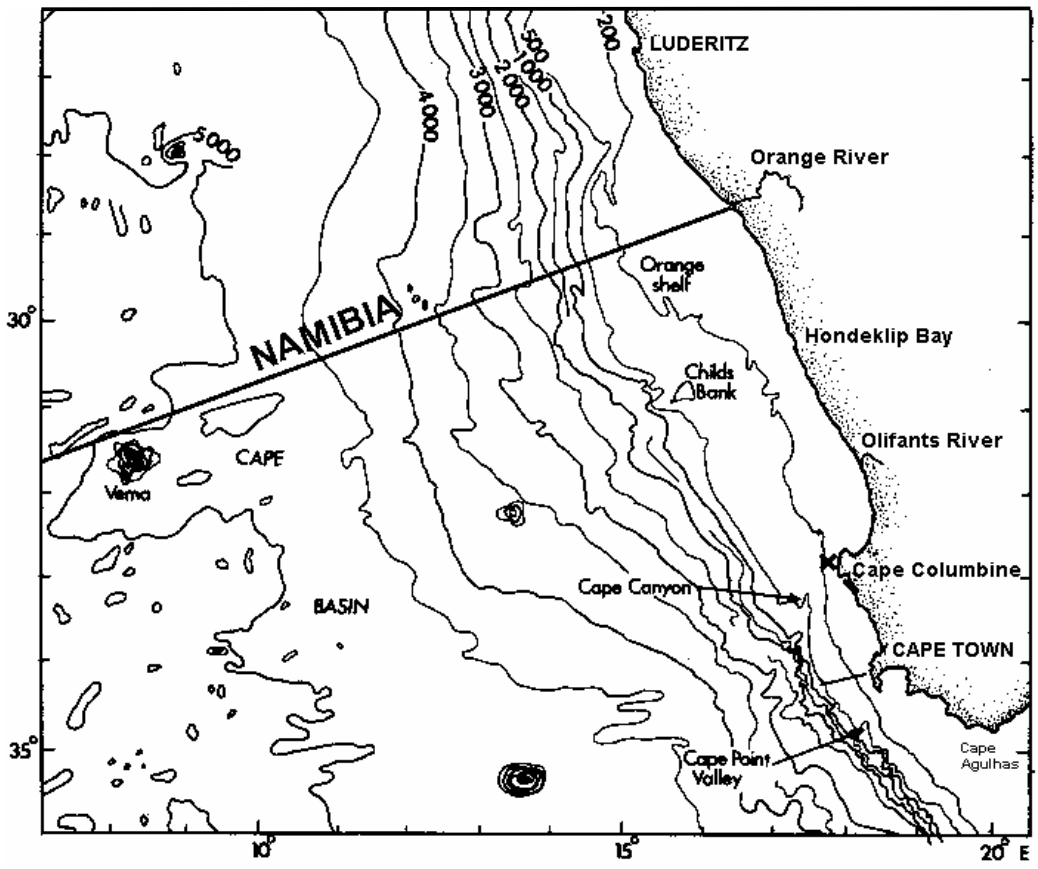

Figure 4.2: Bathymetry of the continental shelf off the West Coast of southern Africa (after Dingle *et al.* 1987).

The proposed prospecting activities would be undertaken within a 27 600 km^2 area in water depths of between 50 m to 200 m.

4.1.2.4 Sediments

Figure 4.3 summarises the distribution of seabed surface sediment types off the South African west coast. As a result of erosion on the continental shelf, the unconsolidated sediment cover is generally thin, often less than 1 m. Sediments are finer seawards, changing from sand on the inner and outer shelves to muddy sand and sandy mud in deeper water. However, this general pattern has been modified considerably by biological deposition (large areas of shelf sediments contain high levels of calcium carbonate) and localised river input. An almost 500 km long mud belt (of up to 40 km wide, and of 15 m average thickness) is situated over the outer edge of the middle shelf between the Orange River and St Helena Bay (Birch, Rogers, Bremner and Moir 1976). Within the broad study area, sediment is dominated by muddy sands, sandy muds, mud and some sand.

Present day sedimentation is limited to input from the Orange River. This sediment is generally transported northward. Most of the sediment in the area is therefore considered to be relict deposits by now ephemeral rivers active during wetter climates in the past. The Orange River, when in flood, still contributes largely to the mud belt as suspended sediment is carried southward by poleward flow. In this context, the absence of large sediment bodies on the inner shelf reflects on the paucity of terrigenous sediment being introduced by the few rivers that presently drain the South African West Coast coastal plain. Nearshore sediments are subject to suspension by waves and longshore transport. This effect penetrates to 90 m. Natural turbidity levels range from 3 and 12 mg/l with significantly higher concentrations associated with storm waves and floods.

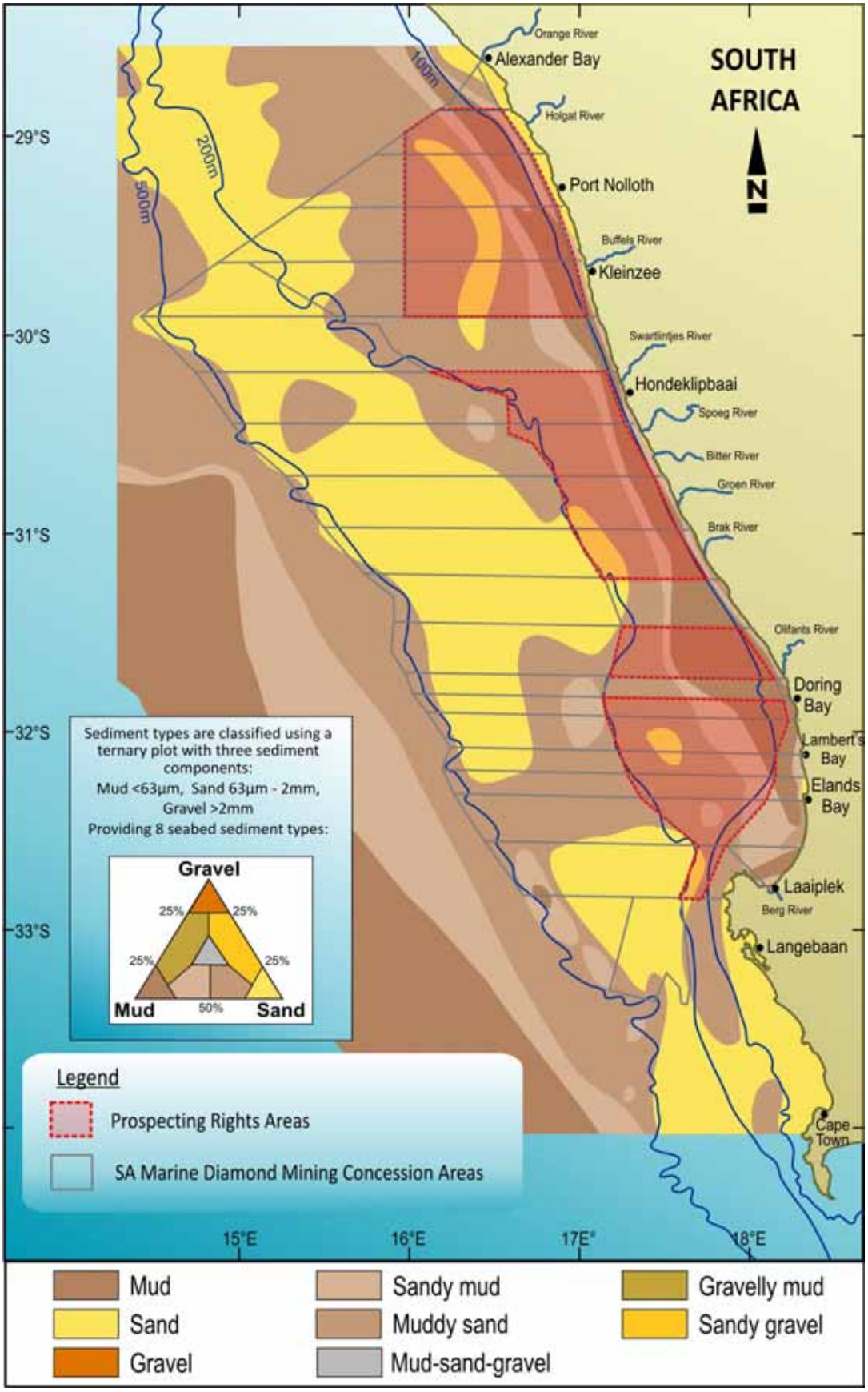

Figure 4.3: Map of the distribution of seabed surface sediment types off the South African west coast (from Lane & Carter 1999).

4.1.2.5 Water masses and sea surface temperatures

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

Off the south-western Cape the upwelling of cool water occurs during the summer months stabilising the seawater temperature along this coastline to some extent so that the average sea surface temperature changes little throughout the year (13 to 15 °C). In the northern Benguela system where cool upwelling occurs during the winter months, a far more pronounced seasonal difference (12 to 17 °C) in sea surface temperatures occurs (Shannon 1985). The sea surface temperature along the coast of Namaqualand near Port Nolloth ranges from a minimum of 10 °C to a maximum of just over 20 °C, with 84 % of the temperatures falling within a range of 12 °C to 17 °C (Figure 4.4).

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

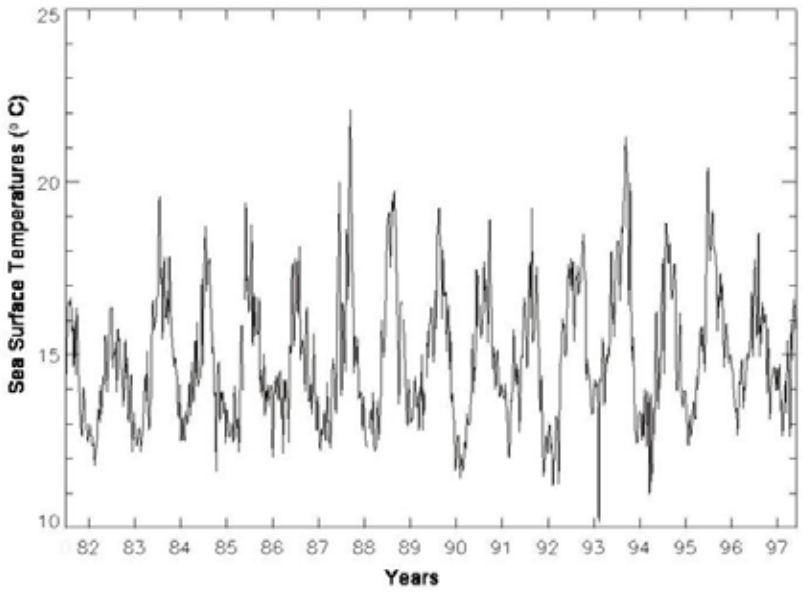

Figure 4.4: Weekly sea surface temperature recordings for the Namaqualand coastal waters, from 1980 – 1998 (Figure after Enviro-Fish Africa, Grahamstown).

4.1.2.6 Water Circulation

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

The ocean currents occurring off the Namaqualand coast are complex. Data suggests that currents north of Cape Columbine are weaker and more variable than the currents to the south (Boyd *et al*. 1992). The most

important is the Benguela current, which constitutes a broad, shallow and slow NW flow along the West Coast between the cool coastal upwelled waters and warmer Central Atlantic surface waters further offshore. The current is driven by the moderate to strong S to SE winds which are characteristic of the region and is most prevalent at the surface, although it does follow the major seafloor topographic features (Nelson and Hutchings 1983). The average current speed is reported to be about 2.5 $cm.s^{-1}$ (Heydorn and Tinley 1980), but varies according to the topography. Shelf edge jet currents exist off both Cape Columbine (Nelson and Hutchings 1983) and the Cape Peninsula (Bang 1970; Shillington 1998), where flow is locally more intense (up to 50 $cm.s^{-1}$ off Cape Columbine and 70 $cm.s^{-1}$ off the Cape Peninsula).

A southward flow of surface water occurs close inshore during periods of barotropic reversals and during winter when upwelling is not taking place. Agulhas Current water does occasionally enter the south-east Atlantic in summer as warm water filaments (<50 m deep) or eddies (several 100 m wide and deep). These warm water tongues are usually at least 180 km offshore and seldom move further north than 33°S and do not appear to impact the Benguela shelf region.

4.1.2.7 Upwelling

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

Upwelling occurs along the West Coast from Cape Agulhas to northern Namibia (Figure 4.5). The principle upwelling centre on the West Coast lies off Lüderitz and the Lüderitz upwelling cell effectively divides the Benguela Upwelling system into a northern and southern region, which are meteorologically distinct (Pitcher *et al.* 1992). In the south upwelling-favourable SE winds are most prevalent during spring and summer, and upwelling occurs mostly between September and March. Upwelling in the southern Benguela area is highly variable on macro, meso and micro scales. Both continental shelf bathymetry and upwelling winds drive upwelling in the southern Benguela which is further influenced by local topography and meteorology (Shannon 1985), resulting in centres of enhanced upwelling off Namaqualand (30°S), Cape Columbine (33°S) and Cape Peninsula (34°S).

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

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

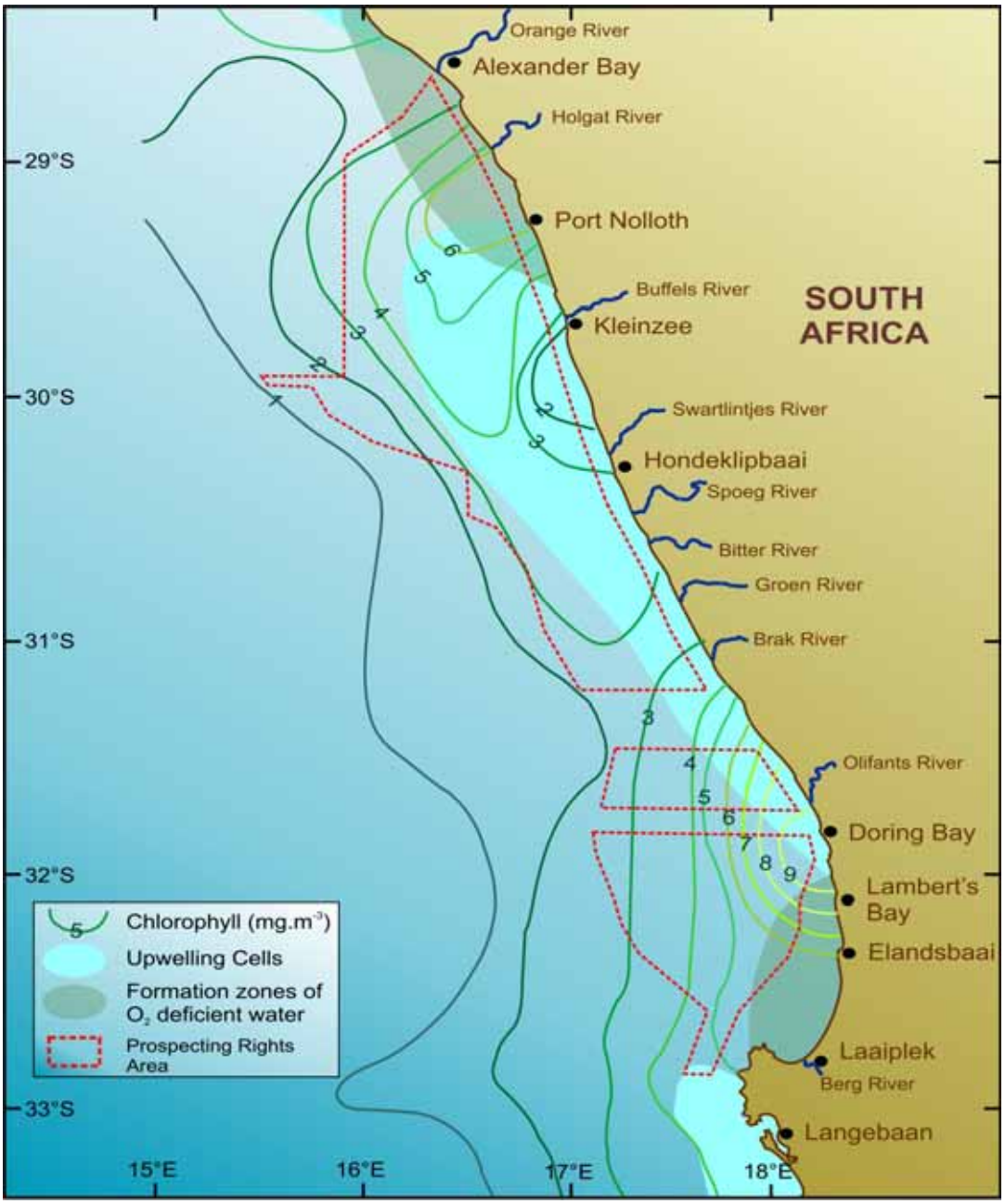

Figure 4.5: Map of the main upwelling areas, contours of resultant mean phytoplankton production (measured as mg.m^{-3} of chlorophyll-a and areas of subsequent natural formation of low oxygen water off the South African west coast (modified from Brown *et al*. 1991) (Pulfrich, 2011).

4.1.2.8 Nutrient distribution

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

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

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

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

4.1.2.9 Oxygen concentration

The Benguela system is characterised by large areas of very low oxygen concentrations, including three centres of oxygen-depleted shelf water; one of which is well north of the region (2°S to 24°S), another to the north of the Namaqualand upwelling cell and the third in St Helena Bay (Chapman and Shannon 1985).

Generally, oxygen concentrations appear to increase from the Orange River region southward. Surface oxygen levels are higher than bottom waters (water is regularly supersaturated) due to phytoplankton production, especially during less intense upwelling.

Oxygen depleted water has at times upwelled along the West Coast, resulting in rock lobster strandings.

4.1.2.10 Turbidity

Natural turbidity and/or suspended sediment concentration measurements from the West Coast are sparse. Suspended sediment distributions within South African nearshore waters range between 5 $mg.l^{-1}$ – 5 $g.l^{-1}$. The higher values are associated with high wave conditions resulting from storms and/or floodwaters (Bremner, Rogers and Willis 1990).

4.1.3 BIOLOGICAL OCEANOGRAPHY

4.1.3.1 Plankton

Plankton comprises three components:

(a) Phytoplankton

Features of phytoplankton distribution in the Benguela system are summarised in Figure 4.6.

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

Mean chlorophyll concentrations measured in the surface 30 m of the water column in each of inshore and offshore areas off the West Coast to the north of Cape Columbine are shown in Table 4.1. A well-defined thermal front separates high biomass of phytoplankton in coastal waters from the lower biomass found in more oceanic waters offshore.

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

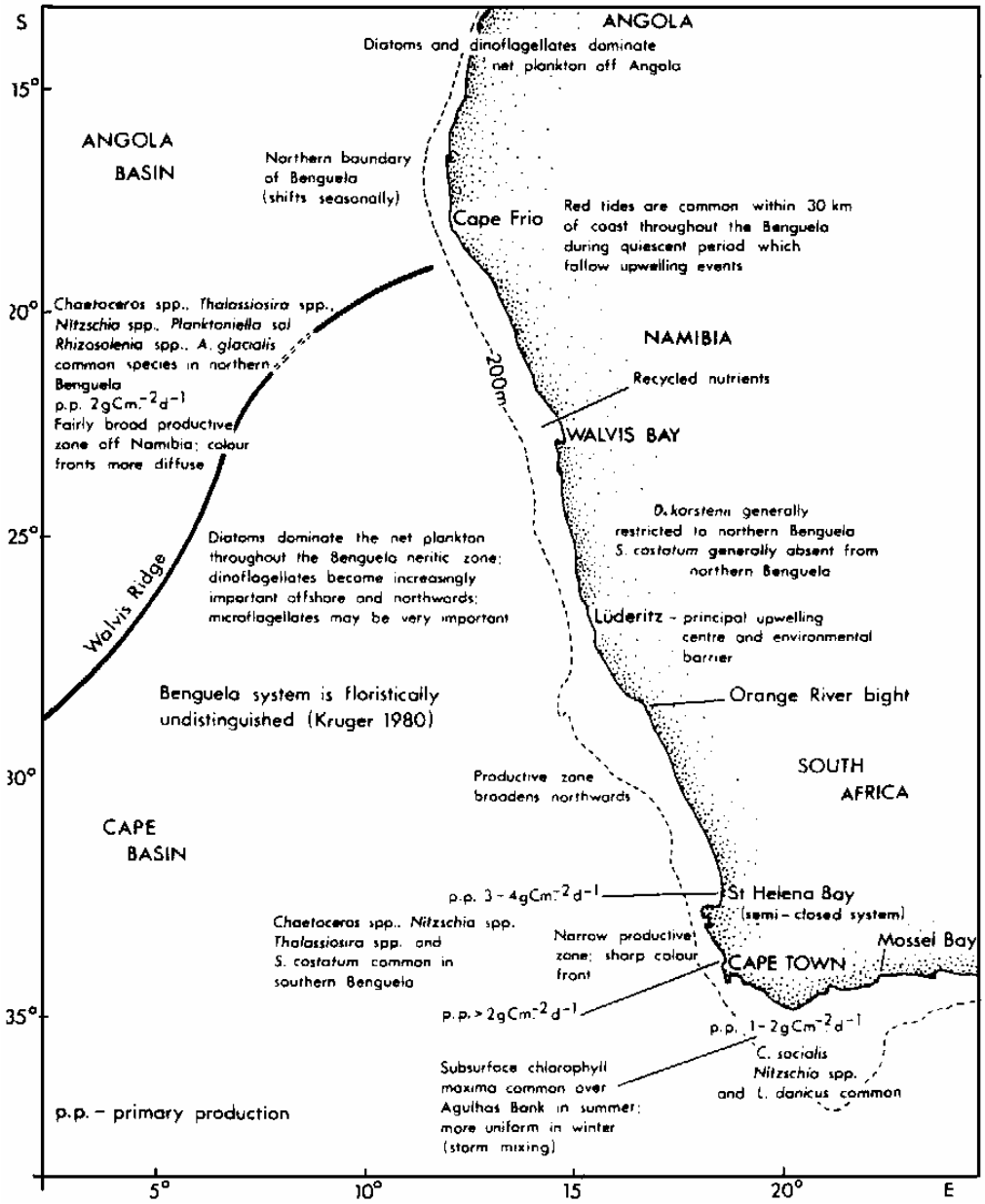

Figure 4.6: Features of phytoplankton distribution in the Benguela System (after Shannon and Pillar 1986).

Although diatoms are reported to contribute the bulk of the phytoplankton in the Benguela current (Andrews and Hutchings 1980; Olivieri 1983), dinoflagellates are also important (Chapman and Shannon 1985). Red tides (dinoflagellate and/or ciliate blooms) may occur inshore along the coast north of Cape Point (especially in the Lamberts Bay to St Helena Bay region), usually during relaxation of upwelling cells in late summer to autumn. Such red tides (which can range in colour) may be toxic and animals, particularly filter feeding species, may accumulate toxins in their tissues. Furthermore, decomposition of red tides may strip the remaining oxygen from the water and turning it anoxic (known as a "black tide"), having catastrophic

consequences on the inshore fauna of the affected area. The massive mortality of fish, lobsters and other inter- and subtidal invertebrates between Cape Columbine and the Berg River mouth during 1994 serves as an example of a black tide.

Table 4.1: Mean concentrations of chlorophyll a in the southern Benguela system over the period 1971 to 1989 (after Brown 1992).

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

(b) Zooplankton

Features of the zooplankton distribution in the Benguela system are summarised in Figure 4.7.

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

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

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

(c) Ichthyoplankton

Ichthyoplankton comprises both fish eggs and larvae, and despite comprising a small component of the overall plankton, is important due to commercial fisheries. Features of the ichthyoplankton distribution in the Benguela system are summarised in Figure 4.7 (Shannon and Pillar 1986).

Separate spawning areas exist for pilchard (*Sardinops sagax*) off the south-western Cape and off Namibia (Figure 4.8), and it is generally accepted that there are two populations separated by the Lüderitz upwelling

cell. Within the southern Benguela system two spawning areas for pilchard once existed namely off St Helena Bay and on the Western Agulhas Bank, (Shannon and Pillar, 1986), although spawning off St Helena Bay declined to negligible levels by 1966, possibly due to overfishing (Crawford 1980).

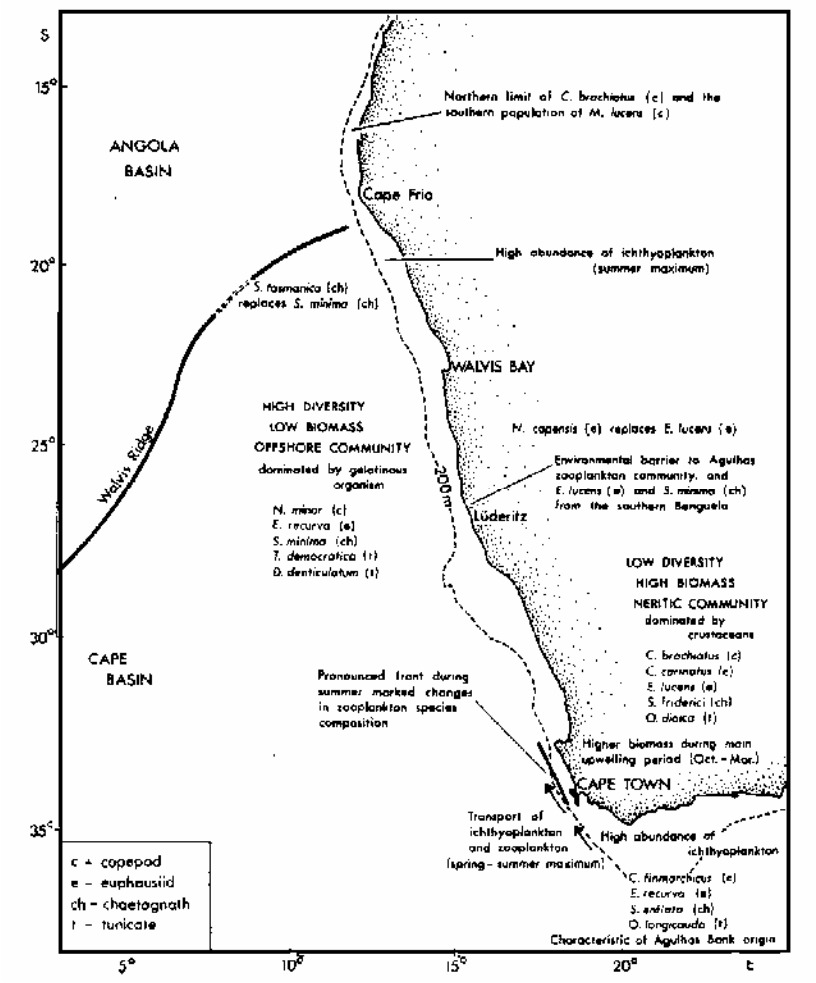

Figure 4.7: Features of zooplankton and ichtyoplankton distribution in the Benguela system (after Shannon and Pillar 1986).

As with pilchard, separate spawning areas exist for anchovy (*Engraulis japonicus*) off Namibia and the south-western Cape (Figure 4.8), and it is generally accepted that these are separate stocks. Each spring, anchovy migrate southwards from the West Coast to spawning grounds on the western Agulhas Bank (Peterson *et al.* 1992), where the fish spawn serially with frequency of spawning being dependent on food concentration (copepod biomass). Most spawning takes place to the east of Cape Point some 40 to 100 km offshore in 16 to 19°C water. Unlike pilchard and anchovy, the round herring spawns seaward of the shelf break. Horse mackerel spawns offshore in fairly deep water off the Cape (Figure 4.8).

Of the demersal species, the two hake species (*Merluccius capensis* and *M. paradoxus*) spawn on the continental shelf off St Helena Bay and the western Agulhas Bank (see Figure 4.9). Hake spawning occurs in spring and early summer, with a secondary spawning peak in autumn. Kingklip (*Genypterus capensis*) spawning occurs along the southern African West Coast from Cape Point northwards (Payne 1977). Eggs and/or larvae of snoek (*Thyrsites atun*), jacopever (*Helicolenus dactylopterus*), dragonet (*Paracallionymus costatus*) and saury (*Scomberesox saurus scomberoides*) have also been reported in the southern Benguela.

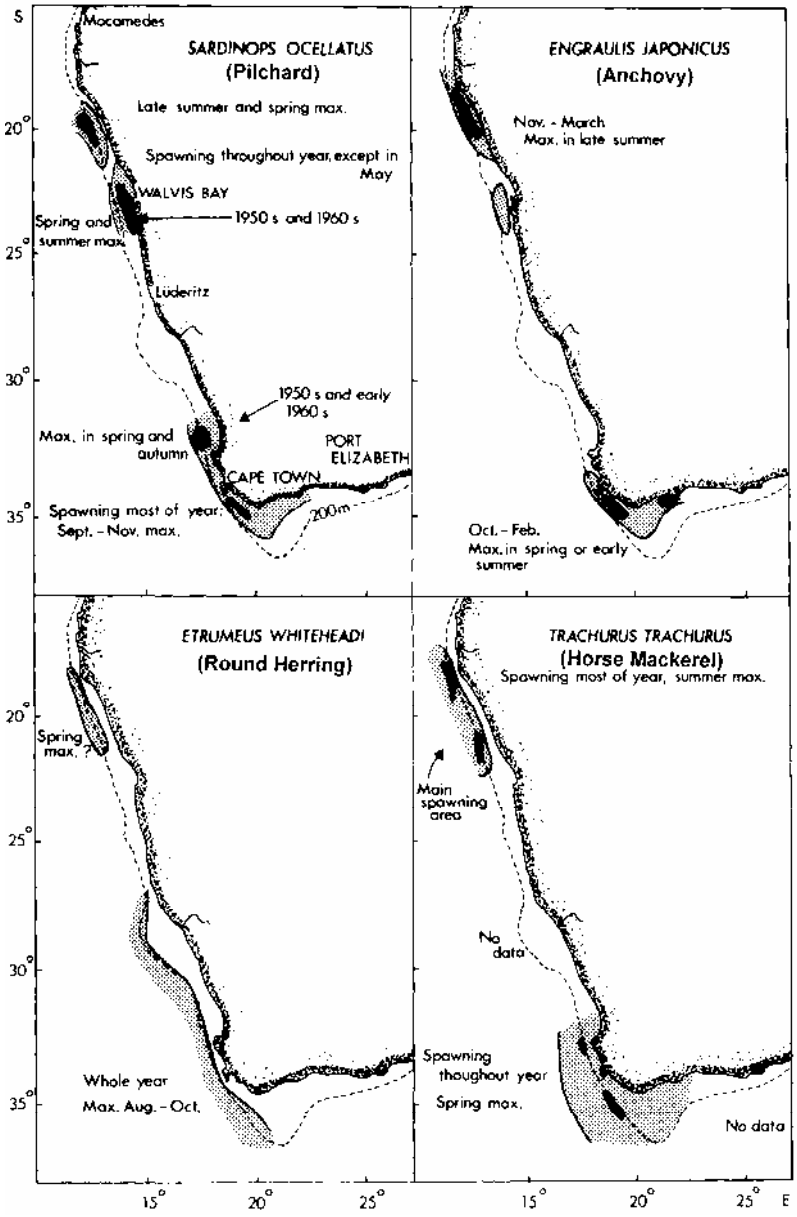

Figure 4.8: Spawning and recruitment areas for different pelagic species inhabiting the West Coast. Modified from Shannon & Pillar (1986).

4.1.3.2 Benthic macrofauna

Benthic macrofauna (species living within or above seabed sediments) are considered good indicator species with which to measure environmental impacts (Gray 1974, Warwick 1993, Salas *et al.* 2006). These organisms influence major ecological processes (e.g. nutrient cycling, pollutant metabolism, sediment stability) and serve as important prey for commercially valuable fish species (Gray 1974, Snelgrove 1998, Salas *et al.* 2006). 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 to evaluate the status of marine ecosystems in monitoring for long-term responses and site-specific impacts (Salas *et al.* 2006).

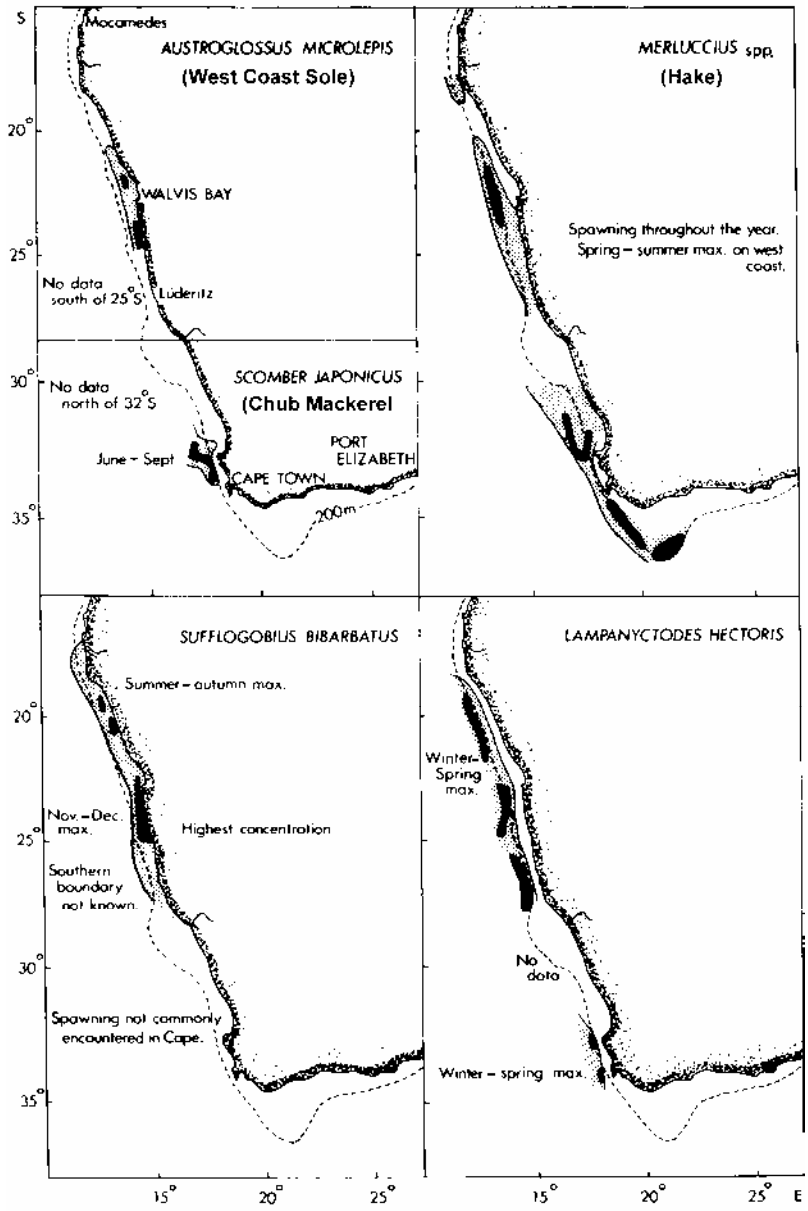

Figure 4.9: Spawning and recruitment information for a number of pelagic and demersal fish species inhabiting the West Coast. Modified from Shannon & Pillar (1986).

Living within or in close proximity to the sediment, macrofaunal communities are strongly influenced by the sediment type and texture (Gray 1974, Warwick *et al.* 1991). Apart from the strong influence of biogeography and water depth, sediment composition has been defined as one of the most important physical factors shaping benthic macrofaunal assemblages (Gray 1974, Warwick *et al.* 1991). Long-term or permanent changes in physical sediment physical properties (e.g. grain size) affect other factors like organic content, pore-water chemistry and microbial composition (Snelgrove & Butman 1994), which in turn influence the macrofaunal composition.

According to Pulfrich (2011), the only systematic study to date to specifically investigate change in macrobenthic community distributions across the continental shelf has been that conducted by Christie (1974, 1976) off Lamberts Bay, South Africa. It is likely that the sediment characteristics of the mudbelt and the impact of environmental stressors (such as low oxygen events) off Lambert's Bay are likely to differ from those in other deepwater areas along this coast. As the composition and structure of benthic communities is

largely determined by these physical factors, the mid-shelf benthic communities in other areas are likely to differ from those described by Christie (1974).

The sediment type within the study area (which ranges from sand to mud) supports diverse infaunal assemblages. From the shore to 80 m depth the benthic environment comprises primarily of polychaetes (bristle worms), crustaceans (largely amphipods, crabs and prawns), molluscs (bivalves and gastropods), cnidarians and some echinoderms (brittle stars and sea cucumbers). In contrast, the mid-shelf mudbelt (70 - 120 m depth) is a particularly rich benthic habitat and clays, silts and very fine sands dominate the sediment texture in the mudbelt and scavenging and carnivorous polychaete worms, together with cnidarians, dominate the fauna (Pulfrich, 2011). Below this mid-depth zone, very fine sands dominate the sediment texture and crustaceans increase in relative importance in the biota, with amphipods comprising the major component at these deeper depths (Pulfrich, 2011).

Monitoring surveys undertaken by De Beers Marine have infrequently found a species of sea pen (*Virgilaria* spp.) and should, therefore, be considered rare in the habitat type occurring in the study area.

On the West Coast continental shelf vulnerable ecosystems include cold water coral reefs, sponge beds, high profile reefs and sea pen aggregations (Sink and Samaai 2010). According to Pulfrich (2011), these are all ecosystems that are easily disturbed by human activities and are slow to recover, or which may never recover. Apart from an initiative by De Beers Marine to map rocky outcrop features in their mining licence areas, data on the distribution and biodiversity of Vulnerable Marine Ecosystems (VMEs) on the West Coast is limited. Whilst there is no sound evidence for the presence of such sensitive or vulnerable habitats or species occurring within the study area, there is a possibility that cold-water coral reefs and carbonate mounds may occur in the area. The presence of cold water reef building corals (*Solenosmilia variabilis* and possibly *Lophelia pertusa*) have been noted in Block 2A, a section of which overlays a portion of the prospecting area.

4.1.3.3 Cephalopods

On the basis of abundance and trophic links with other species, eight species of cephalopod are important and a further five species of have potential importance within the Benguela system (Table 4.2).

Table 4.2: Cephalopod species of importance or potential importance within the Benguela System (after Lipinski 1992).

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

4.1.3.4 Fishes

(a) Recruitment areas, distribution and movement

This section reports on species-specific recruitment and the recruitment areas, distribution and movement of post larval fishes of fishery importance, namely pelagic and demersal species. There are two groups of pelagic species: i) mainly clupeoid filter-feeding species that are planktivorous, and ii) larger predatory species that feed mostly on the smaller pelagic species including the large highly migratory tunas and billfishes.

Demersal species are those that are usually associated with the substrate and are generally found on or near the sea floor. Most demersal species are piscivorous, often migrating diurnally in the water column. Figure 4.10 depicts the recruitment areas of some important commercial fish species.

(b) Pelagic species

Nought-year-old *pilchards* recruit to the pelagic fishery along the coast north of Cape Point (particularly north of Cape Colombine) in March. Pilchard spawn on the South Agulhas Bank from August to December. The adults then migrate back up the West Coast. Eggs from the spawn drift northwards in the Benguela current in the water column and hatch after about two weeks. Thereafter the larvae develop quickly along the West Coast. The bays along the coast act as sanctuaries for these juveniles who feed on the nutrient rich waters and soon recruit to the fishery in their first year. As the year progresses surviving one to two year old fish migrate southwards again and spawn in Spring and early Summer on the Agulhas Bank. No movement of pilchard from the Western Cape into Namibia has been reported, while little movement has been reported in the opposite direction.

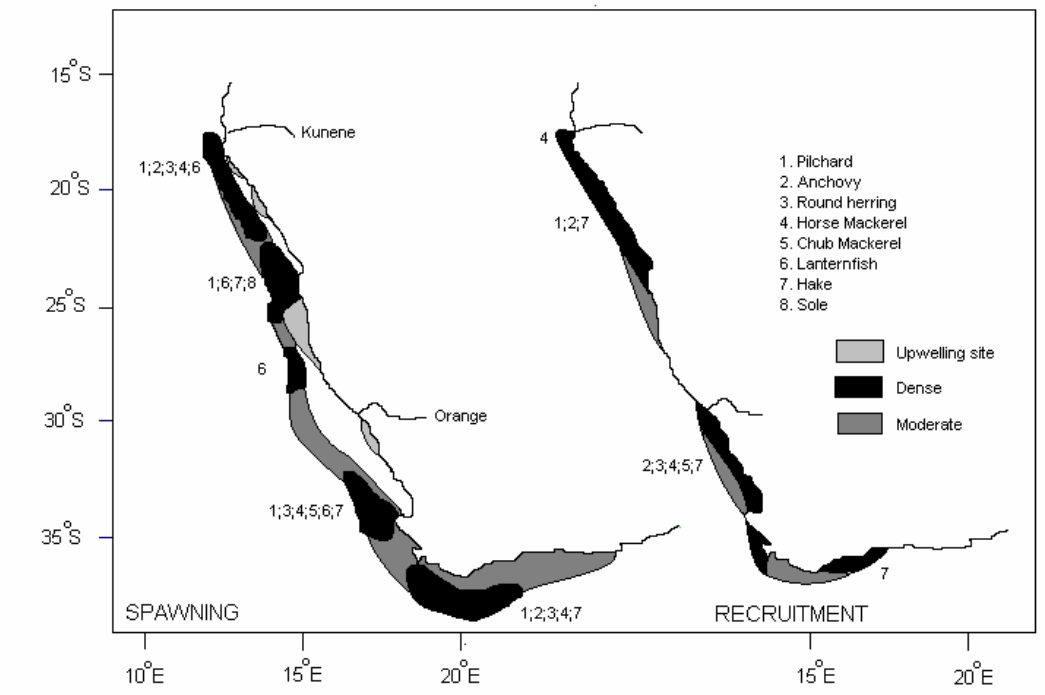

Figure 4.10: Schematic of the main spawning and recruitment areas of different fish species from the southern Benguela, in relation to upwelling centres. Modified from Crawford (1989).

Anchovy spawning movements are similar to those of pilchard (Crawford *et al.* 1987). Juvenile anchovies are often found shoaling with juvenile pilchards, round herrings and horse mackerel of similar size (juvenile pelagic fish generally form large shoals of similar sized individuals). However, as they mature and recruit to the fishery the shoals disperse into species specific shoals.

Round herring juveniles, like those of pilchard and anchovy, also move south at the end of winter. Round herring are caught by the purse seine fleet on the West Coast predominantly from January to May and are found further offshore than pilchard and anchovy and shoal in deeper water.

The purse seine fishery also catches *horse mackerel* juveniles. Availability varies inter annually with catches of juveniles highest on the West Coast between January and May.

Snoek and chub mackerel are landed mainly within the zone west of Cape Agulhas to 15°S. Both species occur in the northern Benguela region during spring and summer, move south inshore during autumn and winter, and back north offshore in spring. Their migration is related to prey availability. Snoek spawn offshore between the Western Cape and Namibia (July to October), while chub mackerel spawn and recruit inshore, moving offshore as they age.

Yellowtail is an inshore pelagic species encountered seasonally west of Cape Point, with maximum abundance between Cape Point and Cape Agulhas. It spawns along the southern Cape coast, although its recruitment areas are not well known. Adults are abundant on shallow banks inshore.

A number of *tuna* species inhabit waters off the West Coast (Table 4.3), these usually being distributed offshore near the thermal front (at the shelf break). Their offshore distribution is also related to the presence of shoaling pelagic fish species (*e.g.* pilchard, anchovy, round herring). Many of these tuna species are found along the whole of the West Coast, although no tuna populations are permanently resident within the Benguela system, and no tuna species spawn within it. Tuna are classified as highly migratory species and the many stocks of these species are a shared resource between the coastal states on both sides of the South Atlantic.

Table 4.3: Percentage contribution of catches of some tuna species landed along the West Coast of South Africa to the overall catch of these landed within the south-eastern Atlantic during 1972-1984 (from ICSEAF Statistical Bulletins).

Common name	Scientific name	% Contribution
Longfin tuna	*Thunnus alalunga*	99.8
Yellowfin tuna	*Thunnus albacares*	31.3
Southern bluefin tuna	*Thunnus maccoyii*	20.0
Bigeye tuna	*Thunnus obesus*	99.8
Skipjack tuna	*Katsuwonus pelamis*	1.9
Eastern little tuna	*Euthynnus alletteratus*	0.8
Bullet tuna	*Auxis thazard*	-

(c) Demersal species

Hake: Adult *Merluccius paradoxus* (deep-water hake) inhabit deeper waters than adult *M. capensis* (shallow-water hake), although juvenile *M. paradoxus* mix with adult *M. capensis* at intermediate depths (250 to 350 m). Both species appear to recruit north of Cape Colombine with concentrations of juveniles of both species being found inshore on the West Coast in the bays.

Kingklip: A single kingklip stock is found between 27 and 35°S on the West Coast. Kingklip inhabit predominantly hard or rocky substrates but are also found on trawl grounds (normal soft muddy

substrates). Juveniles are mostly found inshore, and are reported to migrate into deeper water as they age.

Monkfish : Monkfish (*Lophius spp*) have an extensive distribution along the West Coast with the larger fish found in deeper water (up to 600 m). They are a bycatch of the hake-directed trawl fishery but are being increasingly targeted by the trawl fleets.

The inshore stretch of the West Coast east of Cape Point is inhabited by a large number of reef and soft-bottom fishes. The spawning areas of many are unknown, although estuaries, the surf zone and shallow protected embayments are important recruitment areas for some of them.

4.1.3.5 Birds

Seabirds inhabiting the Benguela system comprise migrant pelagic species (which do not breed in the system) and resident species (which breed within the system) (Duffy, Siegfried and Jackson 1987).

(a) Migrant pelagic species

Table 4.4 lists the densities and population estimates of nineteen migrant species, and shows that the majority of these are most abundant offshore of the shelf break in winter. The coast between Cape Point and the Orange River mouth is estimated to support 33% and 38% of the overall winter and summer populations of migrant seabirds found between Cape Point and the northern Namibian border respectively. The Blackbrowed Albatross, Yellownosed Albatross and Southern Giant Petrel are listed in the South African Red Data Book as “Near threatened".

Table 4.4: Densities (individuals/km^2) and population estimates (thousands) of migrant seabirds in the southern Benguela (Orange River mouth to Cape Point). Modified from Crawford *et al.* (1991).

Common name	Scientific name	Density		Population estimate	
		Inshore	Offshore	Winter	Summer
Shy albatross	*Diomedea cauta*	0.20	0.80	46.0	23.0
Black browed albatross	*Diomedea melanorphrys*	0.05	1.80	83.5	20.9
Yellownosed albatross	*Thalassarche chlororhynchos*	0.02	0.20	10.0	7.0
Southern Giant Petrel	*Macronectes giganteus*	0.02	0.05	3.3	1.6
Pintando petrel	*Daption capensis*	0.02	1.80	82.0	-
Great winged petrel	*Pterodroma macroptera*	0.08	0.20	1.3	13.0
Soft plumaged petrel	*Pterodroma mollis*	0.00	0.15	6.8	0.7
Prion spp.	*Pachyptila spp.*	4.00	7.00	515.0	-
Whitechinned petrel	*Procellaria aequinoctialis*	1.80	2.80	216.0	97.2
Cory's shearwater	*Calonectris diomedia*	0.01	1.00	-	50.0
Great shearwater	*Puffinus gravis*	0.80	1.20	28.2	28.2
Sooty shearwater	*Puffinus griseus*	2.00	2.40	208.0	104.0
Storm petrel spp.	*Hydrobates or Oceanites sp.*	0.80	1.40	103.0	72.1
Shua spp.	*Stercorarius spp.*	0.20	0.02	0.5	10.9
Subantarctic skua	*Catharacta antartica*	0.02	0.10	5.5	1.7
Sabine's gull	*Larus sabini*	0.05	0.01	-	3.0
Sandwich tern	*Sterna sandvicensis*	*	*	0.8	15.0
Common/arctic tern	*Sterna spp.*	*	*	10.0	200.0
Antartic tern	*Syerna vittata*	*	*	12.0	-

(b) Resident breeding species

The availability of breeding sites is extremely important determinant in the distribution of resident seabirds. Although breeding areas are distributed along the whole coast, islands are especially important, particularly those between Dyer Island and Lambert's Bay. Thirteen resident species breed along the West Coast (Table 4.5).

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

Table 4.5: Estimated number of non-chick populations of different species of breeding seabirds between Cape Point and the Orange River mouth during the early or mid 1980s. Information is summarised from different sources in Crawford *et al.* (1991).

Common name	*Scientific name*	Numbers
African penguin	*Spheniscus demersus*	17 000
Cape gannet	*Morus capensis*	78 000
Cape cormorant	*Phalacrocorax carbo*	339 000
Great cormorant	*Phalacrocorax capensis*	2 000
Bank cormorant	*Phalacrocorax neglectus*	4 000
Crowned cormorant	*Phalacrocorax coronatus*	4 000
White pelican	*Pelecanus onocrotalus*	1 000
Kelp gull	*Larus dominicanus*	20 000
Greyheaded gull	*Larus cirrocephalus*	<1 000
Hartlaub's gull	*Larus hartlaubii*	29 000
Caspian tern	*Sterna caspia*	<1 000
Swift tern	*Sterna bergii*	14 000
Damara tern	*Sterna balaenarum*	<1000

Most of these resident species feed on fish (with the exception of the gulls, which scavenge, and feed on molluscs and crustaceans). Feeding strategies can be grouped into surface plunging (gannets and terns), pursuit diving (cormorants and penguins) and scavenging and surface seizing (gulls and pelicans). All these species feed relatively close inshore, although gannets and kelp gulls may feed some distance offshore.

African penguin colonies (*Spheniscus demersus*) occur at 27 localities around the coast of South Africa and Namibia, being found throughout the West Coast region (Figure 4.11). The species forages at sea with most birds being found within 20 km of their colonies. African penguin distribution at sea is consistent with that of the pelagic shoaling fish, which generally occur within the 200 m isobath.

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

The Cape Gannet, a plunge diver feeding on epipelagic fish, is thought to have declined as a result of the collapse of the pilchard, whereas the Cape Cormorant was able to shift its diet to pelagic goby. Furthermore,

the recent increase in the seal population has resulted in seals competing for island space to the detriment of the breeding success of both gannets and penguins.

