



Amendment of Environmental Management Programmes for  
Mining Rights 554MRC, 10025MR, 512MRC and 513MRC

Volume 2: Mining Right 554MRC

SLR Project No.: 720.01087.00001

Report No.: 2

Revision No.: 0

November 2017

Alexkor RMC Pooling and Sharing Joint Venture





Amendment of Environmental Management Programmes for  
Mining Rights 554MRC, 10025MR, 512MRC and 513MRC

Volume 2: Mining Right 554MRC

SLR Project No.: 720.01087.00001

Report No.: 2

Revision No.: 0

November 2017

Alexkor RMC Pooling and Sharing Joint Venture



**DOCUMENT INFORMATION**

<b>Title</b>	Amendment of Environmental Management Programmes for Mining Rights 554MRC, 10025MR, 512MRC and 513MRC
<b>Sub-title</b>	Volume 2: Mining Right 554MRC
<b>Project Manager</b>	Jeremy Blood
<b>Project Manager e-mail</b>	jblood@slrconsulting.com
<b>Authors</b>	Jeremy Blood and Jeremy Midgely
<b>Reviewer</b>	Andrew Bradbury
<b>Client</b>	Alexkor RMC Pooling and Sharing Joint Venture
<b>Date last printed</b>	2017/11/08
<b>Date last saved</b>	2017/11/08
<b>Keywords</b>	Alexkor RMC; diamonds; Sea Concessions a, b & c; Orange River; Mining Rights 554MRC, 10025MR, 512MRC & 513MRC
<b>Project Number</b>	720.01087.00001
<b>Report Number</b>	2
<b>Revision Number</b>	0
<b>Status</b>	Draft report for I&AP review and comment
<b>Issue Date</b>	November 2017

**REPORT COMPILED BY:** Jeremy Blood and Jeremy Midgely


.....

Jeremy Blood Pr.Sci.Nat.; CEAPSA  
SLR Senior Environmental Assessment Practitioner



.....

Jeremy Midgely Pr.Sci.Nat.  
PRM

**REPORT REVIEWED BY:** Andrew Bradbury and Neil Fraser


.....

Andrew Bradbury Pr.Sci.Nat.  
SLR Technical Director: Cape Town



.....

Neil Fraser Pr.Sci.Nat.; MAusIMM  
PRM Director

This report has been prepared by an SLR Group company with all reasonable skill, care and diligence, taking into account the manpower and resources devoted to it by agreement with the client. Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

No warranties or guarantees are expressed or should be inferred by any third parties.

This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.





# VOLUMES OF THE EMPR AMENDMENT PROCESS

## **Volume 1: EMPR Amendment Overview**

Volume 1 includes supporting information applicable to all four marine mining right areas, including the key legislative requirements, public participation process, specialist studies and baseline description.

## **Volume 2: Mining Right 554MRC**

Volume 2 deals with the coastal and marine operations in the surf zone, Sea Concession 1a, 2a, 3a and 1b), as well as the management/rehabilitation of the Orange River Mouth Estuary.

## **Volume 3: Mining Right 10025MR**

Volume 3 deals with Sea Concession 1c operations.

## **Volume 4: Mining Right 512MRC**

Volume 4 deals with Sea Concession 4a operations.

## **Volume 5: Mining Right 513MRC**

Volume 5 deals with Sea Concession 4b operations.



# AMENDMENT OF ENVIRONMENTAL MANAGEMENT PROGRAMMES FOR MINING RIGHTS 554MRC, 10025MR, 512MRC AND 513MRC

## VOLUME 2: MINING RIGHT 554MRC

### EXECUTIVE SUMMARY

#### 1. PROJECT BACKGROUND

In 2011, Alexkor SOC Limited (Alexkor) and the Richtersveld Mining Company (Pty) Ltd (RMC) formed a Pooling and Sharing Joint Venture (hereafter referred to as "PSJV") in order to oversee all current and future mining activities relating to Alexkor's mining rights.

The PSJV thus manages an onshore and four marine mining rights on and off the West Coast of South Africa. These Mining Rights are located roughly between the Orange River in the north and Kleinsee in the south (see Figure 1). The current mining activities are approved and executed under three approved Environmental Management Programmes (EMPRs), as amended.

The PSJV is amending its EMPRs for the marine Mining Rights to comply with the current requirements of the National Environmental Management Act, 1998 (No. 108 of 1998) (NEMA) and the Environmental Impact Assessment (EIA) Regulations 2014, as amended, and to ensure alignment with each other, all new legislation, environmental standards, as well as internal PSJV Performance Assessment Reports. The EMPR for the onshore Mining Right 550MRC, which was approved in April 2017, is not being amended as part of this process as agreed to with the Department of Mineral Resources.

SLR Consulting (South Africa) (Pty) Ltd ("SLR"), in association with Placer Resource Management (Pty) Ltd ("PRM"), has been appointed by the PSJV as the independent environmental consultant to amend the existing EMPRs for Mining Rights 554MRC, 10025MRC, 512MRC and 513MRC and undertake the associated public participation process.