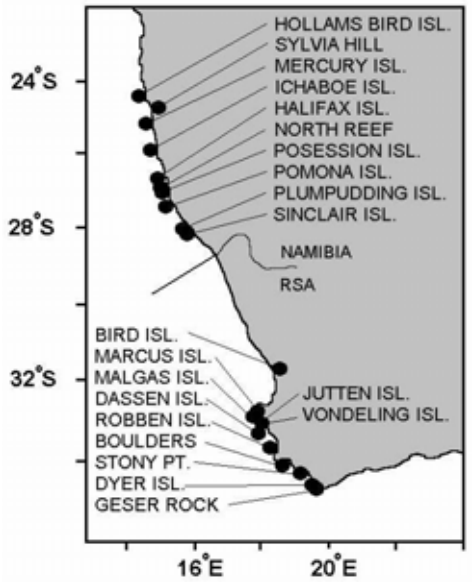

Figure 4.11: The distribution of breeding colonies of African penguins on the South African West Coast.

4.1.3.6 Marine mammals

The marine mammal fauna of the West Coast comprises between 28 and 31 species of cetaceans (whales and dolphins) and one seal species, the Cape fur seal (*Arctocephalus pusillus*).

The range of cetacean species reflects largely taxonomic uncertainty at species and sub-species level, rather than uncertainty of occurrence or distribution patterns (which are summarised in Table 4.6 and Figure 4.12, after Findlay *et al.* 1992).

Table 4.6: Whale and dolphin species found along the West Coast (After Best 1967; Findlay *et al.* 1992).

Common name	Scientific name	Distribution
Migratory cetaceans		
Southern right whale	*Eubalaena australis*	Extreme inshore
Humpback whale	*Megaptera novaeangliae*	Transit inshore
Minke whale	*Balaenoptera acutorostrata*	Cosmopolitan
Blue whale	*Balaenoptera musculus*	Transit offshore
Sei whale	*Balaenoptera borealis*	Transit offshore
Fin whale	*Balaenoptera physalus*	Transit offshore
Bryde's whale	*Balaenoptera brydei*	Seasonal offshore
Possibly migratory cetaceans		
Pygmy right whale	*Caperea marginata*	Possible extreme inshore
Strap-toothed whale	*Mesoplodon layardii*	Offshore
Arnoux's beaked whale	*Berardius arnuxii*	Recorded from Cape Columbine eastwards
Cetaceans resident in pelagic waters offshore of the continental shelf		
Killer whale	*Orcinus orca*	Cosmopolitan
Southern right-whale dolphin	*Lissodelphis peronii*	Localised distribution (see text)
Risso's dolphin	*Grampus griseus*	Offshore and shelf edge

Common name	Scientific name	Distribution
False killer whale	*Pseudorca crassidens*	Offshore
Pygmy killer whale	*Feresa attenuata*	Offshore
Long-finned pilot whale	*Globicephala melas*	Offshore
Sperm whale	*Physeter macrocephalus*	Offshore
Pygmy sperm whale	*Kogia breviceps*	Offshore
Dwarf sperm whale	*Kogia sima*	Offshore east of Cape Columbine
Cuvier's beaked whale	*Ziphius cavirostris*	Offshore
Gray's beaked whale	*Mesoplodon grayi*	Offshore
Blainville's beaked whale	*Mesoplodon densirostris*	Offshore east of Cape Columbine
True's beaked whale	*Mesoplodon mirus*	Offshore east of Cape Columbine
Common dolphin	*Delphinus species*	Offshore
Bottlenose dolphin	*Tursiops truncatus*	Offshore
Cetaceans resident over the shelf		
Heaviside's dolphin	*Cephalorhynchus heavisidii*	Extreme Inshore north of Cape Point
Dusky dolphin	*Lagenorhynchus obscurus*	Extreme Inshore west of False Bay
Longbeaked common dolphin	*Delphinus delphis*	Continental shelf south of Lamberts Bay
Southern right-whale dolphin	*Lissodelphis peronii*	Localised distribution (see text)
Killer whale	*Orcinus orca*	Cosmopolitan
Bryde's whale	*Balaenoptera brydei?*	Continental shelf south of Lamberts Bay

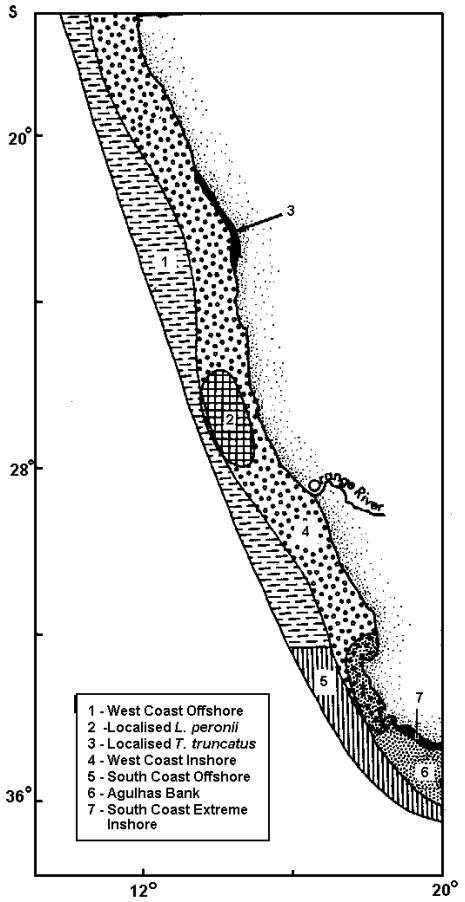

Figure 4.12: Distribution of resident cetaceans within the West Coast region (From Findlay *et al.* 1992).

(a) Cetaceans

The majority of migratory cetaceans in South African waters are large baleen whales. Populations of large baleen whales in South African waters were decimated by historical whaling and are presently a fraction of their pre-exploitation densities.

Blue (*Balaenoptera musculus*), fin (*B. physalus*), sei (*B. borealis*), minke (*B acutorostrata / B bonaerensis*) and humpback whales (*Megaptera novaeangliae*) make winter migrations through the West Coast region *en route* from Antarctic summer feeding grounds to winter breeding grounds (Table 4.7). While blue, fin and sei whales migrate off or along the continental shelf edge (and are thus distributed in deeper waters), humpback whales migrate over the continental shelf and along the coast.

Two types of Bryde's whales are recorded from South African waters (Best 1977) - a smaller neritic form (of which the taxonomic status is uncertain) and a larger pelagic form described as *Balaenoptera brydei*. While the smaller neritic form is resident (particularly over the Agulhas Bank) the larger offshore form is migratory along the African west coast, being found off Saldanha Bay in winter. Southern Right whales (*Eubalaena australis*) migrate into the extreme near-shore region of the West Coast (mainly south of Lamberts Bay) between June and January each year (animals may be sighted as early as April and as late as February).

Table 4.7 Synopsis of published migration trends of rorqual whales within Cape coast whaling Grounds.

Species	Source	Cape*
Blue	Olsen (1914)	U (Present from May to June)
	Harmer (1931)	U/B
Fin	Olsen (1914)	Throughout season
	Harmer (1931)	B (May-July, October-November
	Best (1967)	U
Sei	Harmer (1931)	B
	Matthews (1938)	B (May, August-October)
	Bannister and Cambell (1965)	U
	Best (1967)	B (May, June-September)
Humpback	Olsen (1914)	B
	Harmer (1931)	Touch coast north of Cape Town

* U = unimodal trend, B = bimodal trend. Months of maxima are presented in brackets.

This population is increasing at approximately 7% per annum, yet is still probably around 10% of the pre-exploitation abundance (Best 2000).

Killer whales are found year round in the waters of the West Coast, although the seasonality of sightings within the whaling grounds (in September and October) suggests that some killer whales are highly migratory. The pygmy right whale (*Caperea marginata*) shows a strong summer seasonality in water depths of less than 50 m along the coast between Algoa Bay in the east and Walvis Bay, Namibia. Arnoux's beaked whale (*Berardius arnuxii*) has been recorded along the West Coasts to the east of 18° E during summer. Layard's beaked whale (*Mesoplodon layardii*) is distributed throughout the West Coast pelagic waters in summer and early autumn.

Four faunal provinces define the distribution of resident cetaceans within the West Coast region (after Findlay *et al.* 1992; Peddemors 1999) (Figure 4.12). These include:

- *Agulhas Bank to Lamberts Bay (inshore)* - Two species, the long beaked common dolphin (*Delphinus delphis*) and the resident smaller inshore Bryde's whale appear to be strongly associated with the Agulhas Bank region and the West Coast inshore region as far north as Lambert's Bay. Although these species will be found elsewhere in southern African waters (a common dolphin species is

recorded from strandings on the Namibian coast) the majority of records are from the Agulhas Bank region.

- *West Coast Inshore* – Two species, the Heaviside's dolphin (*Cephalorhynchus heavisidii)* and the dusky dolphin (*Lagenorhynchus obscurus)* are resident over the shelf with Heaviside's dolphin found inshore to the north of Cape Point and dusky dolphin found inshore west of False Bay.
- *West Coast Offshore* - Two pelagic species of cetacean, True's beaked whale (*Mesoplodon mirus*) and the dwarf sperm whale (*Kogia sima*) appear to be limited to offshore region between Cape Columbine and the Eastern Cape. A further two species, Gray's beaked whale (*Mesoplodon grayii*) and the long finned pilot whale (*Globicephala melas*) appear to be limited to the offshore region between Namibia and the Eastern Cape. These species are found in deep waters elsewhere in the world and apart from the pilot whale are recorded only as strandings on the South African coast. A localised distribution of southern right-whale dolphins is recorded off the coast of southern Namibia and may range into the northern waters of the South African West Coast region.
- *Cosmopolitan* - Killer whales (*Orcinus orca*) and minke whales (possibly *Balaenoptera acutorostrata*) are found in both continental shelf and offshore waters of the West Coast. Cuvier's beaked whale (*Ziphius cavirostris*), pygmy sperm whales (*Kogia breviceps*), False killer whales (*Pseudorca crassidens*), pygmy killer whales (*Feresa attenuata*), Risso's dolphins (*Grampus griseus*), and sperm whales (*Physeter macrocephalus*) are found throughout the offshore waters of the West Coast. A second common dolphin species occurs in the offshore region of the West Coast.

(b) Seals

The Cape fur seal (*Arctocephalus pusillus pusillus*) congregates in seven breeding and five non-breeding colonies along the West Coast (Figure 4.13). Five other seal species may occasionally be found as vagrants along the West Coast.

Cape fur seals were heavily exploited up until the late nineteenth century in South African waters. After 1 900 seals were harvested from certain colonies almost every year up until 1983, during which an estimated 2.5 million pups and bulls were harvested. The population has shown a rapid increase since the 1940s and in 1984 the population was thought to be some 1.1 million animals and increasing at about 3.7% per annum (1971 to 1984). In 1990, an estimated two million seals were distributed around the southern African coast (Butterworth and Wickens 1990), although numbers fluctuate. The increase is presumed to reflect the population's natural response to past overexploitation.

Kleinsee has the largest of the breeding colonies (population estimates ranging from 35 450 in 1972 to 74 620 in 1989) in South Africa, and produces the largest number of pups in the country (Table 4.8).

Cape fur seals appear to forage over the continental shelf to a maximum depth of approximately 200 m. However, two females from the Kleinsee colony tagged with depth recorders showed over 70% of dives to depths of less than 50 m (Kooyman and Gentry 1986).

Table 4.8: The contribution of seal pups (% of total born in South Africa) born at each of the breeding seal colonies depicted in Figure 4.13. Modified from Wickens (1994).

Breeding colony	% Seal pups
Kleinsee	65.2
Elephant Rock	2.9
Paternoster Rock	1
Jacobs Reef	3.4
Robbesteen	1.1
Seal Island	11.8
Geyser Rock	11.2
Quoin Rock	1.8

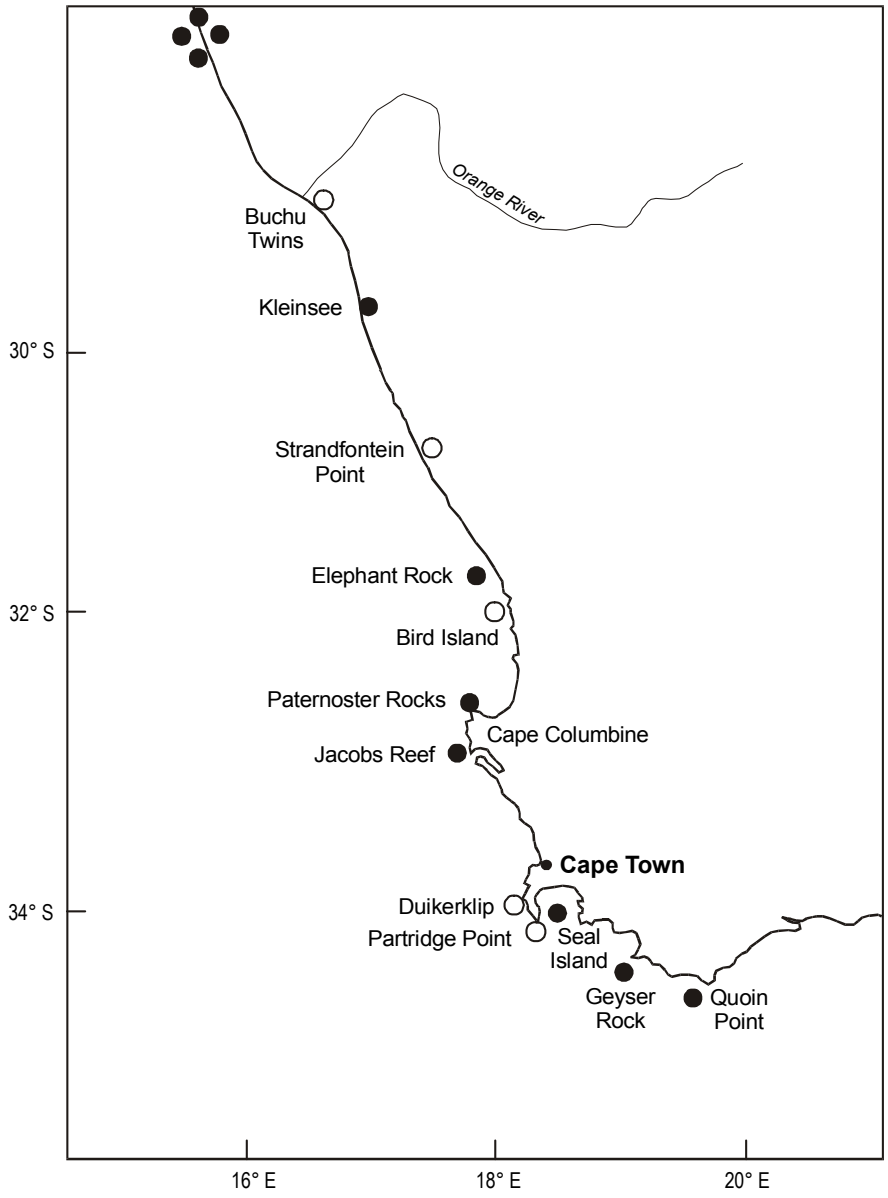

Figure 4.13: The location of breeding (●) and non-breeding (○) colonies of Cape fur seals along the West Coast (after Wickens *et al.* 1992).

4.1.4 HUMAN UTILISATION

4.1.4.1 Fisheries and other harvesting

The South African fishing industry consists of approximately 20 commercial sectors operating within the 200 nautical mile Exclusive Economic Zone (EEZ)[1]. The western coastal shelf is a highly productive upwelling ecosystem (Benguela current) and supports a number of fisheries.

The largest and most economically valuable of these are the demersal trawl and long-line fisheries, targeting the cape hakes *Merluccius paradoxus* and *M. capensis*, and the pelagic purse-seine fishery targeting pilchard (*Sardinops sagax)*, anchovy (*Engraulis encrasicolus*) and round herring (*Etrumeus whitheadii*).

[1] The Exclusive Economic Zone is the zone extending from the coastline out to a distance of 200 nautical miles within which South Africa holds exclusive economic rights.

Secondary commercial species in the hake-directed fisheries include an assemblage of demersal (bottom-dwelling) fish of which monk fish (*Lophius vomerinus*) and snoek (*Thyrsites atun*) are the most important commercial species. Other fisheries active on the West Coast are the pelagic long-line fishery for tunas and swordfish and the tuna pole and traditional linefish sectors. West Coast rock lobster (*Jasus lalandi*) is an important trap fishery exploited close to the shoreline (waters shallower than 100 m) including the intertidal zone and kelp beds off the West Coast. The main commercial sectors operating in the vicinity of the study area are discussed below:

(a) Demersal longline

The target species of this fishery is hake (*M. capensis* and *M. paradoxus*) with a small non-targeted commercial by-catch species that includes kingklip. The hake long-line fishery is a relatively new fishery in South Africa. Currently 64 vessels are active within this sector and operate from all major fishing harbours. The fishery is directed both in inshore and offshore areas. Inshore hake long-lining is restricted in the number of hooks that may be set per line (a maximum of 5 000 hooks per day), while offshore long-lining may only take place in water deeper than 110 m and is restricted to a maximum of 20 000 hooks per line.

Bottom-set long-line gear is robust and comprises two lines as well as dropper lines with subsurface floats attached (see Figure 4.14). Lines are set over mostly rocky bottoms adjacent to demersal trawling grounds. Demersal long-lines are anchored at either end and marked by an array of large buoys. Boats “stand by” their gear and are also restricted in their movements when hauling and shooting. Hooks are spaced about one fathom apart and lines can be up to 20 km long.

On the West Coast, demersal long-liners operate in well-defined offshore areas extending along the shelf break from Port Nolloth to Cape Agulhas where they may be found working between the 200 and 750 m bathycontours. Although the predominant areas of operation lie well to the west of the study area, isolated fishing events have been recorded in the study area (see Figure 4.15).

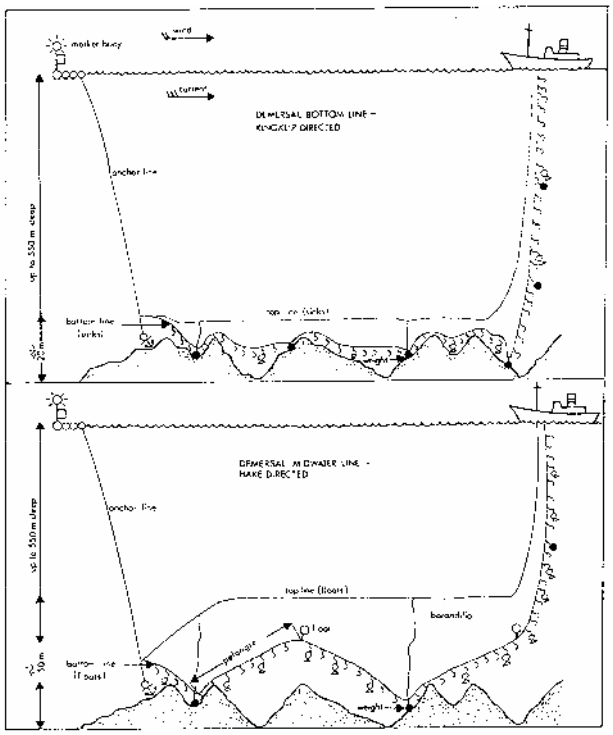

Figure 4.14: Diagram illustrating typical fishing gear deployed when fishing for demersal (bottom dwelling) species (gear for hake on bottom and kingklip on topi).

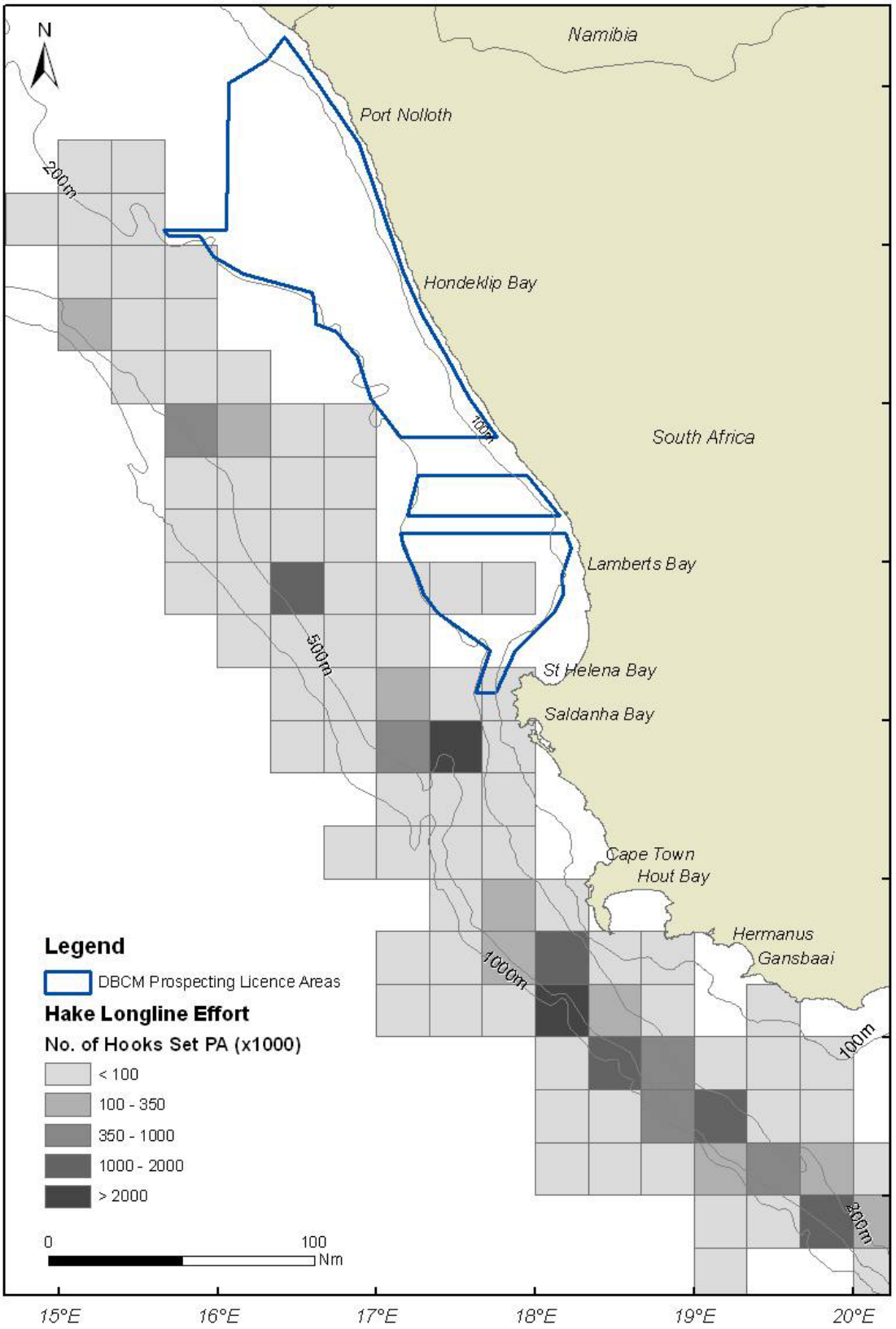

Figure 4.15: Distribution of effort within the demersal hake-directed long-line fishery (Capfish, 2011).

(d) Rock lobster trap fishery

This fishery targets the West Coast rock lobster (*Jasus lalandii*) along the West Coast. The fishery is divided into an inshore and offshore fishery which makes use of hoop-nets and traps, respectively. The inshore fishery operates from the coast up to one nautical mile offshore (predominantly waters shallower than 15 m), while the offshore trap fishery operates up to a depth of 100 m. Catch and effort figures are recorded according to management zone and prospecting licence areas coincide with zones A, B and C. Effort is seasonal (1 November to 20 June) and small boats operate from the shore and coastal harbours.

Activity within Zone A (extending from the Namibia / RSA border down to 31° 6' S is currently solely restricted to the hoop-net fishery and therefore is unlikely to coincide with the prospecting license area north of this point (see Figures 4.16 and 4.17).

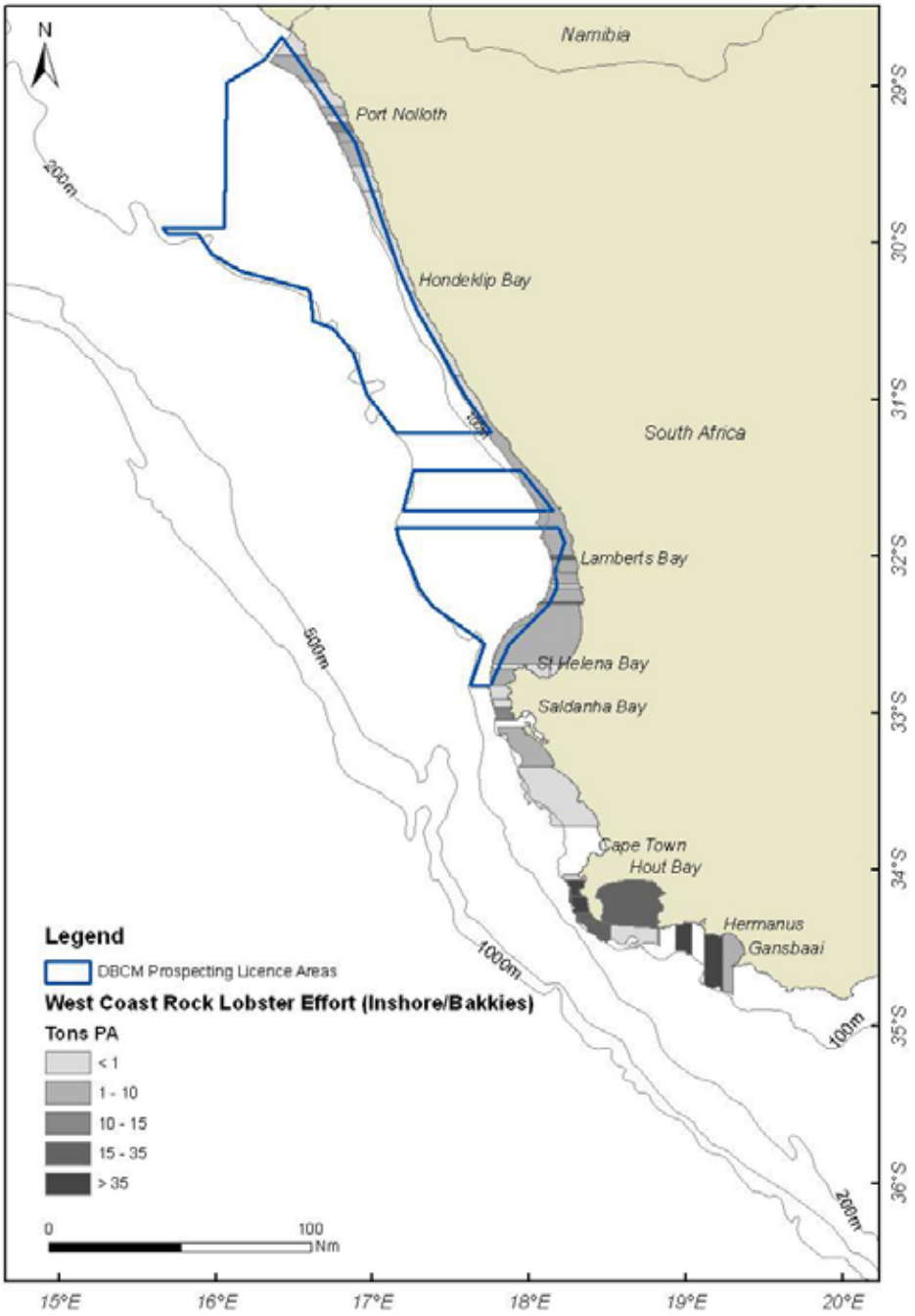

Figure 4.16: Distribution of catch within the inshore West Coast rock lobster fishery (Capfish, 2011).

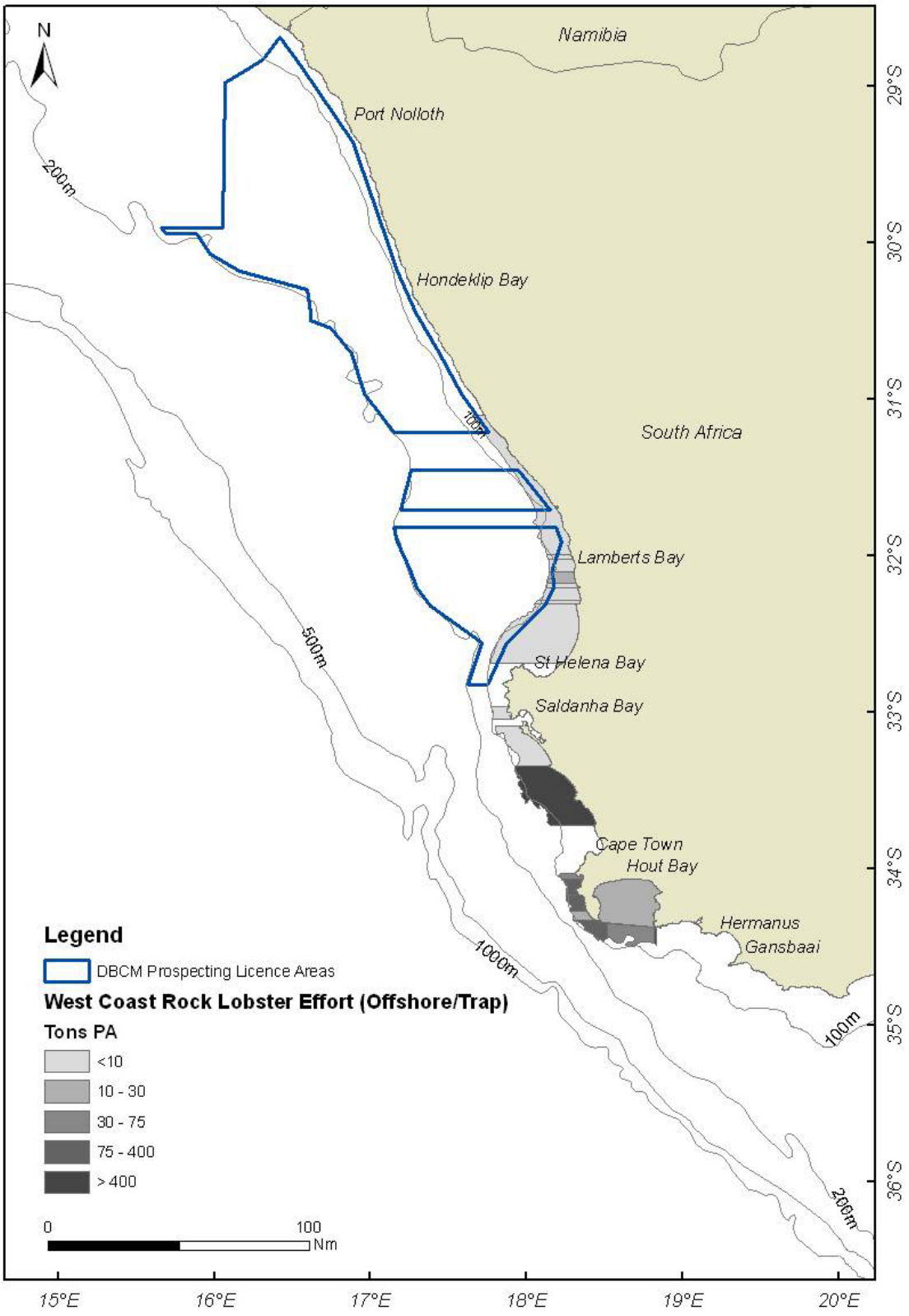

Figure 4.17: Distribution of catch within the offshore West Coast rock lobster fishery (Capfish, 2011).

(e) Pelagic purse-seine

The small pelagic purse-seine fishery targets pilchard (*Sardinops sagax*) and anchovy (*Engraulis encrasicolus*) and is the second most economically valuable commercial fishery in South Africa. Approximately 100 vessels operate within this fishery, predominantly along the West Coast from the harbours St Helena, Saldanha, Cape Town and Hout Bay. As the targeted species are coastal, fishing effort is not displaced more than 50 nm from harbours. Typically a vessel will fish overnight and return the following day to the harbour to offload their catch. A schematic diagram of the typical gear configuration of a pelagic purse-seiner is shown in Figure 4.18. The southern half of the prospecting area overlaps with the pelagic fishery. The concentration of pelagic purse-seine effort is the greatest inshore of the 100 m isobath, with effort increasing significantly towards the shallower portions of the study area (see Figure 4.19).

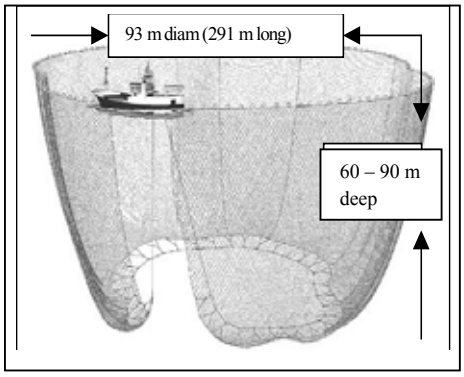

Figure 4.18: Typical gear configuration of a pelagic purse-seiner.

(f) Pelagic long-lining (large pelagic species)

The pelagic tuna long-line fishery is another fishery that occurs extensively off the West Coast of South Africa. The fishery targets tunas (including bluefin *Thunnus thynnus*, yellowfin *T. albacares*, bigeye *T. obsesus* and longfin or albacore *T. alalunga*), shark and broadbill swordfish (*Xiphias gladius).* Long-lining is carried out both by local and foreign vessels that fish around the entire South African coast. Approximately 30 vessels (17 tuna-directed and 14 swordfish-directed) are presently operational within this sector with activity predominantly centred along the continental shelf break and offshore. Occasional fishing events have been recorded closer inshore in the vicinity of the prospecting licence areas. Figure 4.20 shows the typical gear used and Figure 4.21 shows the annual distribution of long-line tuna effort on the West Coast.

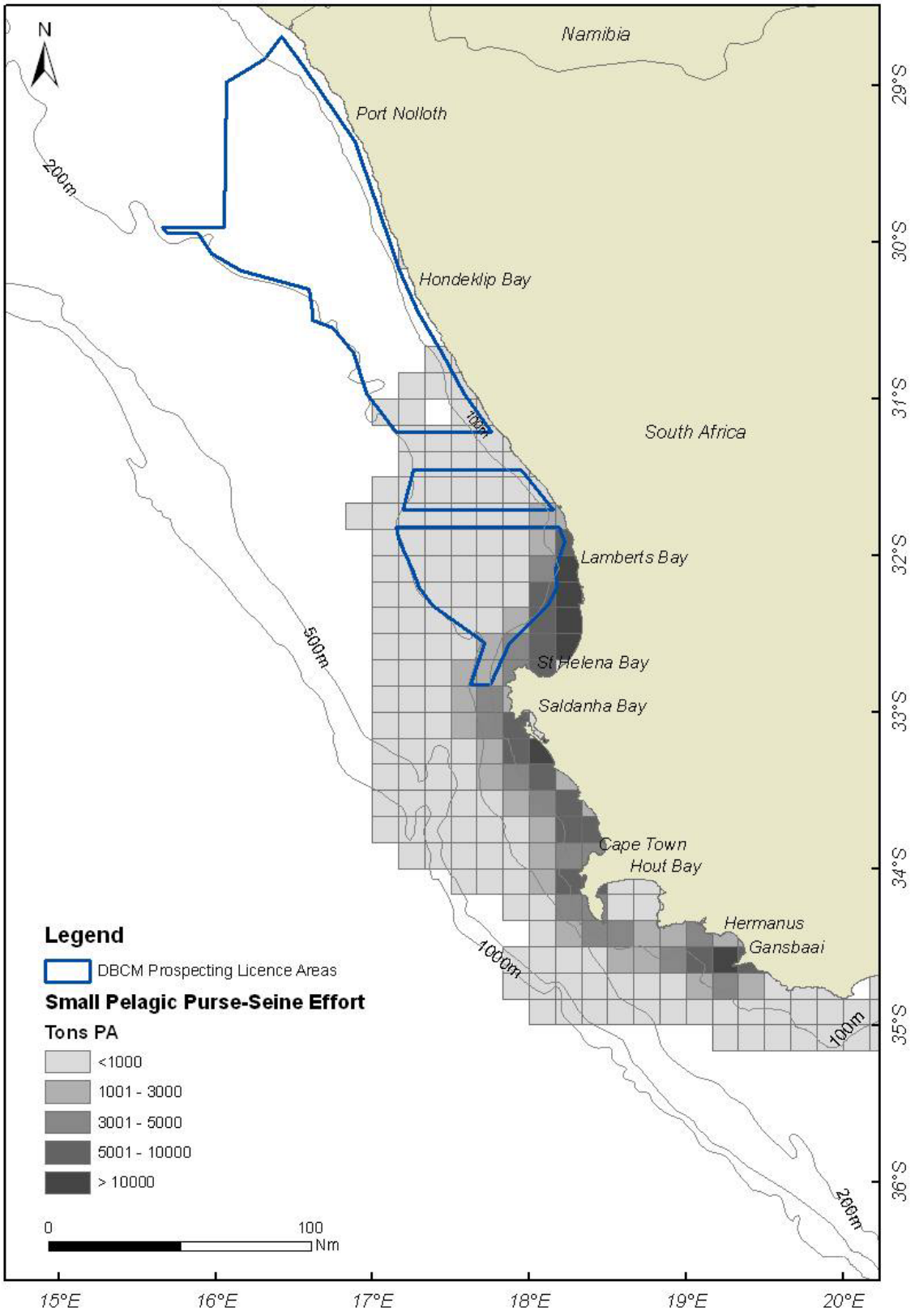

Figure 4.19: Distribution of catch within the pelagic purse-seine fishery (Capfish, 2011).

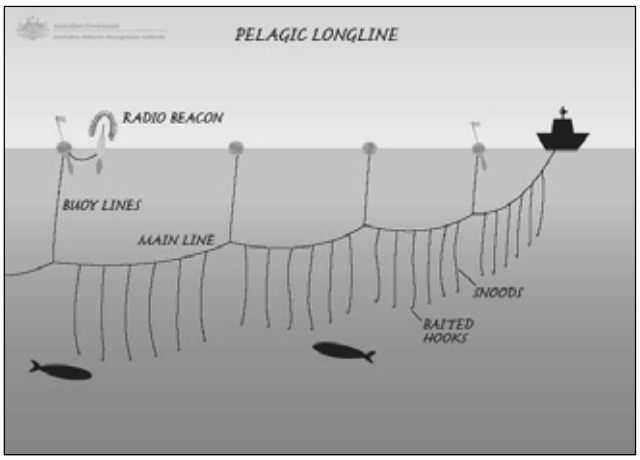

Figure 4.20: Typical pelagic longline gear configuration (tuna, swordfish and shark) (Capfish, 2011).

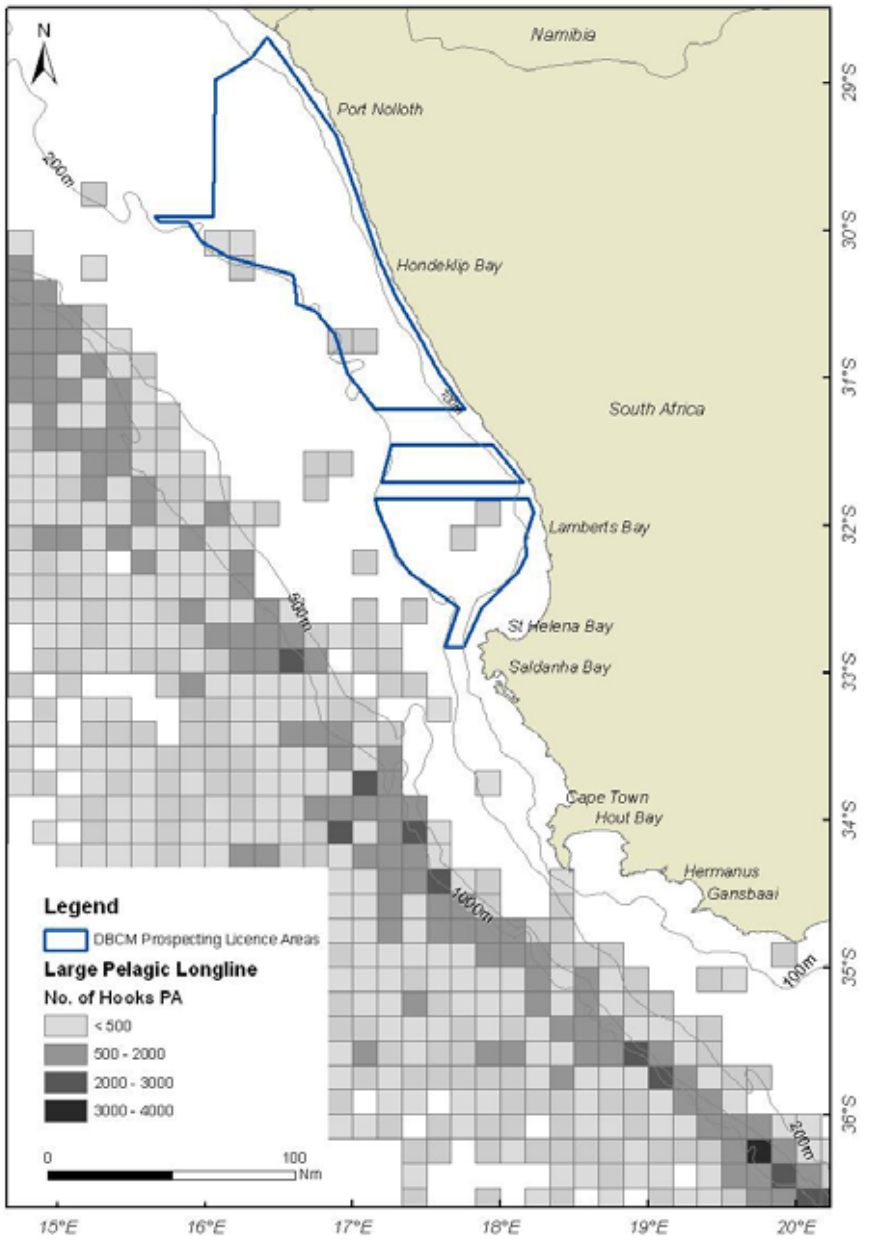

Figure 4.21: Distribution of catch within the pelagic long-line fishery (Capfish, 2011).

(e) Tuna Pole (large pelagic species)

The tuna pole fishery is conducted using handline, pole, rod and real fishing gear. Tuna species, predominantly yellowfin tuna (*Thunnus albacares*) and albacore (*Thunnus alalunga*), are targeted while other species caught include snoek, angel fish, oil fish, escolar, dorado, wahoo, yellowtail and squid. The fishery operates on the West Coast and sees an average annual catch of 3 500 tons.

The tuna pole fleet comprises up to 200 vessels (and a maximum of 3 600 crew) operating predominantly from Cape Town harbour. The fishery is seasonal with most of the effort conducted from October to early May. Vessels work from the 100 m bathycontour offshore and particularly along the shelf break at 500 m. These vessels drift whilst attracting and catching shoals of pelagic tunas. Once a shoal of tuna is located, water is sprayed alongside the vessel to attract fish to the surface, at which point they are caught with baited hooks and gaffed on board. There is little commercial information available for the tuna pole fishery off the west coast, however, some tuna pole fishing is likely to occur within the study area around the 100 m bathycontour. There is currently no map available showing the specific extent of this fishery.

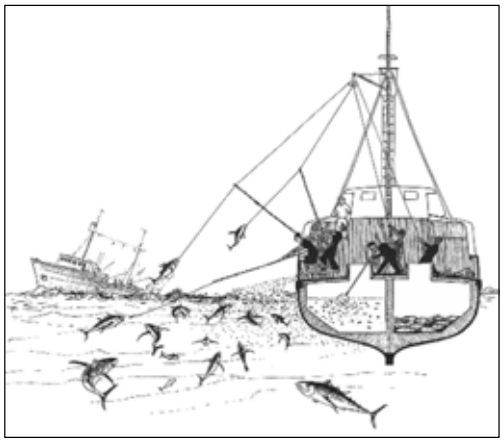

Figure 4.22: Schematic diagram of pole and line operation (www.fao.org/fishery).

4.1.4.2 Shipping transport

The majority of shipping traffic is located on the outer edge of the continental shelf with traffic inshore of the continental shelf along the West Coast largely comprising fishing and mining vessels, especially between Kleinsee and Oranjemund (Figure 4.23). Charted Traffic Separation Schemes, which are International Maritime Organisation (IMO) adapted, and other relevant information are listed in the South African Annual Notice to Mariners No 5. International shipping routes fall outside of the study area.

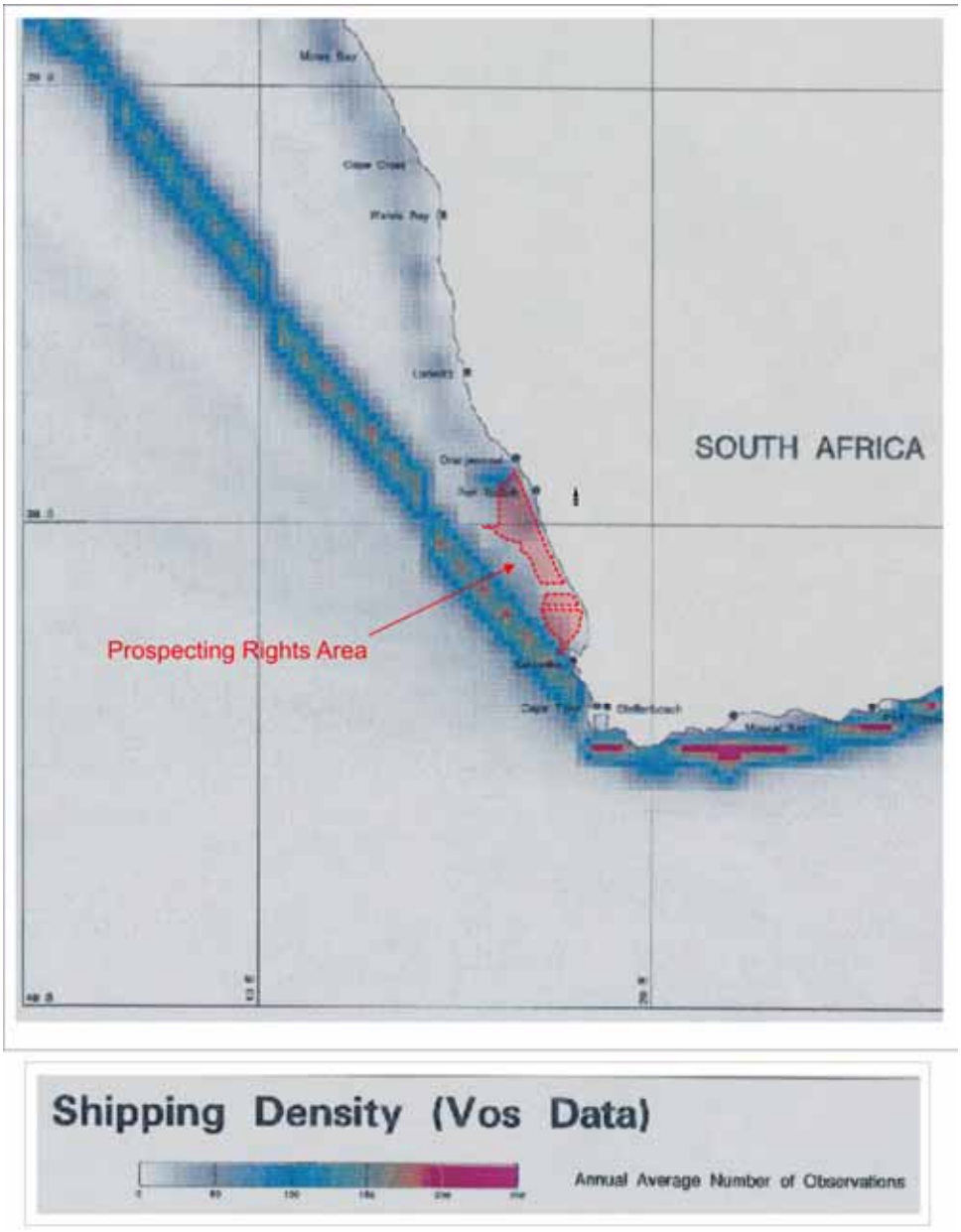

Figure 4.23: Primary and secondary shipping routes off the west coast of South Africa (from Lane & Carter 1999).

4.1.4.3 Oil and Gas exploration and production

(a) Exploration

Oil and gas exploration in the South African offshore commenced with seismic surveys in 1967. Since then numerous 2D and 3D seismic surveys have been undertaken on the west coast. Since 1976, approximately 40 wells have been drilled.

Prior to 1983, reliable technology was not available for removing wellheads from the seafloor. Since then, however, on completion of drilling operations, the well casing has been severed 3 m below the sea floor and removed from the seafloor together with the permanent and temporary guide bases. Of the approximately 40 wells drilled, 35 wellheads remain on the seafloor (Figure 4.24). Location and wellhead details are available from the Hydrographic office of the South African Navy (which issues the details to the public in a notice to mariners) or directly from PASA.