#### 2. EMPR AMENDMENT PROCESS

##### 2.1 APPROACH

A combined process is being undertaken to streamline the EMPR amendment processes for the four marine mining right areas and to avoid duplication. Some of the information gathered as part of this combined process is applicable to all four amendment applications. Five separate reports (or volumes) have been prepared as part of this EMPR amendment process:

- Volume 1: EMPR Amendment Overview (applicable to all mining right areas).
- Volume 2: EMPR for Mining Right 554MRC - this volume.
- Volume 3: EMPR for Mining Right 10025MR.

- Volume 4: EMPR for Mining Right 512MRC.
- Volume 5: EMPR for Mining Right 513MRC.

This Executive Summary is applicable to Volume 2: Mining Right 554MRC

#### 3. MINING RIGHT DETAILS

In November 2010 the "old order mining right" associated with Mining Right 554MRC was converted to a "new order mining right" in terms of the Mineral and Petroleum Resources Development Act, 2002 (No. 28 of 2002) (MPRDA), as amended, which was granted for a period of 20 years (expiring on 1 July 2030).

The total mining right area is 32 723.59 ha in extent and comprises of the following portions:

- Centre line of the Orange River, to the bank of along the following properties: Corridor-Wes (Farm No. 2), Portion 17 (a portion of Portion 8), Portion 16 (a portion of Portion 9), Portion 15 (a portion of Portion 10), Arrisdrift (Farm No. 616), Farm No. 1, and Farm Brandkaros (Farm No. 517);
- Surf zone along Farm No. 1 and Farm No. 155;
- Sea Concession 1a, 1b, 2a and 3a.

#### 4. HISTORIC, CURRENT AND FUTURE MINING

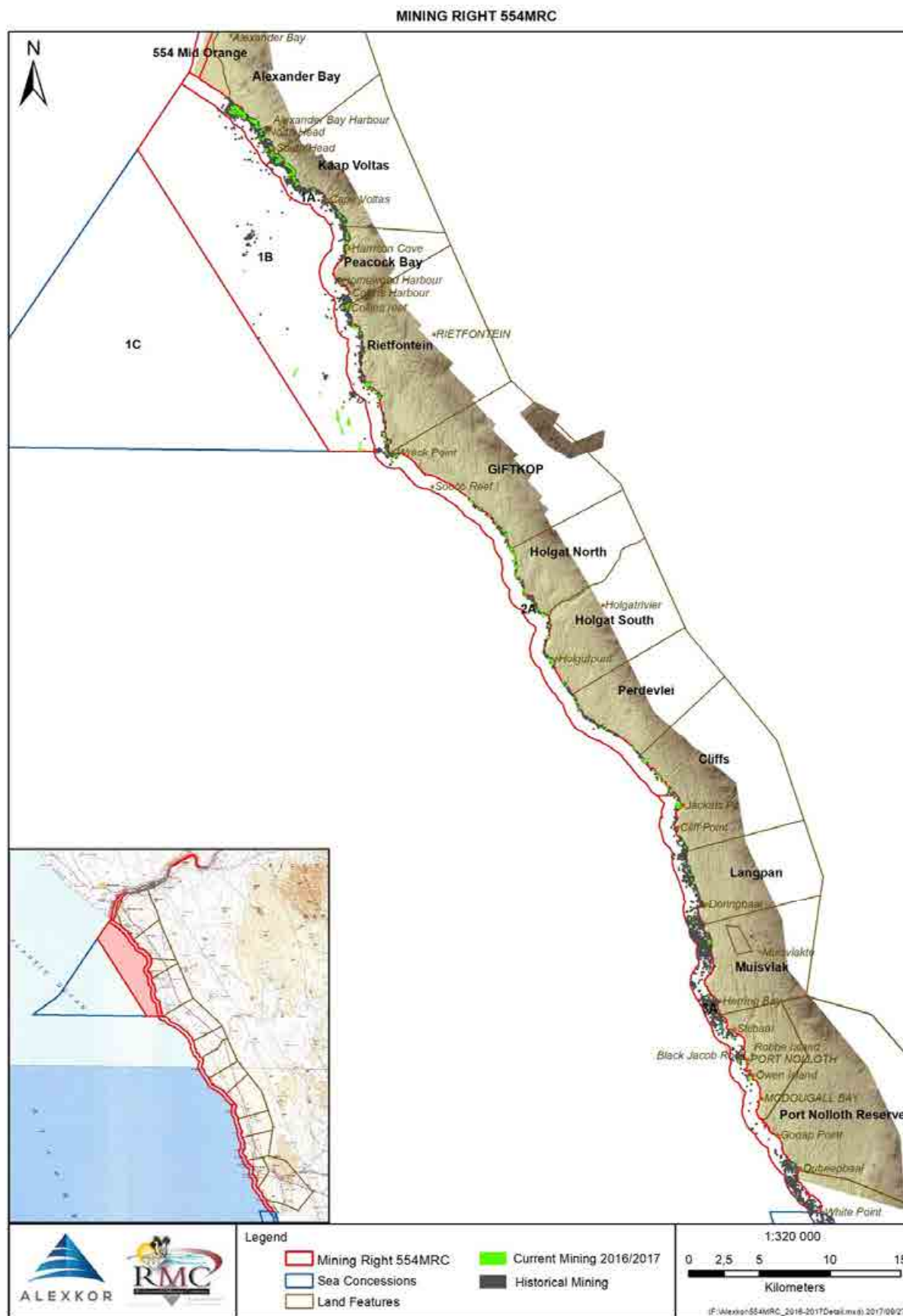
Historical mining areas associated with Mining Right 554MRC are indicated in Figure 2. Although a portion of the Orange River is included in the mining right, no prospecting or mining have occurred within this location.

The PSJV outsources the majority of the marine prospecting and mining operations to contractors. Currently, the PSJV undertakes relatively low intensity prospecting and mining in its mid-water and deep-water (> 30 m) concession areas (specifically Sea Concession 1b). The majority of current mining effort is directed at the subtidal concession areas (namely the beach, surf zone and Sea Concessions 1a, 2a and 3a) (see Figure 2).

Potential future mining areas are indicated in Figure 3. Since mining targets unconsolidated gravels, mining is unlikely to occur in areas with exposed bedrock areas. Survey data reveals approximately 43% and 30% bedrock is exposed on the seabed of Sea Concessions 1a and 1b, respectively. Mining is unlikely in areas with exposed bedrock.



**Figure 1: Location map of the PSJV's existing Mining Rights on and off the West Coast of South Africa**



**Figure 2: Historical and current (1 March 2016 to 28 February 2017) mining activity**

## 4.1 MARINE PROSPECTING

### 4.1.1 GEOPHYSICAL SURVEYS

Geophysical surveys are undertaken to investigate the structure and makeup of seabed and underlying sediment sequences. A number of surveying tools can be considered for use, including: single beam echo sounder; bottom profiler; multi beam or swath bathymetry; side scan sonar; topas; compressed high intensity radar pulse (Chirp); boomer; and sparker.

These surveys can be undertaken from a small ski boat or large ocean going survey vessel, depending primarily on the water depths over which the survey is to be conducted. Shallow water surveys (< 20 m) would be conducted from ski boats, which would return to port daily. Mid- to deep-water surveys (> 20 m) would be undertaken from larger survey vessels that are capable of remaining at sea for several days at a time.

### 4.1.2 SAMPLING

Following geophysical survey data acquisition, samples are collected to understand the distribution and grade (number of stones and carats) of diamonds within the target gravel horizon.

Coring (e.g. vibrocoring / drop coring), grab samples or box coring, drill sampling, bulk sampling, and small vessel-based diver assisted and mobile pump unit sampling are used to ground-truth geophysical survey interpretations.

## 4.2 MARINE MINING

### 4.2.1 VESSEL-BASED DIVER ASSISTED MINING

The diver operations commonly operate in water depths of less than 12 m. These vessels are small enough to operate out of Alexander Bay or Port Nolloth. There are currently approximately 23 vessel-based contractors operating in the PSJV shallow water concession areas.

The dredging operations are typically conducted using vessel mounted suction pumps and hoses, which are guided by divers into gullies, potholes and bedrock depressions to retrieve the diamond-bearing gravel. The divers operate via a surface supplied airline, with air generated from a vessel based air compressor.

The gravel is pumped up through the hose gravel pump system to the on-board screening system (trommel). Fine material (<2 mm) and oversized material (>20 mm) discharged from the screening unit washes directly back into the sea. The diamond-bearing gravel is bagged and transported to the onshore processing plants for further processing.



**Figure 3: Typical vessel-based diver assisted mining operation (Source: J. Blood)**

### 4.2.2 SHORE-BASED DIVER ASSISTED MINING

Mining in the surf zone to water depths of up to 12 m can also be shore-based and locally referred to as “Walpomp” (beach pumping units). There are currently at least 64 shore-based units operating in the surf zone area.

These mining operations are typically confined to small trap sites. The submerged target gravels are mined by at least two diver-guided suction hoses. The hoses are connected to a tractor that is modified to drive a centripetal pump (see Figure 4), which feeds the gravel into a rotary classifier (Trommel). The classifier screens the pumped material and extracts the size fraction of interest (2 to 20 mm). The large size fraction tailings (>20 mm) accumulate around the classifier (being later dispersed during the high tide or mechanically redistributed over the beach), while the fine tailings (<2 mm) are returned directly to the sea as a sediment slurry.

The diamond-bearing gravel is bagged and transported to the nearest processing facility for diamond recovery.



**Figure 4: “Walpomp” (beach pumping) mining method. A modified tractor drives the pump (Source: J. Blood)**





**Figure 3: Future marine mining locations**

### 4.2.3 COFFER DAM MINING

Surf zone and sub-tidal mining using coffer dams occurs from the high-water mark to potentially up to approximately 300 m seaward of the low water mark (see Figure 5).

This type of mining involves the removal of beach sand overburden with heavy machinery to access target gravels overlying the bedrock. The submerged bedrock below the beach sand is often below mean sea level, hence the construction of sea walls to prevent flooding during mining operations. The material used to construct these breakwaters typically consists of a basal core of quarried material, which gets progressively coarser towards the outside and is covered by an outer layer of large armour rock. Cofferdams are constantly maintained to restrict the inflow of sea water into the active mining block. When sea water ingresses into the mining area, submersible pumps are used to pump the water back into the sea.

Overburden material from the mine block is commonly used in the construction/maintenance of the sea wall. The target gravel is screened at a nearby infield screening facility and the separated size fraction is transported to the nearest processing plant for further treatment.