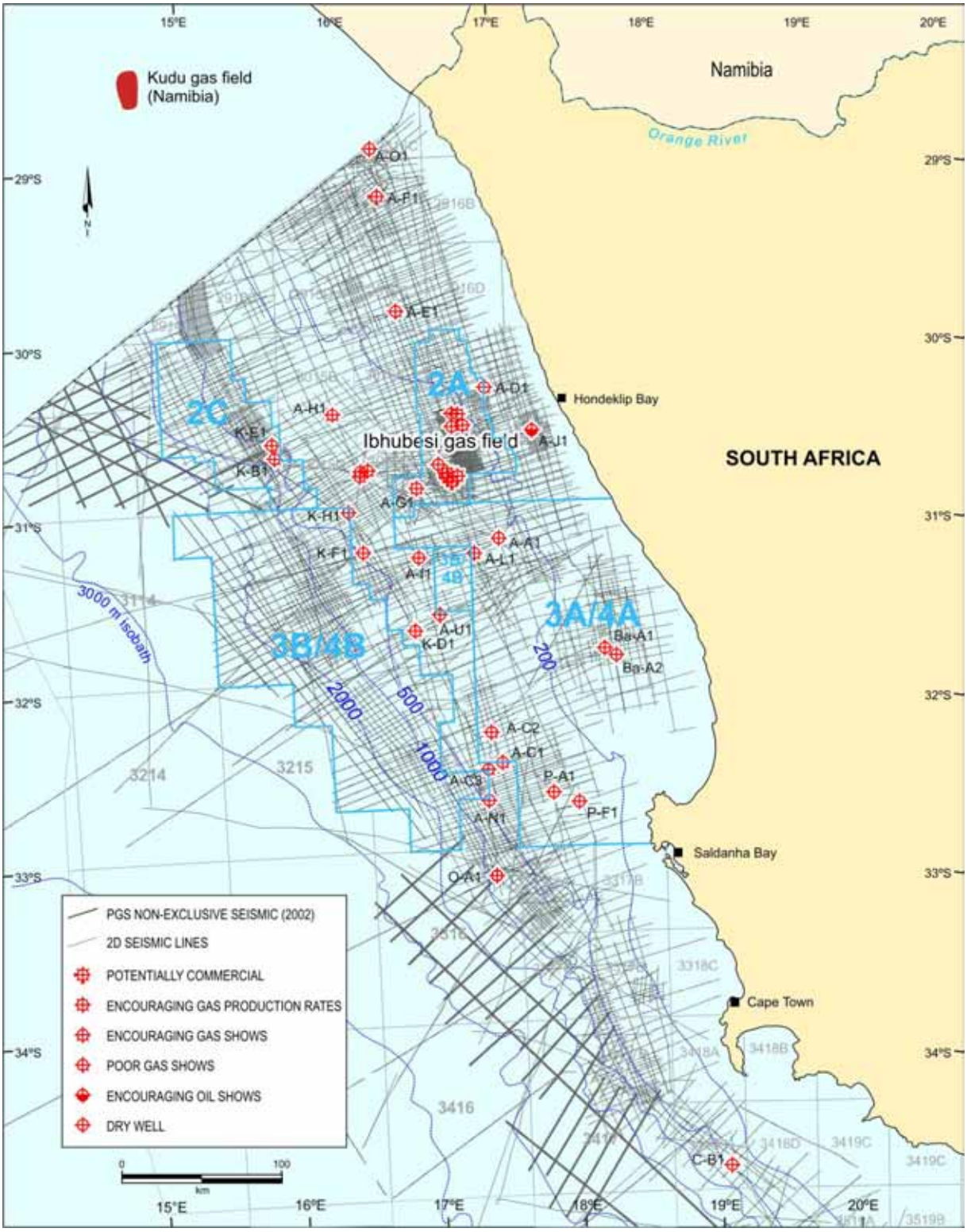

Figure 4.24: Location of wellheads and seismic lines off the West Coast of South Africa (after PASA).

Exploration for oil and gas off the West Coast of South Africa is currently undertaken in the following blocks (see Figure 4.25):

- Block 1: PetroSA - 4 to 6 exploration wells proposed (current project);
- Block 2A: Forest Exploration International (South Africa) – 99 production wells proposed;
- Block 2B: Thombo Petroleum;
- Block 2C: Forest Exploration International (South Africa) – 3 exploration wells proposed;
- Block 3A/4A: BHP Billiton – 1 exploration well proposed; and
- Block 3B/4B: BHP Billiton.

(b) Development and production

There is no current development or production from the South African west coast offshore. The Ibhubesi Gas Field (Block 2A) and Kudu Gas Field (which lies several hundred kilometres to the north-west off the coast of southern Namibia) have been identified for development.

4.1.4.4 Diamond prospecting and mining

The Department of Minerals and Energy have demarcated marine diamond concession areas on the west coast of South Africa, which are referred to as the South African Sea Areas (SASA). The concessions are divided into four categories from the coat seaward (see Figure 26 and Table 4.9):

- 'a' concessions which begin at 31.49 m seaward of the Low Water Mark and end 1 km from the High water mark;
- 'b' concessions which start 1 km from the high water mark and end 5 km from the high water mark;
- 'c' concessions which begin at 5 km from the high water mark to a water depth of 200 m below sea level; and
- 'd' concessions which occur between 200 m and 500 m water depths.

The majority of concessions worked at present are those closer inshore, where diamonds are mined either by divers who employ suction pipes to deliver gravel to land or vessels for sorting, or by land-based mining equipment that extracts the gravel from areas where the sea has been pushed back by temporary dykes.

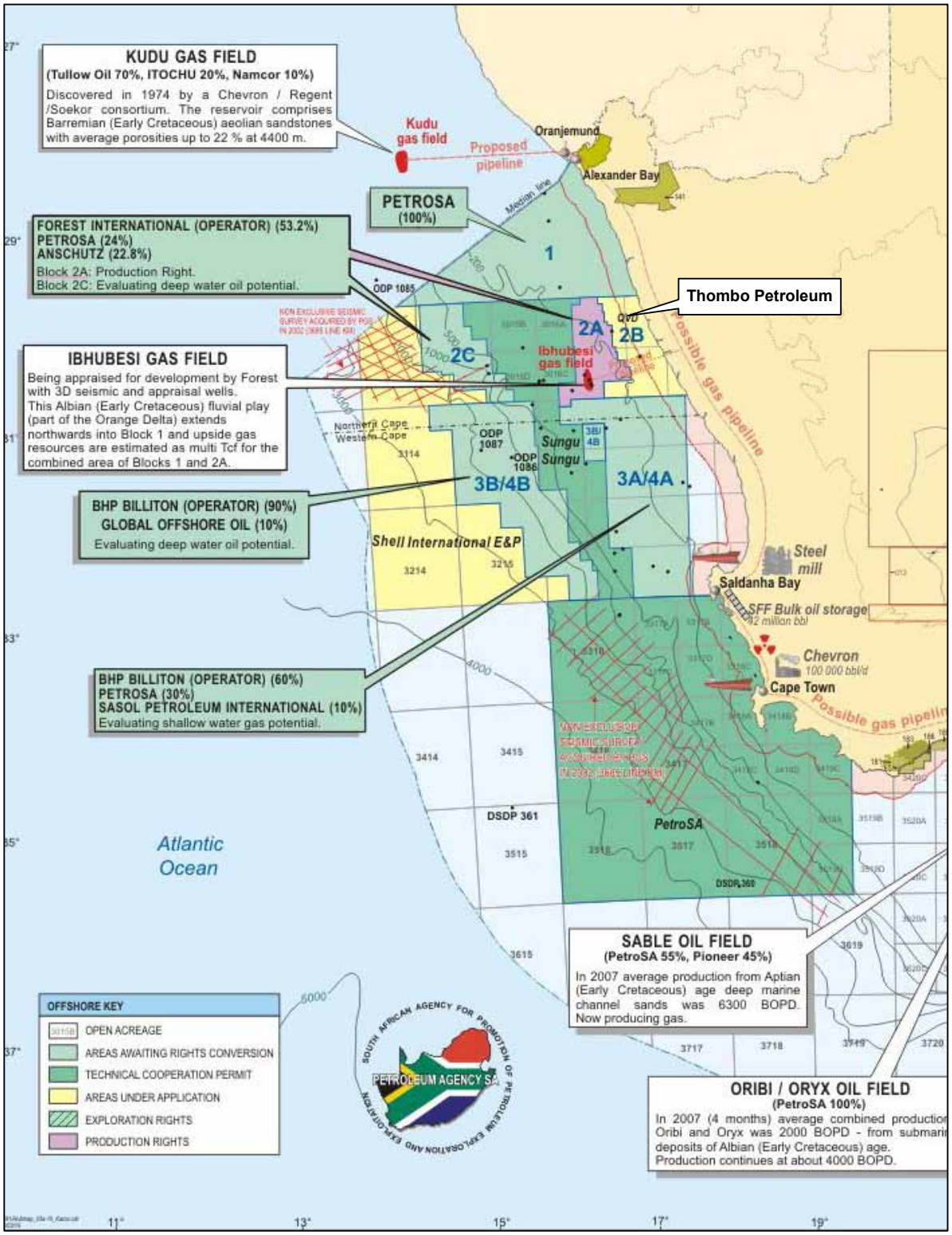

Figure 4.25: Petroleum exploration blocks off the west coast of South Africa (after PASA, 2011).

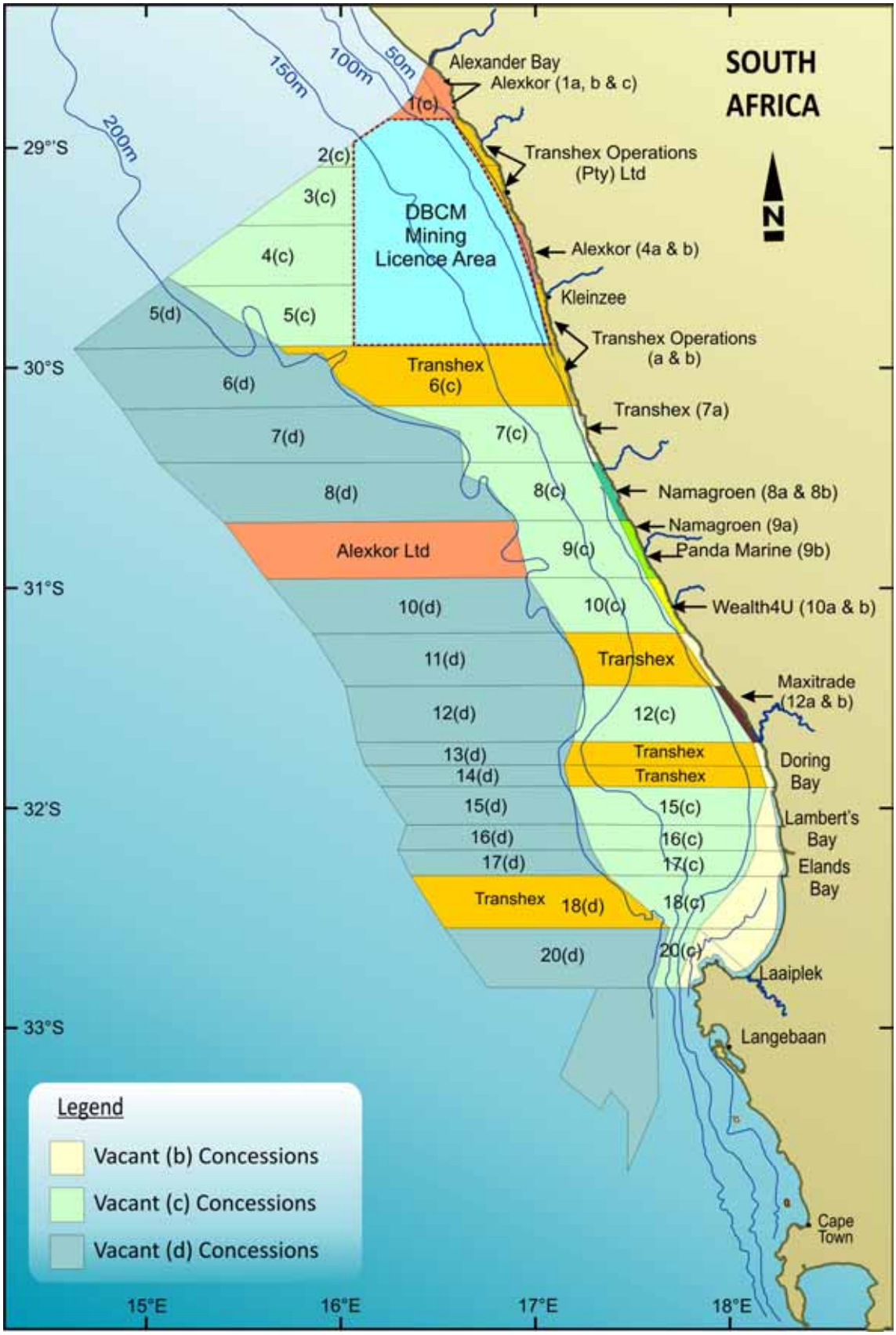

Figure 4.26: South African Diamond Rights Holders off the west coast (compiled by De Beers, 2011).

Table 4.9: Offshore diamond concession holders in and around the proposed study area.

Block	Concession holder			
	a	b	c	d
1	Alexkor Diamond Mines	Alexkor Diamond Mines	Alexkor Diamond Mines	-
2	Alexkor Diamond Mines	Trans Hex Operations	De Beers Consolidated Mines	-
3	Alexkor Diamond Mines	Trans Hex Operations	De Beers Consolidated Mines	-
4	Alexkor Diamond Mines	Alexkor Diamond Mines	De Beers Consolidated Mines	-
5	Trans Hex Operations	Trans Hex Operations	De Beers Consolidated Mines	Vacant
6	Trans Hex Operations	Trans Hex Operations	Trans Hex Operations	Vacant
7	Trans Hex Operations	De Beers Consolidated Mines	Vacant	Vacant
8	Namagroen Prospecting	Namagroen Prospecting	Vacant	Vacant
9	Namagroen Prospecting	Panda marine	Vacant	Alexkor Diamond Mines
10	Wealth 4 U	Wealth 4 U	Vacant	Vacant
11	Vacant	Vacant	Transhex	Vacant
12	Maxitrade	Maxitrade	Vacant	Vacant
13	Vacant	Vacant	Transhex	Poseidon Marine
14	Vacant	Vacant	Transhex	Vacant
15	Vacant	Vacant	Vacant	Vacant
16	Vacant	Vacant	Vacant	Vacant
17	Vacant	Vacant	Vacant	Vacant
18	Vacant	Vacant	Vacant	Transhex
20	Vacant	Vacant	Vacant	Vacant

4.1.4.5 Prospecting and mining of other minerals

(a) Heavy minerals

Heavy mineral sands containing, amongst other minerals, zircon, ilmenite, garnet and rutile may be found offshore of the West Coast. Although a literature search has not identified any published studies that detail the distribution of heavy minerals offshore, concentrations are known to exist onshore. Namakwa Sands is currently exploiting heavy minerals from onshore deposits near Brand-se-Baai (approximately 385 km north of Cape Town).

(b) Glauconite and phosphate

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

Prospecting permits for glauconite and phosphorite have been applied for three offshore areas between Cape Town and Saldanha. The co-ordinates of such prospecting is shown in Figure 4.27 and Table 4.10. On technical and economic grounds glauconite and phosphate are not being considered for mining at present.

(c) Manganese nodules in ultra-deep water

Rogers (1995) and Rogers and Bremner (1991) report that manganese nodules enriched in valuable metals occur in deep water areas (>3 000 m) off the West Coast. The nickel, copper and cobalt contents of the nodules fall below the current mining economic cut-off grade of 2% over most of the area, but the possibility exists for mineral grade nodules in the areas north of 33°S in the Cape Basin and off northern Namaqualand.

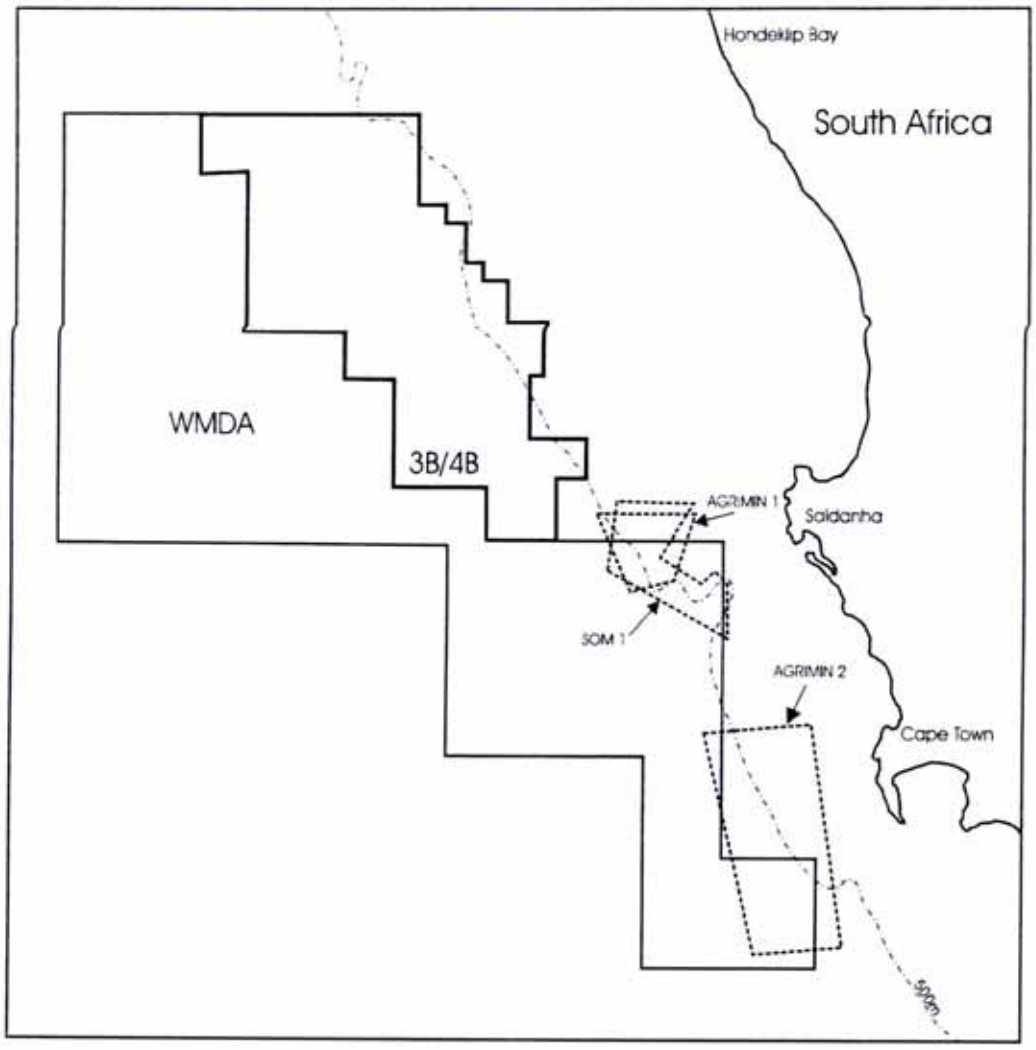

Figure 4.27: Location of glauconite and phosphorite prospecting areas (Agrimin1, Agrimin2 and SOM1).

Table 4.10: Limits of prospecting blocks for glauconite and phosphorite within the West Coast region. In each case the block is a polygon of points labelled A, B, C, D, etc.

Block Title	Corner points	Latitude (S):	Longitude (E):
Agrimin1	A	32º 49' 40.11''	17º 19' 57.12"
	B	32º 49' 39.93"	16º 44' 23.13"
	C	33º 17' 40.92"	17º 01' 11.70"
	D	33º 13' 59.88"	17º 07' 59.99"
Agrimin2	A	33º 56' 23.4654"	17º 27' 23.9975"
	B	34º 54' 31.9601"	18º 07' 40.2233"
	C	34º 53' 59.5830"	18º 27' 34.4074"
	D	33º 55' 43.0337"	17º 57' 58.6973"
SOM1	A	32º 49' 39.00"	16º 50' 9.66"
	B	33º 10' 24.74"	16º 53' 29.30"
	C	33º 40' 00.00''	17º 50' 00.00"
	D	33º 23' 30.00"	17º 50' 00.00"
	E	33º 19' 00.00"	17º 24' 00.00"
	F	33º 29' 00.00"	17º 41' 00.00"
	G	33º 16' 00.00"	17º 41' 00.00"
	H	32º 49' 00.00"	17º 20' 08.08"

4.1.4.6 Other

(a) Anthropogenic marine hazards

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

(b) Undersea cables

Two telecommunication cables (SAT-1 and SAT-2) from western Europe are laid on the seafloor approximately on the 3 000 m isobath. They run up the Cape Canyon to land at Melkbosstrand, north of Cape Town. Although SAT-1 is abandoned, SAT-2 (a fibre-optics cable) is functional. There is an exclusion zone applicable to the telecommunication cables one nautical mile each side of the cable in which no anchoring is permitted.

(c) Archaeological sites

Over 2 000 shipwrecks are present along the South African coastline. The majority of known wrecks along the West Coast are located in relatively shallow water close inshore (within the 100 m isobath) (see Figure 4.28). Wrecks older than 60 years old have National Monument status.

(d) Ammunition dump sites

Details of ammunition dumped at the ammunition dumpsites on the West Coast are given on the respective SAN charts.

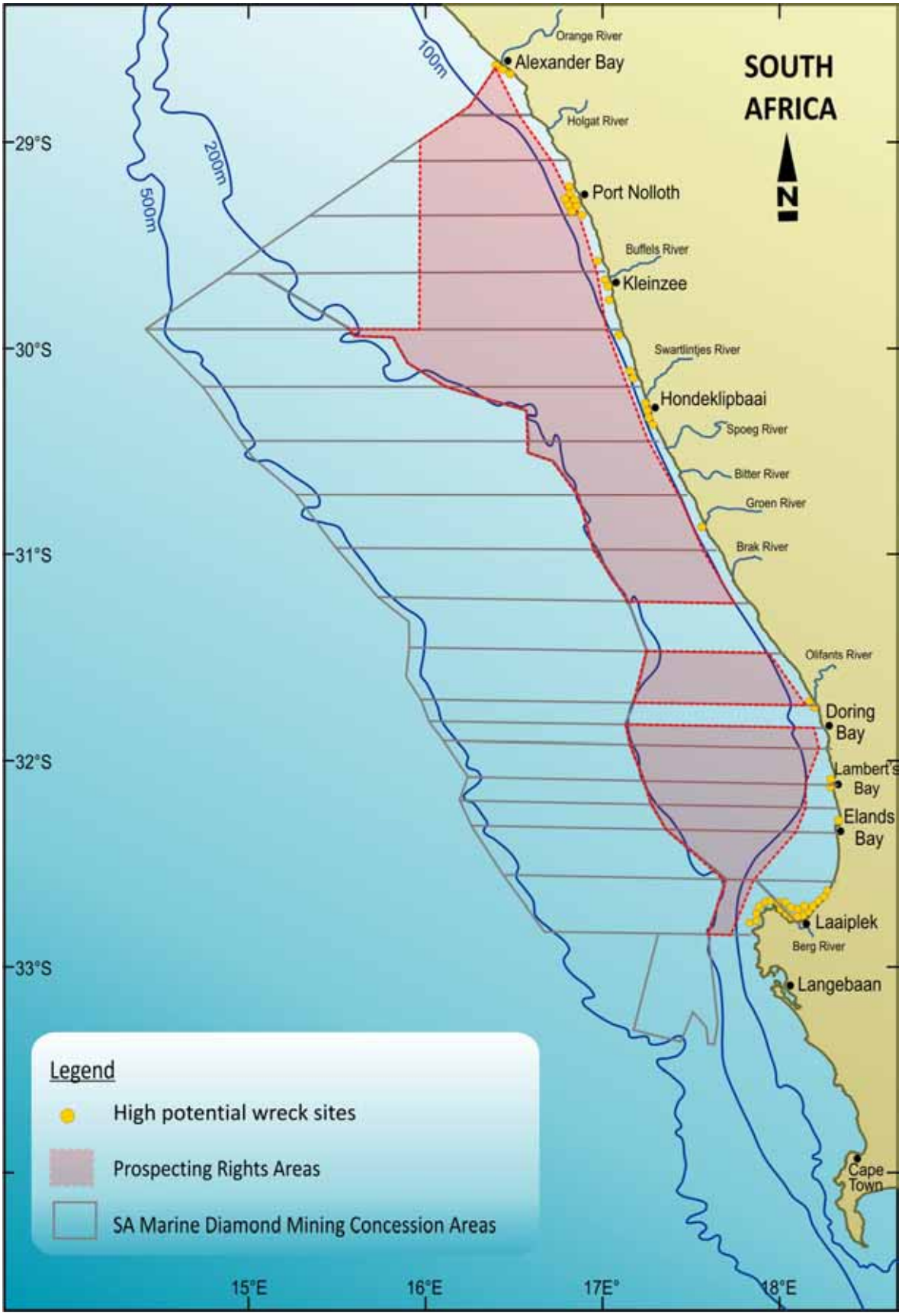

Figure 4.28: Known and presumed positions of shipwrecks along the South African west coast (from Lane & Carter, 1999).

4.2 MARINE PROTECTED AREAS

4.2.1 NEARSHORE REGION AND SHORELINE

The National Biodiversity Spatial Assessment Report (NBSA) (Lombard and Strauss 2004) provides a useful context within which to place the proposed study area. The NBSA is a spatial assessment of the conservation status of selected marine biodiversity patterns in South Africa at a national scale. It addresses a subset of marine species and broad scale intertidal and subtidal habitats within South African waters.

South Africa is divided into five bioregions, of which the Namaqua Bioregion, within which the proposed project area falls, forms one distinct component (Figure 4.29). It is a cool temperate region that extends from Sylvia Hill in Namibia to Cape Columbine. The rationale for the break at Sylvia Hill just north of Lüderitz is that the area constitutes the northern edge of a large upwelling cell. This break is supported by seaweed and invertebrate data and for intertidal and subtidal habitats (Bustamante and Branch 1996; Bolton and Anderson 1997; Emanuel *et al.* 1992; Engledow *et al.* 1992).

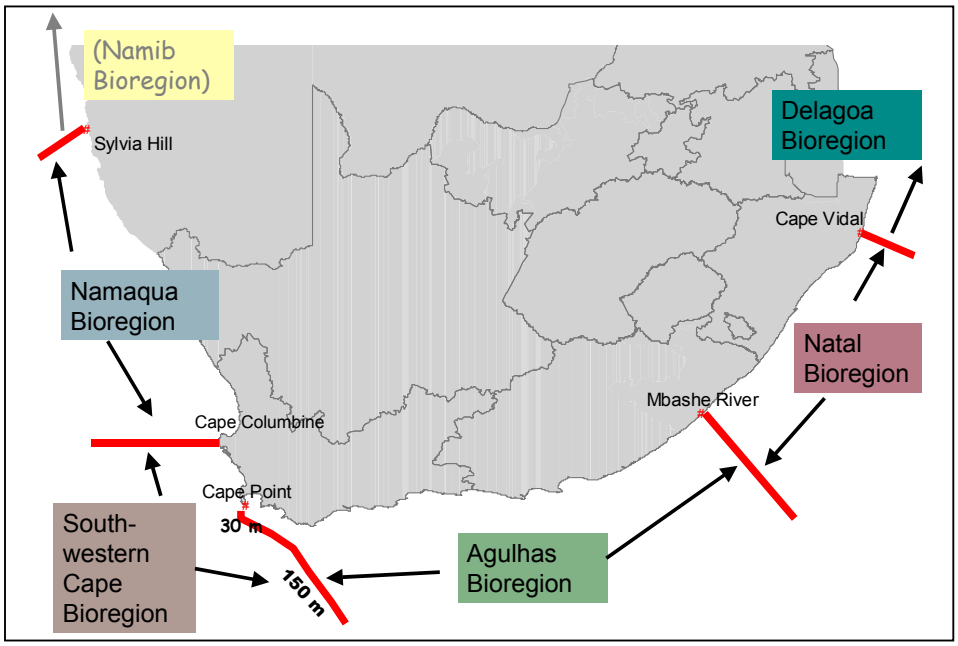

Figure 4.29: The five bioregions defined by the NBSA study (Lombard and Strauss 2004).

The NBSA study analysed available data on rocky shores, mixed shores, sandy beaches, pebble beaches and boulder beaches and identified areas of high value / irreplaceability (Figure 4.30). The proposed Namaqualand Marine Protected Area (MPA), which is located between the Spoeg and Groen Rivers and extends to the edge of the EEZ, is located within the study area.

Two coastal habitat types that dominate the Namaqua bioregion are rocky shores (approximately 53% of the coastline) and sandy shores (about 37%). Mixed shores make up a further 9%. Pebble or boulder beaches are very rare in the Namaqua bioregion, making up less than 1% of the coastline (Lombard & Strauss 2004). The offshore Namaqua Bioregion benthic environment, which is dominated by muds and sands is not well studied, and is regarded by Lombard and Straus (2004) to have a high biozone priority status[2].

[2] Biozone priority status is a measure of the priority status for conservation intervention based on its protection status and threat status (Lombard and Strauss 2004).

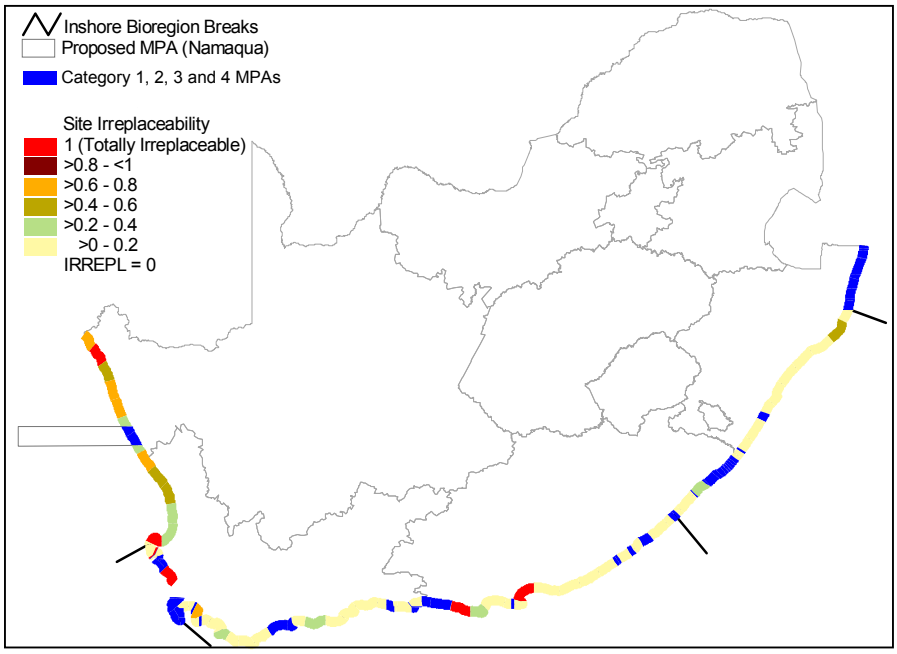

Figure 4.30: Irreplaceability analyses for intertidal habitats, in 50 km strips around South Africa, per bioregion (Lombard and Strauss 2004).

4.2.1.1 Proposed Namaqualand Marine Protected Area

On 17 February 2004 the Department of Environmental Affairs invited comment on a "Notice of intention to declare the Namaqualand MPA under section 43 of the Marine Living Resources Act, No. 18 of 1998" (Government Gazette No 26050) (see Figure 4.31). Although a number of MPA's have in fact been promulgated since 2004, the Namaqualand MPA remains as a proposed MPA. Of the AuruMar concession areas under consideration, only 8c and 9c coincide with the proposed Namaqualand MPA.

De Beers Marine is partnering with the World Wildlife Fund for Nature (WWF) and the South African National Biodiversity Institute (SANBI) in the Offshore Marine Protected Areas (OMPA) Project. This project aims to facilitate the development of a representative Offshore MPA network that has broad support from the various offshore marine use sectors and is based on the best available scientific information, for the persistent conservation of South Africa's offshore biodiversity and the wise use of offshore marine resources.

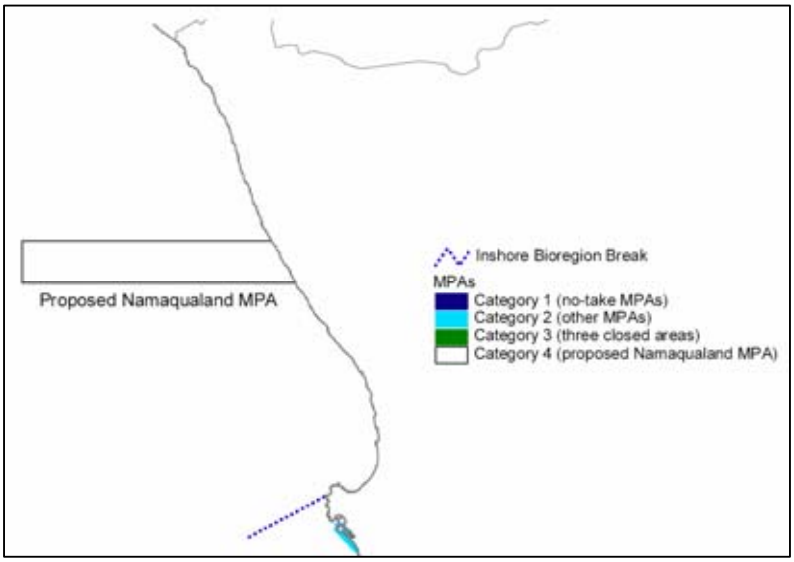

Figure 4.31: Proposed Namaqualand MPA off the West Coast of South Africa (Lombard and Strauss 2004).

4.2.1.2 Other important biodiversity areas

According to Lombard and Strauss (2004), there is one area, just north of Port Nolloth inshore of 50 m that contains the only boulder beaches in the bioregion and biodiversity assessment targets for boulder beaches can only be met here. However, this area has not yet been formally protected and would not be affected by the proposed sampling as this area is inshore of the proposed project area.

Deep photic complexity of reefs has been undertaken within the subtidal environment to determine their type, distribution, density, etc., using available data. Figures 4.32 a and b show these results within the subtidal environment and the area just north of Port Nolloth was identified as important, supporting the results of the intertidal habitat analyses (Lombard and Strauss, 2004).

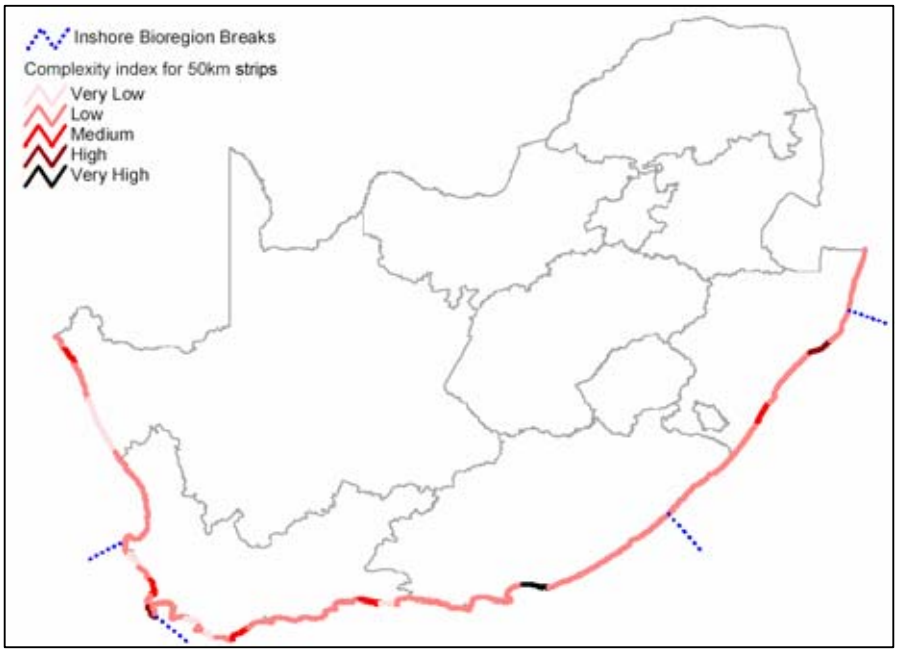

Figure 4.32a: Deep photic complexity in 50 km strips around the Southern African coastline (Lombard and Strauss 2004).

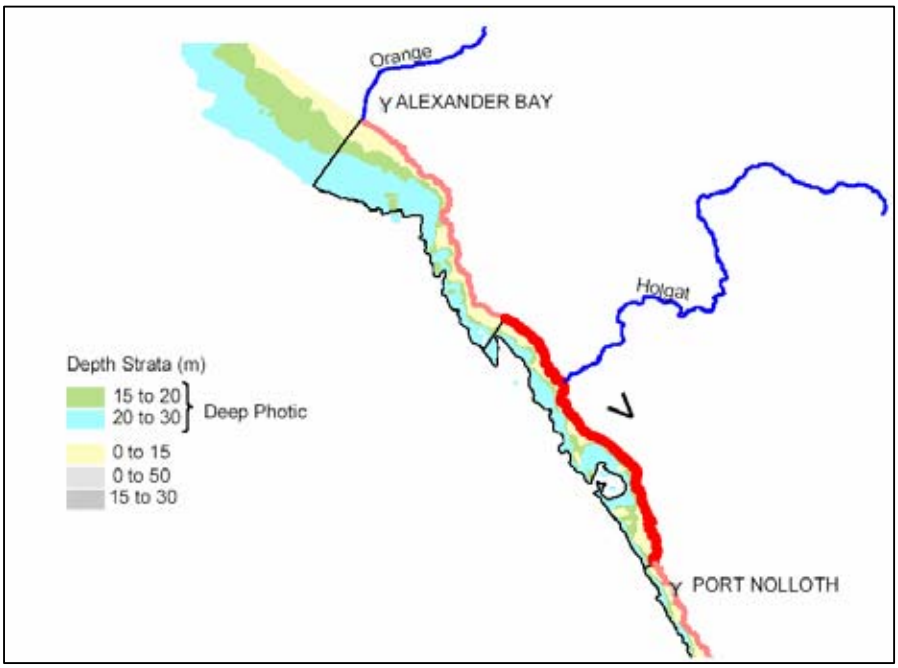

Figure 4.32b: The 50 km strip with the highest deep photic complexity index in the Namaqua bioregion (Lombard and Strauss 2004).

4.2.1.3 Offshore biodiversity priorities

In 2009 SANBI initiated a process to identify potential priority areas for spatial management in the offshore environment. This included workshop sessions with various industry role players and a draft report titled 'Systematic Biodiversity Planning to identify a potential offshore MPA network for South Africa' (Sink, et. al., March 2010) was presented for discussion. This report states that the offshore MPA project was developed to address the inshore bias in South Africa's protected area system and identify a potential network of offshore MPA's. This report further states that systematic biodiversity planning allows for an integrated approach that facilitates the consideration of multiple sectors in a transparent process to identify priority areas for spatial biodiversity management. The aim is to identify potential areas that meet a pre-defined set of biodiversity targets at minimum economic cost (Sink, et. al., March 2010). Six benthic bioregions were recognised by the offshore MPA project and within these six bioregions, 20 benthic biozones were identified (see Figure 4.33). The proposed project overlaps with the Namaqua inner shelf and Southern Benguela outer shelf bioregions.

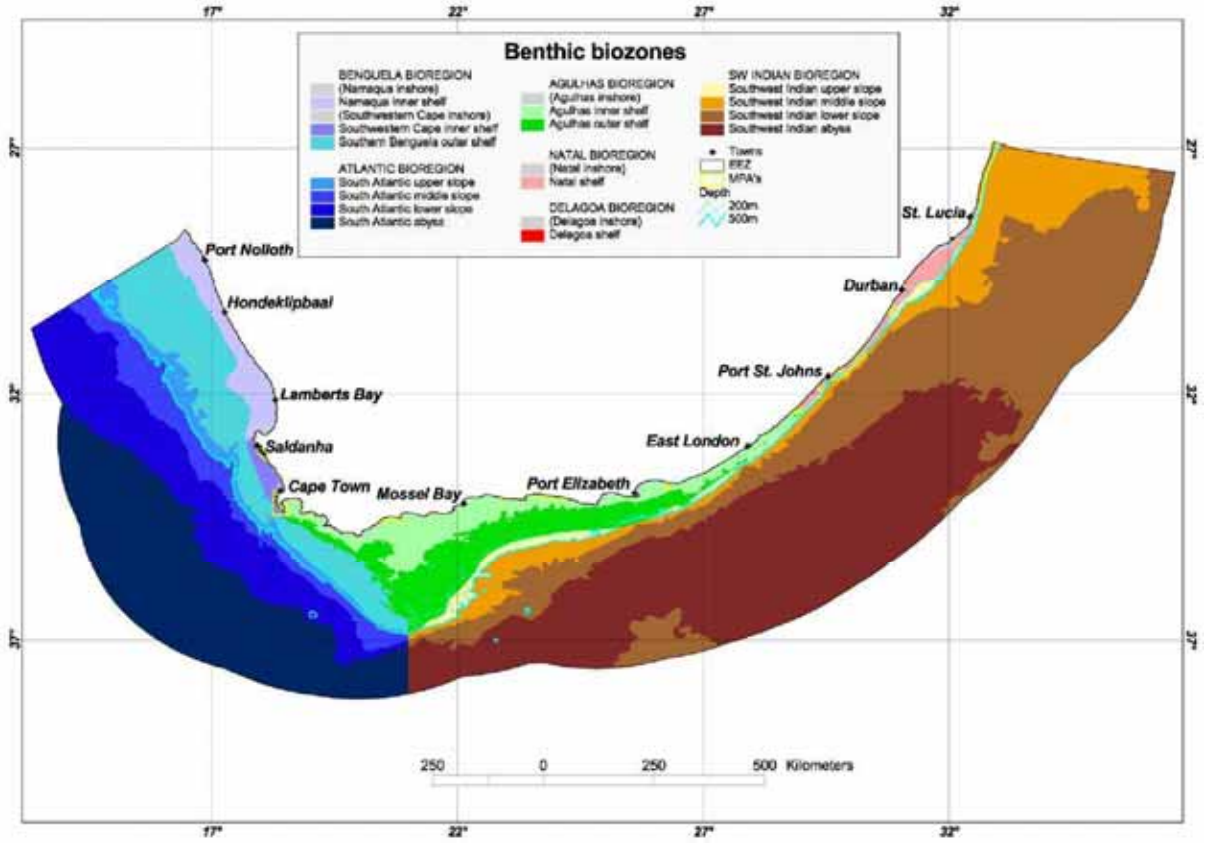

Figure 4.33: The benthic biozones of South Africa (Sink, et. al., 2010).

Sink et. al., (2010) also identified areas that are important benthic protection priorities, which are highlighted as darker areas in Figure 4.34. These areas have been identified as important to protect as they have fewer opportunities to meet biodiversity targets, i.e. they contain biodiversity that is not known to occur anywhere else. Key areas that have been identified off the west coast include Child's Bank and Ibhubesi reef. Untrawlable grounds and deep reefs contribute strongly to areas of higher selection frequency on the west and south coasts (Sink et. al., 2010). The proposed prospecting operation would coincide with one potential benthic priority area located to the north-west of Hondeklipbaai (see Figure 4.34).

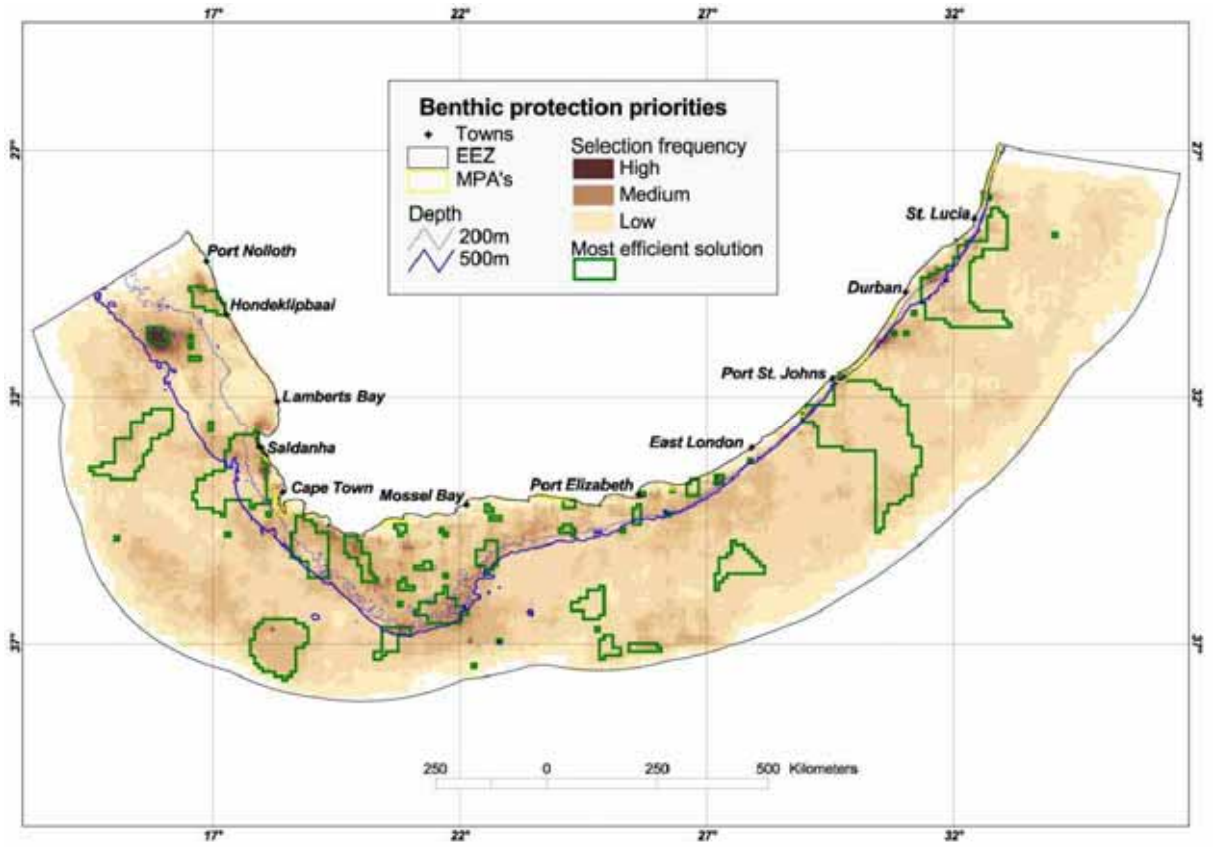

Figure 4.34: Potential priority areas for seabed protection in the offshore environment (Sink, et. al., 2010).

4.2.2 COASTAL REGION OCEANOGRAPHY

This section briefly describes the oceanography of the coastal region of the West Coast.

4.2.2.1 Rocky shores

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

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

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

barnacles such as *Tetraclita serrata* and *Chthamalus dentatus* are present in the Namaqualand bioregion, the limpet *Patella granularis* (and to some extent *P. granatina*) is by far the most common animal species. The green alga called "sea lettuce" (*Ulva* spp.) is the most common floral representative found in this zone.

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

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

A list of the marine macro-fauna and flora likely to occur on rocky shores in the study area is presented in Tables 4.11 and 4.12, respectively.

Table 4.11: Expected common rocky shore-associated macro-fauna from the central Namaqua Bioregion.

Descriptive group	Species	Common name	Zone
Amphipods	*Hyale grandicornis*	Seaweed amphipod	Intertidal
	Temnophlias capensis	Louse amphipod	Intertidal
Barnacles	*Austromegabalanus cylindricus*	Giant barnacle	Intertidal
	Chthamalus dentatus	Toothed barnacle	Intertidal
	Notomegabalanus algicola	White dwarf barnacle	Intertidal
	Octomeris angulosa	Eight-shell baracle	Intertidal
	Tetraclita serrata	Volcano barnacle	Intertidal
Bivalves	*Gregariella petagnae*	Half-hair mussel	Intertidal
	Mytilus galloprovincialis	Mediterranean mussel	Intertidal
Brittlestars	*Amphioplus integer*	Port Natal brittlestar	Intertidal
	Amphiura capensis	Equal-tailed brittlestar	Intertidal
Chitons	*Callochiton castaneus*	Broad chiton	Intertidal
	Chaetopleura papilio	Hairy chiton	Intertidal

Descriptive group	Species	Common name	Zone
	Chiton nigrovirescens	Brooding chiton	Intertidal
	Ischnochiton bergoti	Ribbed-scale chiton	Intertidal
	Ischnochiton textiles	Textile chiton	Intertidal
Crabs	*Cyclograpsus punctatus*	Shore crab	Intertidal
	Plagusia chabrus	Cape rock crab	Intertidal
Hermit crabs	*Paguristes gamianus*	Pink hermit crab	Intertidal
Hydroids	*Eudendrium spp.*	Bushy hydroids	Intertidal
	Lytocarpus filamentosus	Smoky feather hydroid	Intertidal
	Obelia dichotoma	Obelia	Intertidal
Isopods	*Cirolana hirtipes*	Grooved cirolanid	Intertidal
	Cirolana undulate	Crimped cirolanid	Intertidal
	Deto echinata	Horned isopod	Intertidal
	Ligia dilatata	Sea slater	Intertidal
	Notasellus capensis	Hairy isopod	Intertidal
	Sphaeramene polytylotos	Button isopod	Intertidal
Limpets	*Helcion pectunculus*	Prickly limpet	Intertidal
	Patella argenvillei	Argenville's limpet	Intertidal
	Patella cochlear	Pear limpet	Intertidal
	Patella granatina	Granite limpet	Intertidal
	Siphonaria capensis	Cape false limpet	Intertidal
Keyhole limpets	*Diodora parviforata*	Conical keyhole limpet	Intertidal
	Fissurella mutabilis	Cape keyhole limpet	Intertidal
Lamp shells	*Kraussina rubra*	Ruby lamp shell	Intertidal
Nudibranchs	*Melibe rosea*	Cowled nudibranch	Intertidal
Periwinkles	*Nodilittorina Africana*	African periwinkle	Intertidal
	Tricolia capensis	Pheasant shell periwinkle	Intertidal
Polychaete worms	*Arabella iricolor*	Iridescent worm	Intertidal
	Dodecaceria puchra	Black borer worm	Intertidal
	Eunice aphroditois	Wonderworm	Intertidal
	Euphrosine capensis	Plump bristleworm	Intertidal
	Gunnarea capensis	Cape reefworm	Intertidal
	Lysidice natalensis	Three antennae worm	Intertidal
	Platynereis dumerilii	Comb-toothed nereid	Intertidal
	Polydora spp.	Blister worms	Intertidal
	Pseudonereis variegata	Musselworm	Intertidal
	Thelepus spp.	Tangleworms	Intertidal
	Timarete capensis	Orange thread-gill worm	Intertidal
Sea anemones	*Actinia equine*	Plum anemone	Intertidal
	Anthopleura michaelseni	Long-tentacled anemone	Intertidal
	Anthothoe stimpsoni	Striped anemone	Intertidal
	Bunodactis reynaudi	Sandy anemone	Intertidal
	Bunodosoma capensis	Knobbly anemone	Intertidal
	Pseudactinia flagellifera	False plum anemone	Intertidal
Sea cucumbers	*Pentacta doliolum*	Mauve sea cucumber	Subtidal reefs
	Pseudocnella insolens	Red-chested sea cucumber	Subtidal reefs
Sea spiders	*Tanystylum brevipes*	Compact sea spider	Intertidal
Sea squirts	*Botrylloides leachi*	Ladder ascidian	Subtidal reefs
	Botryllus magnicoecus	Star ascidian	Subtidal reefs
Slipper limpets	*Calyptraea chinensis*	Chinese hat limpet	Subtidal reefs
	Crepidula porcellana	Slipper limpet	Subtidal reefs
Sponges	*Hymeniacedon perlevis*	Bread sponge	Intertidal
Starfish	*Patiriella exigua*	Dwarf cushion star	Intertidal

Descriptive group	Species	Common name	Zone
	Pteraster capensis	Brooding cushion star	Subtidal reefs
Teleost fish	*Caffrogobius nudiceps*	Barehead goby	Intertidal
	Chirodactylus brachydactylus	Twotone fingerfin	Intertidal
	Chorisochismus dentex	Rocksucker	Intertidal
	Clinus agilis	Agile klipvis	Intertidal
	Clinus heterodon	West coast klipvis	Intertidal
	Clinus superciliosus	Super klipvis	Intertidal
	Diplodus sargus	Blacktail	Subtidal reefs
	Ephinephelus marginatus	Yellowbelly rockcod	Subtidal reefs
	Muraenoclinus dorsalis	Nose-stripe klipvis	Intertidal
	Pachymetopon blochii	Hottentot	Subtidal reefs
	Scartella emarginata	Maned blenny	Intertidal
Turretshells	*Clionella sinuate*	Ribbed turretshell	Intertidal
Unsegmented worms	*Golfingia capensis*	Peanut worm	Intertidal
Whelks	*Burnupena catarrhacta*	Flam-patterned burnupena	Intertidal
	Cymatium cutaceum	Furry triton	Intertidal
	Nucella cingulata	Girdled dogwelk	Subtidal reefs
	Nucella dubia	Common dogwelk	Intertidal
	Nucella squamosa	Scaly dogwelk	Subtidal reefs
Winkles	*Oxystele variegate*	Variegated topshell winkle	Intertidal

Table 4.12: Expected common rocky shore-associated macro-flora from the central Namaqua Bioregion.

Descriptive group	Species	Common name	Zone
Brown algae	*Chordariopsis capensis*	Cord weed	Intertidal
	Family Chordariaceae	Furry slime strings	Intertidal
	Scytosiphon simplicissima	Sausage skins	Intertidal, subtidal
	Splachnidium rugosum	Dead man's finger	Intertidal
Encrusting algae	*Leptophytum foveatum*	Thin coralline crust	Intertidal, subtidal
Green algae	*Cladophora flagelliformis*	Cape cladiphora	Intertidal, subtidal
Red algae	*Aeodes orbitosa*	Slppery orbit	Intertidal
	Aristothamnion collabens	Aristocratic plume weed	Intertidal, subtidal
	Caulacanthus ustulatus	Spiky turf weed	Intertidal
	Ceramium capense	Cape ceramium	Intertidal, subtidal
	Ceramium diaphanum	Beaded ceramium	Intertidal, subtidal
	Ceramium obsoletum		Intertidal, subtidal
	Ceramium planum	Flat fern ceramium	Intertidal, subtidal
	Champia lumbricalis	Earthworm champia	Intertidal
	Gigartina stiriata	Twisted Gigartina	Intertidal
	Grateloupia doryphora	Rippled ribbon-weed	Intertidal
	Grateloupia filicina	Tattered rag weed	Intertidal
	Gymnogongrus complicatus	Complicated gymnogongrus	Subtidal
	Iridaea capensis	Spotted iridaea	Intertidal
	Nothogenia erinacea	Hedgehog seaweed	Intertidal
Red algae (cont.)	*Plocamium cornutum*	Horny plocamium	Intertidal
	Plocamium rigidum		Intertidal
	Porphyra capensis	Purple laver	Intertidal
	Pterosiphonia cloiophylla	Red feather weed	Intertidal, subtidal
	Schizymenia obovata	Orange sheets	Intertidal
	Trematocarpus flabellatus	Comb-fan weed	Intertidal

4.2.2.2 Sandy shores

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

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

The South African sandy beach up/down-shore environment can be divided into a number of zones (Brown and MacLachlan 1990) (Figure 4.35) including:

1. The *supralittoral zone* runs from the foredunes to the high water drift line. The sand remains mostly dry. The dominant force disturbing the substrate in this zone is the wind. The zone is populated by insects and air-breathing crustaceans.
2. The *littoral or intertidal zone* extends from the high tide drift line down to the low tide mark. This zone is flushed periodically by the changing tide, and the sand is generally damp. The dominant force in this zone comes from the swash. No macro-flora grows in this zone, especially on an exposed beach. Near the drift line, air-breathing crustaceans such as the pill bug isopod *Tylos granulatus* or the beach hopper amphipod *Talorchestia capensis* are common, as well as some oligochaete worms, usually found under rotting beach cast seaweed. Further down the beach, isopods such as the right-angle beach louse *Eurydice longicornis* and the wide-foot beach louse *Pontogeloides laticeps* typify the mid-shore region. Also common to this region of the zone are polychaete worms such as *Scolelepis squamata.* While the white sand mussel *Donex serra* occurs in certain instances, it apparently is not found in the Port Nolloth region. In the lower reaches of the intertidal zone, including the sublittoral fringe, the common organisms are the surf mysid shrimp *Gastrosaccus psammodytes* and a ubiquitous gastropod scavenger, the finger ploughshell *Bullia digitalis*.
3. The *surf zone* starts below the low water level. In the surf zone the sand substrate is always saturated, and experiences strong wave action and currents. The sand bed is generally in a state of mobility in this zone. The macro-fauna found in this zone are much the same as that which occurs in the sublittoral fringe, with some species of amphipods present. Micro-flora in the form of diatoms can be an important component in this zone, migrating between the water column during the day and the sandy substrate at night. High densities of these diatoms can result in semi-stable formations of foam in the inner surf zone.
4. The *transition zone* occurs between the turbulence of the surf zone and the more stable outer turbulent zone. This is the region across which the wave break line will range, depending on the prevailing weather conditions.
5. The *outer turbulent zone* is typified by a return to stability after the turbulence of the surf zone. The currents are weak compared to the surf zone, and although the effects of wave surge are apparent, the sandy substrate is stable enough to be colonised by macro-fauna including amphipods and other small crustaceans, tube-building polychaetes such as *Nephys* spp., delicate cnidarians and anemones such as *Anthopleura michaelseni.*

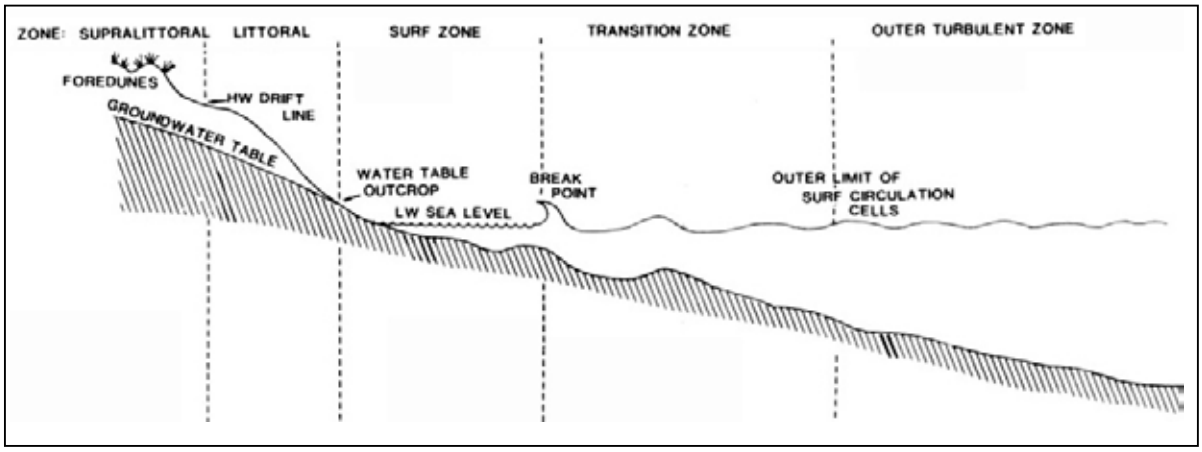

Figure 4.35: Generalised scheme of zonation on sandy shores (Modified from Brown & MacLachlan 1990).

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

A list of the marine macro-fauna likely to occur on sandy shores in the study area is presented in Table 4.13.

Table 4.13: Expected common sandy shore-associated macro-fauna from the central Namaqua Bioregion.

Descriptive group	Species	Common name	Zone
Amphipods	*Ceradocus rubromaculatus*	Red-striped amphipod	Intertidal
	Talorchestia capensis	Beach hopper	Intertidal
	Urothoe grimaldii	Burrowing amphipod	Intertidal
Bivalves	*Donax serra*	White mussel	Subtidal
	Dosinia lupinus orbignyi	Heart clam	Subtidal
	Venerupis corrugatus	Corrugated venus clam	Subtidal
	Venus verrucosa	Warty venus clam	Subtidal
Brittlestars	*Ophioderma wahlbergi*	Serpent-skinned brittlestar	Subtidal
Crabs	*Ovalipes trimaculatus*	Threespot swimming crab	Intertidal
Elasmobranchs	*Dasyatis chrysonota*	Blue stingray	Shallow neritic
Isopods	*Eurydice longicornis*	Right-angle beach louse	Intertidal
	Pontogeloides laticeps	Wide-foot beach louse	Intertidal
	Tylos granulatus	Pill bug	Intertidal
Keyhole limpets	*Dendrofissurella scutellum*	Saddle keyhole limpet	Intertidal
Mysid shrimp	*Gastrosaccus psammodytes*	Surf mysid	Subtidal
Ploughshells	*Bullia digitalis*	Finger ploughshell	Intertidal
	Bullia laevissima	Fat ploughshell	Subtidal

Descriptive group	Species	Common name	Zone
Polychaetes	*Euclymene spp.*	Bamboo worms	Intertidal
	Lumbrineris tetraura	False earthworm	Intertidal
	Nephtys spp.	Nephthys sandworms	Intertidal
Sea anemones	*Anthopleura stephensoni*	Violet-spotted anemone	Shallow neritic
Sea cucumbers	*Roweia fraunfeldii*	Horseshoe sea cucumber	Subtidal
Sea pens	*Virgularia schultzei*	Feathery sea pen	Shallow neritic
Sea urchins	*Spatogobrissus mirabilis*	Heart urchin	Subtidal
Shrimps	*Palaemon peringueyi*	Sand shrimp	Intertidal
Teleosts	*Lithognathus lithognathus*	White steenbras	Shallow neritic
	Lithognathus mormyrus	Sand steenbras	Shallow neritic
	Liza richardsonii	Mullet	Shallow neritic

4.2.2.3 Kelp beds

Kelp beds are the dominant sub-littoral reef communities along the west coast of southern Africa (Branch & Griffiths 1988). The dominant kelp species in the central Namaqualand region is the split fan kelp *Laminaria pallida*, replacing the sea bamboo *Ecklonia maxima*, which is the more common shallower water kelp species along much of the south and west coast of South Africa. The kelp beds occur in shallow water to depths of about 30 m. Epiphyte and macrophyte algae species are associated with the kelp beds are presented in Table 4.14.

The shallow kelp beds are colonised by relatively few faunal species, with diversity increasing on their deeper, seaward fringes (Branch & Griffiths 1988). Examples of the types of organisms associated with the kelp beds are presented in Table 4.15. The faunal species include grazers such as the sea urchin *Parechinus angulosus*, limpet *Patella compressa*, kelp louse *Paridotea reticulata* and amphipods; and filter feeders including mussels, sponges, ascidians and barnacles. Carnivorous species are also represented, including anemones, whelks, starfish, fish and crustaceans (including the most important predator in the ecosystem, the west coast rock lobster). Several of these species also occur on sublittoral rocky shores, and are described in Section 4.2.2.1.

Table 4.14: Kelp bed-associated macro-flora from the central Namaqua Bioregion.

Descriptive group	Species	Common name	Type
Brown algae	*Desmarestia firma*	Acid weed	Under-storey
Red algae	*Botryglossum platycarpum*	Platycarpum	Under-storey
	Carpoblepharis flaccida	Flaccid kelp weed	Epiphyte
	Epymenia obtuse	Broad wine-weed	Under-storey/Kelp holdfasts
	Gigartina clathrata	Clathrata	Under-storey
	Hymenena venosa	Veined oil-weed	Under-storey
	Neuroglossum binderianum	Veined tongue	Under-storey
	Pachymenia carnosa	Red rubber weed	Under-storey
	Phyllymenia belangeri	Corrugated red algae	Under-storey
	Polysiphonia virgata	Kelp fern	Epiphyte
	Suhria vittata	Red ribbons	Epiphyte

Table 4.15: Kelp bed-associated fauna from the central Namaqua Bioregion.

Descriptive group	Species	Common name
Bivalves	*Aulacomya ater*	ribbed mussel
Bryozoans	*Membranipora tuberculata*	Membranous lace animal
Crustaceans	*Pilumnoides rubus*	Kelp crab
	Jasus lalandii	West coast rock lobster
Hydroids	*Obelia geniculata*	Thick-walled obelia
Isopods	*Paridotea reticulata*	Kelp louse
Limpets	*Patella compressa*	Kelp limpet
	Haliotis midae	Perlemoen
Sea urchins	*Parechinus angulosus*	Cape urchin
Teleost fishes	*Pachymetopon blochii*	Hottentot

4.2.3 ORANGE RIVER MOUTH RAMSAR SITE

The Orange River Mouth area is ranked as the sixth-most important coastal wetland in southern Africa in terms of the number of birds it supports and is used by water birds either for breeding purposes or as a stopover on migratory routes. Many birds depend on the area for food, as well as for shelter from the strong coastal winds. These factors have led to the mouth being declared a Wetland of International Importance under the Ramsar Convention. The sensitivity of the area needs to be considered when managing airborne logistics operations either from Alexander Bay or Oranjemund airports.

4.2.4 ANTHROPOGENIC ACTIVITIES

4.2.4.1 Mariculture industries

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

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

4.2.4.2 Recreational utilisation

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

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

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

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

4.2.4.3 Marine outfall/intake pipes

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

5. IMPACT DESCRIPTION AND ASSESSMENT

This chapter describes and assesses the significance of potential impacts related to the proposed prospecting activities in the identified study area. All impacts are systematically assessed and presented according to predefined rating scales (see Appendix 5). Mitigation or optimisation measures are proposed which could ameliorate the negative impacts or enhance potential benefits, respectively. The status of all impacts should be considered to be negative unless otherwise indicated. The significance of impacts with and without mitigation is also assessed.

Specialist input was provided in order to address the likely effect of the proposed prospecting activities on marine benthic fauna (see Appendix 3). In addition, this EIA used as a basis the key issues identified from similar previous EIA studies for projects on the West Coast. The project team have assessed the relevance of these issues to this project.

5.1 IMPACT OF THE VESSEL

5.1.1 DISCHARGES/DISPOSAL TO THE SEA

Discharges to the marine environment include deck drainage, machinery space drainage, sewage, galley wastes and solid wastes from both the sampling and survey vessels.

5.1.1.1 Deck Drainage

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

Assessment
Oils, solvents and cleaners could be introduced into the marine environment in small volumes through spillage and drainage of deck areas. The potential impact of deck drainage on the marine environment would, therefore, be of low intensity across the prospecting area over the short-term, and is considered to be of **VERY LOW** significance with or without mitigation (see Table 5.1).

Mitigation
The following measures are recommended for mitigation of deck drainage discharges from the vessel:

- Machinery spaces must drain into bilge tanks in compliance with MARPOL Annex I;
- Save-alls must be utilised around specific equipment, bunkering points and vents on open deck areas to prevent release of contaminated water overboard;
- Training and awareness of crew in spill management could minimise contamination;
- Low-toxicity biodegradable detergents and reusable absorbent cloths should be used in cleaning of all deck spillage; and
- All hydraulic systems should be adequately maintained.

Table 5.1: Impact of deck drainage from vessels.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	Local	Local
Duration	Short-term	Short-term
Intensity	Low	Low
Probability	Highly Probable	Highly Probable
Confidence	High	High
Significance	**Very Low**	**VERY LOW**
Cumulative impact	None	None
Nature of Cumulative impact	The nominal quantity of deck drainage that would enter the sea would not result in a cumulative impact.	
Degree to which impact can be reversed	Fully reversible - deck drainage would be quickly dispersed and diluted by the high wind and wave energy of the offshore sea environment.	
Degree to which impact may cause irreplaceable loss of resources	N/A	
Degree to which impact can be mitigated	Very Low	

5.1.1.2 Machinery space drainage

Description of impact

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

Assessment

All operations would comply fully with international agreed standards regulated under MARPOL 73/78. All machinery space drainage would pass through an oil/water filter to reduce the oil in water concentration to 15 parts per million, in accordance with MARPOL 73/78 requirements.

Concentrations of oil reaching the marine environment through drainage of machinery spaces are therefore expected to be low. The potential impact of such low concentrations would be of low intensity and limited to the sampling area over the short-term. The potential impact of machinery space drainage on the marine environment is therefore considered to be of **VERY LOW** significance with or without mitigation (see Table 5.2).

Mitigation

No mitigation measures are deemed necessary (assuming compliance with the Marpol 73/78 standards).

Table 5.2: Impact of machinery space drainage from vessels.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	Local	Local
Duration	Short-term	Short-term
Intensity	Low	Low
Probability	Highly Probable	Highly Probable
Confidence	High	High
Significance	**Very Low**	**VERY LOW**
Cumulative impact	None	None
Nature of Cumulative impact	The nominal quantity of machine drainage that would enter the sea would not result in a cumulative impact.	

Degree to which impact can be reversed	Fully reversible - machine drainage would be quickly dispersed and diluted by the high wind and wave energy of the offshore sea environment.
Degree to which impact may cause irreplaceable loss of resources	N/A
Degree to which impact can be mitigated	Very Low

5.1.1.3 Sewage

Description of impact

Sewage poses an organic and bacterial loading on the natural degradation processes of the sea, resulting in an increased biological oxygen demand.

Assessment

The volumes of sewage wastes released from the vessels would be small and comparable to volumes produced by vessels of similar crew compliment. The high wind and wave energy is expected to result in rapid dispersal.

The potential impact of sewage effluent from the sampling and survey vessels on the marine environment is expected to be limited to the sampling area over the short-term, and is therefore considered to be of **VERY LOW** significance with or without mitigation (see Table 5.3).

Mitigation

- Contractors would be required to comply with the MARPOL 73/78 Annex IV requirements, wherever possible.

Table 5.3: Impact of sewage effluent discharge from vessels.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	Local	Local
Duration	Short-term	Short-term
Intensity	Low	Low
Probability	Highly Probable	Highly Probable
Confidence	High	High
Significance	**Very Low**	**VERY LOW**
Cumulative impact	None	None
Nature of Cumulative impact	The nominal quantity of sewage that would enter the sea would not result in a cumulative impact.	
Degree to which impact can be reversed	Fully reversible - sewage would be quickly dispersed and diluted by the high wind and wave energy of the offshore sea environment.	
Degree to which impact may cause irreplaceable loss of resources	N/A	
Degree to which impact can be mitigated	N/A	

5.1.1.4 Galley waste

Description of impact

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

Assessment

The volume of galley waste from a vessel would be small and comparable to wastes from any vessel of a similar crew compliment. Discharges of galley wastes, according to MARPOL 73/78 Annex V standards, would be comminuted to particle sizes smaller than 25 mm prior to disposal to the marine environment if less than 12 nautical miles (± 22 km) from the coast and no disposal within 3 nautical miles (± 5.5 km) of the coast. The potential impact of galley waste disposal on the marine environment would be of low intensity and limited to the sampling area over the short-term. The potential impact of galley waste on the marine environment is therefore considered to be of **VERY LOW** significance with or without mitigation (see Table 5.4).

Mitigation

Minimise the discharge of waste material should obvious attraction of marine fauna be observed.

Table 5.4: Impact of galley waste disposal from vessels.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	Local	Local
Duration	Short-term	Short-term
Intensity	Low	Low
Probability	Highly Probable	Highly Probable
Confidence	High	High
Significance	**Very Low**	**VERY LOW**
Cumulative impact	None	None
Nature of Cumulative impact	The nominal quantity of galley waste that would enter the sea would not result in a cumulative impact.	
Degree to which impact can be reversed	Fully reversible – galley waste would be quickly dispersed and diluted by the high wind and wave energy of the offshore sea environment.	
Degree to which impact may cause irreplaceable loss of resources	N/A	
Degree to which impact can be mitigated	Very Low	

5.1.1.5 Solid waste

Description of impact

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

Assessment

Solid waste would be transported onshore for disposal on land, and consequently would have no impact on the marine environment. Recycling would occur onboard and the solid waste would be sorted in separate containers before being taken to an appropriate onshore recycling facility. Specialist waste disposal contractors would dispose of hazardous waste. The potential impact of the disposal of solid waste on the marine environment is therefore **INSIGNIFICANT** (see Table 5.5).

Mitigation

No solid waste may be disposed to the marine environment and consequently no mitigation measures are required.

Table 5.5: Impact of solid waste disposal from vessels.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	Local	Local
Duration	Short-term	Short-term
Intensity	Zero	Zero
Probability	Probable	Probable
Confidence	Medium	Medium
Significance	**Insignificant**	**INSIGNIFICANT**
Cumulative impact	None	None
Nature of Cumulative impact	N/A	
Degree to which impact can be reversed	N/A	
Degree to which impact may cause irreplaceable loss of resources	N/A	
Degree to which impact can be mitigated	Very Low	

5.2 IMPACT ON MARINE FAUNA

5.2.1 SEDIMENT REMOVAL

Description of impact

During sampling activities sediment cores would be removed from the seabed. Benthic fauna typically inhabit the top 20 to 30 cm of sediment. Therefore, the cores would eliminate any benthic infaunal and epifaunal biota in the core footprints, resulting in a loss of some benthic biodiversity.

Assessment

The proposed Initial Deposit Assessment Phase would result in the removal of up to 300 core samples. This would equate to a total loss of sediment of 53 m³ from the seabed. During the proposed Resource Delineation Programme up to 4 500 core samples may be taken, which would equate to a total loss of sediment of 799 m³. Therefore the total volume of sediment to be removed from the seabed would be a maximum of 852 m³ and would cover approximately 85 m² from the total sea area under consideration of 27 600 km². Any change in sediment composition is expected to be minimal and will not affect recovery.

Impacts on the offshore benthos as a result of sediment removal are considered to be of low intensity at a local scale (i.e. sampling locations). Full recovery is expected to take place within 1 to 5 years (i.e. short term), as the excavations would be refilled through sediment influx and recolonisation would occur through recruitment and immigration from adjacent areas. Therefore, this impact is assessed to be of **VERY LOW** significance (see Table 5.6).

Mitigation

No mitigation measures are possible.

Table 5.6: Impact of sediment removal on offshore benthic communities.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	Local	Local
Duration	Short-term	Short-term
Intensity	Low to High	Low
Probability	Definite	Definite
Confidence	High	High
Significance	**Very Low**	**VERY LOW**
Cumulative impact	None	None
Nature of Cumulative impact	The small area impacted by sediment removal during sampling activities would not result in a cumulative impact.	
Degree to which impact can be reversed	Irreversible – the removal of sediments and associated macrofaunal communities would be irreversible. However, the recovery of excavations through sediment influx and recolonisation will occur over the short term through recruitment and immigration from adjacent areas.	
Degree to which impact may cause irreplaceable loss of resources	Negligible considering the total surface area of seabed affected.	
Degree to which impact can be mitigated	No possible mitigation identified.	

5.2.2 PHYSICAL CRUSHING OF BENTHIC BIOTA

Description of impact

During sampling activities a 6 x 6 m hollow frame would be placed on the seabed to hold the sampling tool in place. The frame's footprint would smother or crush epifauna and infauna, resulting in a reduction in benthic biodiversity. Crushing is likely to primarily affect soft-bodied species. Some molluscs and crustaceans may be robust enough to survive being temporarily smothered by the frame.

The Assessment

Sampling activities would only take approximately 1.5 hours to complete at each site, thus the duration of the impact is very short. It is expected that recolonisation would occur over the short term from adjacent undisturbed sediments. Although some sampling activities would occur within potential benthic protection priority areas (one area has been identified to the north-west of Hondeklipbaai), a very small surface area would be impacted at any one sampling site. Thus due to the very low impact intensity at each sample site, the proposed activities are likely to have only a very small impact on benthic biota and any proposed protected area.

The physical crushing of benthic biota would be highly localised, short term and of local intensity. The significance of this impact is considered to be **VERY LOW** with and without mitigation (see Table 5.7).

Mitigation

The desktop study, previous geophysical surveys and the detailed geophysical survey should identify areas that are not suitable for sampling sites. However, in the majority of the prospecting area the quality of the data is insufficient to determine specific local surface characteristics. Ecological data to motivate for the exclusion of sites does not exist in sufficient detail.

Table 5.7: Impact of crushing on benthic biota.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	Local	Local
Duration	Short-term (1.5 hours per site)	Short-term
Intensity	Low	Low
Probability	Highly Probable	Highly Probable
Confidence	High	High
Significance	**Very Low**	**VERY LOW**
Cumulative impact	None	None
Nature of Cumulative impact	The total area impacted by the sampling frame on the seabed would not result in any cumulative effects.	
Degree to which impact can be reversed	Irreversible – the loss of epifauna and infauna as a result of crushing would be irreversible. However, the recovery would occur over the short term through recruitment and immigration from adjacent areas.	
Degree to which impact may cause irreplaceable loss of resources	Negligible considering the total surface area of seabed affected.	
Degree to which impact can be mitigated	Very Low	

5.2.3 NOISE ASSOCIATED WITH SAMPLING ACTIVITIES

Description of impact

During sampling activities, noise and vibrations from the SVC, as well as noise from the vessel, may have an impact on macrobenthic communities, fishes and marine mammals in the area.

Assessment

Noise measurements have been taken for the SVC and at a distance of 25 m from the tool the noise was measured at 160 to 180 dB re 1µPa. At a distance of 110 m from the tool the noise is typically 155 dB re 1µPa and 164 dB re 1µPa. The 1/3 octave analysis showed there was a 1/3 octave tone at 100 Hz and 125 Hz with harmonics at 200 Hz and 250 Hz (Hegley, 2010). Sound levels radiating from typical vessels range from 160 to 220 dB re1µPa at 1 m. Harmful / damaging levels of noise occur at levels greater than 220 dB.

Noise and vibrations generated during coring would, therefore, not be harmful or reach lethal amplitudes, even at the source. The noise generated would only be for a very brief period and would be within the noise range of an average size shipping vessel.

Any mobile marine fauna particularly sensitive to noise (e.g. dolphins, penguins and finfish species) would be expected to avoid the area once sampling commences. It is, therefore, likely that no direct impacts to these biota would occur during the sampling activities. There may be some temporary disturbance of benthic invertebrates in response to the vibrations, but this is likely to be at sublethal levels. The maximum radius over which the noise may influence is very small compared to the population distribution ranges of the potentially sensitive species. The potential noise generated by the vessel would be similar to that of any other vessel at sea. However, according to Pulfrich (2011) the proposed sampling activities would occur in shallower water than other transport vessels, which would restrict the propagation of low frequencies to within a few kilometres, thereby reducing the area over which the noise is heard.

The noise from sampling activities would be highly localised, of short term and of low intensity. The significance of impact is thus considered to be **VERY LOW** with or without mitigation (see Table 5.8).

Mitigation

No mitigation measures are considered necessary.

Table 5.8: Impact of noise associated with sampling activities.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	Local	Local
Duration	Short-term (1.5 hours per site)	Short-term
Intensity	Low	Low
Probability	Improbable	Improbable
Confidence	High	High
Significance	**Very Low**	**VERY LOW**
Cumulative impact	None	None
Nature of Cumulative impact	Due to the short duration of the noise emitted per site, any form of cumulative impact is highly unlikely.	
Degree to which impact can be reversed	Fully reversible – any disturbance of behaviour, auditory "masking" or reductions in hearing sensitivity that may occur as a result of ship noise or vibrations from the SVC would be temporary due to low sound levels at the source.	
Degree to which impact may cause irreplaceable loss of resources	Negligible	
Degree to which impact can be mitigated	No possible mitigation identified.	

5.2.4 NOISE ASSOCIATED WITH GEOPHYSICAL SURVEYING

Description of impact

The source levels produced by the geophysical survey acoustic equipment could affect marine mammal species in the surrounding area.

Assessment

The proposed equipment to be used (refer to Chapter 3) would probably be insufficient to result in auditory or non-auditory trauma to marine mammals in the region (Findlay, 2005). Sound levels from the acoustic equipment would range from 190 to 220 dB re 1 µPa at 1m. However, at source certain of the tools do produce sounds in the 220 dB range where exposure could result in trauma. Mobile species within the area would be able to flee and move away from the noise.

The noise from geophysical surveying would be localised, short term and of medium to high intensity. The significance of impact is thus assessed to be **low** without mitigation and **VERY LOW** with mitigation (see Table 5.9).

Mitigation

- Carry out visual scans around the survey vessel prior to the initiation of any acoustic impulses;
- Pre-survey scans should be limited to 15 minutes prior to the start of survey equipment;
- Terminate the survey if any marine mammals show affected behaviour within 500 m of the survey vessel or equipment until the mammal has vacated the area;
- "Soft starts" should be carried out for any equipment of source levels greater than 210 dB re 1 µPa at 1 m over a period of 20 minutes;
- The geophysical surveying should largely be undertaken between December and May, however, during the transition periods in June and November, surveying would be possible with stricter mitigation measures;
- Ensure that PAM (passive acoustic monitoring) is incorporated into any surveying taking place in June and / or November;

- Geophysical surveying should not be undertaken in the southern concession areas between October and January, when there is a likelihood of Southern Right whales being in the area; and
- A Marine Mammal Observer would be appointed to ensure compliance with mitigation measures during seismic geophysical surveying.

Table 5.9: Impact of noise associated with geophysical surveying.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	Local	Local
Duration	Short-term	Short-term
Intensity	Medium to High	Low to Medium
Probability	Probable	Probable
Confidence	Medium	Medium
Significance	**Low**	**VERY LOW**
Cumulative impact	None	None
Nature of Cumulative impact	No cumulative impacts are anticipated. Any impact is likely to be at individual level rather than species level.	
Degree to which impact can be reversed	Fully reversible – any disturbance of behaviour, auditory "masking" or reductions in animal hearing sensitivity that may occur as a result of survey noise below 220 dB would be temporary.	
Degree to which impact may cause irreplaceable loss of resources	Negligible	
Degree to which impact can be mitigated	Low	

5.3 IMPACT ON OTHER USERS OF THE SEA

5.3.1 POTENTIAL IMPACT ON FISHING INDUSTRY

Description of impact

Sampling activities and geophysical surveying could impact on some sectors within the fishing industry as a result of the stationary vessel at each sampling site and the presence of a survey vessel and equipment.

Assessment

Pelagic purse-seine

The prospecting area overlaps with the pelagic fishery. The concentration of pelagic purse-seine effort is the greatest inshore of the 100 m isobath, with effort increasing significantly towards the shallower portions of the study area. Activities in the southern portion of the prospecting area would impact on pelagic purse-seine fishing.

Demersal longline

On the West Coast, demersal long-liners may be found working between the 200 and 750 m bathycontours. Although the predominant areas of operation lie well to the west of the study area, isolated fishing events have been recorded in the prospecting area.

Pelagic long-lining (large pelagic species)

Majority of these fishing activities are located at some distance to the west of the prospecting area. However, occasional fishing events have been recorded closer inshore in the vicinity of the study area.

Tuna Pole (large pelagic species)
There is little commercial information available for the tuna pole fishery. However, this industry predominantly fishes off the 200 m to 500 m bathycontours, but some fishing does occur off the 100 m bathycontour. Fishing activities tend to be located in the vicinity of the offshore trawling grounds.

The potential impact of the proposed prospecting activities on pelagic purse-seine and demersal longline would be localised, short term and of high intensity. The significance of impact is thus considered to be **LOW** with and without mitigation (see Table 5.10).

The potential impact of the proposed prospecting activities on pelagic long-lining and tuna pole would be localised, short term and of low intensity. The significance of impact is thus considered to be **VERY LOW** with and without mitigation (see Table 5.10).

Mitigation

- Communication channels should be set up with the fishing industry, the Department of Agriculture, Forestry and Fisheries: Marine Resource Management (DAFF: MRM) and all other interested and affected parties. This would involve pre-sampling and geophysical survey notifications and regular updates on the sampling progress via email. Fishing industry associations should include: Association of Small Hake Industries, South African Deep Sea Trawling Industry Association, South African Pelagic Fishing Industry Association, South African Commercial Linefish Association, South African Tuna Association, Fresh Tuna Exporters Association, South African West Coast Rock Lobster Association, Shark Long-line Association. Interested and affected parties should include: South African Navy (SAN) Hydrographic office, the various concession holders and any other relevant users of the sea.

Table 5.10: Assessment of the potential impact of sampling and geophysical surveying on commercial fishing activities off the west coast.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Purse-seine and demersal longline		
Extent	Local	Local
Duration	Short-term	Short-term
Intensity	High	High
Probability	Probable	Probable
Confidence	High	High
Significance	**Low**	**LOW**
Cumulative impact	None	None
Pelagic long-lining and tuna pole		
Extent	Local	Local
Duration	Short-term	Short-term
Intensity	Low	Low
Probability	Probable	Probable
Confidence	High	High
Significance	**Very Low**	**VERY LOW**
Cumulative impact	None	None
Nature of Cumulative impact	No cumulative impacts are anticipated.	
Degree to which impact can be reversed	Fully reversible	
Degree to which impact may cause irreplaceable loss of resources	N/A	
Degree to which impact can be mitigated	Very Low	

5.3.2 POTENTIAL IMPACT ON MARINE PROSPECTING / MINING

Description of impact

The proposed sampling and geophysical surveying could potentially exclude users undertaking marine diamond prospecting and mining activities in their relevant concession areas. Refer to Chapter 4, Table 4.9 for a list of the relevant concession holders.

Assessment

Diamond mining

The following companies hold concession rights off the west coast within the study area, namely: De Beers in sea areas 2c, 3c, 4c, 5c and Transhex in sea areas 6c, 11c, 13c and 14c. The proposed prospecting activities could potentially temporarily affect and disrupt activities in these sea areas.

No activities are currently taking place in the 'd' concession areas, located to the west of the study area. Concession areas 'a' and 'b' are located inshore of the study area and would not be affected by the proposed prospecting activities.

The impact of sampling activities and geophysical surveying on diamond mining activities would be localised, in the short term and of low intensity. The significance of impact is consequently **VERY LOW** with or without mitigation (see Table 5.11).

Other mining

Potential mining operations include minerals such as manganese nodules, agricultural minerals such as glauconite and phosphorite, and heavy minerals such as ilmenite and rutile. Manganese nodules enriched with valuable metals occur in water depths of over 3 000 m on the west, south and east coasts of South Africa and would, therefore, not be affected by the sampling activities. Prospecting permits for glauconite and phosphorite have been applied for in three areas between Cape Town and Saldanha. These areas are located further offshore than the proposed prospecting area and would thus not be affected. There is presently no extraction of heavy metals from sand mining within the marine environment in South Africa.

The impact of sampling activities and geophysical surveying on other mining activities would be localised, in the short term and of low intensity. The significance of impact is consequently **VERY LOW** with or without mitigation (see Table 5.11).

Mitigation

Any companies undertaking marine prospecting or diamond mining activities within the study area should be contacted prior to sampling and geophysical surveying in order to notify them of the planned activities.

Table 5.11: Assessment of impacts on marine mining / prospecting.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	Local	Local
Duration	Short-term	Short-term
Intensity	Low	Low
Probability	Improbable to Probable	Improbable
Confidence	High	High
Significance	**Very Low**	**VERY LOW**
Cumulative impact	None	None
Nature of Cumulative impact	Mining activities could possibly be delayed, as a result of the sampling activities and the geophysical survey, however, this would be in the short term. The vessel would also only be stationary for a few hours and may only affect other activities for a short duration. Therefore, no cumulative impacts are likely to result.	

Degree to which impact can be reversed	Fully reversible
Degree to which impact may cause irreplaceable loss of resources	N/A
Degree to which impact can be mitigated	Very Low

5.3.3 POTENTIAL IMPACT ON PETROLEUM EXPLORATION

Description of impact

The sampling activities and geophysical surveying could affect petroleum exploration activities overlapping with the study area, and vice versa.

Assessment

The proposed prospecting area overlaps with a number of petroleum exploration and production blocks, namely Block 1 (PetroSA (Pty) Ltd), Block 2A (Forest Exploration International (South Africa) (Pty) Ltd), 2B (Thombo Petroleum) and Block 3A/4A (BHP Billiton) (refer to Figure 4.25 in Chapter 4). The proposed sampling and geophysical activities could affect and disrupt activities in these blocks if exploration / prospecting activities coincide in the same area at the same time. However, the likelihood of this happening is low.

The impact on petroleum exploration would be localised, short term and of low to medium intensity. The significance of impact is consequently **very low to low**, without mitigation and **VERY LOW** with mitigation (see Table 5.12).

Mitigation

- Notify PetroSA, Forest Exploration International, Thombo Petroleum and BHP Billiton and its contractors, as well as any other operators, prior to the commencement of activities; and
- AuruMar should liaise with all petroleum exploration operators to ensure that there is no overlapping of activities in the same area over the same time period.

Table 5.12: Impact on petroleum exploration activities.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	Local	Local
Duration	Short-term	Short-term
Intensity	Low to Medium	Low
Probability	Probable	Probable
Confidence	High	High
Significance	**Very Low to Low**	**VERY LOW**
Cumulative impact	None	None
Nature of Cumulative impact	No cumulative impacts are expected.	
Degree to which impact can be reversed	Fully reversible	
Degree to which impact may cause irreplaceable loss of resources	N/A	
Degree to which impact can be mitigated	Low	

5.3.4 POTENTIAL IMPACT ON MARINE TRANSPORT ROUTES

Description of impact

The presence of the sampling and geophysical survey vessels could interfere with shipping in the area.

Assessment

The majority of shipping traffic is located on the outer edge of the continental shelf, which is located to the west of the proposed prospecting area. The inshore traffic of the continental shelf along the West Coast is largely comprised of fishing and mining vessels, especially between Kleinzee and Oranjemund (see Figure 4.23 in Chapter 4).

It is, therefore, unlikely that shipping transport routes would be affected by the proposed prospecting activities. The impact on shipping traffic is considered to be localised, of low intensity in the short-term. The significance of this impact is therefore assessed to be **VERY LOW** with and without mitigation (Table 5.13).

Mitigation

- Prior to the commencement of activities, AuruMar must notify relevant bodies including: PASA, South African Maritime Safety Authority (SAMSA), the South African Navy (SAN) Hydrographic Office, relevant Port Captains and DAFF: MRM. These bodies must be notified of the navigational co-ordinates of any location prior to commencement of such activities;
- The vessels must be certified for seaworthiness through an appropriate internationally recognised marine certification programme (e.g. Lloyds Register, Det Norske Veritas). The certification, as well as existing safety standards, requires that safety precautions would be taken to minimise the possibility of an offshore accident. Collision prevention equipment should include radar, multi-frequency radio, foghorns, etc. The law also requires equipment and training to ensure the safety and survival of the crew in the event of an accident; and
- A Notice to Mariners should provide: the co-ordinates of the sampling area and an indication of sampling and geophysical survey timeframes.

Table 5.13: Assessment of interference with marine transport routes.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	Local	Local
Duration	Short-term	Short-term
Intensity	Low	Low
Probability	Improbable	Improbable
Confidence	High	High
Significance	**Very Low**	**VERY LOW**
Cumulative impact	None	None
Nature of Cumulative impact	No cumulative impacts are expected.	
Degree to which impact can be reversed	Fully reversible	
Degree to which impact may cause irreplaceable loss of resources	N/A	
Degree to which impact can be mitigated	Very Low	

5.4 IMPACT ON CULTURAL HERITAGE MATERIAL

Description of impact
Sampling activities could disturb cultural heritage material on the seabed, particularly historical shipwrecks.

Assessment
The likelihood of disturbing a shipwreck is expected to be very small considering the vast size of the South African offshore area. A desktop study by JJ Boshoff (2009) was undertaken for concession areas 12c, 14c, 15c, 17c, 18c and 20c (as well as 7c to 10c as part of a previous study, J Visser, 2006) and concluded that there was a low possibility of finding historical shipwrecks in the area (see Appendix 9). However, the report did not rule out the possibility of unknown wrecks in the area. Majority of the shipwrecks are located along the coastline in shallow waters and it is less likely that historical wrecks would be found in deeper water. The desktop study and previous geophysical surveys would also identify subsea structures.

The impact on cultural heritage material would be at the national level, in the short term and of medium intensity. The significance of impact is consequently **medium**, without mitigation and **VERY LOW** with mitigation (see Table 5.14).

Mitigation
- The sampling sites should avoid any cultural heritage material identified during the desktop study and previous geophysical surveys for the area; and
- If any cultural heritage material is found during sampling activities the South African Heritage Resources Agency (SAHRA) should be notified immediately. If any material older than sixty years is to be disturbed a permit would be required from SAHRA.

Table 5.14: The assessment of the potential impact of sampling activities on heritage material.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	National	National
Duration	Short-term	Short-term
Intensity	Medium	Low
Probability	Improbable	Improbable
Confidence	High	High
Significance	**Medium**	**VERY LOW**
Cumulative impact	None	None
Nature of Cumulative impact	No cumulative impacts are expected.	
Degree to which impact can be reversed	Irreversible	
Degree to which impact may cause irreplaceable loss of resources	Low	
Degree to which impact can be mitigated	Medium	

5.5 NO-GO ALTERNATIVE

Description of impact
The implications of not going ahead with the proposed prospecting activities are as follows:
- Loss of opportunity to establish whether or not a viable offshore heavy mineral resource exists off the west coast of South Africa; and
- Lost economic opportunities related to costs already incurred in the initial prospecting phase.

Assessment

The potential impact related to the lost opportunity to further explore for heavy mineral resources on the west coast and maximise the use of South Africa's own resources should they exist is considered to be of **LOW to MEDIUM** significance (see Table 5.15).

Table 5.15: Assessment of impact related to No-Go alternative.

CRITERIA	WITHOUT MITIGATION
Extent	Regional
Duration	Permanent
Intensity	Low
Probability	Improbable
Confidence	Low
Significance	**LOW TO MEDIUM**
Cumulative impact	Yes
Nature of Cumulative impact	Potential loss of opportunity to expand South Africa's own heavy mineral resources.
Degree to which impact can be reversed	Reversible
Degree to which impact may cause irreplaceable loss of resources	N/A
Degree to which impact can be mitigated	N/A

6. CONCLUSIONS AND RECOMMENDATIONS

AuruMar, as operator, is proposing to undertake prospecting activities over a 27 600 km^2 area within sea areas: 1c, 2c, 3c, 4c, 5c, 6c, 7c, 8c, 9c, 10c, 12c, 14c, 15c, 16c, 17c, 18c and 20c, off the west coast of South Africa. The proposed prospecting activities include the sourcing of heavy minerals, platinum group metals, gold and sapphire (gemstones).

CCA was appointed to act as the independent environmental consultant to undertake the necessary Basic Assessment and associated public consultation process for the proposed project. The Basic Assessment process was undertaken so as to comply with the requirements of the EIA Regulations 2010 promulgated in terms Sections 24(5), 24M and 44 of NEMA (No. 107 of 1998).

Specialist input was provided on the likely impact on the benthic environment and fisheries by the proposed prospecting activities. The findings of the specialist input and other relevant information have been integrated and synthesised into this Final BAR. The two main objectives of this Final BAR are, firstly, to assess the environmental significance of impacts resulting from the proposed prospecting activities and to suggest ways of mitigating negative impacts and enhancing benefits, and secondly to provide I&APs with an opportunity to comment on the proposed project.

This chapter summarises the key findings of the study and presents the recommendations in terms of mitigation measures that should be implemented if the proposed prospecting activities are authorised.

6.1 CONCLUSIONS

A summary of the assessment of potential environmental impacts associated with the proposed prospecting activities and No-Go Alternative is provided in Table 6.1.

All of the impacts associated with the prospecting activities would occur in the immediate vicinity of the vessel, would be of short term duration and of low to high intensity, and are considered to be of **VERY LOW** to **LOW** significance after mitigation.

The implications of not going ahead with the proposed prospecting activities relate to the lost opportunity to establish whether or not a viable offshore heavy mineral resource exists off the West Coast and the lost economic opportunities related to costs already incurred in the initial prospecting phase. This potential impact of the No-Go Alternative is considered to be of **LOW** to **MEDIUM** significance.

Table 6.1: Summary of the significance of the potential impacts associated with the proposed prospecting activities and No-Go Alternative.

Potential impact	Significance	
	Without mitigation	With mitigation
Vessel operations:		
Deck drainage into the sea	VL	**VL**
Machinery space drainage into the sea	VL	**VL**
Sewage effluent into the sea	VL	**VL**
Galley waste disposal into the sea	VL	**VL**
Solid waste disposal into the sea	N/A	**N/A**
Impact on marine fauna:		
Sediment removal	VL	**VL**

Potential impact		Significance	
		Without mitigation	With mitigation
Physical crushing of benthic biota		VL	**VL**
Noise associated with sampling activities		VL	**VL**
Noise associated with geophysical surveying		L	**VL**
Impact on other users of the sea:			
Fishing industry	Pelagic purse-seine	L	**L**
	Demersal long-line	L	**L**
	Tuna pole	VL	**VL**
	Pelagic long-line	VL	**VL**
Marine mining and prospecting	Diamond mining	VL	**VL**
	Other mining	VL	**VL**
Petroleum exploration		VL-L	**VL**
Marine transport routes		VL	**VL**
Impact on cultural heritage material:			
Impact on historical shipwrecks		M	**VL**
No-Go Alternative:			
Lost opportunity to establish whether or not a viable offshore heavy mineral resource exists off the West Coast and the lost economic opportunities related to costs already incurred in the initial prospecting phase.		L-M	**-**

VH=Very High	H=High	M=Medium	L=Low	VL=Very low	Insig = insignificant	N/A= Not applicable

6.2 RECOMMENDATIONS

6.2.1 COMPLIANCE WITH ENVIRONMENTAL MANAGEMENT PROGRAMME AND MARPOL 73/78 STANDARDS

- All phases of the proposed project must comply with the Environmental Management Programme presented in Chapter 7. In addition, vessels must ensure compliance with MARPOL 73/78 standards.

6.2.2 NOTIFICATION AND COMMUNICATION WITH KEY STAKEHOLDERS

- Notify PetroSA, Forest Exploration International, Thombo Petroleum, BHP Billiton and Transhex and its contractors, as well as any other operators, prior to the commencement of activities;
- AuruMar should liaise with all petroleum exploration operators to ensure that there is no overlapping of activities in the same area over the same time period;
- Prior to the commencement of activities, AuruMar must notify relevant bodies including: DMR, South African Maritime Safety Authority (SAMSA), the South African Navy (SAN) Hydrographic Office, relevant Port Captains and DAFF: MRM. These bodies must be notified of the navigational co-ordinates of any location prior to commencement of such activities;
- Communication channels should be set up with I&APs. This would involve pre-sampling and survey notifications via email (see bullet below). Key stakeholders should include:
  - > Fishing industry (Association of Small Hake Industries, South African Deep Sea Trawling Industry Association, South African Pelagic Fishing Industry Association, South African Commercial Linefish Association, South African Tuna Association, Fresh Tuna Exporters Association, South African West Coast Rock Lobster Association, and Shark Long-line Association);

> Marine mining / prospecting industry (Transhex); and
> Authorities (SAN Hydrographic office, DAFF: MRM, DMR, SAMSA and relevant Port Captains).

- Appropriate notices should be distributed timeously to mariners providing the following:
  1. the co-ordinates of the sampling and survey activities;
  2. an indication of the sampling and survey timeframes; and
  3. reports on the location of prospecting vessels.

6.2.3 DISCHARGES AND EMISSIONS

- Provide training and awareness to crew members of the need for thorough cleaning up of any spillages immediately after they occur in order to minimise the volume of contaminants washing off decks;
- Use low toxicity, biodegradable detergents and reusable absorbent cloths during deck cleaning to further minimise the potential impact of deck drainage on the marine environment;
- Machinery spaces must drain into bilge tanks in compliance with MARPOL Annex I;
- Save-alls must be utilised around specific equipment, bunkering points and vents on open deck areas to prevent release of contaminated water overboard;
- Undertake adequate maintenance of all hydraulic systems;
- Minimise the discharge of waste material should obvious attraction of marine fauna be observed; and
- Contractors would be required to comply with the MARPOL 73/78 Annex IV requirements, wherever possible.

6.2.4 VESSEL SEAWORTHINESS AND SAFETY

- The vessels must be certified for seaworthiness through an appropriate internationally recognised marine certification programme (e.g. Lloyds Register, Det Norske Veritas); and
- Vessels should be equipped with collision prevention equipment including radar, multi-frequency radio, foghorns, etc. The law also requires equipment and training to ensure the safety and survival of the crew in the event of an accident.

6.2.5 GEOPHYSICAL SURVEYING

- Carry out visual scans around the survey vessel prior to the initiation of any acoustic impulses;
- Pre-survey scans should be limited to 15 minutes prior to the start of survey equipment;
- Terminate the survey if any marine mammals show affected behaviour within 500 m of the survey vessel or equipment until the mammal has vacated the area;
- “Soft starts” should be carried out for any equipment of source levels greater than 210 dB re 1 µPa at 1 m over a period of 20 minutes;
- The geophysical surveying should largely be undertaken between December and May, however, during the transition periods in June and November, surveying would be possible with stricter mitigation measures;
- Ensure that PAM (passive acoustic monitoring) is incorporated into any surveying taking place in June and / or November;
- Geophysical surveying should not be undertaken in the southern concession areas between October and January, when there is a likelihood of Southern Right whales being in the area; and
- A Marine Mammal Observer would be appointed to ensure compliance with mitigation measures during seismic geophysical surveying.

CCA Environmental (Pty) Ltd
7 June 2011

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7. ENVIRONMENTAL MANAGEMENT PROGRAMME FOR SAMPLING AND GEOPHYSICAL SURVEYING

The EMP compiled for prospecting activities is set out in Table 7.1. Specific issues are addressed under each of the following sections:

7.1 EMP Monitoring and Performance Assessment
- 7.1.1 EMP compliance
- 7.1.2 EMP amendments
- 7.1.3 Financial provision
- 7.1.4 Closure

7.2 Natural Environmental Factors
- 7.2.1 Seismic surveying
- 7.2.2 Sampling
- 7.2.3 Air emissions
- 7.2.4 Pollution control and waste management
- 7.2.5 Dealing with emergencies / marine pollution

7.3 Socioeconomic factors
- 7.3.1 Communication with interested and affected parties
- 7.3.2 Presence of vessel / impact of prospecting activities on other industries
- 7.3.3 Heritage sites
- 7.3.4 Incidental loss of equipment
- 7.3.5 Location of oil and gas exploration wellheads
- 7.3.6 Inform relevant parties of survey completion

The fundamental elements of this management programme are to be implemented at all times, as and when appropriate.