**Figure 5: Cofferdam mining operations in Mining Right 554MRC (2017)**

### 4.2.4 INTER-TIDAL BEACH MINING USING MOBILE PUMP UNITS

An alternative mining technique deployed in the surf zone is a dredging unit mounted on an excavator or on a jack-up rig (see Figure 6). Both systems make use of a remotely operated articulated dredging arm, which scours / dredges the seafloor.

Areas with generally lower grade, larger volumes of gravel and thicker sand overburden are optimally mined using these methods. Material is pumped from the seafloor and screened through a classifier, which is normally mounted on-board the mining platform or mobile unit. The screened material is pumped ashore into storage bins, which are transported to the onshore processing plants for diamond recovery.

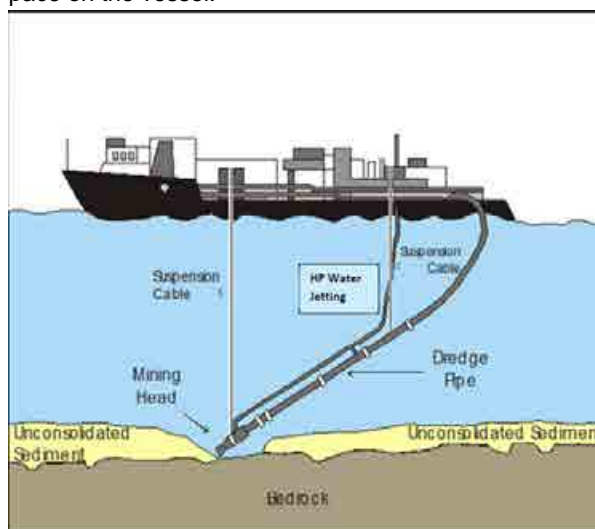


**Figure 5: Jack-up rig / platform (Source: Namdeb/ADP)**

### 4.2.5 VESSEL-BASED REMOTE DREDGE PUMP MINING

This mining method is typically used in the 'a' and 'b' sea concessions in water depths typically less than 30 m. These vessels are smaller than those used in remote airlift and crawler mining described below and can operate out of Port Nolloth and Alexander Bay.

The mining system uses vessel mounted pumps to dredge sediments from the seabed via hoses and a digging head (see Figure 6). The mining tool is suspended over the side from the aft or along either side of the vessel. On-board screening and processing is self-contained with final recovery of diamonds taking place on the vessel.



**Figure 6: Illustration of remote dredge pump mining (Source: GEMPR, Alexkor)**

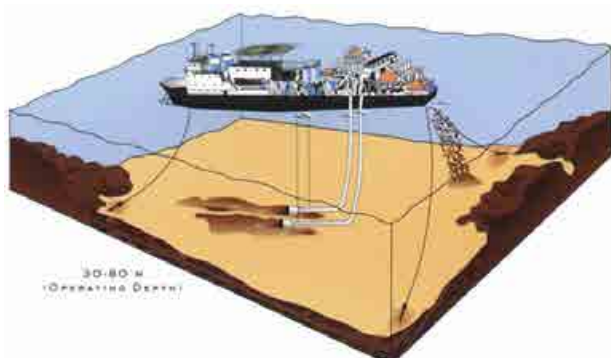
### 4.2.6 VESSEL-BASED AIRLIFT MINING

This system is similar in many respects to the dredge pump mining method. However, in the airlift mining method air is pumped down to the digging head, which creates a pressure differential between aerated seawater in the return hose and that of ambient seawater, which in turn draws up (sucks) the gravel and sediment to the surface (see Figure 7).

This mining method can operate in greater water depths and is typically used in the 'b' and 'c' concessions in water depths between 30 m and 150 m. The mining tool



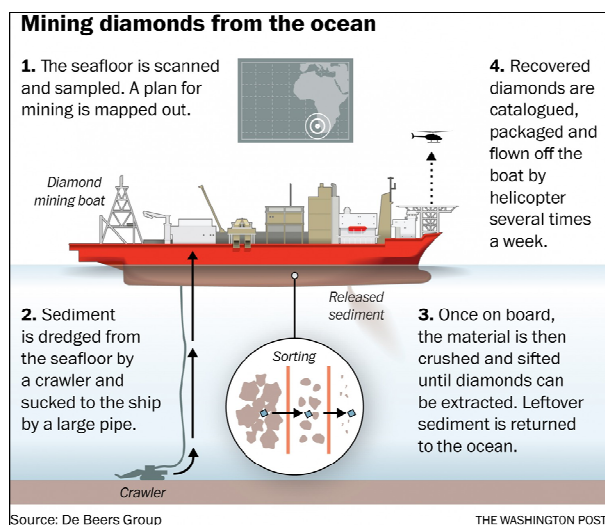
is suspended from davits (cranes) situated along the side of the vessel. On-board screening and processing is self-contained with final recovery of diamonds taking place on the vessel.



**Figure 7: Illustration of airlift mining (Source: BENCO)**

#### 4.2.7 VESSEL-BASED REMOTE CRAWLER MINING

This mining method uses a remotely operated crawler to mine in the 'b' and 'c' sea concessions in water depths between 30 m and 200 m (see Figure 8). The mining vessel operates on a 4-point mooring spread with dynamic positioning to assist the crawler mining operations.