Table 7.1: Environmental Management Programme for proposed prospecting activities in various concession areas off the west coast of South Africa.

7.1 EMP MONITORING AND PERFORMANCE ASSESSMENT			
Item No.	**Action Plans & Control Measures**	**Responsibilities**	**Timing**
7.1.1 EMP Compliance	➢ Ensure that a copy of the EMP is onboard operational vessels. ➢ Conduct monitoring of EMP compliance ➢ Compile and submit EMP Performance Assessment Reports to the Department of Mineral Resources (DMR). ➢ Ensure compliance with the International Maritime Organisation's International Safety Management (ISM) Code developed for the proper development, implementation and assessment of safety and pollution prevention management in accordance with good practice.	Venture Manager, AuruMar	Continuous
7.1.2 EMP Amendments	➢ On an ongoing basis, identify and address new activities and remove obsolete ones, particularly when new or changed mining methods and/or equipment are used. If required, amend the EMP and submit to DMR for approval.	Venture Manager, AuruMar	When there is a change in scope
7.1.3 Financial Provision	➢ Ensure that the requirements of the MPRDA in terms of financial provision for remediation of environmental damage are met by: – Allocating operational costs to meet EMP requirements; – Maintaining adequate Protection and Indemnity (P&I) Insurance Cover to allow for cleanups in the event of oil spills and other eventualities; and – Providing sufficient funds to execute the environmental management plan in the event of premature closure or in then event that on closure the environmental management plan has not been successfully executed.	Venture Manager, AuruMar	Ongoing
7.1.4 Closure	➢ When applying for closure, submit the following documentation to the DMR: – A final layout plan; – A Closure Plan as contemplated in Regulation 62 of the MPRDA; – An Environmental Risk Report as contemplated in Regulation 60 of the MPRDA; – A Final Performance Assessment Report as contemplated in Regulation 55(9) of the MPRDA; and – A completed application form to transfer environmental responsibilities and liabilities, if such transfer has been applied for. ➢ Submit Performance Assessment Report to the Department of Environmental Affairs.	De Beers Consolidated Mines	Prior to closure application

7.2 NATURAL ENVIRONMENTAL FACTORS			
Item No.	**Action Plans & Control Measures**	**Responsibilities**	**Timing**
7.2.1 Seismic surveying	➢ Maintain sightings programme (including marine mammals, turtles, etc.) from operational vessels. ➢ Ensure that Geophysical survey activities are conducted in compliance with the following: – Carry out visual scans around the survey vessel prior to the initiation of any acoustic impulses. – Pre-survey scans should be limited to 15 minutes prior to the start of survey equipment. – Terminate the survey if any marine mammals show affected behaviour within 500 m of the survey vessel or equipment until the mammal has vacated the area. – "Soft starts" should be carried out for any equipment of source levels greater than 210 dB re 1 µPa at 1 m over a period of 20 minutes. – The geophysical surveying should largely be undertaken between December and May, however, during the transition periods in June and November, surveying would be possible with stricter mitigation measures. – Ensure that PAM (passive acoustic monitoring) is incorporated into any surveying taking place in June and / or November. – Geophysical surveying should not be undertaken in the southern concession areas between October and January, when there is a likelihood of Southern Right whales being in the area. – A Marine Mammal Observer would be appointed to ensure compliance with mitigation measures during seismic geophysical surveying.	Venture Manager, AuruMar	Ongoing
7.2.2 Sampling	➢ Avoid placing the support frame, where possible, on any identified shipwrecks and sensitive habitats, such as rocky outcrops, cold-water coral reefs and any other structural habitat feature. ➢ Calculate and report on annual and cumulative sampled area. ➢ Where possible make available data of a non-confidential nature to relevant agencies / regional or national programmes involved in biodiversity conservation / evaluation and management of marine ecosystems.	Venture Manager, AuruMar	Ongoing
7.2.3 Air emissions	➢ Ensure that contracted vessels comply with the MARPOL requirements with regards to exhaust emissions.	Venture Manager, AuruMar	Ongoing

7.2.4 Pollution control and waste management (of products disposed of: into the air (exhausts, CFCs and incinerators), to sea (sewage, food, oils), to land (used oils, etc, metals, plastics, glass, etc.)	➢ Ensure that contracted vessels: – Implement all applicable MARPOL standards for disposal of general waste, hazardous waste, organic waste (food waste and sewage effluent), greywater, sewerage, bilge water, incineration of shipboard waste and the maintenance of waste records. – Minimise the discharge of waste material should obvious attraction of fauna be observed. – Record types and volumes of chemical and hazardous substances brought on board during the prospecting programme (e.g. neon lights, fluorescent tubes, toner cartridges, batteries etc.) and destination of wastes. – Dispose of wastes generated during AuruMar operation through an acceptable recycling company or at a licensed landfill site. ➢ Ensure applicable crew is trained in spill management.	Venture Manager, AuruMar	Ongoing
7.2.5 Dealing with emergencies / marine pollution (owing to collision, vessel break-up, refuelling etc.)	➢ Ensure that contracted vessels: – Maintain all emergency procedures as legally required. – Adhere to obligations regarding other vessels in distress. – Where diesel, which evaporates relatively quickly, has been spilled, the water should be agitated or mixed using a propeller boat/dinghy to aid dispersal and evaporation. ➢ In the event of an emergency including fire, grounding or sinking, or collision, ensure that the approved Shipboard Oil Pollution Emergency Plan and Emergency Response Manuals are followed, which include: – Ensuring safety of personnel onboard; – Stabilising the ship and limit damages; – Containing the spill, if possible; and – Immediately reporting accidental spills to the relevant Authorities and Professional Bodies providing full details of the incident.	Venture Manager, AuruMar	Ongoing
	➢ In the event of an oil spill immediately implement emergency plans and notify (a) the Principal Officer of the nearest SAMSA office, (b) the DEA's Chief Directorate of Marine Pollution in Cape Town and (c) PASA. Information that should be supplied when reporting a spill includes: – The type and circumstances of incident, ship type, port of registry, nearest agent representing the ships company; – Geographic location of the incident, distance off-shore and extent of oil spill; – Prevailing weather conditions, sea state in affected area (wind direction and speed, weather and swell); and – Persons and authorities already informed of the spill. – Where feasible, provide facilities to rescue, stabilise, and fly oiled seabirds to SANCCOB for further rehabilitation.	Venture Manager, AuruMar	Per event
	➢ Notification to Transhex Operations of the occurrence of any Moderate or Major overboard spills during prospecting activities.	Venture Manager, AuruMar	Per event

7.3. SOCIOECONOMIC FACTORS			
Task No.	**Action Plans & Control Measures**	**Responsibilities**	**Timing**
7.3.1 Communication with Interested and Affected Parties	➢ Through normal maritime communication channels, Radio Navigation Warnings, Notices to Mariners and other notifications keep the following interested and affected parties updated on the prospecting activities: – Overlapping and neighbouring users with delineated boundaries in the oil & gas exploration & production industries and any prospecting and mining industries; – SAN Hydrographic Office (Silvermine); – Fishing industry (including Association of Small Hake Industries, SA Deep Sea Trawling Industry Association, SA Pelagic Fishing Industry Association, SA Commercial Linefish Association, SA Tuna Association, Fresh Tuna Exporters Association, SA West Coast Rock Lobster Association and Shark Long-line Association); – Government departments with jurisdiction over marine activities, particularly DEA, DAFF: MRM, PASA and DMR; and – SAMSA and local Port Captains.	Venture Manager, AuruMar	14 days prior to operations
7.3.2 Presence of vessel / impact of prospecting activities on other industries	➢ Liaise with BHP Billiton, Transhex, PetroSA, Forest Exploration International (South Africa) and Thombo Petroleum regarding prospecting plans, including information regarding location of operations, specific starting and finishing dates, as well as progress of operation.	Venture Manager, AuruMar	During Work Plan Preparation & Quarterly thereafter
	➢ Inform the West Coast Rock Lobster Sea Management Association if any activities are activated within the 100m contour line.	Venture Manager, AuruMar	Per event
	➢ Ensure that Vessel masters of contracted vessels record sightings of and interactions with other vessels to note potential conflicts over rights of passage and access to resources.	Venture Manager, AuruMar	Per event

7.3.3 Heritage sites	➢ Should any archaeological sites or historical material be identified during survey or sampling operations ensure that: – Position of the site is documented; – The Maritime Archaeologist at the South African Heritage Resources Agency, Cape Town and the Maritime Archaeology Unit of Isiko Museum, Cape Town are notified; and – Sampling in the immediate area to be avoided to prevent damage until feedback from the authorities is received.	Venture Manager, AuruMar	Per event
7.4.4 Incidental loss of equipment – obstacles	➢ Maintain hazards database listing the type of gear left on the seabed and/or in the mine/prospecting area with the dates of loss and locations and where applicable, the dates of retrieval. ➢ If requested, report these data to the relevant authority.	Venture Manager, AuruMar	Per event
7.5.5 Location of oil and gas exploration wellheads	➢ Ensure that location of wellheads is mapped on the prospecting database and that the necessary exclusion zone is applied.	Venture Manager, AuruMar	Prior to survey or sampling operations
7.5.6 Inform relevant parties of survey completion	➢ Inform all key stakeholders (see Section 7.3.1) that the sampling and survey vessels have completed operations as per normal maritime communication practice.	Venture Manager, AuruMar	Within two weeks of completion

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Capricorn Fisheries Monitoring cc was contacted and asked to provide updated fishing maps and to provide input on the fishing industries operating off the west coast of South Africa. 14 April 2011.

APPENDIX 1

DEA's STANDARD BAR TEMPLATE

environmental affairs
Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

	(For official use only)
File Reference Number:	
Application Number:	
Date Received:	

Basic assessment report in terms of the Environmental Impact Assessment Regulations, 2010, promulgated in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended.

SECTION A: ACTIVITY INFORMATION

Has a specialist been consulted to assist with the completion of this section?	YES	**NO ✓**

If YES, please complete the form entitled "Details of specialist and declaration of interest" for appointment of a specialist for each specialist thus appointed:
Any specialist reports must be contained in Appendix D.

1. ACTIVITY DESCRIPTION

Describe the activity, which is being applied for, in detail[1]:

De Beers Consolidated Mines Ltd (De Beers) is the current Prospecting Rights holder for the sea areas: 1c, the inshore portions of 2c, 3c, 4c and 5c, as well as 6c, 7c, 8c, 9c, 10c, 12c, 14c, 15c, 16c, 17c, 18c and 20c. AuruMar (Pty) Ltd (AuruMar), the operator, would undertake the proposed prospecting activities, which includes the indentification of heavy minerals, platinum group metals, gold and sapphire (gemstones).

The prospecting activities would be conducted in a phased approach, with each phase dependant on the results of the previous phase. The two phases planned are as follows and it is proposed that they would run from October 2010 to November 2013:

- Phase I: Initial Deposit Assessment Programme
- Phase II: Resource Delineation Programme

It should be noted that AuruMar has already undertaken a desktop study and developed a geological model and an associated mineralisation model, based on existing information. The desktop study included the review of published geophysical, geotechnical and sampling data as well as the review of data that De Beers has collected from existing and adjacent concession areas. Geophysical surveys and follow up ground-truthing was also undertaken in areas highlighted as potential targets by the desktop studies and where there was insufficient detail to guide further exploration.

AuruMar is currently in the processes of identifying the potential sampling areas for Phase I. However, this information is only likely to be completed towards September 2011.

Phases I and II would utilise the exploration sampling method, detailed below.

[1] Please note that this description should not be a verbatim repetition of the listed activity as contained in the relevant Government Notice, but should be a brief description of activities to be undertaken as per the project description.

EXPLORATION SAMPLING

The proposed prospecting activities would utilise AuruMar's Sonic VibroCorer (SVC) in order to collect the required samples. The system utilises a vibratory head, which has been adapted from land based technology, where the vibration energy is transferred into the drill string and enables the drill-string to penetrate into the seabed down to 10 m with a radius of 75 mm. The system can penetrate through most unconsolidated seabed lithologies, to produce a discrete high integrity core, which can then be analysed in detail. The sampling system is mounted in a frame, which is lowered to the seabed from a purpose built Launch and Recovery System (LARS) on a suitable vessel of opportunity (refer to Section 3.4.3 below).

Noise measurements have been taken for the SVC and at a distance of 25 m from the tool the noise was measured at 160 – 180 dB re 1µPa. At a distance of 110 m from the tool the noise is typically 155 dB re 1µPa and 164dB re 1µPa. The 1/3 octave analysis showed there was a 1/3 octave tone at 100 Hz and 125 Hz with harmonics at 200Hz and 250Hz (Hegley, 2010).

SVC core samples would be logged and stored onboard the vessel and transferred ashore at regular intervals for further analysis. Once the cores are logged they would then be analysed onshore for heavy mineral content. This would entail initial sizing, screening and sub-sampling, followed by an evaluation of a sub-sample at an appropriately accredited onshore laboratory. Results from the sample treatment and the evaluation process would provide inputs into the geological model.

PHASE I – INITIAL DEPOSIT ASSESSMENT PROGRAMME

The aim of Initial Deposit Assessment Programme would be to groundtruth the geological model compiled during the desktop study and to identify the possible presence of mineralisation for further resource delineation (i.e. Phase II).

It is proposed that approximately 300 cores would be collected within identified areas in the prospecting rights areas. Up to 60 target areas would be selected over the 27 600 km² prospecting area based on the results of an ongoing desktop study. Clusters of up to five cores would be collected in each target area with individual core spacing of approximately 70 metres. The 300 core sampling activities would result in a total disturbance area of 53 m³ (see Table 1).

The Initial Deposit Assessment Programme would extend for approximately 80 days.

Table 1: Total disturbance area during Phase I.

Total disturbance for Deposit Assessment Programme			
# cores	**Area (m2)**	**Disturbance area as % of total prospecting right area**	**Volume (m3)**
300	5	1.8×10^{-8}	53
Note: Calculations of area and volume disturbed based on a radius of 75.18 mm for each recovered core. Calculated volume per 10m deep sampling hole is 0.1775 m^3 and area of each sampling hole is 0.0178 m^2			

PHASE II - RESOURCE DELINEATION PROGRAMME

Phase II is split into a detailed geophysical survey as well as further exploration sampling.

Geophysical Survey

A detailed geophysical survey would be undertaken, based on the findings of Phase I. The following geophysical tools are available for prospecting surveys:

- *Swath bathymetry*
  The swath bathymetry system produces a digital terrain model of the seafloor.
- *Shallow (2 to 10 Khz) and medium penetration (0.5 to 2 Khz) "Chirp" seismic systems*:
  Chirp seismic systems generate profiles up to 10 m beneath the seafloor to give a cross section view of the

sediment layers.

- *Medium penetration Sleevegun seismic systems*:
  Sleevegun seismic systems generate medium penetration profiles up to 50 m beneath the seafloor to give a cross section view of the sediment layers.
- *100 Khz side scan sonar*:
  Side scan sonar systems produce acoustic intensity images of the seafloor and are used to map the different sediment textures of the seafloor.
- *Magnetometer:*
  The magnetometer measures local variations in the intensity of the Earth's magnetic field, which are caused by differences in composition of the sediment layers beneath the seafloor and help identify where deposits lie in the seabed.

It is proposed that the Focus towfish could be used to collect side scan sonar as well as Chirp seismic data. Hull mounted swath bathymetry and towed magnetometers would be deployed to gather additional data. In addition, the Autonomous Underwater Vehicle (AUV) could be used to survey in areas where the survey line spacing is less than 50 m apart. The survey tools are deployed off a vessel of opportunity contracted for the period of the survey programme. Table 2 lists the survey tools likely to be used for the geophysical survey.

Table 2: Specifications of acoustic equipment to be utilised in the proposed survey

Type	Frequency	Cycle (impulses per second)	Source level (dB re 1 µPa at 1m)
Chirp sub - bottom profiler	1.5 to 12.5 kHz	4	202
Klein Side Scan Sonar	100 or 500 kHz	10	210
SRD swath Bathymetry	240 kHz	15	190
AVTRAK acoustic positioning	18 to 35 kHz	0.5	190
RDI Doppler system	1200 kHz		214
RESON 8101 Bathymetry system	240 kHz	up to 30	220
10 inch Sleeve gun system	100-800 Hz	1	about 220

Resource Delineation Programme

Once the detailed geophysical surveying has been completed and the results further analysed, it is assumed that these results would yield at least one deposit that would justify further sampling in the Resource Delineation Programme. The proposed method of sampling would be the same as the process undertaken in Phase. Phase II is intended to increase the level of confidence regarding the presence of a mineral resource in the deposit area. This confidence level would ultimately determine whether it is viable to apply for commercial mining rights.

It is assumed that the potential deposit area to be sampled would be approximately 56 km² in extent. It is estimated that up to 4 500 core samples would be required within this deposit area. The core spacings would be between 50 and 200 m apart. The total volume of disturbance would be approximately 799 m³ (see Table 3).

Table 3: Total disturbance area for the Resource Delineation Programme.

Total disturbance for Resource Delineation Programme			
# cores	**Area (m2)**	**Disturbance area as % of total prospecting right area**	**Volume (m3)**
4500	80	$2.9 \times e^{-7}$	799
Note: Calculations of area and volume disturbed based on a radius of 75.18 mm for each recovered core. Calculated volume per 10 m deep sampling hole is 0.1775 m^3 and area of each sampling hole is 0.0178 m^2.			

2. FEASIBLE AND REASONABLE ALTERNATIVES

Site Alternative:
All the prospecting rights areas for which De Beers has Prospecting Rights, i.e. 1c, the inshore portions of 2c, 3c, 4c and 5c, as well as 6c, 7c, 8c, 9c, 10c, 12c, 14c, 15c, 16c, 17c, 18c and 20c, are being considered in the Basic Assessment. AuruMar is proposing to undertake prospecting activities in these areas, which includes the identification of heavy minerals, platinum group metals, gold and sapphire (gemstones). Actual sample sites are still to be determined based on existing data and the desktop study (ongoing).

Other Alternatives:
These include:

- Number of sample sites:
  AuruMar is currently proposing to take 300 core samples during Phase I and 4 500 core samples in Phase II. However, the total number of cores to be taken will be determined by the ongoing desktop study, which aims to identify specific sampling areas. Therefore, the number of cores is subject to change.

- Sampling techniques:
  AuruMar has investigated various options of collecting samples including the use of standard vibrocorers and the skirted mega-drill with an airlift system. However, the standard vibrocorers are unable to penetrate clays and do not collect samples of sufficient volume. The mega-drill is unable to collect high integrity, isolated samples in the vertical profile. This sampling tool also has difficulty in penetrating consolidated sediments and collects larger samples than required for the purposes of this prospecting programme. Thus, it is proposed to use the SVC in order to collect the core samples (refer to Section A 1 above).

- Choice of survey tools:
  Numerous geophysical tools are available, however, AuruMar is proposing to use shallow penetration seismic tools and multibeam ecosounders for sea floor analysis (refer to Section A 1 above.)

- Choice of sampling platform:
  AuruMar conducts global reviews of potential vessels of opportunity to ensure selection of vessels that both meet operation needs and comply with international maritime requirements. The SVC tool requires a particular aft deck space for the launch and recovery system. Review of various vessels of opportunity have identified rig support vessels as being the most appropriate vessel type for these operations. These are typically 60 m in length and 16 m wide. Survey programmes require smaller vessels, typically 45 m in length and 10 m wide.

No-Go Alternative:
The implications of not going ahead with the proposed prospecting activities are as follows:

- Loss of opportunity to establish whether or not a viable offshore heavy mineral resource exists off the west coast of South Africa; and
- Lost economic opportunities related to costs already incurred in the initial prospecting phase.

3. ACTIVITY POSITION

The co-ordinates of the proposed prospecting area boundary are provided below and refer to Figure 3.1 in Chapter 3 of the Final BAR.

Point	Latitude	Longitude
Prospecting Right Areas 1c -10c		
1	16° 25.094' E	28° 41.056' S
2	16° 33.595' E	28° 52.491' S
3	16° 43.129' E	29° 5.490' S
4	16° 53.281' E	29° 21.372' S
5	16° 59.347' E	29° 37.885' S
6	17° 4.881' E	29° 54.322' S
7	17° 10.278' E	30° 10.890' S
8	17° 17.461' E	30° 26.489' S

9	17° 26.495' E	30° 42.271' S
10	17° 35.211' E	30° 57.871' S
11	17° 45.478' E	31° 12.853' S
12	17° 9.077' E	31° 12.852' S
13	16° 57.543' E	30° 57.870' S
14	16° 53.077' E	30° 42.271' S
15	16° 44.910' E	30° 32.655' S
16	16° 37.076' E	30° 29.789' S
17	16° 37.226' E	30° 26.489' S
18	16° 36.043' E	30° 18.039' S
19	16° 10.112' E	30° 10.939' S
20	15° 58.742' E	30° 4.407' S
21	15° 53.175' E	29° 56.441' S
22	15° 41.725' E	29° 56.441' S
23	15° 39.674' E	29° 54.274' S
24	16° 3.567' E	29° 54.394' S
25	16° 3.722' E	29° 37.724' S
26	16° 3.872' E	29° 21.374' S
27	16° 4.016' E	29° 5.492' S
28	16° 4.078' E	28° 58.528' S
29	16° 14.298' E	28° 52.491' S
30	16° 18.653' E	28° 49.603' S
Prospecting Right Area 12c		
31	17° 56.745' E	31° 27.269' S
32	18° 9.296' E	31° 42.584' S
33	17° 11.860' E	31° 42.584' S
34	17° 15.577' E	31° 27.268' S
Prospecting Right Areas 14c – 20c		
35	18° 11.612' E	31° 48.951' S
36	18° 13.712' E	31° 54.734' S
37	18° 10.212' E	32° 5.166' S
38	18° 10.495' E	32° 12.182' S
39	18° 6.928' E	32° 19.165' S
40	17° 52.461' E	32° 33.464' S
41	17° 45.261' E	32° 49.613' S
42	17° 37.660' E	32° 49.615' S
43	17° 42.928' E	32° 33.464' S
44	17° 23.010' E	32° 19.165' S
45	17° 17.910' E	32° 12.182' S
46	17° 15.277' E	32° 5.166' S
47	17° 10.677' E	31° 54.733' S
48	17° 9.027' E	31° 48.950' S

4. PHYSICAL SIZE OF THE ACTIVITY

The entire prospecting area covers 27 600 km^2 and is located between the 50 m and 200 m depth contours. Sampling would occur in water depths ranging from 90 m to 200 m and would cover an area of approximately 85 m^2.

5. SITE ACCESS

N/A – The proposed project is located off the west coast of South Africa.

6. SITE OR ROUTE PLAN

Refer to Chapter 3 of the Final BAR, specifically Figure 3.1.

7. SITE PHOTOGRAPHS

Refer to Chapter 3 of the Final BAR. No specific photographs of the site are available, as it is located on the seabed and in the ocean.

8. FACILITY ILLUSTRATION

Refer to Chapter 3 of the Final BAR.

9. ACTIVITY MOTIVATION

9(a) Socio-economic value of the activity

What is the expected capital value of the activity on completion?	Zero (Prospecting activities are conducted in order to prove up resources for potential future mining activities.)	
What is the expected yearly income that will be generated by or as a result of the activity?	Zero – no income is expected during the prospecting phase. Income would only materialise if, based on the result of the prospecting phase, AuruMar were to obtain a Mining Right and commence with production.	
Will the activity contribute to service infrastructure?	YES	**NO ✓**
Is the activity a public amenity?	YES	**NO ✓**
How many new employment opportunities will be created in the development phase of the activity?	Zero	
What is the expected value of the employment opportunities during the development phase?	n/a	
What percentage of this will accrue to previously disadvantaged individuals?	n/a	
How many permanent new employment opportunities will be created during the operational phase of the activity?	n/a – the current application forms part of a prospecting right application and there would be no permanent operations envisaged during the prospecting phase. This would only be applicable on application for a mining right.	
What is the expected current value of the employment opportunities during the first 10 years?	n/a	
What percentage of this will accrue to previously disadvantaged individuals?	n/a	

9(b) Need and desirability of the activity

Motivate and explain the need and desirability of the activity (including demand for the activity):

When considering the need and desirability of this project it is important to consider the role that mining plays within the South African economy. The Minister's statement in the Department of Minerals Resources Strategic Plan 2008/09 - 2010/11 refers "*the growth of the mining industry is historically intertwined with the growth of our economy*" and states further that "*Mining has and will continue to be the mainstay of our economy*."

In order for mining to continue to be a core contributor to the South African economy and in the pursuance of the sustainable development of the nation's mineral resources it is necessary to identify new resources through prospecting.

A key intent of the Minerals and Mining Policy of South Africa states that Government will: "*promote exploration and investment leading to increased mining output and employment*" (Minerals and Mining Policy of South Africa, 1998). The Policy states further that:

- *"The South African mining industry, one of the country's few world-class industries, has the capacity to continue to generate wealth and employment opportunities on a large scale.*
- *Mining is an international business and South Africa has to compete against developed and developing countries to attract both foreign and local investment. Many mining projects in South Africa have tended to be unusually large and long term, requiring massive capital and entailing a high degree of risk.*
- *South Africa has an exceptional minerals endowment, and in several major commodities has the potential to supply far more than the world markets can consume."*

If one looks at gold in particular, the Chamber of Mines' explains that *"With the stabilisation in world mine production and central bank sales, the prospect of any major sources of new supply of gold have diminished. The continued focus on productivity and consolidation in the South African gold mining industry will result in a decline in production - although replacement tonnage from new mines will slow the rate of decline.* "

This project aims to establish whether economically viable heavy mineral deposits, including gold, occur on the continental shelf off the west coast of South Africa.

Rationale for the proposed project

The principal objective of this project is to use the best available technology to ground-truth the geological model for the existence and regional distribution of potentially economic and accessible placer deposits within the prospecting rights areas, to determine the mineralogical content of such deposits and to determine the regional distribution of grades in technologically and economically assessable shelf sediments.

10. APPLICABLE LEGISLATION, POLICIES AND/OR GUIDELINES

List all legislation, policies and/or guidelines of any sphere of government that are applicable to the application as contemplated in the EIA regulations, if applicable:

Title of legislation, policy or guideline:	**Administering authority:**	**Date:**
Minerals and Petroleum Resources Development Act (No. 28 of 2002)	Department of Mineral Resources	2002
National Environmental Management Act (No. 107 of 1998)	Department of Environmental Affairs (DEA)	1998
National Heritage Resources Act (No. 25 of 1998)	South African Resources Agency	1998

11. WASTE, EFFLUENT, EMISSION AND NOISE MANAGEMENT

11(a) Solid waste management

Will the activity produce solid construction waste during the construction/initiation phase?	YES	**NO ✓**
If yes, what estimated quantity will be produced per month?	m^3	
How will the construction solid waste be disposed of (describe)?		
Where will the construction solid waste be disposed of (describe)?		
N/A		
Will the activity produce solid waste during its operational phase?	**YES ✓**	NO
If yes, what estimated quantity will be produced per month?	m^3 PTO	

Estimated volume/mass of wastes produced during sampling activities of 100 days.

Waste Type	Volume / Mass produced per day	Total Volume / Mass produced during sampling
Rubbish/trash	120 kg	12 000 kg
Scrap metal	50 kg	5 000 kg
Drums/containers	0-2 units	Up to 200 units
Used oil	0.1 m^3	10 m^3
Chemicals/hazardous water	0.02 m^3	2 m^3
Infectious waste	negligible	negligible
Filters and filter media	5 kg	500 kg

How will the solid waste be disposed of (describe)?

All solid waste would be temporarily stored onboard in containers until being transported onshore. The solid waste would then be taken to a local registered landfill site. Where possible, material for recycling of waste, such as scrap metal, wood, glass, used oil, etc., would be stored separately onboard and taken to a local land based recycling facility. Solid waste is likely to comprise the following:

Garbage: This includes waste paper, plastics, wood, metal, glass, etc.

Scrap metal and other metals: Scrap metal would be stored and disposed of or recycled on land.

Drums and containers: Rinsed and non-rinsed drums brought onshore would be disposed of in a local landfill site.

Used oil: Examples include used lubricating and gear oil, solvents, hydrocarbon-based detergents and machine oil. Toxicity varies depending on oil type. All non-recycled waste oils would be securely stored, transported to shore and disposed of at a licensed site acceptable to the relevant authorities.

Infectious Wastes: Infectious wastes include bandages, dressings, surgical waste, tissues, medical laboratory wastes, needles, and food wastes from persons with infectious diseases. Only minor quantities of medical waste are expected. Prevention of exposure to contaminated materials is essential, requiring co-operation with local medical facilities to ensure proper disposal.

Chemical waste:
Disposal of any unexpected chemical and hazardous substance (e.g. fluorescent tubes, toner cartridges, batteries, etc.) would be done on a case-by-case basis and in a manner acceptable to appropriate regulatory authorities.

Filters and filter media:
Infectious wastes include bandages, dressings, surgical waste, tissues, medical laboratory wastes, needles, and food wastes from persons with infectious diseases. Only minor quantities of medical waste are expected. Prevention of exposure to contaminated materials is essential, requiring co-operation with local medical facilities to ensure proper disposal. All such waste will be stored and brought onshore for disposal via a registered medical waste company.

Where will the solid waste be disposed if it does not feed into a municipal waste stream (describe)?

N/A

If the solid waste (construction or operational phases) will not be disposed of in a registered landfill site or be taken up in a municipal waste stream, then the applicant should consult with the competent authority to determine whether it is necessary to change to an application for scoping and EIA. N/A

Can any part of the solid waste be classified as hazardous in terms of the relevant legislation?	YES	**NO ✓**

If yes, inform the competent authority and request a change to an application for scoping and EIA.

Is the activity that is being applied for a solid waste handling or treatment facility?	YES	**NO ✓**

If yes, then the applicant should consult with the competent authority to determine whether it is necessary to change to an application for scoping and EIA.

11(b) Liquid effluent

Will the activity produce effluent, other than normal sewage, that will be disposed of in a municipal sewage system?	YES	**NO ✓**
If yes, what estimated quantity will be produced per month?		N/A
Will the activity produce any effluent that will be treated and/or disposed of on site?	**YES ✓**	NO

If yes, the applicant should consult with the competent authority to determine whether it is necessary to change to an application for scoping and EIA. N/A

Note:

The types of liquid waste and the associated treatment, storage and disposal thereof are presented in detail in the BAR (see Section 3.5). In summary, effluent would include:

Sewage: Whilst South Africa is not yet a signatory to MARPOL Annex IV - Regulations for the Prevention of Pollution by Sewage from Ships – the contracted vessels would be required to comply wherever possible with the requirements of this Annex.

Will the activity produce effluent that will be treated and/or disposed of at another facility?	YES	**NO ✓**
If yes, provide the particulars of the facility:	N/A	

Describe the measures that will be taken to ensure the optimal reuse or recycling of waste water, if any:
N/A

11(c) Emissions into the atmosphere

Will the activity release emissions into the atmosphere?	**YES ✓**	NO
If yes, is it controlled by any legislation of any sphere of government?	YES	**NO ✓**

If yes, the applicant should consult with the competent authority to determine whether it is necessary to change to an application for scoping and EIA. N/A

If no, describe the emissions in terms of type and concentration:

Air emissions would result from the vessels themselves (see Section 3.5 of the Final BAR).

11(d) Generation of noise

Will the activity generate noise?	**YES ✓**	NO
If yes, is it controlled by any legislation of any sphere of government?	YES	**NO ✓**

If yes, the applicant should consult with the competent authority to determine whether it is necessary to change to an application for scoping and EIA.

If no, describe the noise in terms of type and level:

Noise would be generated by the vessels, the Sonic VibroCorer (SVC) and the geophysical survey tools. Noise from the vessels is likely to be no higher than noise from other shipping vessels of a similar size in the region. Noise from the SVC has been measured at 160 to 180 dB re 1µPa at a distance of 25 m from the tool.

Sound levels from the acoustic equipment would range from 190 to 220 dB re 1 µPa at 1m. The sounds emitted would probably be insufficient to result in auditory or non-auditory trauma to marine mammals in the region (Findlay, 2005).

12. WATER USE

Please indicate the source(s) of water that will be used for the activity by ticking the appropriate box(es)

municipal	water board	groundwater	river, stream, dam or lake	other	**the activity will not use water ✓**

If water is to be extracted from groundwater, river, stream, dam, lake or any other natural feature, please indicate the volume that will be extracted per month:

N/A	
YES	**NO ✓**

Does the activity require a water use permit from the Department of Water Affairs?
If yes, please submit the necessary application to the Department of Water Affairs and attach proof thereof to this application if it has been submitted.

13. ENERGY EFFICIENCY

Describe the design measures, if any, that have been taken to ensure that the activity is energy efficient:

None

Describe how alternative energy sources have been taken into account or been built into the design of the activity, if any:

None

SECTION B: SITE/AREA/PROPERTY DESCRIPTION

Important notes:

1. **For linear activities (pipelines, etc) as well as activities that cover very large sites, it may be necessary to complete this section for each part of the site that has a significantly different environment. In such cases please complete copies of Section C and indicate the area, which is covered by each copy No. on the Site Plan.** Refer to the Final BAR for full details of the proposed project.

Section C Copy No. (e.g. A):

2. Paragraphs 1 - 6 below must be completed for each alternative.

3. Has a specialist been consulted to assist with the completion of this section? **YES ✓** | NO

If YES, please complete the form entitled "Details of specialist and declaration of interest" for each specialist thus appointed:
All specialist reports must be contained in Appendix D.
Please refer to Appendix 3 of the Final BAR for the Benthic Specialist Report.

Property description/physical address:	The proposed core sampling and geophysical survey would be undertaken within the sea areas 1c, 2c, 3c, 4c, 5c, 6c, 7c, 8c, 9c, 10c, 12c, 14c, 15c, 16c, 17c, 18c and 20c off the west coast of South Africa (refer to Figure 1.1 of Final BAR). Sea areas 1c, 2c, 3c, 4c, 5c, 6c, 7c, 8c, 9c and 10c are located off the Northern Cape coast, while the remaining sea areas are located off the Western Cape coast. The entire prospecting area covers 27 600 km^2 and is located between the 50 m and 200 m depth contours. Sampling would occur in water depths ranging from 90 m to 200 m. The co-ordinates of the proposed prospecting area boundary are provided in Section A 1, above.
Current land-use zoning:	Offshore concession areas.

Is a change of land-use or a consent use application required?	YES	**NO ✓**
Must a building plan be submitted to the local authority?	YES	**NO ✓**

Locality map: Refer to Figure 1.1 in Chapter 1 of the Final BAR.

1. GRADIENT OF THE SITE

Alternative S1:

Flat	1:50 – 1:20	1:20 – 1:15	1:15 – 1:10	1:10 – 1:7,5	1:7,5 – 1:5	Steeper than 1:5

* The proposed project is located offshore in water depths ranging from 90 m to 200 m and the floor slope varies within the prospecting area. A bathymetry map is presented in Chapter 4 of the Final BAR, Figure 4.2.

2. LOCATION IN LANDSCAPE

Indicate the landform(s) that best describes the site:

2.1 Ridgeline
2.2 Plateau
2.3 Side slope of hill/mountain
2.4 Closed valley
2.5 Open valley
2.6 Plain
2.7 Undulating plain / low hills
2.8 Dune
2.9 Seafront
2.10 Offshore / open water ✓

3. GROUNDWATER, SOIL AND GEOLOGICAL STABILITY OF THE SITE

Is the site(s) located on any of the following (tick the appropriate boxes)?

	Alternative S1:	
Shallow water table (less than 1.5m deep)	YES	**NO ✓**
Dolomite, sinkhole or doline areas	YES	**NO ✓**
Seasonally wet soils (often close to water bodies)	YES	**NO ✓**
Unstable rocky slopes or steep slopes with loose soil	YES	**NO ✓**
Dispersive soils (soils that dissolve in water)	YES	**NO ✓**
Soils with high clay content (clay fraction more than 40%)	YES	**NO ✓**
Any other unstable soil or geological feature	YES	**NO ✓**
An area sensitive to erosion	YES	**NO ✓**

4. GROUNDCOVER

Indicate the types of groundcover present on the site: The location of all identified rare or endangered species or other elements should be accurately indicated on the site plan(s).

Natural veld – good condition[E]	Natural veld with scattered aliens[E]	Natural veld with heavy alien infestation[E]	Veld dominated by alien species[E]	Gardens
Sport field	Cultivated land	Paved surface	Building or other structure	**Bare soil ✓***

* Sediments within the broad prospecting area are dominated by muddy sands, sandy muds, mud and some sand. Sediments are discussed further in Chapter 4 of the Final BAR (see Section 4.1.2.4).

5. LAND USE CHARACTER OF SURROUNDING AREA

Indicate land uses and/or prominent features that does currently occur within a 500 m radius of the site and give description of how this influences the application or may be impacted upon by the application:

5.1 Natural area ✓
5.2 Low density residential
5.3 Medium density residential
5.4 High density residential
5.5 Informal residential[A]
5.6 Retail commercial & warehousing
5.7 Light industrial
5.8 Medium industrial [AN]
5.9 Heavy industrial [AN]
5.10 Power station
5.11 Office/consulting room
5.12 Military or police base/station/compound
5.13 Spoil heap or slimes dam[A]
5.14 Quarry, sand or borrow pit
5.15 Dam or reservoir
5.16 Hospital/medical centre
5.17 School
5.18 Tertiary education facility
5.19 Church
5.20 Old age home
5.21 Sewage treatment plant[A]
5.22 Train station or shunting yard [N]
5.23 Railway line [N]
5.24 Major road (4 lanes or more) [N]
5.25 Airport [N]
5.26 Harbour
5.27 Sport facilities
5.28 Golf course
5.29 Polo fields
5.30 Filling station [H]
5.31 Landfill or waste treatment site
5.32 Plantation
5.33 Agriculture
5.34 River, stream or wetland
5.35 Nature conservation area
5.36 Mountain, koppie or ridge
5.37 Museum
5.38 Historical building
5.39 Protected Area
5.40 Graveyard
5.41 Archaeological site
5.42 Other land uses (describe) ✓

The proposed study area is located offshore in water depths ranging from 90 m to 200 m. A number of fisheries operate in this area. There are also a number of diamond mining and prospecting concession areas and petroleum exploration blocks located within and adjacent to the study area. Refer to Chapter 4, Section 4.1.4 for further details and figures.

If any of the boxes marked with an "[N] "are ticked, how will this impact / be impacted upon by the proposed activity?
N/A

If any of the boxes marked with an "An" are ticked, how will this impact / be impacted upon by the proposed activity?

N/A

If any of the boxes marked with an "H" are ticked, how will this impact / be impacted upon by the proposed activity.

N/A

6. CULTURAL/HISTORICAL FEATURES

Are there any signs of culturally or historically significant elements, as defined in section 2 of the National Heritage Resources Act, 1999, (Act No. 25 of 1999), including Archaeological or palaeontological sites, on or close (within 20m) to the site?	YES	NO
	Uncertain ✓	
If YES, explain:		
If uncertain, conduct a specialist investigation by a recognised specialist in the field to establish whether there is such a feature(s) present on or close to the site.		
Briefly explain the findings of the specialist:	The proposed project is located offshore with a total surface area of 27 600 km² and it is not yet known whether there are any historical features, e.g. shipwrecks in the proposed sampling areas. However existing maritime heritage desktop studies, such as JJ Boshoff (2009) have concluded that there is a low probability of finding historical shipwrecks in these prospecting areas. The majority of the shipwrecks are located along the coastline in shallow waters and it is less likely that historical wrecks would be found in deeper water. Whilst this does not rule out the possibility of unknown wrecks in the area, the existence of unknown wrecks should be brought to light by the geophysical survey activities. Should potential wreck sites be identified from survey data, AuruMar would ensure that sampling sites avoid any shipwrecks. (Also see Section 4.1.4.6 and Figure 4.28 of the Final BAR).	
Will any building or structure older than 60 years be affected in any way?	YES	**NO ✓**
Is it necessary to apply for a permit in terms of the National Heritage Resources Act, 1999 (Act 25 of 1999)?	YES	**NO ✓**

If yes, please submit or, make sure that the applicant or a specialist submits the necessary application to SAHRA or the relevant provincial heritage agency and attach proof thereof to this application if such application has been made.

SECTION C: PUBLIC PARTICIPATION

Tasks undertaken to date include the following:

- An Application Form and Declaration of Interest were submitted to DEA on 31 March 2011 (see Appendix 2 of Final BAR).
- Specialist input was provided on the likely impact on the benthic environment and fishing industry by the proposed prospecting activities (see Appendices 3 and 4, respectively). Impacts were assessed according to pre-defined rating scales (see Appendix 5).
- The specialist input and other relevant information was integrated into the Final BAR. The Final BAR aims to present all information in a clear and understandable format, suitable for easy interpretation by I&APs and authorities, and to provide an opportunity for I&APs and authorities to comment on the proposed project and Basic Assessment process (see Section 1.4 of Final BAR).
- A preliminary interested and affected party (I&AP) database has been compiled which consists of authorities (local and regional), Non-Governmental Organisations, Community-based Organisations and other key stakeholders. This database was compiled using databases of previous studies in the area. To date 62 I&APs have been registered on the project database (see Appendix 6 of Final BAR).
- The Draft BAR was made available to I&APs for a 40-day comment period.
- A notification letter was sent to all I&APs registered on the project database. A copy of the Draft BAR Executive Summary was enclosed with the letter.
- Advertisements were placed in Die Weslander and Ons Kontrei on 18 April 2011 and in the Cape Times and Die Burger on 22 April 2011.

- A total of five comments were received, three of which were from commenting authorities.
- A Comments and Responses Report was compiled (see Appendix 8 of Final BAR).
- The Draft BAR was updated to a Final BAR and has been made available for a further 30-day comment period (see Section 1.4 of Final BAR).
- A notification letter was sent to all I&APs registered on the project database.

It should be noted that I&APs have previously been consulted as part of the MPRDA Prospecting Rights application for proposed Marine Prospecting Activities. During this process, comments received did not raise any significant issues of concern.

1. ADVERTISEMENT

It should be noted that since the proposed project is located offshore, in the open ocean there are no adjacent landowners and no notice has been erected on site, as is recommended. Advertisements were placed in four newspapers, two local and two regional (see details below).

2. CONTENT OF ADVERTISEMENTS AND NOTICES

Adverts have been placed in the following papers and provided information on the proposed prospecting activities, public participation process and 40-day commenting period (see Appendix 7 of the Final BAR):

- Ons Kontrei – 14 April 2011
- Weslander – 14 April 2011
- Cape Times – 18 April 2011
- Die Burger – 18 April 2011

3. PLACEMENT OF ADVERTISEMENTS AND NOTICES

Four adverts have been placed in the relevant newspapers (see above for details).

4. DETERMINATION OF APPROPRIATE MEASURES

An Information-sharing Meeting is not considered necessary. All the key stakeholders are included on the project database (see Appendix 6 of Final BAR) and they have been notified of the proposed project and availability of the Final BAR. It should be noted that I&APs have previously been consulted as part of the MPRDA Prospecting Rights application for proposed Marine Prospecting Activities. During this process, comments received did not raise any significant issues of concern. Key I&APs include:

- Diamond mining / prospecting industries;
- Oil and gas exploration and production industries;
- South African Navy Hydrographic Office;
- South African and foreign fishing vessels (including the Association of Small Hake Industries, South African Deep Sea Trawling Industry Association, South African Pelagic Fishing Industry Association, South African Commercial Linefish Association, South African Tuna Association, Fresh Tuna Exporters Association, South African West Coast Rock Lobster Association, Shark Long-line Association);
- South African Maritime Safety Authority (SAMSA); and
- Government departments, particularly DEA: MRM, SAHRA and DMR.

5. COMMENTS AND RESPONSE REPORT

A Comments and Responses Report has been completed and can be found in Appendix 8 of the Final BAR. A total of five written comments were received, three of which were from the following commenting authorities:

- Department of Environmental Affairs and Development Planning, Western Cape;
- Department of Environment and Nature Conservation, Northern Cape; and
- Department of Environmental Affairs: Ocean and Coasts.

6. AUTHORITY PARTICIPATION

Please note that a complete list of all organs of state and or any other applicable authority with their contact details must be appended to the basic assessment report or scoping report, whichever is applicable.

Refer to Appendix 6 of the Final BAR for the I&AP Database.

Authorities are key interested and affected parties in each application and no decision on any application will be made before the relevant local authority is provided with the opportunity to give input.

List of authorities informed:

Department of Environmental Affairs: Ocean and Coasts
Department of Agriculture, Forestry and Fisheries: Marine Resource Management
Department of Environmental Affairs and Development Planning (DEA&DP) (Western Cape)
Department of Environmental Affairs and Nature Conservation (Northern Cape)
South African Heritage Resources Agency

List of authorities from whom comments have been received:

- Department of Environmental Affairs and Development Planning, Western Cape;
- Department of Environment and Nature Conservation, Northern Cape; and
- Department of Environmental Affairs: Ocean and Coasts.

7. CONSULTATION WITH OTHER STAKEHOLDERS

Has any comment been received from stakeholders?	YES	**NO ✓**

Key authorities who have been contacted include the following (also complete I&AP list in Appendix 6 of Final BAR):

- Department of Mineral Resources;
- Department of Environmental Affairs: Oceans and Coast;
- Department of Agriculture, Forestry and Fisheries: Marine Resource Management;
- South African Heritage Resources Agency; and
- South African Maritime Safety Authority.

Other key stakeholders include the following:

- Diamond mining / prospecting industries;
- Oil and gas exploration and production industries;
- South African and foreign fishing vessels (including the Association of Small Hake Industries, South African Deep Sea Trawling Industry Association, South African Pelagic Fishing Industry Association, South African Commercial Linefish Association, South African Tuna Association, Fresh Tuna Exporters Association, South African West Coast Rock Lobster Association, Shark Long-line Association).

If "YES", briefly describe the feedback below (also attach copies of any correspondence to and from the stakeholders to this application):

A Comments and Responses Report has been compiled and is included in Appendix 8 of the Final BAR. The written comments are also included in Appendix 8. The key issues raised were largely related to potential Marine Protected Areas (MPA) and the possible impact of the proposed project on these areas. Additional information on proposed MPA's was also added to the Final report to provide sufficient information.

It should be noted that I&APs have previously been consulted as part of the MPRDA Prospecting Rights application for proposed Marine Prospecting Activities. During this process, comments received did not raise any significant issues of concern. Records of consultation formed part of the submission to the DMR.

SECTION D: IMPACT ASSESSMENT

1. ISSUES RAISED BY INTERESTED AND AFFECTED PARTIES

List the main issues raised by interested and affected parties.

The key issues raised related to the impact of the proposed project on the biophysical environment, especially MPA's. Other issues related to the proper disposal of waste products from the vessels, potential effect of noise impacts on marine mammals, etc. Please refer to Appendix 8 where all issues raised are included in the Comments and Responses Report.

Response from the practitioner to the issues raised by the interested and affected parties (A full response must be given in the Comments and Response Report that must be attached to this report as Annexure E):

Refer to the Comments and Responses Report in Appendix 8 of the Final BAR.

2. IMPACTS THAT MAY RESULT FROM THE PLANNING AND DESIGN, CONSTRUCTION, OPERATIONAL, DECOMMISSIONING AND CLOSURE PHASES AS WELL AS PROPOSED MANAGEMENT OF IDENTIFIED IMPACTS AND PROPOSED MITIGATION MEASURES

For the comprehensive assessment of the proposed project, refer to Chapter 5 of the Final BAR. The following is a summary table of the findings for the proposed prospecting activities.

Potential impact		Significance	
		Without mitigation	With mitigation
Vessel operatiosn:			
Deck drainage into the sea		VL	**VL**
Machinery space drainage into the sea		VL	**VL**
Sewage effluent into the sea		VL	**VL**
Galley waste disposal into the sea		VL	**VL**
Solid waste disposal into the sea		N/A	**N/A**
Impact on marine fauna:			
Sediment removal		VL	**VL**
Physical crushing of benthic biota		VL	**VL**
Noise associated with sampling activities		VL	**VL**
Noise associated with geophysical sampling		L	**VL**
Impact on other users of the sea:			
Fishing industry	Pelagic purse-seine	L	**L**
	Demersal long-line	L	**L**
	Tuna pole	VL	**VL**
	Pelagic long-line	VL	**VL**
Marine mining and prospecting	Diamond mining	VL	**VL**
	Other mining	VL	**VL**
Petroleum exploration		VL-L	**VL**
Marine transport routes		VL	**VL**
Impact on cultural heritage material:			
Impact on historical shipwrecks		M	**VL**
NO-GO ALTERNATIVE:			
Lost opportunity to establish whether or not a viable offshore heavy mineral resource exists off the West Coast and the lost economic opportunities related to costs already incurred in the initial prospecting phase.		L-M	**-**

VH=Very High	H=High	M=Medium	L=Low	VL=Very low	Insig = insignificant	N/A= Not applicable

3. ENVIRONMENTAL IMPACT STATEMENT

Taking the assessment of potential impacts into account, please provide an environmental impact statement that summarises the impact that the proposed activity and its alternatives may have on the environment after the management and mitigation of impacts have been taken into account, with specific reference to types of impact, duration of impacts, likelihood of potential impacts actually occurring and the significance of impacts.

Alternative A (preferred alternative)

All of the impacts associated with sampling and geophysical surveying would occur in the immediate vicinity of the vessels, would be of short term duration and of low to high intensity, and are considered to be of **VERY LOW to LOW** significance after mitigation.

The proposed activities would not result in any potential impacts that could cause severe damage to the environment. Based on the total prospecting area, the proposed sampling and geophysical activities would have a low impact on the environment. Phase I of the sampling would disturb an area of 1.8 x 10^{-8}%, while Phase II would disturb 2.9 x e^{-7}%,

which equates to an area of 85 m² of the 27 600 m² prospecting area.

No-go alternative (compulsory)

The implications of not going ahead with the proposed prospecting activities relate to the lost opportunity to establish whether or not a viable offshore heavy mineral resource exists off the West Coast and the lost economic opportunities related to costs already incurred in the initial prospecting phase. This potential impact of the No-Go Alternative is considered to be of **LOW** to **MEDIUM** significance.

SECTION E. RECOMMENDATION OF PRACTITIONER

Is the information contained in this report and the documentation attached hereto sufficient to make a decision in respect of the activity applied for (in the view of the environmental assessment practitioner)?	**YES ✓**	NO

If "NO", indicate the aspects that should be assessed further as part of a Scoping and EIA process before a decision can be made (list the aspects that require further assessment):

N/A

If "YES", please list any recommended conditions, including mitigation measures that should be considered for inclusion in any authorisation that may be granted by the competent authority in respect of the application:

The following mitigation measures should be adhered to during the prospecting activities:

Compliance with the Environmental Management Programme

All phases of the proposed project must comply with the Environmental Management Programme presented in Chapter 7 of the Final BAR. In addition, vessels must ensure compliance with MARPOL 73/78 standards.

Notification and communication with key stakeholders

- Notify PetroSA, Forest Exploration International, Thombo Petroleum, BHP Billiton and Transhex and its contractors, as well as any other operators, prior to the commencement of activities.
- AuruMar should liaise with all petroleum exploration operators to ensure that there is no overlapping of activities in the same area over the same time period.
- Prior to the commencement of activities, AuruMar must notify relevant bodies including: DMR, South African Maritime Safety Authority (SAMSA), the South African Navy (SAN) Hydrographic Office, relevant Port Captains and DAFF: MRM. These bodies must be notified of the navigational co-ordinates of any location prior to commencement of such activities.
- Communication channels should be set up with I&APs. This would involve pre-sampling and survey notifications and regular updates on the sampling and survey progress via email (see bullet below). Key stakeholders should include:
  - > Fishing industry (Association of Small Hake Industries, South African Deep Sea Trawling Industry Association, South African Pelagic Fishing Industry Association, South African Commercial Linefish Association, South African Tuna Association, Fresh Tuna Exporters Association, South African West Coast Rock Lobster Association, and Shark Long-line Association);
  - > Marine mining / prospecting industry (Transhex); and
  - > Authorities (SAN Hydrographic office, DAFF: MRM, DMR, SAMSA and relevant Port Captains).
- Appropriate notices should be distributed timeously to mariners (including the fishing and diamond mining industries). A Notice to Mariners should provide:
  1. the co-ordinates of the sampling and survey activities;
  2. an indication of the sampling and survey timeframes; and
  3. reports on the location of prospecting vessels.

Discharges and emissions

- Provide training and awareness to crew members of the need for thorough cleaning up of any spillages immediately after they occur in order to minimise the volume of contaminants washing off decks.
- Use low toxicity, biodegradable detergents and reusable absorbent cloths during deck cleaning to further minimise the potential impact of deck drainage on the marine environment.

- Machinery spaces must drain into bilge tanks in compliance with MARPOL Annex I.
- Save-alls must be utilised around specific equipment, bunkering points and vents on open deck areas to prevent release of contaminated water overboard.
- Undertake adequate maintenance of all hydraulic systems.
- Minimise the discharge of waste material should obvious attraction of marine fauna be observed.
- Contractors would be required to comply with the MARPOL 73/78 Annex IV requirements, wherever possible.

Vessel sea worthiness

- The vessels must be certified for seaworthiness through an appropriate internationally recognised marine certification programme (e.g. Lloyds Register, Det Norske Veritas).
- Vessels should be equipped with collision prevention equipment including radar, multi-frequency radio, foghorns, etc. The law also requires equipment and training to ensure the safety and survival of the crew in the event of an accident.

Geophysical surveying

- Carry out visual scans around the survey vessel prior to the initiation of any acoustic impulses;
- Pre-survey scans should be limited to 15 minutes prior to the start of survey equipment.
- Terminate the survey if any marine mammals show affected behaviour within 500 m of the survey vessel or equipment until the mammal has vacated the area.
- "Soft starts" should be carried out for any equipment of source levels greater than 210 dB re 1 µPa at 1 m over a period of 20 minutes.
- The geophysical surveying should largely be undertaken between December and May, however, during the transition periods in June and November, surveying would be possible with stricter mitigation measures.
- Ensure that PAM (passive acoustic monitoring) is incorporated into any surveying taking place in June and / or November.
- Geophysical surveying should not be undertaken in the southern concession areas between October and January, when there is a likelihood of Southern Right whales being in the area.
- A Marine Mammal Observer would be appointed to ensure compliance with mitigation measures during seismic geophysical surveying.

Is an EMP attached? The EMP must be attached as Appendix F.	**YES ✓***	NO

* Refer to Chapter 7 of the Final BAR.

SECTION F: APPENDIXES

Refer to the Final BAR for the list of appendices:

environmental affairs
Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

	(For official use only)
File Reference Number:	12/12/20/
NEAS Reference Number:	DEAT/EIA/
Date Received:	

Application for authorisation in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2010

PROJECT TITLE

BASIC ASSESSMENT PROCESS FOR MARINE PROSPECTING ACTIVITIES IN VARIOUS SOUTH AFRICAN SEA AREAS OFF THE WEST COAST

Specialist:	Pisces Environmental Services (Pty) Ltd		
Contact person:	Dr Andrea Pulfrich		
Postal address:	PO Box 31228, Tokai		
Postal code:	7966	Cell:	
Telephone:	021 782 9553	Fax:	021 782 9553
E-mail:	apulfricj@pisces.co.za		
Professional affiliation(s) (if any)	Registered Environmental Assessment Practitioner and member of the South African Council for Natural Scientific Professions, South African Institute of Ecologists and Environmental Scientisits and IAIA (South Africa).		

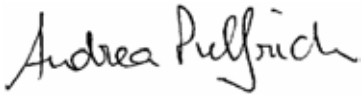
Project Consultant:	N/A		
Contact person:			
Postal address:			
Postal code:		Cell:	
Telephone:		Fax:	
E-mail:			

4.2 The specialist appointed in terms of the Regulations

I, Andrea Pulfrich, declare that --

General declaration:

- I act as the independent specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of section 24F of the Act.



Signature of the specialist:

Pisces Environmental Services (Pty) Ltd

Name of company (if applicable):

15 April 2011

Date:

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

	(For official use only)
File Reference Number:	12/12/20/
NEAS Reference Number:	DEAT/EIA/
Date Received:	

Application for authorisation in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2010

PROJECT TITLE

Marine Prospecting Activities in various areas off the west coast of South Africa: Fisheries Sector

Specialist:	Capricorn Fisheries Monitoring cc		
Contact person:	David Japp		
Postal address:	P.O. Box 50035, Waterfront		
Postal code:	8001	Cell:	0827886737
Telephone:	0214256226	Fax:	0214251994
E-mail:	jappy@iafrica.com		
Professional affiliation(s) (if any)			

Project Consultant:			
Contact person:			
Postal address:			
Postal code:		Cell:	
Telephone:		Fax:	
E-mail:			

4.2 The specialist appointed in terms of the Regulations

I, David William Japp , declare that --

General declaration:

- I act as the independent specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of section 24F of the Act.

Signature of the specialist:

Capricorn Fisheries Monitoring cc

Name of company (if applicable):

9 June 2011

Date:

APPENDIX 2

APPLICATION FORM, DEA CORRESPONDENCE AND I&AP LETTER

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

APPLICATION FORM FOR ENVIRONMENTAL AUTHORISATION

	(For official use only)
File Reference Number:	12/12/20/
NEAS Reference Number:	DEAT/EIA/
Date Received:	

Application for authorisation in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2010

PROJECT TITLE

BASIC ASSESSMENT PROCESS FOR MARINE PROSPECTING ACTIVITIES IN VARIOUS SOUTH AFRICAN SEA AREAS OFF THE WEST COAST

SITE IDENTIFICATION AND LINKAGE

Please indicate all the Surveyor-general 21 digit site (erf/farm/portion) reference numbers for all sites (including portions of sites) that are part of the application.

Not applicable. The proposed study area is located off the West Coast of South Africa. The proposed core sampling would be undertaken within the prospecting right areas 2c, 3c, 4c and 5c (inshore portions), 6c, 7c, 8c, 9c, 10c, 12c, 14c, 15c, 16c, 17c, 18c and 20c (refer to Figure 1).

1. BACKGROUND INFORMATION

Project applicant:	De Beers Consolidated Mines Ltd		
Trading name (if any):			
Contact person:	Mr Neil Fraser, Venture Manager, AuruMar (Pty) Ltd		
Physical address:	DBM Gardens, Golf Park, Raapenberg Rd, Pinelands, Cape Town		
Postal address:	PO Box 87, Cape Town		
Postal code:	8000	**Cell:**	0833888788
Telephone:	+27-21-658-3213	**Fax:**	0216583354
E-mail:	neil.fraser@aurumar.co.za		
Provincial Authority:	Department of Environmental Affairs and Development Planning (DEA&DP: Western Cape)		
Contact person:	Mr Anthony Barnes		
Postal address:	Directorate: Integrated Environmental Management (Region B) Private Bag X 9086 Cape Town		
Postal code:	8000	**Cell:**	
Telephone:	021 483 4094	**Fax:**	021 483 4372
E-mail:	Anbarnes@pgwc.gov.za		
Provincial Authority:	Department of Environment Affairs and Nature Conservation (Northern Cape)		
Contact person:	Mr Julius Mutyourauta (Director: Environmental Management)		
Postal address:	Private Bag X6102, KIMBERLY		
Postal code:	8300	**Cell:**	083 285 2373
Telephone:	053 807 7430	**Fax:**	053 831 3530
E-mail:	jmutyorauta@half.ncape.gov.za		
Landowner:	N/A – The study area is located off the west coast of South Africa.		
Contact person:			
Postal address:			
Postal code:		Cell:	
Telephone:		Fax:	
E-mail:			

In instances where there is more than one landowner, please attach a list of landowners with their contact details to this application.

Local authority in whose jurisdiction the proposed activity will fall:	N/A – Project is located offshore.		
Nearest town or districts:			
Contact person:			
Postal address:			
Postal code:		**Cell:**	
Telephone:		**Fax:**	
E-mail:			

In instances where there is more than one local authority involved, please attach a list of local authorities with their contact details to this application. See attached list.

2. ACTIVITIES APPLIED FOR TO BE AUTHORISED

For an application for authorisation that involves more than one listed or specified activity that, together, make up one development proposal, all the listed activities pertaining to this application must be indicated.

Indicate the number and date of the relevant notice:	**Activity No (s) (in terms of the relevant notice) :**	**Describe each listed activity as per project description:**
GN No, R544, 18 June 2010	16(vi)	*Construction or earth moving activities in the sea ..., in respect of infrastructure covering 50 m² or more.* Sampling activities are planned in the prospecting rights areas identified above from October 2011 to November 2013. These activities will be undertaken by AuruMar (Pty) Ltd on behalf of the prospecting rights holder, De Beers Consolidated Mines. During the initial deposit assessment phase, it is proposed that a minimum of 300 core samples would be obtained. This will be followed by a resource delineation phase during which a maximum of 4 500 cores would be obtained. The sampling will be undertaken utilising a vibracoring tool, mounted in a frame which is lowered to the seabed during the coring operation to provide stability. The frame has a footprint of 6m x 6m. It is not fixed to the seabed in any way and is only positioned on the seabed during the coring process, which takes no more than 1.5 hours. The tool is then recovered to the deck of the sampling vessel where the sediment core is removed. The vessel then moves to the next sampling location.

Indicate the number and date of the relevant notice:	Activity No (s) (in terms of the relevant notice) :	Describe each listed activity as per project description:
GN No, R544, 18 June 2010	18(ii)	*The infilling or depositing of any material of more than 5 m^3 into, or the dredging, excavation, removal or moving soil, sand, shells, shell grit, pebbles or rock from the sea.* The 300 core samples planned for the initial deposit assessment programme will be collected in up to 60 targets over the 27 600km^2 prospecting area. Clusters of up to 5 cores will be collected in each target with individual core spacing of approximately 70 metres. The volume of each core is calculated to be 0.178m^3 at each core site and therefore the total volume of seabed sediment that will be removed will be approximately 53m^3 over the total prospecting area. The estimated 4 500 cores that will be collected during the resource delineation programme will be at a core spacing of 50 to 200 metres apart. The total volume of seabed sediment that will be removed during this phase will be approximately 799m^3 over the total prospecting area. There will be no infilling or depositing of material during the sampling process.

3. OTHER AUTHORISATIONS REQUIRED

3.1 DO YOU NEED ANY AUTHORISATIONS IN TERMS OF ANY OF THE FOLLOWING LAWS?

3.1.1	National Environmental Management: Waste Act	YES	**NO ✓**
3.1.2	National Environmental Management: Air Quality Act	YES	**NO ✓**
3.1.3	National Environmental Management: Protected Areas Act	YES	**NO ✓**
3.1.4	National Environmental Management: Biodiversity Act	YES	**NO ✓**
3.1.5	Mineral Petroleum Development Resources Act *	**YES ✓**	NO
3.1.6	National Water Act	YES	**NO ✓**
3.1.7	National Heritage Resources Act	YES	**NO ✓**
3.1.8	Other (please specify)	YES	**NO ✓**
3.2	Have such applications been lodged already?	YES	**NO ✓**

* Note that four separate Environmental Management Programmes have previously been submitted to DMR in terms of the Mineral and Petroleum Resources Development Act (No. 28 of 2002) and have been approved for all of the prospecting rights areas.

4. DECLARATIONS

4.1 The Applicant

I, MICHAEL MARTIN BROWN ,declare that I -

- am, or represent[1], the applicant in this application;
- have appointed an environmental assessment practitioner to act as the independent environmental assessment practitioner for this application / will obtain exemption from the requirement to obtain an environmental assessment practitioner[2];
- will provide the environmental assessment practitioner and the competent authority with access to all information at my disposal that is relevant to the application;
- will be responsible for the costs incurred in complying with the Environmental Impact Assessment Regulations, 2010, including but not limited to –
  - costs incurred in connection with the appointment of the environmental assessment practitioner or any person contracted by the environmental assessment practitioner;
  - costs incurred in respect of the undertaking of any process required in terms of the Regulations;
  - costs in respect of any fee prescribed by the Minister or MEC in respect of the Regulations;
  - costs in respect of specialist reviews, if the competent authority decides to recover costs; and
  - the provision of security to ensure compliance with conditions attached to an environmental authorisation, should it be required by the competent authority;
- will ensure that the environmental assessment practitioner is competent to comply with the requirements of these Regulations and will take reasonable steps to verify whether the EAP complies with the Regulations;
- will inform all registered interested and affected parties of any suspension of the application as well as of any decisions taken by the competent authority in this regard;
- am responsible for complying with the conditions of any environmental authorisation issued by the competent authority;
- hereby indemnify the Government of the Republic, the competent authority and all its officers, agents and employees, from any liability arising out of the content of any report, any procedure or any action which the applicant or environmental assessment practitioner is responsible for in terms of these Regulations;
- will not hold the competent authority responsible for any costs that may be incurred by the applicant in proceeding with an activity prior to obtaining an environmental authorisation or prior to an appeal being decided in terms of these Regulations;
- will perform all other obligations as expected from an applicant in terms of the Regulations;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 71 and is punishable in terms of section 24F of the Act.

Signature of the applicant[3]/ Signature on behalf of the applicant:

DE BEERS CONSOLIDATED MINES

Name of company (if applicable):

30 MARCH 2011

Date:

[1] If this is signed on behalf of the applicant, proof of such authority from the applicant must be attached.
[2] If exemption is obtained from appointing an EAP, the responsibilities of an EAP will automatically apply to the person conducting the environmental impact assessment in terms of the Regulations.
[3] If the applicant is a juristic person, a signature on behalf of the applicant is required as well as proof of such authority.

DE BEERS
A DIAMOND IS FOREVER

CONFIRMATION OF SIGNING AUTHORITY

I, **IAN NORMAN SCHEEPERS**, in my capacity as the Assistant Secretary of **DE BEERS CONSOLIDATED MINES LIMITED** (DBCM) hereby confirm that Mr Michael Martin Brown, the Chief Operations Officer of DBCM, is a member of the Executive Committee of DBCM and in that capacity is duly authorised to sign the Application form for Environmental Authorisation (File Reference No. 12/12/20; NEAS Reference No. DEAT/EIA) with the Project Title "Basic assessment process for marine prospecting activities in various South African sea areas off the west coast" in terms of the attached resolution of the directors of DBCM under the heading "Signing Authorities" dated 2 August 2004.

I N Scheepers
ASSISTANT SECRETARY
31 March 2011

HEAD OFFICE
De Beers Consolidated Mines Limited Registration No. 1888/000007/06

36 STOCKDALE STREET KIMBERLEY 8301
PO BOX 616 KIMBERLEY 8300
TEL +27 (0) 53 839 4111 FAX +27 (0) 53 839 4210
www.debeersgroup.com

DE BEERS CONSOLIDATED MINES LIMITED

EXTRACT FROM THE MINUTES OF A MEETING OF DIRECTORS OF DE BEERS CONSOLIDATED MINES LIMITED HELD ON MONDAY, 2 AUGUST 2004

SIGNING AUTHORITIES
RESOLVED :

1.1 that the resolution of directors passed at a meeting of the board held on 13 November 1964 under the subject "Signature of Documents" is hereby rescinded;

1.2 that the resolution of directors passed at a meeting of the board held on 28 November 1989 under the subject "Banking Arrangements" is hereby rescinded;

1.3 that the resolution of directors passed at a meeting of the board held on 17 September 1990 under the subject "General Signing Authority" is hereby rescinded;

1.4 that the resolution of directors passed at a meeting of the board held on 3 February 2003 under the subject "Signing Authorities - Corporate Headquarters" is hereby rescinded;

1.5 that

i) any two directors or,

ii) any one director and the Secretary or Assistant Secretary or any member of the Executive Committee of the Company for the time being

be hereby authorised to sign:

1.5.1 all powers of attorney, guarantees, suretyships, bonds, deeds, contracts, undertakings and any such other documents; and

1.5.2 any documents required in connection with the opening of any banking account, any agreement relating to the provision to the Company of any banking facility, the appointment of signatories to operate any banking account or any changes to such signatories and the appointment of representatives related to electronic banking and matters incidental thereto.

RESOLVED FURTHER :

that, in the absence of a Director of the Company, all notarial agreements, deeds of suretyship, bonds of indemnity, powers of attorney to pass transfer, transfer deeds, consents to cancellation of bonds or releases of properties from the operation on bonds, applications to any Deeds Registry or any other documents required in connection with the registration or endorsement of any title in any Deeds Registry, and all other documents requiring the official signature of the Company, be signed by the Secretary or the Assistant Secretary or any member of the Executive Committee of the Company.

Certified a true extract

I N Scheepers
Assistant Secretary
Kimberley
31 March 2011

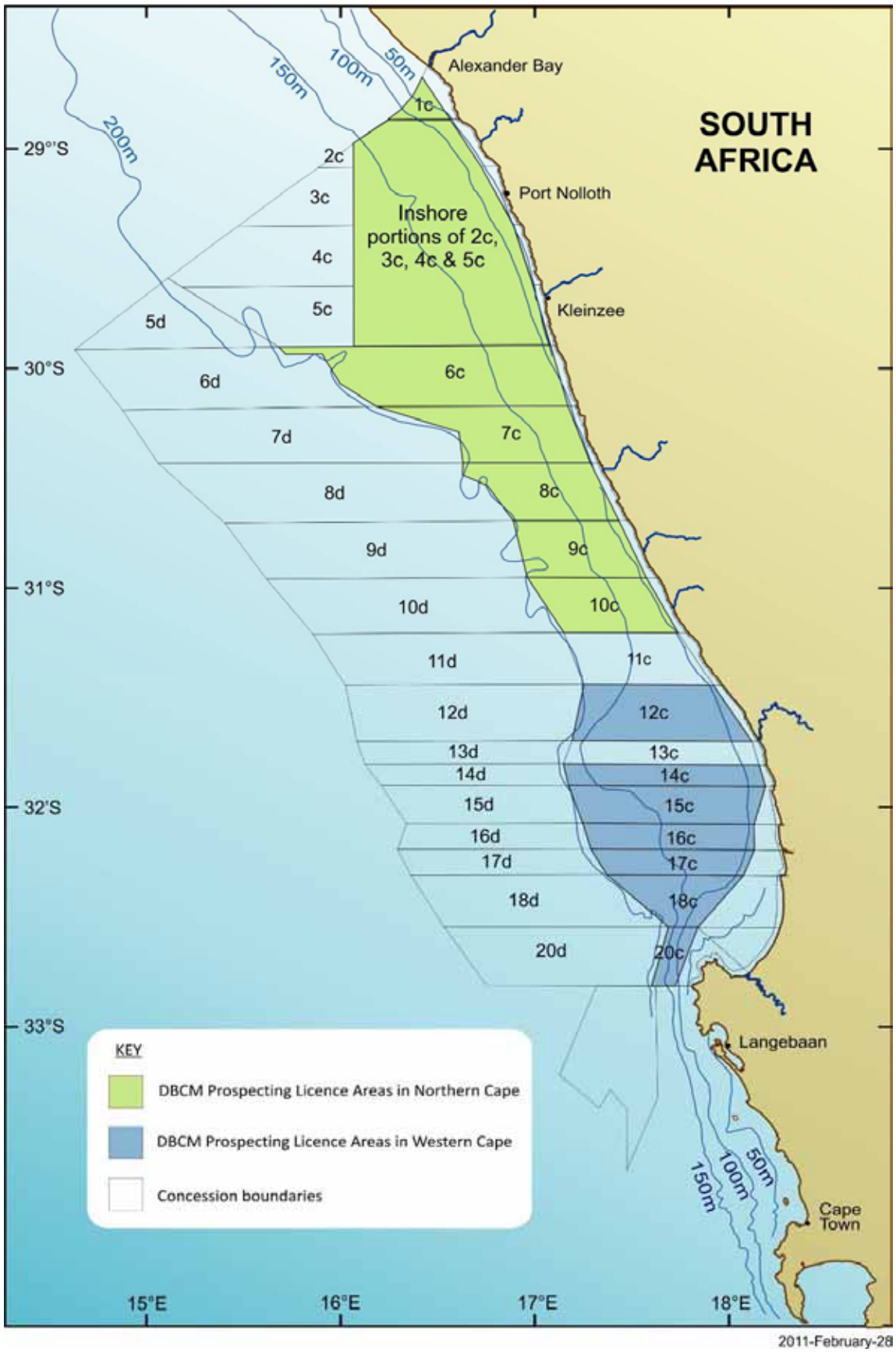


Figure 1: **The proposed coring / sampling activities would be undertaken in the blue and green shaded blocks off the West Coast of South Africa.**

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF EAP AND DECLARATION OF INTEREST

	(For official use only)
File Reference Number:	12/12/20/
NEAS Reference Number:	DEAT/EIA/
Date Received:	

Application for authorisation in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2010

PROJECT TITLE

BASIC ASSESSMENT PROCESS FOR MARINE PROSPECTING ACTIVITIES IN VARIOUS SOUTH AFRICAN SEA AREAS OFF THE WEST COAST

Environmental Assessment Practitioner (EAP):[1]	CCA Environmental (Pty) Ltd		
Contact person:	Jonathan Crowther / Tamryn Heydenrych		
Postal address:	PO Box 10145, Caledon Square, CAPE TOWN		
Postal code:	7905	Cell:	
Telephone:	(021) 461 1118/9	Fax:	(021) 461 1120
E-mail:	jonathan@ccaenvironmental.co.za tamryn@ccaenvironmental.co.za		
Professional affiliation(s) (if any)	Jonathan Crowther: • Registered Professional Natural Scientist (Pr.Sci.Nat.) - Environmental Scientist • Certified as an Environmental Practitioner with The Interim Certification Board for Environmental Assessment Practitioners of South Africa - CEAPSA		

Project Consultant:	N/A		
Contact person:			
Postal address:			
Postal code:		**Cell:**	
Telephone:		**Fax:**	
E-mail:			

4.2 The Environmental Assessment Practitioner

I, Jonathan Crowther , declare that –

General declaration:

- I act as the independent environmental practitioner in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting environmental impact assessments, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I will take into account, to the extent possible, the matters listed in regulation **8** of the regulations when preparing the application and any report relating to the application;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I will ensure that information containing all relevant facts in respect of the application is distributed or made available to interested and affected parties and the public and that participation by interested and affected parties is facilitated in such a manner that all interested and affected parties will be provided with a reasonable opportunity to participate and to provide comments on documents that are produced to support the application;
- I will ensure that the comments of all interested and affected parties are considered and recorded in reports that are submitted to the competent authority in respect of the application, provided that comments that are made by interested and affected parties in respect of a final report that will be submitted to the competent authority may be attached to the report without further amendment to the report;
- I will keep a register of all interested and affected parties that participated in a public participation process;
- I will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not
- All the particulars furnished by me in this form are true and correct;
- Will perform all other obligations as expected from an environmental assessment practitioner in terms of the Regulations; and
- I realise that a false declaration is an offence in terms of regulation 71 and is punishable in terms of section 24F of the Act.

Disclosure of Vested Interest

- I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2010:

Signature of the environmental assessment practitioner:

CCA ENVIRONMENTAL (PTY) LTD

Name of company:

28/3/2011

Date:

environmental affairs
Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

Private Bag X 447 · PRETORIA · 0001 · Fedsure Building · 315 Pretorius Street · PRETORIA
Tel (+ 27 12) 310 3911 · Fax (+ 2712) 322 2682

Reference: 12/12/20/2254
Enquiries: Nyiko Ngoveni / Mmatlala Rabothata
Tel: 012 310 1694 /1768 **Fax:** 012 320 7539
E-mail: nngoveni@environment.gov.za / mrabothata@environment.gov.za

Mr Jonathan Crowther
CAA Environmental (Pty) Ltd
PO Box 10145
CALEDON SQUARE
7905

Fax: 021 461 1120

PER FACSIMILE / MAIL

Dear Mr Crowther

APPLICATION FOR ENVIRONMENTAL AUTHORISATION: MARINE PROSPECTING ACTIVITIES IN VARIOUS SOUTH AFRICAN SEA AREAS OFF THE WEST COAST

The Department confirms having received the Application Form and Declaration of Interest submitted by you on 5 April 2011 for environmental authorisation for the abovementioned project. You have submitted these documents to comply with the Environmental Impact Assessment Regulations, 2010.

The Application is accepted. You are hereby reminded that the activity may not commence prior to an environmental authorisation being granted by the Department.

Yours sincerely

Mr Dumisani Mthembu
Chief Director: Environmental Impact Management (Acting)
Department of Environmental Affairs
Letter signed by: Ms Hilda Bezuidenhout
Designation: Assistant Director: Environmental Impact Evaluation
Date: 13/04/2011

AM01/Let_Jun11

8 June 2011

Dear Sir/Madam

BASIC ASSESSMENT PROCESS FOR MARINE PROSPECTING ACTIVITIES IN VARIOUS SOUTH AFRICAN SEA AREAS OFF THE WEST COAST (REF NO. 12/12/20/2254): NOTIFICATION OF THE AVAILABILITY OF A FINAL BASIC ASSESSMENT REPORT FOR PUBLIC REVIEW AND COMMENT

Our previous correspondence dated 15 April 2011, regarding the above-mentioned project refers.

Notice is hereby given in terms of the National Environmental Management Act (No. 107 of 1998) that a Final BAR is available for public review and comment. Copies of the Final BAR will be available at the following locations from **Thursday, 9 June 2011**:

1. Offices of CCA Environmental (Pty) Ltd (Cape Town); and
2. On the CCA Environmental website (www.ccaenvironmental.co.za).

The Final BAR has been made available for a 30-day comment period. Interested and Affected Parties who would like to submit comments on the Final BAR should submit them directly to the Department of Environmental Affairs (DEA) and copied to CCA Environmental **no later than Monday 11 July 2011** for inclusion in DEA's decision-making process.

Submit comments to:	**Copy comments to:**
Department of Environmental Affairs:	CCA Environmental:
Nyiko Ngoveni / Mmatlala Rabothata	Tamryn Heydenrych
Private Bag X447, Pretoria, 0001 or Fedsure Building	Unit 35 Roeland Square, 30 Drury Lane,
315 Pretorius Street, Pretoria, 0001	Cape Town 8001 or PO Box 10145
Tel: 012 310 1694; Fax: 012 320 7539	Caledon Square 7905
E-mail: nngoveni@environment.gov.za /	Tel: 021 461 1118; Fax: 021 461 1120
rabothata@environment.gov.za	E-mail: tamryn@ccaenvironmental.co.za

On completion of the 30-day period, the Final BAR will be submitted to DEA for acceptance and decision-making. DEA's decision on the application will be distributed to I&APs on the project database, after which a statutory Appeal Period will follow.

Should you have any queries on the above, or require any further information, please do not hesitate to contact us.

Yours sincerely

Jonathan Crowther Pr.Sci.Nat., CEAPSA
CCA ENVIRONMENTAL (PTY) LTD

Encl.

Am01pr\Correspondence\I&APs\FBAR\Let I&AP FBAR notifiction - June 2011.doc

AM01/Let_Apr11

15 April 2011

Dear Sir/Madam

BASIC ASSESSMENT PROCESS FOR MARINE PROSPECTING ACTIVITIES IN VARIOUS SOUTH AFRICAN SEA AREAS OFF THE WEST COAST (REF NO. 12/12/20/2254): NOTICE OF AVAILABILITY OF DRAFT BASIC ASSESSMENT REPORT FOR COMMENT

De Beers Consolidated Mines Ltd (De Beers) is the current Prospecting Rights holder for the sea areas: 1c, the inshore portions of 2c, 3c, 4c and 5c, as well as 6c, 7c, 8c, 9c, 10c, 12c, 14c, 15c, 16c, 17c, 18c and 20c.

AuruMar (Pty) Ltd (AuruMar) has been formed to act as the operator to undertake Marine Prospecting Activities in these sea areas. The proposed prospecting activities include the identification of heavy minerals, platinum group metals, gold and sapphire (gemstones).

Notice is hereby given in terms of the National Environmental Management Act (No. 107 of 1998) that a Draft BAR is available for public review and comment. Copies of the Draft BAR will be available at the following locations from **Monday, 18 April 2011**:

1. Offices of CCA Environmental (Pty) Ltd (Cape Town); and
2. On the CCA Environmental website (www.ccaenvironmental.co.za).

The Draft BAR has been made available for a 40-day comment period (plus 5 days to cover public holidays). Interested and Affected Parties who would like to submit comments on the Draft BAR should submit them to CCA Environmental **no later than 1 June 2011** for inclusion in the Final BAR. Comments should be sent to our Tamryn Heydenrych (tamryn@ccaenvironmental.co.za) or to CCA (details below).

A copy of the Executive Summary of the Draft BAR is enclosed for your reference.

Should you have any queries on the above, or require any further information, please do not hesitate to contact us.

Yours sincerely

Jonathan Crowther Pr.Sci.Nat., CEAPSA
CCA ENVIRONMENTAL (PTY) LTD

Encl.

AM01PR/Corr/I&APs /Let I&AP DBAR notification – April 2011

CCA ENVIRONMENTAL (Pty) Ltd • Consulting Services
Unit 35 Roeland Square 30 Drury Lane Cape Town 8001 • PO Box 10145 Caledon Square 7905
Tel +27 (21) 461 1118/9 • Fax +27 (21) 461 1120 • email: info@ccaenvironmental.co.za • website: www.ccaenvironmental.co.za
Directors: J Crowther F Fredericks • Reg No 2003/019026/07

CCA ENVIRONMENTAL (PTY) LTD

ACKNOWLEDGEMENT FORM
LETTERS POSTED

Project:	BASIC ASSESSMENT PROCESS FOR MARINE PROSPECTING ACTIVITIES IN VARIOUS SOUTH AFRICAN AREAS OFF THE WEST COAST
Letter Reference:	AM/01/PR – DBAR FOR PUBLIC COMMENT
Number of letters posted:	7
Date posted:	16 APRIL 2011
Post Office:	Mill Street Post Office, Cape Town

Signed:

CCA Environmental (Pty) Ltd
Director

16/4/2011
Date

Signed:

Mill Street Post Office

FOLIO 3
Millstreet Post Office
2011 -04- 16
Ph: 021-465 1013

Date

cca ENVIRONMENTAL

Mr AM Gordon
Directorate: Social Economic Development
Department of Agriculture Forestry and Fisheries
P O Box 139
LAMBERTS BAY
9130

Ms M Ledingwane
Director: Mineral Development
Department of Mineral Resources
Private Bag X6093
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The Port Manager
National Ports Authority
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PORT NOLLOTH
8280

Mr M Hirs
Prospect 35 (Pty) Ltd
P O Box 12460
MILL STREET
CAPE TOWN
8010

Mr A Delie
Richtersveld Municipality
P O Box 128
ALEXANDER BAY
8290

Dr E van Niekerk
SA Squid Management Industrial Association
P O Box 13130
Suite 196
HUMEWOOD
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Mr H Gomez
Chairman
Shark Longline Association
20 Woodhead Drive
EDGEMEAD
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Tamryn Koning

From: "Tamryn Koning" <tamryn@ccaenvironmental.co.za>
To: <wiaanb@alexcor.co.za>; <pmokubung@ncpg.gov.za>; <marg@ndft.org>; <dcolly@samsa.org.za>; <trevor@thombopetroleum.com>; <vincentm@transhex.co.za>; <gregv@transhex.co.za>
Sent: 18 April 2011 03:49
Attach: Let I&AP DBAR notification letter_15 Apr 11.pdf; DBAR Executive Summary _15 Apr 11_.pdf
Subject: Basic Assessment process: Prospecting Activities in vaious South African sea areas off the west coast

Dear Interested and Affected Party

Please find attached a notification letter regarding the Basic Assessment Process for Marine Prospecting Activities in vaious South African sea areas off the west coast (Ref. No. 12/12/20/2254).

The Executive Summary has also been attached. To view the full report, please visit www.ccaenvironmental.co.za

Yours sincerely

Tamryn

Tamryn Heydenrych
Environmental Consultant

CCA ENVIRONMENTAL (Pty) Ltd • Consulting Services
Unit 35 Roeland Square 30 Drury Lane Cape Town 8001 • PO Box 10145 Caledon Square 7905
Tel + 27 (21) 461 1118/9 • Fax + 27 (21) 461 1120 • tamryn@ccaenvironmental.co.za • website: www.ccaenvironmental.co.za
Directors: J Crowther F Fredericks • Reg No 2003/019026/07

Tamryn Koning

From: "Tamryn Koning" <tamryn@ccaenvironmental.co.za>
To: <JohannAU@daff.gov.za>; <k.sink@sanbi.org.za>; "Roos, Lesley" <Lesley.Roos@debeersgroup.com>; <lionelp@matzikamamun.co.za>; <marg@ndft.org>; <millss@petroleumagencysa.com>; <mmayekiso@environment.gov.za>; <mwdapg@mweb.co.za>; <namagroen@telkomsa.net>; "Neil Fraser" <neil.fraser@aurumar.co.za>; <pandanet@global.co.za>; <patrick@wessa.co.za>; <patti.wickens@debeersgroup.com>; <pbest@iziko.org.za>; <peter.dekker@sasol.com>; <phardcas@pgwc.gov.za>; <pmokubung@met.ncape.gov.za>; <port@lantic.net>; <rball@iafrica.com>; <robert.h@absamail.co.za>; <robert.j.silverman@bhpbilliton.com>; <romar@environment.gov.za>; <safish@new.co.za>; <sakhile.ngcobo@debeersgroup.com>; <scott.s.sanders@bhpbilliton.com>; <tedwell@tac-denver.com>; <trevor@thombopetroleum.co.za>; <varsha.singh@petrosa.co.za>
Sent: 18 April 2011 10:04
Attach: Let I&AP DBAR notification letter_15 Apr 11.pdf; DBAR Executive Summary _15 Apr 11_.pdf
Subject: Basic Assessment process: Prospecting Activities in vaious South African sea areas off the west coast

Dear Interested and Affected Party

Please find attached a notification letter regarding the Basic Assessment Process for Marine Prospecting Activities in vaious South African sea areas off the west coast (Ref. No. 12/12/20/2254).

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Yours sincerely

Tamryn

Tamryn Heydenrych
Environmental Consultant

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Directors: J Crowther F Fredericks • Reg No 2003/019026/07

Tamryn Koning

From: "Tamryn Koning" <tamryn@ccaenvironmental.co.za>
To: <ajfriedrichs@forestoil.co.za>; <Ajohnson@environment.gov.za>; <andrew@kaytrad.co.za>; <babalwa@myezo.co.za>; <bcrouts-knipe@wc.sahra.org.za>; <boating@ telkomsa.net>; <careln@transhex.co.za>; <comfish@mweb.co.za>; <david.biggs@bhpbilliton.com>; <dcolley@samsa.org.za>; "Roy Bross" <deepsea@iafrica.com>; <geoffd@alexkor.co.za>; <georgez@transhex.co.za>; <hydrosan@iafrica.com>; <jan.briers@dmr.gov.za>; "David Japp" <jappy@iafrica.com>; "Jessica Courtoreille" <jessica.Courtoreille@petrosa.co.za>; "John Geeringh" <JGeeringh@environment.gov.za>; <jllanghus@forestoil.co.za>; <jmutyorauta@half.ncape.gov.za>; <petermikkelsen@simco-pet.com>; <dan@w4u.co.za>; <antoinette@tunahake.co.za>
Sent: 18 April 2011 10:03
Attach: Let I&AP DBAR notification letter_15 Apr 11.pdf; DBAR Executive Summary _15 Apr 11_.pdf
Subject: Basic Assessment process: Prospecting Activities in vaious South African sea areas off the west coast

Dear Interested and Affected Party

Please find attached a notification letter regarding the Basic Assessment Process for Marine Prospecting Activities in vaious South African sea areas off the west coast (Ref. No. 12/12/20/2254).

The Executive Summary has also been attached. To view the full report, please visit www.ccaenvironmental.co.za

Yours sincerely

Tamryn

_____
Tamryn Heydenrych
Environmental Consultant

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Directors: J Crowther F Fredericks • Reg No 2003/019026/07

APPENDIX 3

MARINE BENTHIC INPUT

SPECIALIST STATEMENT

Marine Specialist Statement on the potential benthic impacts of proposed sampling for heavy minerals in De Beers Consolidated Mines' Prospecting Right Areas off the west coast of South Africa

PREPARED FOR

AuruMar (Pty) Ltd

on behalf of

CCA Environmental (Pty) Ltd

April 2011

By

Pisces Environmental Services (Pty) Ltd

Contact Details:
Dr A. Pulfrich
P O Box 31228, Tokai 7966, South Africa
Tel & Fax: 27 21-7829553
Email: apulfrich@pisces.co.za

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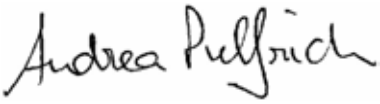
EXPERTISE AND DECLARATION OF INDEPENDENCE

This report was prepared by Dr Andrea Pulfrich of Pisces Environmental Services (Pty) Ltd. Andrea has a BSc (Hons) and MSc degree in Zoology from the University of Cape Town and 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 specialist report was compiled as a desktop study on behalf of CCA Environmental (Pty) Ltd, 35 Roeland Square, 30 Drury Lane, Cape Town, 8001 for their use in preparing a Basic Assessment Report and developing an Environmental Management Plan for a proposed heavy minerals sampling campaign off the South African West Coast. The compilation followed a review process of published (peer reviewed) and unpublished literature and the assessment of potential impacts based on proposed activities and identification of impacts (and their mitigation) within the available literature.

I do hereby declare that Pisces Environmental Services (Pty) Ltd is financially and otherwise independent of the Applicants and CCA Environmental.



Dr Andrea Pulfrich

The specific terms of reference received from CCA Environmental for the marine specialist assessment were:

1 Provide a general description of the marine biodiversity in the identified prospecting areas.
2 Review the information provided in the EMPs for the identified prospecting areas and update, if required.
3 Assess the impact of taking core samples from the seabed on the benthic communities.
4 Assess the impact of the temporary placement of a 6 m x 6 m frame on the seabed during coring (approximately 1.5 hours per core).
5 Identify practicable mitigation measures to reduce negative impacts and indicate how these can be implemented in the sampling phase and management of the proposed project.
6 Comply with DEA&DP's guidelines on specialist study requirements for EIAs.

1. PROJECT DESCRIPTION

1.1 Overview

AuruMar is a joint venture company created by De Beers Group Exploration Holdings Limited and AngloGold Ashanti Marine Exploration Limited to develop offshore gold placer deposits. The company is planning a sampling campaign in De Beers Consolidated Mines' Heavy Mineral Prospecting Right Areas off the west coast of South Africa. The Prospecting Right Concessions are located in both the Northern and Western Cape and include:

- Northern Cape - 1c, inshore portions of 2c, 3c, 4c and 5c, and 6c, 7c, 8c, 9c and 10c
- Western Cape - 12c, 14c, 15c, 16c, 17c, 18c and 20c.

The prospecting activities would be conducted in a phased approach, with each phase dependant on the results of the previous phase. The two phases planned are as follows and it is proposed that they would run from October 2010 to November 2013:

- Phase I: Initial Deposit Assessment Programme
- Phase II: Resource Delineation Programme

It should be noted that AuruMar has already undertaken a desktop study and developed a geological model and an associated mineralisation model, based on existing information. The desktop study included the review of published geophysical, geotechnical and sampling data as well as the review of data that De Beers has collected from existing and adjacent concession areas. Geophysical surveys and follow up ground-truthing was also undertaken in areas highlighted as potential targets by the desktop studies and where there was insufficient detail to guide further exploration.

1.1.1 Exploration Sampling

The proposed prospecting activities would utilise AuruMar's Sonic VibroCorer (SVC) in order to collect the required samples. The system utilises a vibratory head, which has been adapted from land based technology, where the vibration energy is transferred into the drill string and enables the drill-string to penetrate into the seabed down to 10 m with a radius of 75 mm. The system can penetrate through most unconsolidated seabed lithologies, to produce a discrete high integrity core, which can then be analysed in detail. The sampling system is mounted in a frame, which is lowered to the seabed from a purpose built Launch and Recovery System (LARS) on a suitable vessel of opportunity.

SVC core samples would be logged and stored onboard the vessel and transferred ashore at regular intervals for further analysis. Once the cores are logged they would then be analysed onshore for heavy mineral content. This would entail initial sizing, screening and sub-sampling, followed by an evaluation of a sub-sample at an appropriately accredited onshore laboratory. Results from the sample treatment and the evaluation process would provide inputs into the geological model.

1.2 Initial Deposit Assessment

The aim of Initial Deposit Assessment Programme would be to groundtruth the geological model compiled during the desktop study and to identify the possible presence of mineralisation for further resource delineation (i.e. Phase II).

It is proposed that approximately 300 cores would be collected within identified areas in the prospecting rights areas. Up to 60 target areas would be selected over the 27 600 km² prospecting area based on the results of an ongoing desktop study. Clusters of up to five cores would be collected in each target area with individual core spacing of approximately 70 metres. The 300 core sampling activities would result in a total disturbance area of 53 m³. The Initial Deposit Assessment Programme would extend for approximately 80 days.

Total disturbance for Deposit Assessment Programme			
# cores	**Area (m2)**	**Disturbance area as % of total prospecting right area**	**Volume (m3)**
300	5	1.8×10^{-8}	53
Note: Calculations of area and volume disturbed based on a radius of 75.18 mm for each recovered core. Calculated volume per 10m deep sampling hole is 0.1775 m^3 and area of each sampling hole is 0.0178 m^2			

1.3 Resource Delineation

Once the detailed geophysical surveying has been completed and the results further analysed, it is assumed that these results would yield at least one deposit that would justify further sampling in the Resource Delineation Programme. The proposed method of sampling would be the same as the process undertaken in Phase I. Phase II is intended to increase the level of confidence regarding the presence of a mineral resource in the deposit area. This confidence level would ultimately determine whether it is viable to apply for commercial mining rights.

It is assumed that the potential deposit area to be sampled would be approximately 56 km² in extent. It is estimated that up to 4 500 core samples would be required within this deposit area. The core spacings would be between 50 and 200 m apart. The total volume of disturbance would be approximately 799 m³.

Total disturbance for Resource Delineation Programme			
# cores	**Area (m2)**	**Disturbance area as % of total prospecting right area**	**Volume (m3)**
4500	80	$2.9 \times e^{-7}$	799
Note: Calculations of area and volume disturbed based on a radius of 75.18 mm for each recovered core. Calculated volume per 10 m deep sampling hole is 0.1775 m^3 and area of each sampling hole is 0.0178 m^2.			

2. DESCRIPTION OF THE MARINE ENVIRONMENT

This section summarises the important features and processes of the region based on the relevant description of the offshore marine environment documented in Chapter 1 of Volume III (Description of the Environmental Baseline) of the Generic EMPR for Marine Diamond Mining (Lane and Carter 1999). It is supplemented by more recent information from other EIAs and EMPs compiled for the area (e.g. Pulfrich 1999; CCA Environmental 2005, 2007a, 2007b) and the BCLME Report on cumulative effects of diamond mining in the Benguela Region (Penney *et al*. 2007).

2.1 Meteorology

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

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

The South Atlantic high-pressure cell is perennial, but strongest during austral summer when it attains its southernmost extension to the south and south-west (approximately 30°S, 05°E) of the subcontinent. Linked to this high-pressure in summer is a low-pressure cell that forms over the subcontinent due to strong heating over land. The pressure differential of these two systems induces moderate to strong south-easterly (SE) winds near the shore during summer. Furthermore, the southern location of the South Atlantic high-pressure cell limits the impact that mid-latitude cyclones have on summer weather patterns so that, at best, the mid-latitude cyclones cause a slackening of the SE winds. During the austral winter both the weakening and north-ward migration of the South Atlantic high-pressure cell (to approximately 26°S, 10°E) and the increase in atmospheric pressure over the subcontinent result in the eastward moving mid-latitude cyclones advancing closer to the coast.
Strong north-westerly (NW) to south-westerly (SW) winds result from mid-latitude cyclones passing the southern Cape at a frequency of 3 to 6 days. Associated with the approach of mid-latitude cyclones is the appearance of low-pressure cells, which originate from near Lüderitz on the Namibian coast and quickly travel around the subcontinent (Reason and Jury 1990; Jury *et al*. 1990).

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

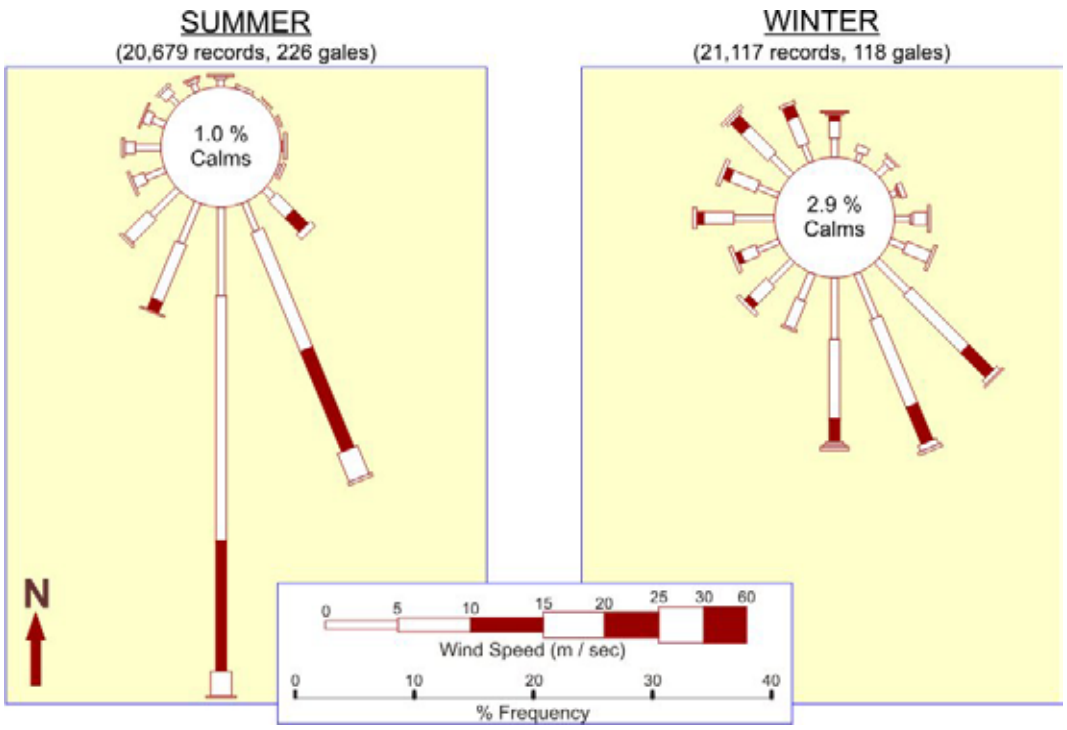


Figure 1: Rose-plots of the distribution of wind strength and direction along the South African west coast between Alexander Bay (29°S) and Saldanha Bay (33° S) during the summer and winter seasons over the period 1960 - 1997. (Redrawn from Lane and Carter 1999. Data from the SA Data Centre for Oceanography.)

2.2 Physical Oceanography

2.2.1 Topography

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

The continental shelf along the West Coast is generally wide and deep, although large variations in both depth and width occur. The shelf maintains a general north-north-west (NNW) trend north of Cape Point, being narrowest in the south between Cape Columbine and Cape Point (40 km) and widening to the north of Cape Columbine to its widest of the Orange River (180 km). The nature of the shelf break varies off the South African West Coast. 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 (to ~8 km wide) rugged rocky zone, which initially slopes steeply seawards to a depth of about 30 m and then gradually to about 80 m. The middle and outer shelf normally lack relief and slope gently seawards reaching the shelf break at a depth of approximately 500 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 Childs Bank, situated ~150 km offshore at about 31°S. A number of submarine canyons cut into the shelf between 31° and 35°S, the most prominent being the Cape Canyon and the Cape Point Valley.

The proposed prospecting activities would be undertaken within a 27,600 km^2 area in water depths of between 50 m to 200 m.

2.2.2 Sediments

Figure 2 illustrates the distribution of seabed surface sediment types off the South African west coast. As a result of erosion on the continental shelf, the unconsolidated sediment cover is generally thin, often less than 1 m. Sediments are finer seawards, changing from sand on the inner and outer shelves to muddy sand and sandy mud in deeper water. However, this general pattern has been modified considerably by biological deposition (large areas of shelf sediments contain high levels of calcium carbonate) and localised river input. An almost 500 km long mud belt (of up to 40 km wide, and of 15 m average thickness) is situated over the outer edge of the middle shelf between the Orange River and St Helena Bay (Birch *et al.* 1976). Within the broad study area, sediment is dominated by muddy sands, sandy muds, mud and some sand.