**Figure 8: Illustration of remote crawler mining (Source: De Beers Group)**

The crawler is then lowered to the seabed by a winch system over the stern of the vessel. The seabed crawler is track-driven and equipped with a dredge pump system, hydraulic power pack and a jet-water system to facilitate the agitation and suction of unconsolidated surficial sediments up to the mining vessel. The seabed crawler can remove seabed sediments to a depth of up to 5 m in a set path within the mine target area.

As the sediment is removed from the seabed it is pumped to the surface for on-board screening and processing. Unwanted material is discarded overboard.

The mining and processing operation is fully self-contained on the mining vessel with final recovery of diamonds taking place on the vessel.

## 5. DESCRIPTION OF THE RECEIVING ENVIRONMENT

### 5.1 GEOPHYSICAL CHARACTERISTICS

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-northwest trend, widening north of Cape Columbine and reaching its widest off the Orange River (180 km). The immediate nearshore area consists mainly of a narrow (about 8 km wide) rugged rocky zone, sloping steeply seawards to a depth of around 80 m. The middle and outer shelf typically lacks relief, sloping gently seawards before reaching the shelf break at a depth of approximately 300 m. Two key seabed features include Child's Bank and Tripp Seamount, both of which are located over 200 km from the mining right areas.

As a result of erosion on the continental shelf, the unconsolidated surface sediment cover is generally thin, often less than 1 m. Sediments are finer seawards, changing from sand on the inner and outer shelves to muddy sand and sandy mud in deeper water. However, this general pattern has been modified considerably by biological deposition and localised river input.

### 5.2 BIOPHYSICAL CHARACTERISTICS

The West Coast is strongly influenced by the Benguela Current system. It is characterised by coastal upwelling of cold nutrient-rich water and is an important centre of plankton production, which supports a global reservoir of biodiversity and biomass of sea life.

Winds are one of the main physical drivers of the nearshore Benguela region. Virtually all winds in summer come from the south-east to south-west. Winter remains dominated by southerly to south-easterly winds, but the closer proximity of the winter cold-front systems results in a significant south-westerly to north-westerly component.

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 south to south-west direction. Winter swells are strongly dominated by those from the south-west to south-south-west.

The Benguela system is characterised by large areas of very low oxygen concentrations, which are attributed to nutrient remineralisation in the bottom waters. The two main areas of low-oxygen water formation in the southern Benguela region are in the Orange River Bight

and St Helena Bay. Upwelling processes can move low-oxygen water up onto the inner shelf and into nearshore waters, often with devastating effects on marine communities.

### 5.3 BIOLOGICAL CHARACTERISTICS

Biogeographically, the mining right areas fall within the cold temperate Namaqua Bioregion. The coastal, wind-induced upwelling characterising the Namibian coastline, is the principal physical process that shapes the marine ecology of the central Benguela region. The Benguela system is characterised by the presence of cold surface water, high biological productivity, and highly variable physical, chemical and biological conditions.

The coastline from Orange River mouth to Kleinsee is dominated by rocky shores, interspersed by isolated short stretches of sandy shores. Sandy beaches are one of the most dynamic coastal environments. Rocky shore and sandy beach habitats are generally not particularly sensitive to disturbance with natural recovery occurring within 2 to 5 years. However, much of the Namaqualand coastline has been subjected to decades of disturbance by shore-based diamond mining operations. These cumulative impacts and the lack of biodiversity protection have resulted in some of the coastal habitat types in Namaqualand being assigned a threat status. Four 'critically endangered' habitats (Namaqua Inshore Hard Grounds, Namaqua Inshore Reef, Namaqua Sandy Inshore and Namaqua Sheltered Rocky Coast) and one 'endangered' habitat (Namaqua Mixed Shore) fall within the four marine mining right areas.

The marine mining right areas lie within the influence of the Namaqua upwelling cell, and seasonally high phytoplankton abundance can be expected in the southern areas. However, in the Orange River Cone area immediately to the north of the upwelling cell, high turbulence and deep mixing in the water column result in diminished phytoplankton biomass and consequently the area is considered to be an environmental barrier to the transport of ichthyoplankton from the southern to the northern Benguela upwelling ecosystems. Phytoplankton, zooplankton and ichthyoplankton abundances in the northern mining areas (Sea Concessions 1a, 1b, 1c and 2a) are thus expected to be comparatively low.

Due to the cold temperate nature of the region, the fish fauna off the West Coast is characterised by a relatively low diversity of species compared with warmer oceans. However, the upwelling nature of the region results in huge biomasses of certain species and supports a commercially important fishery.

The West Coast sustains large populations of breeding and foraging seabird and shorebird species. Most of the seabird species along the West Coast feed relatively close inshore (10-30 km). Cape gannets, however, are known to forage up to 140 km offshore. However, the nearest nesting ground for Cape Gannets is at Bird Island in Lambert's Bay, which is approximately 300 km to the south of the mining right area. Most of the pelagic seabird species in the region reach highest densities offshore of the shelf break (200 to 500 m depth), which is offshore of the mining right area. As Sea Concessions 1a, 2a, 3a, 1b, 4a and 4b fall within 30 km of the coast, encounters with seabirds are highly likely.

Five species of turtles occur off the West Coast. Only one, the Leatherback turtle, is likely to be encountered within the mining right areas, but abundance is expected to be low.