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

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

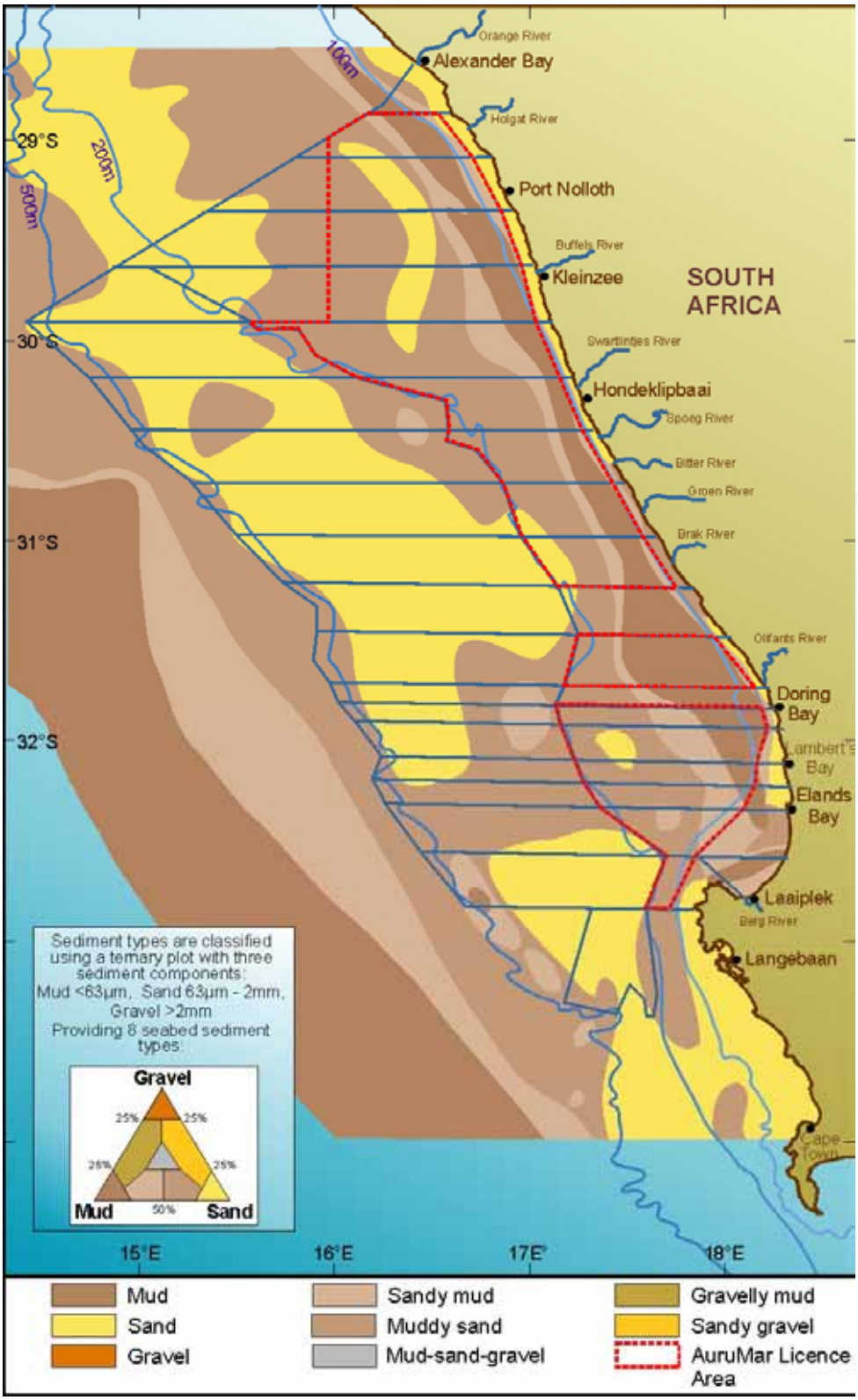


Figure 2: Map of the distribution of seabed surface sediment types off the South African west coast (redrawn from Lane and Carter 1999).

2.2.3 Water masses and sea surface temperatures

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

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

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

2.2.4 Currents & Circulation Patterns

The major coastal and oceanic current and circulation patterns along the Southern African west coast have been overviewed by Shannon and Nelson (1996) (Figure 3). Typical current speeds in the region range from 10 - 50 cm/s, and currents tend to follow major topographic features, particular the continental shelf edge. Off the coast of Angola, the prominent feature is the circular gyre on the Angola Dome, and the resultant warm, southward flowing Angola Current. Another dominant, warm current feature occurs at the opposite end of the system, where the strong Agulhas Current, flowing down the eastern South African shelf edge, along the Agulhas Bank to past Cape Agulhas, periodically results in the generation of massive, warm 'Agulhas Rings', which can result in substantial heat flux into the central South Atlantic ocean. The Agulhas Current is also capable of rounding Cape Point and generating an episodic, northward-flowing current, which can split near Cape Columbine (33°S) into the offshore Cape Canyon jet, and a northward longshore flow.

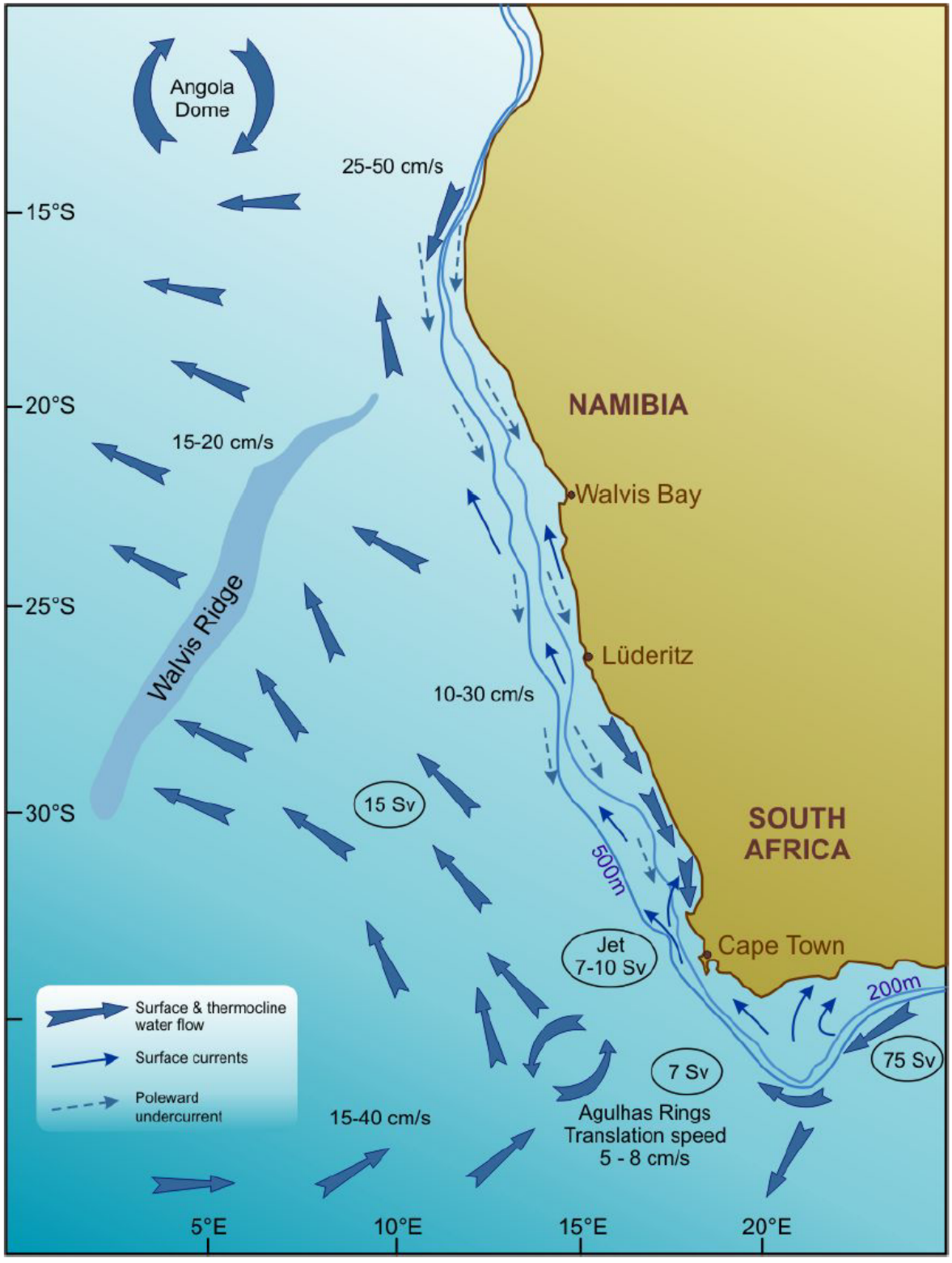


Figure 3: Circulation and volume flows of the Benguela current (after Shannon and Nelson 1996).

Between these two warm features, the Benguela west coast region is dominated more by wind-driven upwelling and swell events, than by consistent current flows. Close inshore over the southern Benguela region, there is a southward flow of cold water near the surface, down the South African west coast, which occurs during periods of barotropic reversals, and during the winter non-upwelling period (Nelson and Hutchings 1983). Significant southerly poleward flow of sub-thermocline water occurs on the continental shelf and at the shelf break, forming a poleward undercurrent, which becomes weaker and more variable north of Cape Columbine (Nelson 1989; Boyd *et al*. 1992; Boyd and Oberholster 1994; Shannon and Nelson 1996).

However, the nearshore Benguela region is primarily characterised by variable, northward flowing, longshore surface currents, generated by consistent, strong winds and swells from the south and southwest (Shillington *et al.* 1990; Shannon and Nelson 1996). These nearshore surface currents remain closely aligned with the coastline and the winds, following the major seafloor topographic features (Nelson and Hutchings 1983). The current constitutes a broad, shallow and slow NW flow between the cool coastal upwelled waters and warmer Central Atlantic surface waters further offshore, although periodic reversals can occur, particularly during Benguela Niños.. The average current speed is about 2.5 $cm.s^{-1}$ (Heydorn and Tinley 1980), but varies according to the topography. Shelf edge jet currents exist off both Cape Columbine (Nelson and Hutchings 1983) and the Cape Peninsula (Bang 1970; Shillington 1998), where flow is locally more intense (up to 50 $cm.s^{-1}$ off Cape Columbine and 70 $cm.s^{-1}$ off the Cape Peninsula).

2.2.5 Swells and Waves

Most of the west coast of southern Africa is classified as exposed, being impacted by heavy south-westerly swells generated in the roaring forties, as well as significant sea waves generated locally by the prevailing moderate to strong southerly winds characteristic of the region. Wave patterns along the West Coast are strongly influenced by the seasonal meteorology.

Typical seasonal swell-height rose-plots are shown in Figure 4 for the Summer and Winter of March 1998 - April 1999 (CSIR 2000). 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. However, winter swells are strongly dominated by those from the SW - SSW, which occur almost 80% of the time. These winter swells also 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. Large wave events usually last for 2 to 4 days, although they may last for as long as a week.

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

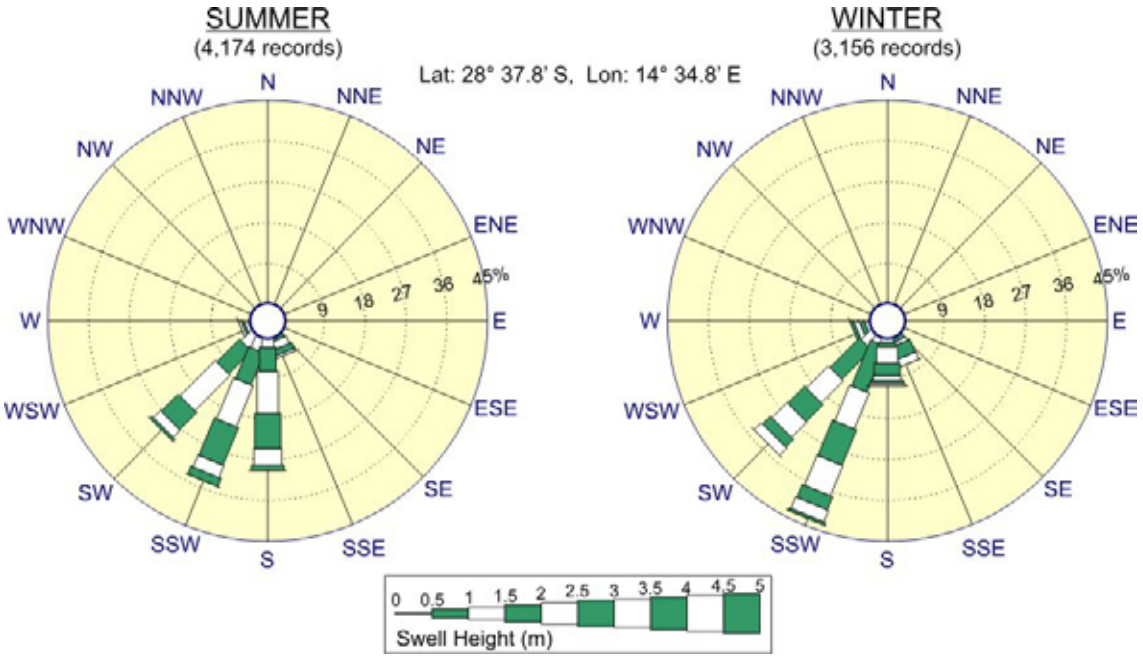


Figure 4: Rose-plots of the distribution of swell height and direction measured in 175 m water depth, 180 km offshore, west of the Orange River mouth, over the summer and winter seasons during March 1998 - April 1999 (redrawn from CSIR 2000).

2.2.5 Tides

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

2.2.6 Upwelling

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

Upwelling occurs along the West Coast from Cape Agulhas to northern Namibia. The principle upwelling centre on the West Coast lies off Lüderitz and this upwelling cell effectively divides the

Benguela Upwelling system into a northern and southern region, which are meteorologically distinct (Pitcher *et al*. 1992). In the south upwelling-favourable SE winds are most prevalent during spring and summer, and upwelling occurs mostly between September and March. Upwelling in the southern Benguela area is highly variable on macro, meso and micro scales. Both continental shelf bathymetry and upwelling winds drive upwelling in the southern Benguela which is further influenced by local topography and meteorology (Shannon 1985), resulting in centres of enhanced upwelling off Namaqualand (30°S), Cape Columbine (33°S) and Cape Peninsula (34°S) (Figure 5).

The Namaqualand upwelling zone (or Hondeklipbaai Cell) is a cool wedge-shaped zone lying between Hondeklip Bay and the Orange Bight, where the narrow shelf to the south-west of Hondeklip Bay results in enhanced upwelling. Both bathymetry and orography control upwelling at Cape Columbine. Two fronts separate a divergence zone off the Columbine Peninsula, an oceanic front at the shelf edge and a shallower inshore front.

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

2.2.7 Nutrient distribution

The cold, upwelled water is rich in inorganic nutrients, the major contributors being various forms of nitrates, phosphates and silicates (Chapman and 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.

2.2.8 Oxygen concentrations

The natural annual input of many millions of tons of organic material onto the seabed off the southern African west coast has a substantial effect on ecosystems of the Benguela region. This organic input provides most of the food requirements of the particulate and filter-feeding benthic communities that inhabit the sandy-muds of this area. However, most of the organic detritus is not directly consumed, and so enters a seabed decomposition cycle. This aerobic decomposition process is capable of depleting deep water oxygen levels, resulting in the substantial seasonal formation of deep, low-oxygen water masses off this coast. Subsequent upwelling processes can move this low-oxygen water up onto the shelf, and into nearshore waters, often with devastating effects on marine communities. In some years (the most recent being 1993-1994), depletion of oxygen in shelf waters has had severe impacts on nearshore resources.

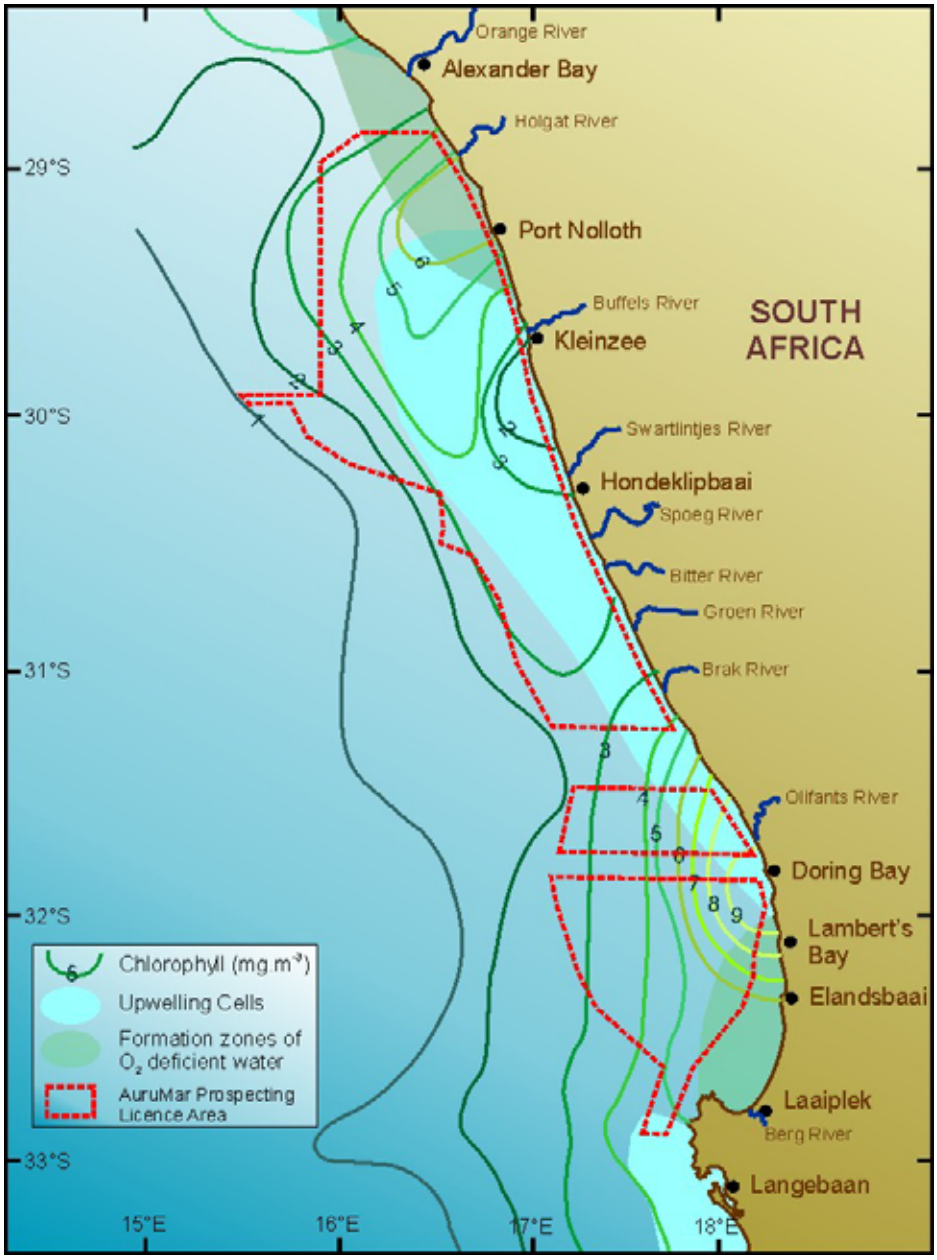


Figure 5: Map of the main upwelling areas, contours of resultant mean phytoplankton production (measured as $mg.m^{-3}$ of chlorophyll-a and areas of subsequent natural formation of low oxygen water off the South African west coast (modified from Brown *et al*. 1991).

Large scale hypoxic or anoxic conditions appear to result primarily from changes in wind patterns, which result in strong upwelling and increased nearshore plankton production, followed by calm seas, proliferation of the bloom and depletion of nutrients, followed by death, deposition and decay of vast quantities of organic material and resultant depletion of oxygen in shelf-seabed water masses (Shannon and O'Toole 2003). Subsequent upwelling can drive this low oxygen water ashore,

causing mass displacements, or even direct mortality, of seabed-associated species. As a result, the continental shelf waters of the Benguela system are characterised by low seabed oxygen concentrations (Chapman and Shannon 1985). The rate of oxygen depletion is dependent on the net organic accumulation in the sediments, and so carbon-rich biogenic mud deposits play an important role. As the mud on the shelf is distributed in discrete patches, there are corresponding primary 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 and Shannon 1985; Bailey 1991; Shannon and O'Toole 1998; Bailey 1999; Fossing *et al*. 2000)(see Figure 5). 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. Water from these zones can advect southwards as compensation flow for the surface north-westerly drift (Nelson and Hutchings 1983). De Decker (1970) showed that the occurrence of low oxygen water off Lambert's Bay is seasonal, with highest development in summer/autumn. Bailey and Chapman (1991), on the other hand, demonstrated that in the St Helena Bay area daily variability exists as a result of downward flux of oxygen through thermoclines and short-term variations in upwelling intensity.

Figure 6: The mass stranding, or 'walk-out' of rock lobsters that occurred at Elands Bay in February 2002 (Photo from http://www.waterencyclopedia.com).

Oxygen-deficient water affects the marine biota in the Benguela region at two levels. It can have sub-lethal effects, such as reduced growth and feeding, localised migrations and increased inter-moult period in rock-lobster populations (Beyers *et al*. 1994). On a larger scale, periodic low-oxygen events in the nearshore region can have catastrophic effects on the marine communities (Diaz and

Rosenberg 1995). Advancing hypoxic water associated with massive 'red-tide' blooms can lead to large-scale stranding of rock lobsters, and mass mortalities of white mussels, rocky shore biota and fish (see Section 2.3.1). Such mass 'walk-outs' of rock lobsters have resulted in the death of up to 3 million lobsters per time (Newman and Pollock 1974; Matthews and Pitcher 1996; Pitcher 1998; Cockcroft 2000; Cockcroft *et al.* 2001) (Figure 6).

2.2.9 Turbidity

Inputs of sediments into the marine environment from terrigenous sources, together with organic inputs due to the high primary productivity characterising the Benguela region, results in naturally turbid coastal waters, particularly in the nearshore areas where waves and currents keep particulate matter in suspension. Total Suspended Particulate Matter (TSPM) consists of Particulate Organic Matter (POM) and Particulate Inorganic Matter (PIM), the ratios between them varying considerably. The POM usually consists of detritus, bacteria, phytoplankton and zooplankton, and serves as a source of food for filter-feeders. PIM, on the other hand, is primarily of geological origin consisting of fine sands, silts and clays. Off Namaqualand, the PIM loading in nearshore waters is strongly related to natural inputs from the Orange River or from 'berg' wind events. On the other hand, seasonal phytoplankton production associated with upwelling events also plays an important role in determining the concentrations of POM in coastal waters.

Concentrations of suspended particulate matter in shallow coastal waters vary spatially and temporally, typically ranging from a few mg/ℓ to several tens of mg/ℓ (Bricelj and Malouf 1984; Berg and Newell 1986; Fegley *et al*. 1992). Field measurements of TSPM and PIM concentrations in the Benguela current system have indicated that outside of major flood events, background concentrations of coastal and continental shelf suspended sediments are generally <12 mg/ℓ, showing significant long-shore variation (Zoutendyk 1995). Considerably higher concentrations of PIM have, however, been reported from southern African west coast waters under stronger wave conditions associated with high tides and storms, or under flood conditions. During storm events, concentrations near the seabed may even reach up to 10,000 mg/ℓ (Miller and Sternberg 1988). In the vicinity of the Orange River mouth, where river outflow strongly influences the turbidity of coastal waters, measured concentrations ranged from 14.3 mg/ℓ at Alexander Bay just south of the mouth (Zoutendyk 1995) to peak values of 7,400 mg/ℓ immediately upstream of the river mouth during the 1988 Orange River flood (Bremner *et al.* 1990). Field measurements of TSPM and PIM concentrations in the southern Benguela are summarized in Table 1.

The current velocities typical of the Benguela (10-30 cm/s) are capable of re-suspending and transporting considerable quantities of sediment northwards. Under calm wind conditions, however, much of the suspended fraction (silt and clay) that remains in suspension for longer periods becomes entrained in the slow southward-flowing poleward undercurrent (Shillington *et al*. 1990; Rogers and Bremner 1991).

Table 1 Mean concentrations of total suspended particulate matter (TSPM) and particulate inorganic matter (PIM) expresses as mg/ℓ from coastal waters in the Benguela.

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

On the inner and middle continental shelf, the ambient currents are insufficient to transport coarse sediments typical of those depths, and re-suspension and shoreward movement of these by wave-induced currents occur primarily under storm conditions (see also Drake *et al*. 1985; Ward 1985). Data from a Waverider buoy at Port Nolloth have indicated that 2-m waves are capable of re-suspending medium sands (200 µm diameter) at ~10 m depth, whilst 6-m waves achieve this at ~42 m depth. Low-amplitude, long-period waves will, however, penetrate even deeper. Most of the sediment shallower than 90 m can therefore be subject to re-suspension and transport by heavy swells (Lane and Carter 1999).

Mean sediment deposition is naturally higher near the seafloor due to constant re-suspension of coarse and fine PIM by tides and wind-induced waves. Aggregation or flocculation of small particles into larger aggregates occurs as a result of cohesive properties of some fine sediments in saline waters. The combination of re-suspension of seabed sediments by heavy swells, and the faster settling rates of larger inorganic particles, typically causes higher sediment concentrations near the seabed. Significant re-suspension of sediments can also occur up into the water column under stronger wave conditions associated with high tides and storms. Re-suspension can result in dramatic increases in PIM concentrations within a few hours (Sheng *et al.* 1994). Wind speed and direction have also been found to influence the amount of material re-suspended (Ward 1985).

Although natural turbidity of seawater is a global phenomenon, there has been a worldwide increase of water turbidity and sediment load in coastal areas as a consequence of anthropogenic activities. These include dredging associated with the construction of harbours and coastal installations, beach replenishment, accelerated runoff of eroded soils as a result of deforestation or poor agricultural practices, and discharges from terrestrial, coastal and marine mining operations (Airoldi 2003). Such increase of sediment loads has been recognised as a major threat to marine biodiversity at a global scale (UNEP 1995).

2.3 Biological Oceanography

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). Described here are the marine communities 'typical' of the region, focusing only on dominant, commercially important and conspicuous species.

2.3.1 Plankton

Plankton comprises three components, namely phytoplankton, zooplankton and ichthyoplankton.

(a) Phytoplankton

Phytoplankton forms the base of the marine food chain, and ultimately sustains the large pelagic and demersal fish stocks that support the major commercial fisheries on the southern African west coast. During periods of upwelling the phytoplankton communities are dominated by large-celled diatoms (Andrews and Hutchings 1980; Olivieri 1983) (Figure 7), whereas during periods of water column stability, they are replaced by a small-celled community dominated by flagellates (Chapman and Shannon 1985; Pitcher *et al.* 1991). Red tides (dinoflagellate and/or ciliate blooms) are also common features in certain areas in the Benguela system, particularly in the Lamberts Bay to St Helena Bay region (Shannon and Pillar 1985; Pitcher 1998) during relaxation of upwelling cells in late summer to autumn. Red tides can reach very large proportions with sometimes spectacular effects such as the large-scale rock-lobster 'walkout' of 1997 (Cockcroft *et al*. 2000; Cockcroft 2001)(Figure 6) and the so-called 'black tide' that occurred between Cape Columbine and the Berg River mouth in 1994 (Matthews and Pitcher 1996). Most of these red-tide events occur quite close inshore although Hutchings *et al*. (1983) have recorded red-tides 30 km offshore.

As would be expected from the short- and long-term variability of the winds that induce upwelling, phytoplankton productivity in the Benguela region is variable, with short-term variability being linked to the frequency and strength of seasonal upwelling and the development and migration of oceanic temperature fronts (Shannon and Pillar 1985). Seasonal variability is also affected by sunlight and water column stability, with production being highest in the austral summer, and lowest in July/August. In the south, upwelling is also pulsed, lasting for 3-7 days and alternating with periods of relaxation or even reversal. The average distribution of phytoplankton (measured as chlorophyll-a) along the southern African West Coast (see Figure 5), reveals high-productivity areas off the Olifants River mouth and off Port Nolloth.

Phytoplankton production is directly linked to nutrient supply, seeding by existing phytoplankton or spores, and water-column stability (Brown 1986). Ideal conditions occur on the South African West Coast continental shelf, but there is longshore variation in water column stability. Boyd (1987) related variation in thermocline depth (an index of water column stability) to local variations in wind strength and shelf topography. As a result, the perennial Namaqua upwelling cell is characterised by deep mixing, whereas areas such as St Helena Bay have well-developed, shallow thermoclines. Phytoplankton production and biomass is high in the latter area but generally low in the former.

Monteiro (1997) modelled the estimated total carbon flux resulting from primary production in the Benguela upwelling system. The Lüderitz upwelling cell effectively forms an environmental boundary, dividing the region into separate northern and southern Benguela sub-systems (Shannon and Nelson 1996). The southern sub-system, with an area 10,400 km^2, supports 6.45 g C/m^2 (or 670 x 103 tons C), with the total annual carbon production estimated at 76.4 x 106 tons C/year.

(b) Zooplankton

Zooplankton biomass varies with phytoplankton production and so seasonal minima occur in winter (Andrews and Hutchings 1980). As with phytoplankton, more intense variation occurs in association with the upwelling cycle, with newly upwelled water supporting low zooplankton biomass due to initial scarcity of food, while high biomasses develop in aged upwelled water after significant phytoplankton blooms. As zooplankton blooms lag phytoplankton blooms they occur even further offshore, with zooplankton biomass being maximal 40 to 100 km offshore in summer. During winter (when no upwelling occurs in the southern Benguela region) maximal zooplankton biomass is observed close inshore, values being low offshore.

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

The macro-zooplankton (>1,600 µm) is dominated by 18 species of euphausiids (Pillar 1986; Pillar *et al.* 1992). Other important groups contributing to the southern Benguela macrozooplankton community are chaetognaths (24 species), hyperiid amphipods (over 70 species within the southern and northern Benguela) and tunicates (42 species) (Figure 7). Macrozooplankton standing stocks are greatest north of Cape Columbine (0.5 $gC.m^{-2}$) and decline southwards and eastwards to 0.1 $gC.m^{-2}$ at the eastern boundary of the West Coast.

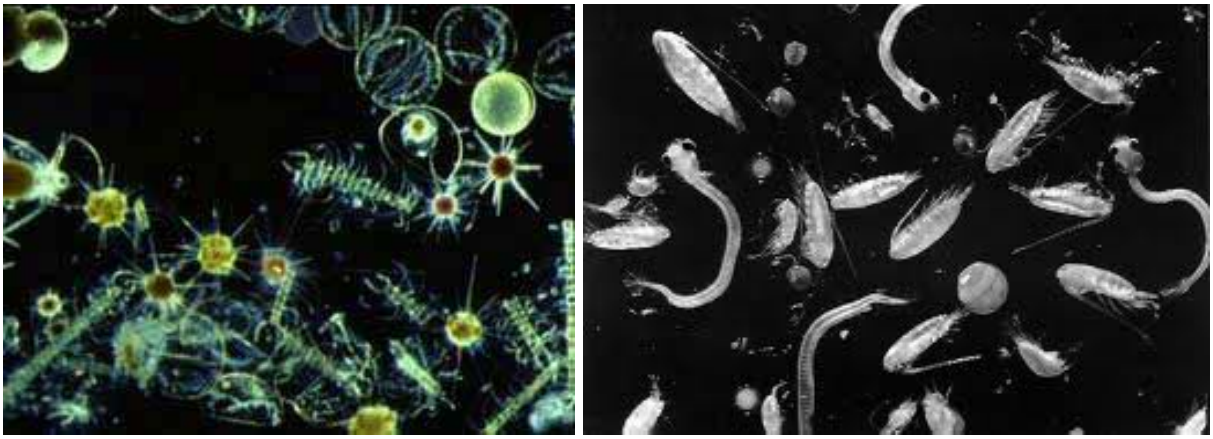


Figure 7: Phytoplankton (left, photo: hymagazine.com) and zooplankton (right, photo: mysciencebox.org) is associated with upwelling cells on the shelf.

(c) Ichthyoplankton

Ichthyoplankton comprises both fish eggs and larvae, and despite contributing only a small component to the overall plankton, is important due to the commercial fisheries of the Benguela region.

Most of the clupeoid 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 for pilchard (*Sardinops sagax*) and anchovy (*Engraulis japonicus*) are distributed on the continental shelf extending from south of St Helena Bay to Mossel Bay on the south coast (Shannon and Pillar 1986). Spawning areas are generally located downstream of the major upwelling centres and on the Western Agulhas Bank (Shannon and Pillar 1986), but spawning off St Helena Bay declined to negligible levels by 1966, possibly due to overfishing (Crawford 1980). Spawning activity takes place over a protracted period during spring and summer, with frequency of spawning being dependent on food concentration (copepod biomass). The eggs and larvae are subsequently carried around Cape Point to find their way back up the West Coast in northward flowing surface waters.

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

2.3.2 Benthic Macrofauna

The seabed is home to many benthic (meaning bottom-dwelling) macro-invertebrate communities that live on (epifauna) or burrow within (infauna) the seabed sediments, usually to a depth of ~30 cm (Figure 8). Benthic organisms are differentiated by size: macrobenthos consists of those organisms retained by a 1 mm mesh sieve, whilst those passing through comprise the meio- (0.1 - 1 mm) and microbenthos (<0.1 mm).

These organisms 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 to evaluate the status of marine ecosystems in monitoring for long-term responses and site-specific impacts (Salas *et al.* 2006). Being considered good indicators with which to measure environmental impacts (Gray 1974; Warwick 1993; Salas *et al*. 2006), numerous studies have been conducted on the southern African west-coast continental-shelf benthos, focussing primarily on mining or pollution impacts (Christie and Moldan 1977; Moldan 1978; Jackson and McGibbon 1991; Environmental Evaluation Unit 1996;

Parkins and Field 1997, 1998; Pulfrich and Penney 1999; Goosen *et al.* 2000; Steffani and Pulfrich 2004, 2007; Steffani 2007a, 2007b 2009a, 2009b, 2010a, 2010b, 2010c).

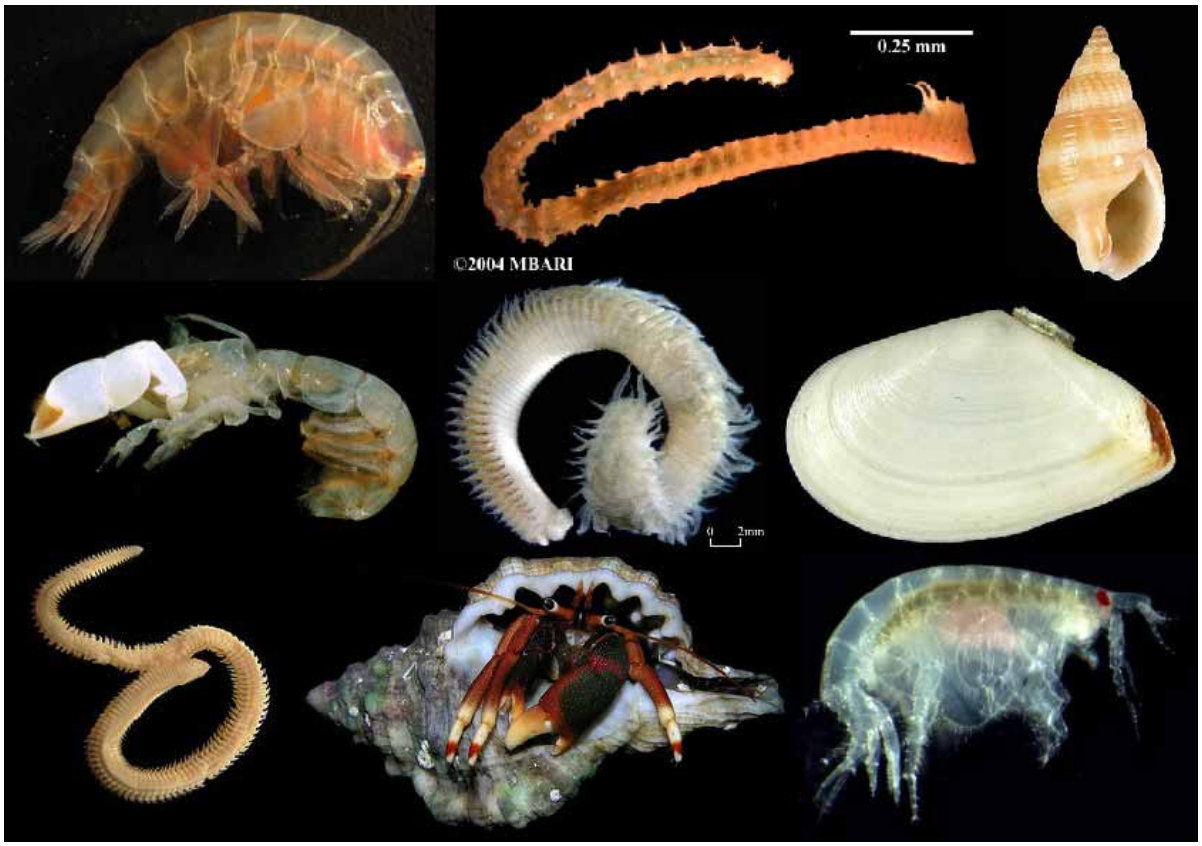


Figure 8: Benthic macrofaunal genera commonly found in nearshore sediments include: (top: left to right) *Ampelisca*, *Prionospio*, *Nassarius*; (middle: left to right) *Callianassa*, *Orbinia*, *Tellina*; (bottom: left to right) *Nephtys*, hermit crab, *Bathyporeia*.

The only systematic study to date to specifically investigate change in macrobenthic community distributions across the continental shelf has been that conducted by Christie (1974, 1976) off Lamberts Bay, South Africa, and the description below is drawn from that study. It must be noted, however, that the sediment characteristics of the mudbelt, and the impact of environmental stressors (such as low oxygen events) off Lambert's Bay are likely to differ from those in other deepwater areas along this coast. As the composition and structure of benthic communities is largely determined by these physical factors, the mid-shelf benthic communities in other areas are likely to differ from those described by Christie (1974).

Biomass distribution off Lambert's Bay shows four clear regions across the continental shelf. From the shore to 80 m deep, biomass ranges from 3.62 g/m^2 dry weight to 16.2 g/m^2. This comparatively low biomass reflects the high depositional environment on the inner continental shelf, with sediments emanating from the Orange River, or re-mobilised and transported in seabed turbulence within depths affected by swells, constantly smothering the area in freshly deposited sediment. Fine sands

almost exclusively dominate sediment texture at these depths, and molluscs, polychaete worms and cnidarians dominate the biota. In contrast, the mid-shelf mudbelt (70-120 m depth) is a particularly rich benthic habitat, and biomass attains 60.3 g/m^2. Clays, silts and very fine sands dominate the sediment texture in the mudbelt, and scavenging and carnivorous polychaete worms, together with cnidarians, dominate the fauna. The comparatively high benthic biomass in this region represents a food resource to carnivores such as the mantis shrimp, cephalopods and demersal fish species (Lane and Carter 1999). Below this mid-depth zone, very fine sands dominate the sediment texture, and biomass declines to 4.9 g/m^2 at 200 m depth and remains consistently low (<3 g/m^2) on the outer shelf, from 200 m - 500 m depth. However, crustaceans increase in relative importance in the biota, with amphipods comprising the major component at these deeper depths.

The structure of benthic communities (e.g. their species composition, diversity, abundance and biomass) within a specific biogeographic region is primarily controlled by water depth, sediment particle size and texture, and its associated biogeochemistry (e.g. Christie 1974; Gray 1974; Warwick *et al*. 1991). Long-term or permanent changes in sediment properties (e.g. grain size) affect other factors like organic content, pore-water chemistry and microbial composition (Snelgrove & Butman 1994), which in turn influence the macrofaunal composition. Recent studies have found that benthic communities can also be highly variable in space and time, on scales of hundreds of metres or less (Kenny *et al.* 1998; Kendall and Widdicombe 1999; van Dalfsen *et al*. 2000; Zajac *et al*. 2000; Parry *et al*. 2003), with evidence of mass mortalities and substantial recruitments (Steffani and Pulfrich 2004). Although a number of empirical studies have also related benthic community structure to sediment composition (Christie 1974; Warwick *et al*. 1991; Yates *et al*. 1993; Desprez 2000; Van Dalfsen *et al.* 2000), it is likely that the distribution of benthic marine communities is controlled by complex interactions between physical and biological factors at the seabed, rather than just by sediment particle size (Snelgrove and Butman 1994; Seiderer and Newell 1999).

There are clearly other natural processes operating in the deepwater shelf areas 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 and 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.

An important aim of the Offshore Biodiversity Initiative (a joint project by SANBI, WWF and M&CM) is to identify and map Vulnerable Marine Ecosystems (VMEs) for consideration during the identification of areas/ecosystems that are to receive protection. On the West Coast continental shelf vulnerable ecosystems include cold water coral reefs, sponge beds, high profile reefs and sea pen aggregations (Sink and Samaai 2010). These are all ecosystems that are easily disturbed by human activities and are slow to recover, or which may never recover. Apart from an initiative by De Beers Marine to map rocky outcrop features in their mining licence areas, data on the distribution and biodiversity of VMEs on the West Coast is limited.

2.3.3 Jellyfish

The hydrozoan jellyfish *Chrysaora lyosulla* and *Aequorea aquorea* have been observed to congregate in large densities on the shelf between Lüderitz and Port Nolloth in late summer. The centre of distribution for both species is Lüderitz to Walvis Bay and populations decrease southwards and northwards. Preferred depth ranges coincide with the mid-shelf (100 – 200 m) with decreasing densities towards the coast and offshore. Jellyfish 'swarms' have been observed off Port Nolloth, although the reasons for this aggregation and their temporal variability are presently unknown (M. Gibbons, UWC, pers. comm.).

2.3.4 Cephalopods

The major cephalopod resource in the southern Benguela, are sepiods/cuttlefish (Lipinski 1992; Augustyn *et al*. 1995). Experimental catches on the northern West Coast were dominated by *Sepia australis* and *S. hieronis*, with *Rossia enigmatica* being more common further south towards Cape Columbine. Most of the resource is distributed on the mid-shelf, *S. australis* being most abundant at depths between 60 - 190 m, whereas *S. hieronis* densities were higher in 110 – 250 m. Both species are tolerant of cold, oxygen poor waters. *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.

Although common in survey catches these species are not commercially exploited at present. North of the Orange River, however, *Todarodes angolensis* forms an important bycatch with landings fluctuating from 2,600 - 15,000 tons between 1980 and 1988 (Lipinski 1992). In the southern Benguela the fishery is dominated by *Loligo v. reynaudii* at levels similar to those for *T. angolensis* in the north.

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).

2.3.5 Fishes

(a) Pelagic species

Fish commonly found in pelagic areas off the South African West Coast comprise several species, including anchovy *Engraulis capensis*, pilchard *Sardinops sagax*, round herring/red-eye *Etrumeus whiteheadi*, chub mackerel *Scomber japonicus* and horse mackerel *Trachurus trachurus* (Figure 9) These species typically occur in mixed shoals of various sizes, the bulk of which are made up of anchovy and pilchards (Crawford *et al.* 1987).

At the start of winter every year, juveniles recruit into coastal waters in large numbers between the Orange River and Cape Columbine, particularly in the areas between the upwelling centres. They recruit 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 on the Agulhas Bank. Following spawning in Spring and early Summer, the adults then migrate back up the West Coast. Although the mechanisms are not well understood, it appears that recruitment success relies on the interaction of oceanographic events. Recruitment is

thus subject to spatial and temporal variability, and consequently the abundance of adults and juveniles of these short lived (1-3 years) small pelagic fish is highly variable both within and between species.

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).

Snoek and chub mackerel are landed mainly within the zone west of Cape Agulhas to 15°S. Both species occur in the northern Benguela region during spring and summer, move south inshore during autumn and winter, and back north offshore in spring. Their migration is related to prey availability. Snoek spawn offshore between the Western Cape and Namibia (July to October), while chub mackerel spawn and recruit inshore, moving offshore as they age.

Yellowtail is an inshore pelagic species encountered seasonally west of Cape Point, with maximum abundance between Cape Point and Cape Agulhas. It spawns along the southern Cape coast, although its recruitment areas are not well known. Adults are abundant on shallow banks inshore.

Tunas and billfish are migratory pelagic fish moving between surface waters and depths exceeding 300 m (Figure 10). Species occurring off western southern Africa include the albacore/longfin tuna *Thunnus alalunga*, yellowfin *T. albacares*, bigeye *T. obesus*, and skipjack *Katsuwonus pelamis tunas*, as well as the Atlantic blue marlin *Makaira nigricans*, the white marlin *Tetrapturus albidus* and the broadbill swordfish *Xiphias gladius* (Payne and 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). Their occurrence in the Benguela is highly seasonal.

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

A number of species of pelagic sharks are also known to occur on the West Coast, including blue *Prionace glauca*, mako *Isurus oxyrinchus* and oceanic whitetip sharks *Carcharhinus longimanus*. Common throughout the world in warm temperate waters, these species are usually found further offshore on the West Coast, although they have been caught in <100 m depth (M. Kroese, SFRI, pers. comm.).

(b) Demersal species

Roel (1987) describes the demersal communities on the continental shelf of the West Coast. As many as 116 species of bony fish, cartilaginous fish and cephalopods were identified during research trawls, and these can be split into two main groups which are primarily influenced by depth. The first group is dominated by the deepwater hake *Merluccius paradoxus* and those species normally found in depths exceeding 380 m, including monkfish *Lophius vomerinus*, kingklip *Genypterus capensis* and various squalid shark species. The second group is a less diverse shelf community (<380 m) dominated by the Cape hake *M. capensis*, and includes jacopever *Helicolenus dactylopterus*, white squid *Loligo vulgaris reynaudii*, and the catshark *Holohalaelurus regani*.

Both species of hake appear to recruit north of Cape Colombine with concentrations of juveniles of both species being found inshore on the West Coast in the bays. Kingklip inhabit predominantly hard or rocky substrates but are also found on soft muddy substrates. Juveniles are mostly found inshore, and are reported to migrate into deeper water as they age.

The deep-sea community was found to be homogenous both spatially and temporally, whereas the shelf communities showed seasonal variations in their distribution ranges. The diversity and distribution of demersal cartilagenous fishes on the West Coast is discussed by Compagno *et al.* (1991).

2.3.6 Sea Birds

Large numbers of pelagic seabirds exploit the pelagic fish stocks of the Benguela system. Duffy *et al.* (1987) listed 49 species of seabirds that occur in the Benguela region, 14 of which were defined as resident, 10 visitors from the northern hemisphere and 25 migrants from the southern Ocean. In the overall region, Cape Agulhas to northern Namibia, 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. Of the migrant pelagic seabird species the Blackbrowed Albatross, Yellownosed Albatross and Southern Giant Petrel are listed in the South African Red Data Book as “Near threatened".

Fourteen Species of seabirds breed in southern Africa; Cape Gannet, African Penguin, four species of Cormorant, White Pelican, three Gull and four Tern species. Although breeding areas are distributed along the whole coast, islands are especially important, particularly those between Dyer Island and Lambert’s Bay. The number of successfully breeding birds at the particular breeding sites varies with food abundance. This is most evident for Cape Gannets whose numbers reduced on the West Coast but increased on the south coast, Algoa Bay, in response to changed abundances in pilchard (Crawford *et al.* 1991).

Cape Gannets breed only on islands (Figure 11), with Bird Island in Lamberts Bay and Malgas Island supporting important colonies. Cape cormorants breed mainly on offshore islands (Dyer, Jutten, Seal, Dassen, Bird (Lamberts Bay), Malgas and Vondeling Islands), although the large colonies may associate with estuaries, lagoons or sewerage works. The bank and crowned cormorants are endemic to the Benguela system and both breed between Namibia and just to the west of Cape Agulhas. Although white-breasted cormorants occur between northern Namibia and the eastern Cape in southern Africa, the majority of the population is concentrated between Swakopmund and Cape Agulhas.

Most of the resident seabird species feed on fish (with the exception of the gulls, which scavenge, and feed on molluscs and crustaceans). Feeding strategies can be grouped into surface plunging (gannets and terns), pursuit diving (cormorants and penguins) and scavenging and surface seizing (gulls and pelicans). All these species feed relatively close inshore, although gannets and kelp gulls may feed some distance offshore.

Within the broader study area African penguin colonies (*Spheniscus demersus*) occur at 4 localities, namely Bird Island in Lamberts Bay, Marcus and Malgas Islands at Saldanha Bay and on Dassen Isalnd (Figure 11). The species forages at sea with most birds being found within 20 km of their colonies. African penguin distribution at sea is consistent with that of the pelagic shoaling fish, which generally occur within the 200 m isobath.

The African Penguin, Cape Gannet and Bank Cormorant are listed in the South African Red Data Book as "Vulnerable". The Caspian Term, Cape Cormorant and Crowned Cormorant are listed in the South African Red Data Book as ""Near-threatened". The Damara Tern is listed as "Endangered".

The decline in the African Penguin population is ascribed primarily to the removal of the accumulated guano from the islands during the Nineteenth Century. Penguins used to breed in burrows in the guano and are now forced to nest in the open, thereby being exposed to much greater predation and thermal stress.

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

Figure 11: Cape Gannets *Morus capensis* (left) (Photo: NACOMA) and African Penguins *Spheniscus demersus* (right) (Photo: Klaus Jost) breed primarily on offshore Islands.

2.3.7 Marine Mammals

The marine mammal fauna of the West Coast comprises between 28 and 31 species of cetaceans (whales and dolphins) and one seal species, the Cape fur seal (*Arctocephalus pusillus*). The range of cetacean species reflects largely taxonomic uncertainty at species and sub-species level, rather than uncertainty of occurrence or distribution patterns (Findlay *et al.* 1992).

(a) Cetaceans

The majority of migratory cetaceans in South African waters are large baleen whales. Populations of large baleen whales in South African waters were decimated by historical whaling and are presently a fraction of their pre-exploitation densities.