Thirty-four species of whales and dolphins are known or likely to occur in South African waters. The distribution of cetaceans in Namibian waters can largely be split into those associated with the continental shelf and those that occur in deep, oceanic water. Importantly, species from both environments may be found in the continental slope (200 to 2 000 m) making this the most species-rich area for cetaceans. Cetacean density on the continental shelf is usually higher than in pelagic waters, as species associated with the pelagic environment tend to be wide ranging.

The Cape fur seal is the only seal species that has breeding colonies along the West Coast. Seals are highly mobile animals with a general foraging area covering the continental shelf up to 120 nm (approximately 220 km) offshore. Since the Buccu Twins seal colony occurs within Sea Concession 1a, numbers can be expected to be high. There is a further seal colony at Kleinsee (incorporating Robeiland).

### 5.4 SOCIO-ECONOMIC ENVIRONMENT

#### 5.4.1 Fishing

Information on the spatial distribution and catch effort of the commercial fishing sectors that operate off the West Coast are given below.

- Demersal trawl: This fishery operates between depths of 300 m and 1 000 m, which is offshore of the mining right areas.
- Small pelagic purse-seine: Fishing grounds occur primarily along the Western Cape and Eastern Cape coast up to a distance of 100 km offshore, but usually closer inshore. There has been no reported effort within the marine mining right areas between the years 2000 and 2016.
- Large pelagic long-line: Fishing effort is widespread predominantly along the shelf break seawards of

the 500 m depth contour. The marine mining right areas occur inshore of these fishing grounds.

- Demersal long-line: Targeted fishing areas by the hake-directed trawl fleet are situated at least 90 km from the marine mining right areas.
- Tuna pole: Fishing activity occurs along the entire South African West Coast beyond the 200 m bathymetric contour. Although negligible levels of fishing effort have been reported in close proximity to the marine mining right areas, no expected overlap with grounds fished by the tuna pole sector is expected.
- Traditional line-fish: Fishing vessels generally range up to a maximum of 40 nm offshore, although fishing at the outer limit of this range is sporadic. Over the period 2000 and 2015, the fishery landed an average of 2.7 tons of tuna per year within the mining right areas (i.e. 0.02 – 0.04% of national catch).
- West Coast Rock lobster: The mining right areas fall within Management Area 1 of the commercial rock lobster fishing zones, which extends from the Orange River Mouth to Kleinsee. The fishery operates seasonally, with closed seasons applicable to different zones; Management Area 1 operates from 1 October to 30 April. Over this period, the fishery landed an average of 14.1 tons of West Coast rock lobster per year within Mining Right 544MRC (i.e. 3.2% of national catch). Over the same period, the fishery set an average of 5 790 traps year (i.e. 9.8% of national effort). No catch or effort has been reported for the other marine mining right areas.
- Abalone ranching: Sea Concessions 1a, 2a, 3a and 4a overlap with ranching Concession Areas 1 and 2. To date, there has been no seeding in Areas 1 or 2 (partly due to the uncertainty relating to user conflict).
- Beach-seine and gill-net fisheries: There are a number of active beach-seine and gill-net operators throughout South Africa. Gill-net and beach-seine landings at Port Nolloth account for less than 10% of the national landings.

## 5.4.2 Shipping

The majority of the international shipping traffic is located on the outer edge of the continental shelf. Traffic inshore of the continental shelf along the West Coast largely comprises fishing and mining vessels, especially between Kleinsee and Oranjemund. International shipping routes fall outside of the mining right areas.

## 5.4.3 Conservation areas

The McDougall's Bay rock lobster sanctuary near Port Nolloth overlaps with Sea Concession 3a. The sanctuary, which extends 1 nm seawards of the high water mark between the promontory at the northern end of McDougall's Bay and the promontory at the southern extremity of McDougall's Bay.

## 5.4.4 Archaeological sites

Fossilised forests have been found during previous marine diamond exploration and/or mining activities off the West Coast (sea Concessions 2c to 5c), none of which occur within the mining right areas.

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). At least 25 known shipwreck sites occur near Alexander Bay, Port Nolloth and Kleinsee. The majority of the wrecks found in the vicinity of the mining right areas were boats that sunk in the 19<sup>th</sup> century. It is, however, noted that the precise location of all these wrecks is unknown as they have been documented only through survivor accounts, archival descriptions and eyewitness reports recorded in archives and databases.

## 5.5 ORANGE RIVER ENVIRONMENT

The Orange River has been significantly impacted by anthropogenic activities along its banks and within its floodplain (including historic mining and associated activities). A major consequence of this is the degradation of the desiccated saltmarsh on the south side of the estuary.

Key mining- and agricultural-related structures that have contributed to the degradation of the saltmarsh include:

- Road embankment: The construction of a road embankment in 1964 isolated approximately a third of the estuary from the active system. In 1997 the seaward end of this embankment was breached in an attempt to re-activate the saltmarsh in the area.
- Scrap machinery ("Detroit riprap"): The seaward end of the embankment was "anchored" or "pinned" in position by means of scrap machinery being embedded in the beach berm. The scrap machinery has prevented the mouth from migrating southwards to its fullest possible extent and thus has also limited the ingress of seawater into the saltmarsh.
- Dunvlei dyke: The construction of the dyke to protect the Dunvlei Farm and extend agricultural land blocked the southernmost channel feeding the saltmarsh in the south-western corner of the estuary.

- Sewage oxidation ponds: Sewage oxidation ponds were also constructed in the floodplain, which also blocked the southernmost channel feeding the saltmarsh.

## 5.6 KEY RECEPTORS AND IMPLICATIONS FOR PROSPECTING AND MINING

Receptor / Variable	Implications for proposed project
<b>1. Bio-physical considerations</b>	
Sensitive benthic habitats	Much of the Namaqualand coastline has been subjected to decades of disturbance by shore-based diamond mining operations. As a result some habitats have been assigned an 'endangered' (Namaqua Mixed Shore) and 'critically endangered' habitats (Namaqua Inshore Hard Grounds, Namaqua Inshore Reef, Namaqua Sandy Inshore and Namaqua Sheltered Rocky Coast) status. Mining within these areas should be restricted and/or avoided.
Bucchu Twins seal colony	The Bucchu Twins seal colony occurs within Sea Concession 1a. Helicopters operating between Oranjemund or Kleinsee and larger mining vessels would need to avoid this seal colony.
Orange River Mouth Estuary	The Orange River Mouth wetland is an Important Bird Area, as it serves as an important habitat for a wide variety of waders and coastal birds. Helicopter flight paths would need to be planned to avoid this area.
Orange River Mouth saltmarsh	Anthropogenic activities (including historic mining and associated activities) have resulted in the degradation of the desiccated saltmarsh on the south side of the estuary. Remediation measures are required to restore the connection between the saltmarsh and the estuary basin.
<b>2. Socio-economic considerations</b>	
Fishing	Fishing plays a significant role in providing livelihoods and income for local communities living in and around Port Nolloth. Key sectors include: traditional line-fish; West Coast rock lobster and beach-seine and gill-net fisheries. Key stakeholders would need to receive adequate notification regarding prospecting and mining activities. Mining vessels would also need to avoid other fishing vessels that are limited in their manoeuvrability.
Heritage/ archaeology	At least 25 known shipwreck sites occur near Alexander Bay, Port Nolloth and Kleinsee; the precise location of some of these is unknown. Mining would need to avoid known shipwrecks

## 6. IMPACT ASSESSMENT CONCLUSIONS

A summary of the assessment of potential environmental impacts associated with prospecting and mining in Mining Right 554MRC is provided in Table 1.

### 6.1 SHORE-BASED DIVER ASSISTED MINING ("WALPOMP")

Sixty-four shore-based diver assisted mining contractors ("walpomp") currently operate throughout the surf-zones and shallow portions of Sea Concessions 1a, 2a and 3a. Although impacts are localised around each individual "walpomp" operation, the extent of the impact is considered to be regional due to the large number of contractors operating throughout the mining right area. The most significant impacts from "walpomp" mining relate to the physical disturbance of the supratidal habitat and rocky intertidal (endangered and critically endangered) habitats, which are considered to be of **high** significance without mitigation. With better management and control of onshore activities in the supratidal zone (e.g. access, campsites, processing, etc.) and the avoidance of sensitive benthic habitats in the intertidal zone (as delineated by SANBI), these impacts would be reduced to **MEDIUM** and **VERY LOW** significance, respectively. The physical disturbance of the benthic habitat would also have a **MEDIUM** significant impact on the West Coast rock lobster sector and future abalone ranching.

### 6.2 COFFER DAM MINING

There are currently (September 2017) five contractors working along the coast in the surf and intertidal zone using coffer dam mining. The building of coffer dams effectively smothers and eliminates any supratidal, intertidal and subtidal biota in the footprint of the coffer dam. On a high-energy coastline, such as in the mining right area, recovery of intertidal and shallow subtidal unconsolidated sediments following localised coffer dam operations that do not use rocks to stabilise the coffer dam walls, can occur within a few tidal cycles under heavy swell conditions, and will typically result in subsequent rapid recovery of the invertebrate faunal communities to their previous state. However, the deposition of large volumes of non-native rock during sea wall construction may result in the physical alteration of the shoreline to an extent that cannot be remediated by swell action. In extreme cases, where the coffer dam wall material is not completely removed, stretches of sandy beach could be permanently transformed into mixed and rocky shore habitats, with concomitant changes in the associated benthic biota. The impacts associated with the disturbance of intertidal and shallow subtidal habitats by coffer dam operations are considered to be of **high** and **very high** significance of

sandy and rocky habitats, respectively. However, with the avoidance of endangered and critically endangered benthic habitats, by limiting the number of coffer dams operational concurrently to only two and removing coffer dam material to below the low tide level during rehabilitation, the impact could be reduced to **HIGH** and **MEDIUM** significance for both rocky and sandy habitats, respectively. The proposed monitoring programme should be used to confirm the significance of the residual impact and, depending on the results, used to inform future mining planning and methods. Similar to “walpomp” operations, associated onshore activities (e.g. access, campsite and in-field processing) are considered to have a **MEDIUM** significant impact on the supratidal zone with the implementation of mitigation. The physical disturbance of the benthic habitat would also have a **MEDIUM** significant impact on the West Coast rock lobster sector and future abalone ranching. Cofferdam mining could also have an impact on shore- and vessel-based diver assisted mining due to the redistribution of finer sediments from coffer dams sea walls. This impact is considered to be of **MEDIUM** significance. The PSJV must manage the exploitation of the resource in a manner that optimises resource management and the contractors that they contract to extract these resources.