Blue (*Balaenoptera musculus*), fin (*B. physalus*), sei (*B. borealis*), minke (*B acutorostrata / B bonaerensis*) and humpback whales (*Megaptera novaeangliae*) make winter migrations through the West Coast region *en route* from Antarctic summer feeding grounds to winter breeding grounds. While blue, fin and sei whales migrate off or along the continental shelf edge (and are thus distributed in deeper waters), humpback whales migrate over the continental shelf and along the coast.

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*. While the smaller neritic form is resident (particularly over the Agulhas Bank) the larger offshore form is migratory along the African west coast, being found off Saldanha Bay in winter. Southern right whales (*Eubalaena australis*) (Figure 12) migrate into the extreme near-shore region of the West Coast (mainly south of Lamberts Bay) between June and January each year (animals may be sighted as early as April and as late as February). This population is increasing at approximately 7% per annum, yet is still probably around 10% of the pre-exploitation abundance (Best 2000).

Killer whales are found year round in the waters of the West Coast, although the seasonality of sightings within the whaling grounds (in September and October) suggests that some killer whales are highly migratory. The pygmy right whale (*Caperea marginata*) shows a strong summer seasonality in water depths of less than 50 m along the coast between Algoa Bay in the east and Walvis Bay, Namibia. Arnoux's beaked whale (*Berardius arnuxii*) has been recorded along the West Coasts to the east of 18° E during summer. Layard's beaked whale (*Mesoplodon layardii*) is distributed throughout the West Coast pelagic waters in summer and early autumn.

Four faunal provinces define the distribution of resident cetaceans within the West Coast region (after Findlay *et al.* 1992; Peddemors 1999). These include:

- *Agulhas Bank to Lamberts Bay (inshore)* - Two species, the long beaked common dolphin (*Delphinus delphis*) and the resident smaller inshore Bryde's whale appear to be strongly associated with the Agulhas Bank region and the West Coast inshore region as far north as Lambert's Bay. Although these species will be found elsewhere in southern African waters (a common dolphin species is recorded from strandings on the Namibian coast) the majority of records are from the Agulhas Bank region.
- *West Coast Inshore* – Two species, the Benguela dolphin (*Cephalorhynchus heavisidii)* (Figure 12) and the dusky dolphin (*Lagenorhynchus obscurus)* are resident over the shelf with the Benguela (Heaviside's) dolphin found inshore to the north of Cape Point and dusky dolphin found inshore west of False Bay.
- *West Coast Offshore* - Two pelagic species of cetacean, True's beaked whale (*Mesoplodon mirus*) and the dwarf sperm whale (*Kogia sima*) appear to be limited to offshore region between Cape Columbine and the Eastern Cape. A further two species, Gray's beaked whale (*Mesoplodon grayii*) and the long finned pilot whale (*Globicephala melas*) appear to be limited to the offshore region between Namibia and the Eastern Cape. These species are found in deep waters elsewhere in the world and apart from the pilot whale are recorded only as strandings on the South African coast. A localised distribution of southern right-whale dolphins is recorded off the coast of southern Namibia and may range into the northern waters of the South African West Coast region.
- *Cosmopolitan* - Killer whales (*Orcinus orca*) and minke whales (possibly *Balaenoptera acutorostrata*) are found in both continental shelf and offshore waters of the West Coast. Cuvier's beaked whale (*Ziphius cavirostris*), pygmy sperm whales (*Kogia breviceps*), False killer whales (*Pseudorca crassidens*), pygmy killer whales (*Feresa attenuata*), Risso's dolphins (*Grampus griseus*), and sperm whales (*Physeter macrocephalus*) are found throughout the

offshore waters of the West Coast. A second common dolphin species occurs in the offshore region of the West Coast.

Figure 12: The endemic Benguela Dolphin *Cephalorhynchus heavisidii* (left) (Photo: De Beers Marine Namibia), and Southern Right whale *Eubalaena australis* (right) (Photo: www.divephotoguide.com; www.aad.gov.au.

(b) Seals

The Cape fur seal (*Arctocephalus pusillus pusillus*) (Figure 13) congregates in four breeding and three non-breeding colonies between the Orange River mouth and Saldanha Bay. Five other seal species may occasionally be found as vagrants along the West Coast.

Figure 13: Colony of Cape fur seals *Arctocephalus pusillus pusillus* (Photo: Dirk Heinrich).

The largest breeding colony on the South African coast is located at Robeiland near Kleinzee. The colony at Buchu Twins, formerly a non-breeding colony, has also attained breeding status (M. Meyer, SFRI, pers. comm.). Further breeding colonies are located at Paternoster Rocks and Jacob's Reef at Cape Columbine. 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). Although the main feeding grounds are south of Lamberts Bay, a northward movement between colonies, particularly among juveniles, is known to occur. 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).

3. ASSESSMENT OF IMPACTS ON MARINE FAUNA

3.1 Assessment Procedure

The following convention was used to determine significance ratings in the assessment:

Rating	Definition of Rating
Extent *– defines the physical extent or spatial scale of the impact*	
Local	Extending only as far as the activity, limited to the site and its immediate surroundings
Regional	Limited to the Western Cape
National	Limited to the coastline of South Africa
International	Extending beyond the borders of South Africa
Duration *– the time frame over which the impact will be experienced*	
Short-term	0 – 5 years
Medium-term	6 – 15 years
Long-term	Where the impact would cease after the operational life of the activity, either because of natural processes or by human intervention
Permanent	Where mitigation either by natural processes or by human intervention would not occur in such a way or in such time span that the impact can be considered transient

Rating	Definition of Rating
Intensity *– establishes whether the magnitude of the impact is destructive or benign in relation to the sensitivity of the receiving environment*	
Zero to Very Low	Where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected.
Low	Where the impact affects the environment in such a way that natural, cultural and social functions and processes continue, albeit in a slightly modified way.
Medium	Where the affected environment is altered, but natural functions and processes continue, albeit in a modified way
High	Where environmental functions and processes are altered to the extent that they temporarily or permanently cease
Loss of Resources - *the degree to which a resource is permanently affected by the activity, i.e. the degree to which a resource is irreplaceable*	
Low	Where the activity results in a loss of a particular resource but where the natural, cultural and social functions and processes are not affected.
Medium	Where the loss of a resource occurs, but natural, cultural and social functions and processes continue, albeit in a modified way.
High	Where the activity results in an irreplaceable loss of a resource.
Status of the Impact *– describes whether the impact would have a negative, positive or zero effect on the affected environment*	
Positive	The impact benefits the environment
Negative	The impact results in a cost to the environment
Neutral	The impact has no effect
Probability *– the likelihood of the impact occurring*	
Improbable	Possibility very low either because of design or historic experience
Probable	Distinct possibility
Highly Probable	Most likely
Definite	Impact will occur regardless of preventive measures
Degree of confidence in predictions *– in terms of basing the assessment on available information and specialist knowledge*	
Low	Less than 35% sure of impact prediction.
Medium	Between 35% and 70% sure of impact prediction.
High	Greater than 70% sure of impact prediction

Using the core criteria above, the significance of the impact is determined:

Significance *– attempts to evaluate the importance of a particular impact, and in doing so incorporates extent, duration and intensity*	
VERY HIGH	Impacts could be EITHER: of high intensity at a regional level and endure in the long term; OR of high intensity at a national level in the medium term; OR of medium intensity at a national level in the long term.
HIGH	Impacts could be EITHER: of high intensity at a regional level enduring in the medium term; OR of high intensity at a national level in the short term; OR of medium intensity at a national level in the medium term; OR of low intensity at a national level in the long term; OR of high intensity at a local level in the long term; OR of medium intensity at a regional level in the long term.

Significance *– attempts to evaluate the importance of a particular impact, and in doing so incorporates extent, duration and intensity*	
MEDIUM	Impacts could be EITHER: of high intensity at a local level and endure in the medium term; OR of medium intensity at a regional level in the medium term; OR of high intensity at a regional level in the short term; OR of medium intensity at a national level in the short term; OR of medium intensity at a local level in the long term; OR of low intensity at a national level in the medium term; OR of low intensity at a regional level in the long term.
LOW	Impacts could be EITHER of low intensity at a regional level, enduring in the medium term; OR of low intensity at a national level in the short term; OR of high intensity at a local level and endure in the short term; OR of medium intensity at a regional level in the short term; OR of low intensity at a local level in the long term; OR of medium intensity at a local level, enduring in the medium term.
VERY LOW	Impacts could be EITHER of low intensity at a local level and endure in the medium term; OR of low intensity at a regional level and endure in the short term; OR of low to medium intensity at a local level, enduring in the short term.
INSIGNIFICANT	Impacts with: Zero intensity with any combination of extent and duration.
UNKNOWN	Where it is not possible to determine the significance of an impact.

Additional criteria to be considered, which could “increase” the significance rating are:

- Permanent / irreversible impacts (as distinct from long-term, reversible impacts);
- Potentially substantial cumulative effects; and
- High level of risk or uncertainty, with potentially substantial negative consequences.

Additional criteria to be considered, which could “decrease” the significance rating are:

- Improbable impact, where confidence level in prediction is high.

The relationship between the significance ratings after mitigation and decision-making can be broadly defined as follows:

Significance after Mitigation - *considering changes in intensity, extent and duration after mitigation and assuming effective implementation of mitigation measures*	
Very Low; Low	Will not have an influence on the decision to proceed with the proposed project, provided that recommended measures to mitigate negative impacts are implemented.
Medium	Should influence the decision to proceed with the proposed project, provided that recommended measures to mitigate negative impacts are implemented.
High; Very High	Would strongly influence the decision to proceed with the proposed project.

Furthermore, the degree to which an impact can be mitigated or enhanced, and reversed is defined as follows.

Degree to which impact can be mitigated – *indicates the degree to which an impact can be reduced or enhanced*	
None	No change in impact after mitigation.
Very low	Where the significance rating stays the same, but where mitigation will reduce the intensity of the impact.
Low	Where the significance rating drops by one level, after mitigation.
Medium	Where the significance rating drops by two to three levels, after mitigation.
High	Where the significance rating drops by more than three levels, after mitigation.

Reversibility of an Impact - *refers to the degree to which an impact can be reversed*	
Irreversible	Where the impact is permanent.
Partially reversible	Where the impact can be partially reversed.
Fully reversible	Where the impact can be completely reversed.

3.2 Assessment of Impacts

3.2.1 Noise and Vibrations

Of all human-generated sound sources, the most persistent in the ocean is the noise of shipping. Depending on size and speed, the sound levels radiating from vessels range from 160 to 220 db re 1 µPa at 1 m (NRC 2003). Especially at low frequencies between 5 to 100 Hz, vessel traffic is a major contributor to noise in the world's oceans and very large geographic areas are affected. Studies have shown that the noise radiating from a prospecting/mining vessel in operation is broadband (140 – 170 db re 1 µPa at 1 m) and essentially has the same noise level as that from a merchant vessel (~170 db re 1 µPa at 1 m) (Coley 1994, 1995; NRC 2003; Pidcock *et al*. 2003). The main difference is that a prospecting vessel is more or less stationary and is producing noise at a constant level, whereas a merchant vessel is moving. On the other hand, prospecting operations are conducted in comparatively shallow water, which restricts the propagation of low frequencies (>10°Hz, the spectrum that potentially propagates for long distances) to within a few kilometres. In contrast, under the right conditions, the low frequencies radiating from merchant vessels can propagate 100s of kilometres.

The potential effects of anthropogenic sounds on marine organisms include disturbance of normal behaviour resulting in possible displacement from areas, restricted detection of natural sounds (auditory "masking"), and temporary or permanent reductions in hearing sensitivity. Exposure to intense sounds for even a short period of time may result in permanent hearing loss, while lower sound levels often result in temporary or transient loss of hearing that may last for minutes, hours, or even days. Hearing, however, ultimately returns to the pre-exposure level.

Despite the large volume of international literature concerned with the description of various impacts of noise upon marine mammals (reviewed in Richardson *et al.* 1995; McCauley 1994), issues regarding the effects of long-term anthropogenic sound on individuals and populations, remain unanswered. It has to be kept in mind, however, that the ocean is a naturally noisy place and that normal physical sea noise may commonly overshadow the influence of any distant, low-level anthropogenic sounds. Findlay (1996) evaluated the potential effects of diamond mining on the marine mammals community in southern Namibia and concluded that the significance of the impact is likely to be minimal based on the assumption that the radius of elevated noise level will be restricted to ~20 km around the mining/prospecting vessel.

During sampling activities, noise and vibrations from the Sonic Vibrocorer may have an impact on macrobenthic communities, fishes and marine mammals in the area. Marine mammals and fish are known to be particularly susceptible to the sound levels associated with, for example, pile driving (Anderson 1990; Reyff 2004; Carstensen *et al*. 2006; David 2006; Carlson and Weiland 2007). Studies conducted during the construction of offshore wind-farms in Europe have indicated that the behaviour of marine mammals and fish could be influenced several kilometres away from the construction site, with avoidance distances ranging between 1.4 km for salmon and harbour porpoises, 4.6 km and 5.5 km for Bottlenose dolphins and cod, respectively (www.wind-energy-the-facts.org). Injurious levels of noise (e.g. greater than 220 dB), however, only occur with impact hammering, which generates impulsive shock characterised by a rapid build-up to a peak followed by decay. In contrast, pile driving using vibrating columns is classified as continuous or intermittent vibration, which may only last a few seconds but is characterised by a build-up to a level that is maintained for a considerable number of cycles. Consequently, sound levels for vibratory piling rigs are generally much lower than those generated by impact pile driving (Parnum 2009).

The comparatively small core-width of the Sonic Vibrocorer suggests that the noise and vibrations generated during coring are unlikely to be injurious or reach lethal amplitudes, even at the source. Any mobile marine fauna particularly sensitive to noise (e.g. dolphins, penguins and finfish species) are expected to avoid the target area once sampling activities commence and as such no direct impacts to these biota are expected during vibrocoring. There may be some temporary disturbance of benthic invertebrates in response to the vibrations, but this is likely to be at sublethal levels. Furthermore, the maximum radius over which the noise may influence is very small compared to the population distribution ranges of the potentially sensitive species.

The impact of noise generated by vibrocoring into the seabed sediments will therefore be highly localised and last only for the ~1.5 hour duration required per core.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	Local	Local
Duration	Short-term (1.5 hours per site over ~ 80 days)	Short-term
Intensity	Low	Low

Status of Impact	Negative	Negative
Probability	Improbable	Improbable
Confidence	High	High
Significance	VERY LOW	VERY LOW
Cumulative impact	None	None
Nature of Cumulative impact	Due to the sound impact lasting for only 1.5 hours per target site any form of cumulative impact is highly unlikely.	
Degree to which impact can be reversed	Fully reversible - any disturbance of behaviour, auditory "masking" or reductions in hearing sensitivity that may occur as a result of ships noise or vibrations from the vibrocorer will be temporary only due to low sound levels at the source.	
Degree to which impact may cause irreplaceable loss of resources	Negligible	
Degree to which impact can be mitigated	None – no mitigation measures possible or necessary.	

3.2.2 Sediment Removal

The samples taken during the deposit assessment and resource delineation operations remove a core of sediment from the seabed. Each sample has a surface area of ~0.02 m^2. Benthic fauna typically inhabit only the top 20 - 30 cm of sediment, and removal of the sediment cores will thus completely eliminate the benthic infaunal and epifaunal biota in the core footprints resulting in a reduction in benthic biodiversity.

The high-intensity negative impact of sediment removal is unavoidable, but as it will be site specific (*i.e*. confined to the core footprints) the impact can confidently be rated as having a very low overall significance. No mitigation measures are possible, or considered necessary for the direct loss of macrobenthos due to core sampling.

Depending on the texture of the sediments at the target sites, slumping of adjacent unconsolidated sediments into the excavation can be expected over the very short-term. Although this may result in localised disturbance of macrofauna associated with these sediments and alteration of sediment structure, it also serves as a means of natural recovery of the excavations. Studies have shown that some mobile benthic animals are capable of actively migrating vertically through overlying sediment thereby significantly affecting the recolonization of impacted areas and the subsequent recovery of sites disturbed by deposited sediments (Maurer *et al*. 1979, 1981a, 1981b, 1982, 1986; Ellis 2000; Schratzberger *et al*. 2000; but see Harvey *et al*. 1998; Blanchard and Feder 2003).

Natural rehabilitation of the seabed following mining operations, through a process involving influx of sediments and recruitment of invertebrates, has been demonstrated on the southern African continental shelf (Penney and Pulfrich 2004; Steffani 2007b, 2009a, 2009b, 2010a, 2010c). Studies on the impacts of diamond mining on benthic communities suggest that the effects can persist for at least five years (Savage 1996; van der Merwe 1996; Winckler 1999; Parkins & Field 1997,1998; Pulfrich & Penney 1999; Savage *et al.* 2001). Recovery rates of the impacted communities are variable, however, and appear to be dependent on the mining approach, sediment influx rates and the influence of natural disturbances on succession communities. The structure of the recovering communities is also highly spatially and temporally variable confirming the high natural variability in benthic communities in the region. The community developing after a mining impact depends on (1) the nature of the impacted substrate, (2) differential re-settlement of larvae in different areas, and (3) environmental factors such as near-bottom dissolved oxygen concentrations. Indications of significant recruitments and natural mortalities in recovering succession communities has provided evidence of natural disturbances, possibly related to low-oxygen events (Pulfrich and Penney 1999). Savage *et al.* (2001) noted similarities in apparent levels of disturbance between mined and unmined areas off the southern African west coast, and areas of the Oslofjord in the NE Atlantic Ocean, which is known to be subject to periodic low oxygen events. They concluded that the lack of clear separation of mined from unmined samples suggests that short-term physical disturbance resulting from mining is no more stressful than regular anoxic events typical of the West Coast continental shelf area.

However, relative to mining, sampling causes disturbance at a significantly smaller scale and in scattered pockets. Accelerated recovery of disturbed sediments and the associated benthic communities can therefore be expected.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	Local	Local
Duration	Short-term	Short-term
Intensity	Low	Low
Status of Impact	Negative	Negative
Probability	Definite	Definite
Confidence	High	High
Significance	VERY LOW	VERY LOW
Cumulative impact	None during the sampling campaign	None during the sampling campaign
Nature of Cumulative impact	Total area impacted by sediment removal during sampling campaign will not have cumulative effects.	
Degree to which impact can be reversed	Removal of sediments and associated macrofaunal communities is irreversible. Recovery of excavations through sediment influx, and	

	recolonisation will occur over the short-term through recruitment and immigration from adjacent areas.
Degree to which impact may cause irreplaceable loss of resources	Negligible considering total surface area of seabed affected.
Degree to which impact can be mitigated	None – no mitigation measures possible or necessary.

3.2.3 Crushing

Some disturbance or loss of adjacent benthic biota can also be expected as a result of the placement on the seabed of the 6 x 6 m frame into which the sampling tool is mounted. Epifauna and infauna beneath the footprint of the frame may be smothered or crushed resulting in a reduction in benthic biodiversity. Crushing is likely to primarily affect soft-bodied species as some molluscs and crustaceans may be robust enough to survive (see for example Savage *et al.* 2001). The impacts are highly localised, and temporary as recolonization will occur over the short-term from adjacent undisturbed sediments.

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	Local	Local
Duration	Short-term (1.5 hours per site)	Short-term
Intensity	Low	Low
Status of Impact	Negative	Negative
Probability	Highly probable	Highly probable
Confidence	High	High
Significance	VERY LOW	VERY LOW
Cumulative impact	None	None
Nature of Cumulative impact	Total area impacted by frame during sampling campaign will not have cumulative effects.	
Degree to which impact can be reversed	Loss through crushing is irreversible. Recovery of impacted biota will occur over the short-term through recruitment and immigration from adjacent areas.	
Degree to which impact may cause irreplaceable loss of resources	Negligible considering total surface area of seabed affected.	
Degree to which impact can be mitigated	None – no mitigation measures possible or necessary.	

4. CONCLUSIONS AND RECOMMENDATIONS

If all environmental guidelines and appropriate mitigation measures advanced in the Basic Assessment Report for the proposed project, are implemented, there is no reason why the proposed sampling campaigns should not proceed. The macrofaunal communities on the continental shelf are largely ubiquitous throughout the southern African West Coast region, being particular only to substrate type or depth zone, and no rare or endangered species have been identified in unconsolidated sediments. Furthermore, as they are frequently exposed to natural disturbances (e.g. low oxygen events, sediment inputs) the marine biota of the Benguela system are inherently robust and recovery of benthic macrofaunal communities to sustainable ecological succession can occur within 1-5 years (Ellis 2001, Newell *et al.* 1998). However, as the structure of mature soft-sediment benthic communities is naturally highly variable, it is difficult to measure when 'equilibrium' has been attained. As a result, it would not be expected that the composition and structure of 'recovered' communities will be identical to the pre-sampling state, which may differ somewhat in physical characteristics. When seen in context against the high degree of natural disturbance, the inherent high variability of benthic communities, and the extremely localised area of seabed affected by core-sampling, the significance of the impacts of the sampling campaign on the benthic macrofauna, both through sediment removal and potential crushing, can be considered negligible.

Reactions to sound by marine fauna depend on a multitude of factors including species, state of maturity, experience, current activity, reproductive state, time of day (Wartzok *et al.* 2004; Southall *et al.* 2007). If a marine animal does react briefly to an underwater sound by changing its behaviour or moving a small distance, the impacts of the change are unlikely to be significant to the individual, let alone the population as a whole (NRC 2005). Noise and vibration effects on marine fauna as a result of the sampling campaign can therefore be considered negligible.

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APPENDIX 4

FISHING INPUT

CAPRICORN FISHERIES MONITORING cc
Reg. No. CK 99 / 24441 / 23
Unit 15 Foregate Square, Table Bay Boulevard, Cape Town, South Africa.
P.O. Box 50035, Waterfront, Cape Town 8002
Tel : (021) 425 1994 Fax: (021) 425 6226 Cell: 082 – 788 6737

14th April 2011

CCA Environmental
Unit 35 Roeland Square
Cnr Roeland Street and Drury Lane
Cape Town
8001
R.S.A

Dear Sir/Madam

Project Reference: Proposed prospecting activities within sea areas 1c, the inshore portions of 2c, 3c, 4c and 5c, as well as 6c, 7c, 8c, 9c, 10c, 12c, 14c, 15c, 16c, 17c, 18c and 20c (De Beers Consolidated Mines Ltd).

Please find herewith attached an assessment of the commercial fisheries active on the west coast of South Africa in relation to proposed marine prospecting activities within the prospecting rights areas held by De Beers Consolidated Mines Ltd.

This report was compiled on behalf of CCA Environmental (Pty) Ltd for their use in undertaking an Environmental Impact Assessment for the proposed prospecting activities to be undertaken by AuruMar (Pty) Ltd, the operator. We do hereby declare that we are financially and otherwise independent of the applicant and CCA Environmental

Kind Regards,

CapFish cc
Vat no. 4960195479
Reg. no: CK 99/24441/23

Sarah Wilkinon

FISHERIES AND OTHER HARVESTING

The South African fishing industry consists of approximately 20 commercial sectors operating with the 200 nautical mile Exclusive Economic Zone (EEZ)[1]. The western coastal shelf is a highly productive upwelling ecosystem (Benguela current) and supports a number of fisheries.

The largest and most economically valuable of these are the demersal trawl and long-line fisheries, targeting the cape hakes *Merluccius paradoxus* and *M. capensis*, and the pelagic purse-seine fishery targeting pilchard (*Sardinops sagax)*, anchovy (*Engraulis encrasicolus*) and round herring (*Etrumeus whitheadii*). Secondary commercial species in the hake-directed fisheries include an assemblage of demersal (bottom-dwelling) fish of which monk fish (*Lophius vomerinus*) and snoek (*Thyrsites atun*) are the most important commercial species. Other fisheries active on the West Coast are the pelagic long-line fishery for tunas and swordfish and the tuna pole and traditional linefish sectors. West Coast rock lobster (*Jasus lalandi*) is an important trap fishery exploited close to the shoreline (waters shallower than 100 m) including the intertidal zone and kelp beds off the West Coast. The main commercial sectors operating in the vicinity of the study area are discussed below:

(a) Demersal longline

The target species of this fishery is hake (*M. capensis* and *M. paradoxus*) with a small non-targeted commercial bycatch species that includes kingklip. The hake long-line fishery is a relatively new fishery in South Africa. Currently 64 vessels are active within this sector and operate from all major fishing harbours. The fishery is directed both in inshore and offshore areas. Inshore hake long-lining is restricted in the number of hooks that may be set per line (a maximum of 5 000 hooks per day), while offshore long-lining may only take place in water deeper than 110 m and is restricted to a maximum of 20 000 hooks per line.

Bottom-set long-line gear is robust and comprises two lines as well as dropper lines with subsurface floats attached. Lines are set over mostly rocky bottoms adjacent to demersal trawling grounds. Demersal long-lines are anchored at either end and marked by an array of large buoys. Boats “stand by” their gear and are also restricted in their movements when hauling and shooting. Hooks are spaced about one fathom apart and lines can be up to 20 km long.

On the West Coast, demersal long-liners operate in well-defined offshore areas extending along the shelf break from Port Nolloth to Cape Agulhas where they may be found working between the 200 and 750 m bathycontours. Well the predominant areas of operation lie well to the west of the study area, isolated fishing events have been recorded in the study area.

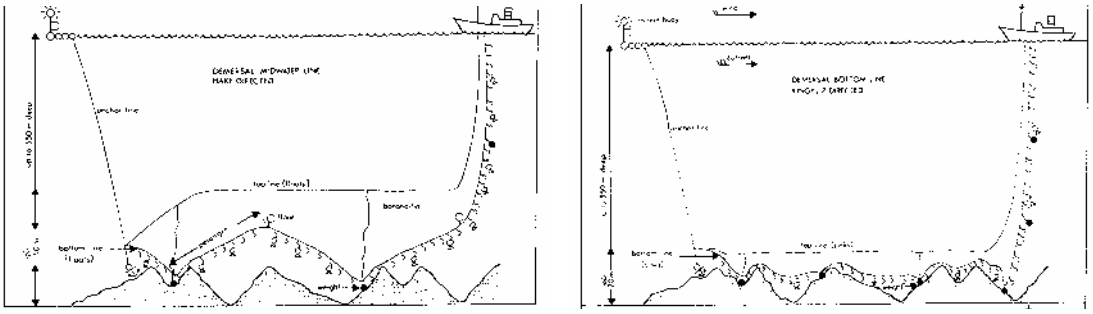
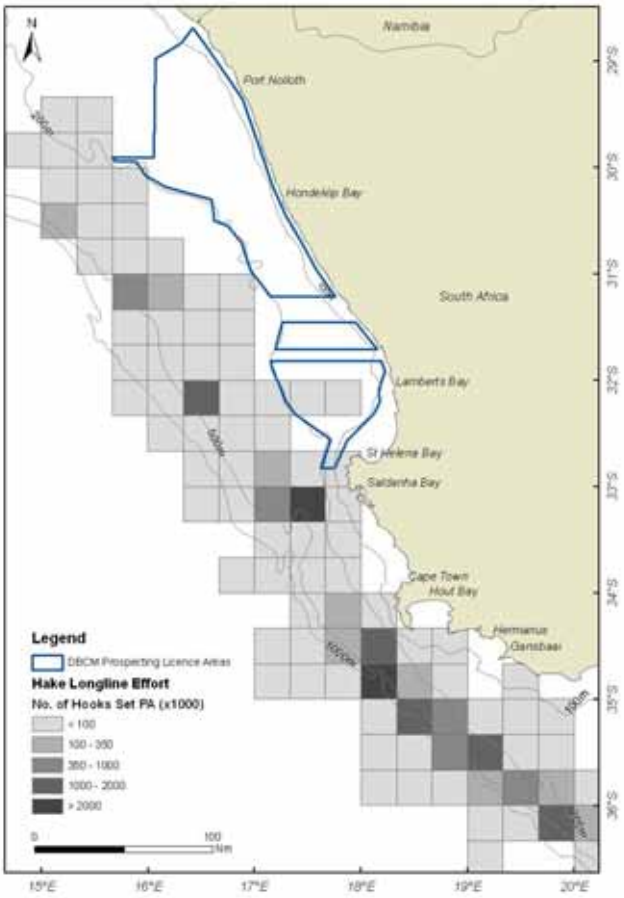


Figure 4.17: Diagram illustrating typical fishing gear deployed when fishing for demersal (bottom dwelling) species (gear for hake on left and kingklip on right).

[1] The Exclusive Economic Zone is the zone extending from the coastline out to a distance of 200 nautical miles within which South Africa holds exclusive economic rights.

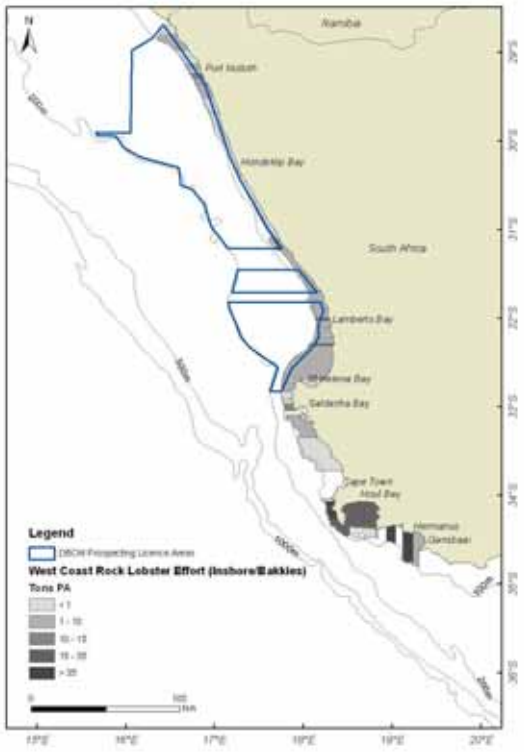


Distribution of effort within the demersal hake-directed long-line fishery.

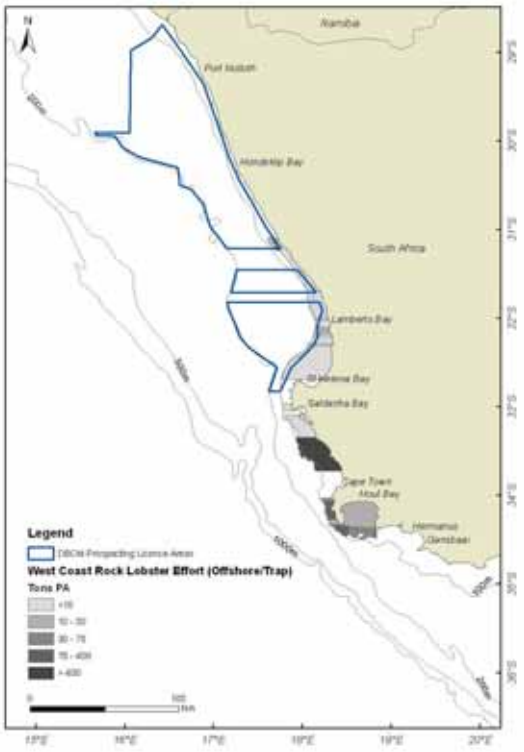
(b) West Coast Rock lobster trap fishery

This fishery targets the West Coast rock lobster (*Jasus lalandii*) along the West Coast. The fishery is divided into an inshore and offshore fishery which makes use of hoop-nets and traps respectively. The inshore fishery operates from the coast up to one nautical mile offshore (predominantly waters shallower than 15 m) while the offshore trap fishery operates up to a depth of 100 m. Catch and effort figures are recorded according to management zone and prospecting licence areas coincide with zones A,B and C. Effort is seasonal (1st November to 20th June) and small boats operate from the shore and coastal harbours.

Activity within Zone A (extending from the Namibia/RSA border up to 31° 6' S is currently solely restricted to the hoop-net fishery and therefore is unlikely to coincide with the prospecting licence area North of this point.



Distribution of catch within the inshore West Coast rock lobster fishery.



Distribution of catch within the offshore West Coast rock lobster fishery.

(c) Pelagic purse-seine

The small pelagic purse-seine fishery targets pilchard (*Sardinops sagax*) and anchovy (*Engraulis encrasicolus*) and is the second most economically valuable commercial fishery in South Africa. Approximately 100 vessels operate within this fishery, predominantly along the West Coast from the harbours St Helena, Saldanha, Cape Town and Hout Bay. As the targeted species are coastal, fishing effort is not displaced more than 50 nm from harbours. Typically a vessel will fish overnight and return the following day to the harbour to offload their catch. A schematic diagram of the typical gear configuration of a pelagic purse-seiner is shown below.

The prospecting area overlaps with the pelagic fishery. The concentration of pelagic purse-seine effort is the greatest inshore of the 100 m isobath, with effort increasing significantly towards the shallower portions of the study area.

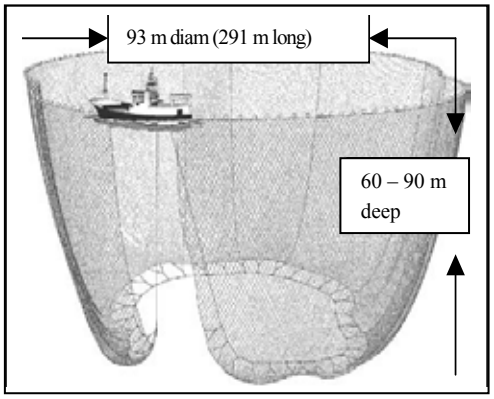
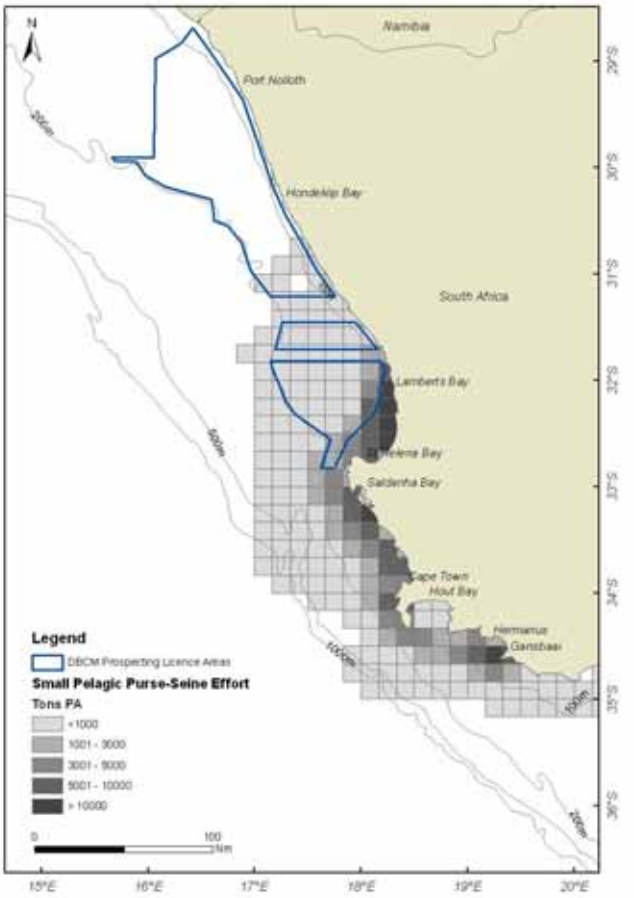


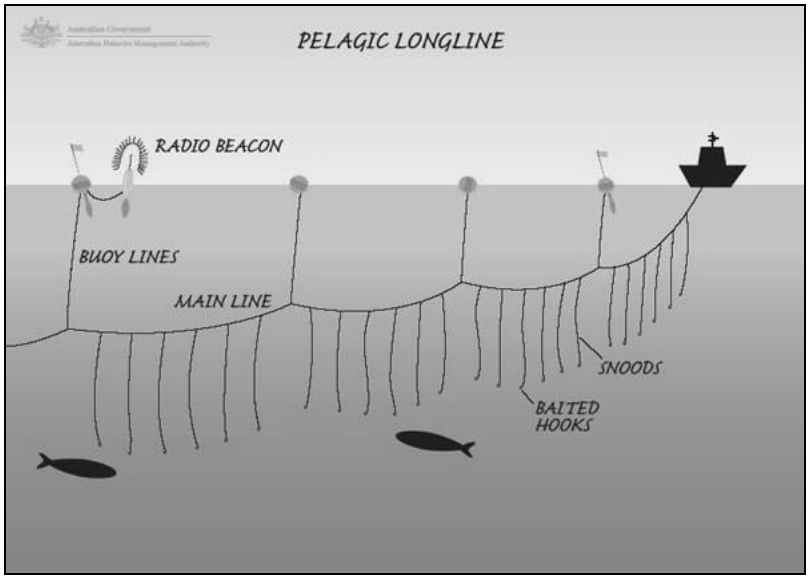
Figure 4.20: Typical gear configuration of a pelagic purse-seiner.



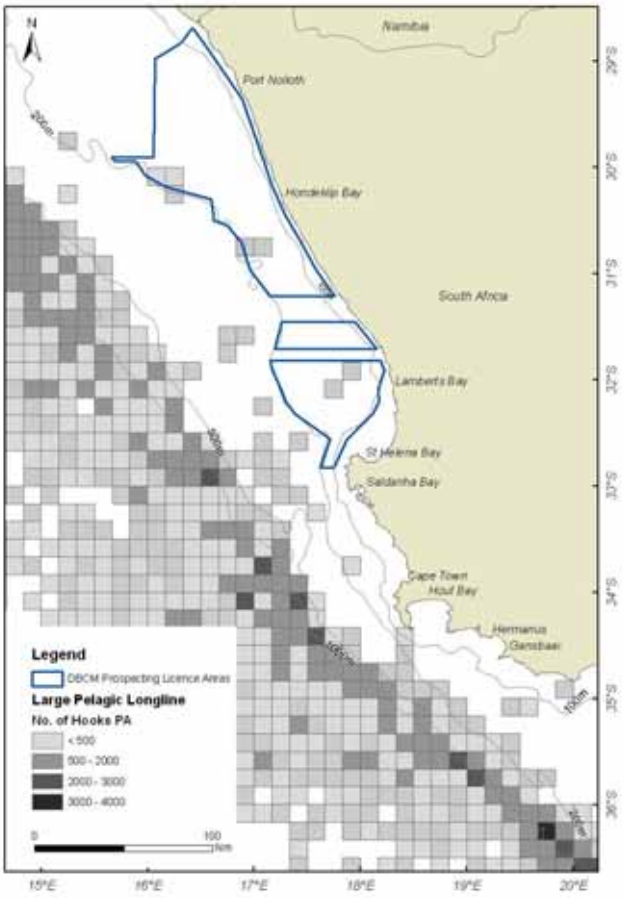
Distribution of catch within the pelagic purse-seine fishery.

(d) Pelagic long-lining (large pelagic species)

The pelagic tuna long-line fishery is another fishery that occurs extensively off the West Coast of South Africa. The fishery targets tunas (including bluefin *Thunnus thynnus*, yellowfin *T. albacares*, bigeye *T. obsesus* and longfin or albacore *T. alalunga*), shark and broadbill swordfish (*Xiphias gladius).* Long-lining is carried out both by local and foreign vessels that fish around the entire South African coast. Approximately 30 vessels (17 tuna-directed and 14 swordfish-directed) are presently operational within this sector with activity predominantly centred along the continental shelf break and offshore. Occasional fishing events have been recorded closer inshore in the vicinity of the prospecting licence areas. The figure below shows the annual distribution of long-line tuna effort on the West Coast.



Typical pelagic longline gear configuration (tuna, swordfish and shark).

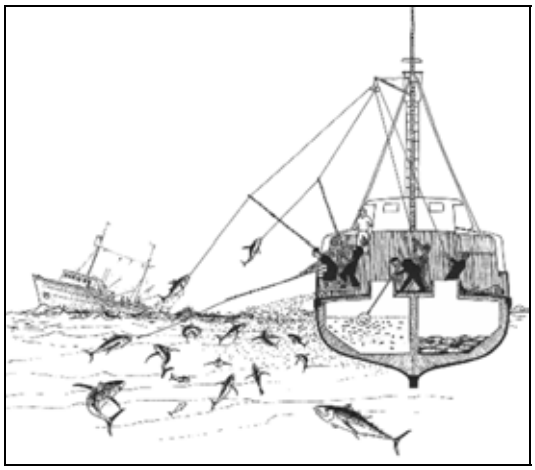


Distribution of catch within the pelagic long-line fishery.

(e) Tuna Pole (large pelagic species)

The tuna pole fishery is conducted using handline, pole, rod and real fishing gear. Tuna species, predominantly yellowfin tuna (*Thunnus albacares*) and albacore (*Thunnus alalunga*), are targeted while other species caught include snoek, angel fish, oil fish, escolar, dorado, wahoo, yellowtail and squid. The fishery operates on the West Coast and sees an average annual catch of 3500 tons.

The tuna pole fleet comprises up to 200 vessels (and a maximum of 3600 crew) operating predominantly from Cape Town harbour. The fishery is seasonal with most of the effort conducted from October to early May. Vessels work from the 100m bathycontour offshore and particularly along the shelf break at 500m. These vessels drift whilst attracting and catching shoals of pelagic tunas. Once a shoal of tuna is located, water is sprayed alongside the vessel to attract fish to the surface, at which point they are caught with baited hooks and gaffed on board.



Schematic diagram of pole and line operation (www.fao.org/fishery).

APPENDIX 5

CONVENTION FOR ASSIGNING SIGNIFICANCE RATINGS TO IMPACTS

CONVENTION FOR ASSIGNING SIGNIFICANCE RATINGS TO IMPACTS

Specialists will consider ten rating scales when assessing potential impacts. These include:

- Extent of impact;
- Duration of impact;
- Intensity of impact;
- Status of impact;
- Probability of impact occurring;
- Degree of confidence of assessment;
- Significance of impact;
- Degree to which a resource is lost;
- Degree to which impact can be mitigated; and
- Reversibility of impact

In assigning significance ratings to potential impacts before and after mitigation specialists are instructed to follow the approach presented below:

1. The core criteria for determining significance ratings are “extent” (Section 1.1), “duration” (Section 1.2) and “intensity” (Section 1.3). The preliminary significance ratings for combinations of these three criteria are given in Section 1.8.

2. Additional criteria to be considered, which could “increase” the significance rating if deemed justified by the specialist, with motivation, are the following:
   - Permanent / irreversible impacts (as distinct from long-term, reversible impacts);
   - Potentially substantial cumulative effects (see Item 9 below); and
   - High level of risk or uncertainty, with potentially substantial negative consequences.

3. Additional criteria to be considered, which could “decrease” the significance rating if deemed justified by the specialist, with motivation, is the following:
   - Improbable impact, where confidence level in prediction is high.

4. The status of an impact is used to describe whether the impact will have a negative, positive or neutral effect on the surrounding environment. An impact may therefore be negative, positive (or referred to as a benefit) or neutral (Section 1.5).

5. Describe the degree to which a resource is impacted (Section 1.4).

6. Describe the impact in terms of the probability of the impact occurring (Section 1.6) and the degree of confidence in the impact predictions, based on the availability of information and specialist knowledge (Section 1.7).

7. When assigning significance ratings to impacts *after mitigation*, the specialist needs to:
   - First, consider probable changes in intensity, extent and duration of the impact after mitigation, assuming effective implementation of mitigation measures, leading to a revised significance rating; and
   - Then moderate the significance rating after taking into account the likelihood of proposed mitigation measures being effectively implemented. Consider:
     - Any potentially significant risks or uncertainties associated with the effectiveness of mitigation measures;
     - The technical and financial ability of the proponent to implement the measure; and
     - The commitment of the proponent to implementing the measure, or guarantee over time that the measures would be implemented.

8. Describe the degree to which an impact can be mitigated or enhanced (Section 1.9) and reversed (Section 1.10).

9. The cumulative impacts of a project should also be considered. “Cumulative impacts” refer to the impact of an activity that may become significant when added to the existing activities currently taking place within the surrounding environment.

10. Where applicable, assess the degree to which an impact may cause irreplaceable loss of a resource. A resource assists in the functioning of human or natural systems, i.e. specific vegetation, minerals, water, agricultural land, etc.

The significance ratings are based on largely objective criteria and inform decision-making at a project level as opposed to a local community level. In some instances, therefore, whilst the significance rating of potential impacts might be “low” or “very low”, the importance of these impacts to local communities or individuals might be extremely high. The importance which I&APs attach to impacts must be taken into consideration, and recommendations should be made as to ways of avoiding or minimising these negative impacts through project design, selection of appropriate alternatives and / or management.

The relationship between the significance ratings after mitigation and decision-making can be broadly defined as follows (see overleaf): substance

Significance rating	Effect on decision-making
VERY LOW; LOW	Will not have an influence on the decision to proceed with the proposed project, provided that recommended measures to mitigate negative impacts are implemented.
MEDIUM	Should influence the decision to proceed with the proposed project, provided that recommended measures to mitigate negative impacts are implemented.
HIGH; VERY HIGH	Would strongly influence the decision to proceed with the proposed project.

1.1 EXTENT

“Extent” defines the physical extent or spatial scale of the impact.

Rating	Description
LOCAL	Extending only as far as the activity, limited to the site and its immediate surroundings. Specialist studies to specify extent.
REGIONAL	Western Cape. Specialist studies to specify extent.
NATIONAL	South Africa
INTERNATIONAL	

1.2 DURATION

“Duration” gives an indication of how long the impact would occur.

Rating	Description
SHORT TERM	0 - 5 years
MEDIUM TERM	5 - 15 years
LONG TERM	Where the impact will cease after the operational life of the activity, either because of natural processes or by human intervention.
PERMANENT	Where mitigation either by natural processes or by human intervention will not occur in such a way or in such time span that the impact can be considered transient.

6.1.3 INTENSITY

"Intensity" establishes whether the impact would be destructive or benign.

Rating	Description
ZERO TO VERY LOW	Where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected.
LOW	Where the impact affects the environment in such a way that natural, cultural and social functions and processes continue, albeit in a slightly modified way.
MEDIUM	Where the affected environment is altered, but natural, cultural and social functions and processes continue, albeit in a modified way.
HIGH	Where natural, cultural and social functions or processes are altered to the extent that it will temporarily or permanently cease.

1.4 LOSS OF RESOURCES

"Loss of resource" refers to the degree to which a resource is permanently affected by the activity, i.e. the degree to which a resource is irreplaceable.

Rating	Description
LOW	Where the activity results in a loss of a particular resource but where the natural, cultural and social functions and processes are not affected.
MEDIUM	Where the loss of a resource occurs, but natural, cultural and social functions and processes continue, albeit in a modified way.
HIGH	Where the activity results in an irreplaceable loss of a resource.

1.5 STATUS OF IMPACT

The status of an impact is used to describe whether the impact would have a negative, positive or zero effect on the affected environment. An impact may therefore be negative, positive (or referred to as a benefit) or neutral.

1.6 PROBABILITY

"Probability" describes the likelihood of the impact occurring.

Rating	Description
IMPROBABLE	Where the possibility of the impact to materialise is very low either because of design or historic experience.
PROBABLE	Where there is a distinct possibility that the impact will occur.
HIGHLY PROBABLE	Where it is most likely that the impact will occur.
DEFINITE	Where the impact will occur regardless of any prevention measures.

1.7 DEGREE OF CONFIDENCE

This indicates the degree of confidence in the impact predictions, based on the availability of information and specialist knowledge.

Rating	Description
HIGH	Greater than 70% sure of impact prediction.
MEDIUM	Between 35% and 70% sure of impact prediction.
LOW	Less than 35% sure of impact prediction.

1.8 SIGNIFICANCE

"Significance" attempts to evaluate the importance of a particular impact, and in doing so incorporates the above three scales (i.e. extent, duration and intensity).

Rating	Description
VERY HIGH	Impacts could be EITHER: of ***high intensity*** at a ***regional level*** and endure in the ***long term***; OR of ***high intensity*** at a ***national level*** in the ***medium term***; OR of ***medium intensity*** at a ***national level*** in the ***long term.***
HIGH	Impacts could be EITHER: of ***high intensity*** at a ***regional level*** and endure in the ***medium term***; OR of ***high intensity*** at a ***national level*** in the ***short term***; OR of ***medium intensity*** at a ***national level*** in the ***medium term;*** OR of ***low intensity*** at a ***national level*** in the ***long term***; OR of ***high intensity*** at a ***local level*** in the ***long term***; OR of ***medium intensity*** at a ***regional level*** in the ***long term.***
MEDIUM	Impacts could be EITHER: of ***high intensity*** at a ***local level*** and endure in the ***medium term***; OR of ***medium intensity*** at a ***regional level*** in the ***medium term***; OR of ***high intensity*** at a ***regional level*** in the ***short term***; OR of ***medium intensity*** at a ***national level*** in the ***short term***; OR of ***medium intensity*** at a ***local level*** in the ***long term***; OR of ***low intensity*** at a ***national level*** in the ***medium term;*** OR of ***low intensity*** at a ***regional level*** in the ***long term.***
LOW	Impacts could be EITHER of ***low intensity*** at a ***regional level*** and endure in the ***medium term***; OR of ***low intensity*** at a ***national level*** in the ***short term***; OR of ***high intensity*** at a ***local level*** and endure in the ***short term***; OR of ***medium intensity*** at a ***regional level*** in the ***short term***; OR of ***low intensity*** at a ***local level*** in the ***long term***; OR of ***medium intensity*** at a ***local level*** and endure in the ***medium term.***
VERY LOW	Impacts could be EITHER of ***low intensity*** at a ***local level*** and endure in the ***medium term***; OR of ***low intensity*** at a ***regional level*** and endure in the ***short term***; OR of ***low to medium intensity*** at a ***local level*** and endure in the ***short term.***
INSIGNIFICANT	Impacts with: Zero to very low intensity with any combination of extent and duration.
UNKNOWN	In certain cases it may not be possible to determine the significance of an impact.

1.9 DEGREE TO WHICH IMPACT CAN BE MITIGATED

This indicates the degree to which an impact can be reduced / enhanced.

Rating	Description
NONE	No change in impact after mitigation.
VERY LOW	Where the significance rating stays the same, but where mitigation will reduce the intensity of the impact.
LOW	Where the significance rating drops by one level, after mitigation.
MEDIUM	Where the significance rating drops by two to three levels, after mitigation.
HIGH	Where the significance rating drops by more than three levels, after mitigation.

1.10 REVERSIBILITY OF AN IMPACT

This refers to the degree to which an impact can be reversed.

Rating	Description
IRREVERSIBLE	Where the impact is permanent.
PARTIALLY REVERSIBLE	Where the impact can be partially reversed.
FULLY REVERSIBLE	Where the impact can be completely reversed.

APPENDIX 6

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