### 6.3 INTER-TIDAL BEACH MINING USING MOBILE PUMP UNITS

Mobile pump unit operations (e.g. jack-up rigs) could primarily be implemented in the surf zone of sandy beaches and shallow sandy bays, none of which have been identified as endangered or critically endangered habitats. Thus, the endangered or critically endangered habitats associated with rocky substrates are unlikely to be affected. Mobile pump unit operations, should they be used, are likely to operate in only a few suitable bays within Sea Concessions 1a, 2a and 3a and any impacts would thus remain localised. The impact of this mining method on the intertidal area of sandy beaches is considered to be **VERY LOW**. Similar to “walpomp” and coffer dam mining operations, unregulated onshore activities (e.g. access and campsite) are considered to have a **MEDIUM** significant impact on the supratidal zone with the implementation of mitigation.

### 6.4 VESSEL-BASED DIVER ASSISTED MINING

The majority of the impacts associated with the normal operation of the smaller diver-assisted mining vessels, although not MARPOL compliant, would be highly localised, of short-term duration and of low intensity, and are considered to be of **VERY LOW** significance after mitigation.

The impacts associated with the removal of seabed sediments and their associated biota by vessel-based

diver assisted operations would be of high intensity, but remain relatively localised within each mining target. However, considering the number of vessels operational in the a-concessions, the extent of the impact is considered to be regional. The impact associated with the removal of seabed sediments is considered to be of **medium** (least threatened habitats) to **high** (endangered or critically endangered habitats) significance without mitigation. The avoidance of mining in the restricted critically endangered Namaqua Inshore Reef habitats, and the restriction of mining within the endangered Namaqua Mixed Shore and critically endangered Namaqua Inshore Hard Grounds and Namaqua Sandy Inshore habitats, which are represented by more extensive areas off the West Coast, to less than 1% of the available habitat annually, the impact could be reduced to **LOW** significance.

Vessel-based diver assisted mining could impact the traditional line-fish and the gill-net sectors. Based on the relatively low levels of fishing activity in the ‘a’ concessions (i.e. 0.02 – 0.04% of national catch for the traditional line-fish and less than 10% for the gill-net sector), the potential impact on these sectors is considered to be of **VERY LOW** significance with or without mitigation.

### 6.5 VESSEL-BASED REMOTE MINING

The majority of the impacts associated with the normal operation of the mining vessel and possible helicopter operations (for crew transfers) would be highly localised, of long-term duration and of low intensity, and are considered to be **INSIGNIFICANT** or of **VERY LOW** significance after mitigation. Key mitigation includes ensuring that the mining vessel comply with MARPOL 73/78 standards; flight paths avoid sensitive areas (e.g. coastal reserves, seal colonies and or Important Bird Areas); prior notification is provided to key stakeholders (including fishing industry and adjacent rights holders); and Radio Navigation Warnings and Notices to Mariners are released throughout the mining period.

The impacts associated with the removal of seabed sediments is considered to be of **medium** (least threatened) to **high** (critically endangered) significance without mitigation. Restricting mining within the critically endangered Namaqua Inshore Hard Grounds and Namaqua Sandy Inshore habitats to less than 1% of the available habitat annually, as well as the avoidance of mining unconsolidated habitats in the close proximity of rocky outcrop areas, would reduce this impact to **LOW** significance.

The only fishing sector which could potentially be impacted by mining in Sea Concession 1b is the traditional line-fish sector. Based on the relatively low levels of fishing activity in Sea Concession 1b, the

potential impact on this sector is considered to be of **VERY LOW** significance with or without mitigation.

## 6.6 ALL MINING METHODS

Mining could also impact cultural heritage material, although this is considered to be unlikely. However, in the event that any cultural heritage material is disturbed during mining activities, the impact could be of **high** significance depending on the cultural significance of the shipwreck. However, with the implementation of mitigation, it is expected that the impact on any shipwreck sites could be avoided or would be **INSIGNIFICANT**.

Mining creates a number of local employment and business opportunities. There are approximately 1 200 people employed based on current mining activities. The overall positive impact on the economy related to job creation and generation of direct revenues is considered to be **HIGH (positive)** significance.

## 6.7 ORANGE RIVER MOUTH ESTUARY REHABILITATION

Although a portion of the Orange River is included in the mining right, no prospecting or mining activities are being considered in the river. However, measures are deemed necessary to manage the estuary in light of the Orange River Mouth Estuarine Management Plan and the proposal by the Department of Environmental Affairs to declare it a protected.

The removal of the existing road embankment, scrap machinery and oxidation ponds (see Section 5.5) are included in the Orange River Mouth Estuarine Management Plan. Should the PSJV successfully implement the recommended remedial actions, the overall positive impact of the Orange River Mouth saltmarsh and associated biota is considered to be **HIGH (positive)** significance.

**Table 8-1: Summary of the significance of the potential impacts associated with prospecting and mining in Mining Right 554MRC (Note: \* indicates that no mitigation is possible and / or considered necessary, thus significance rating remains)**

Potential impact				Significance	
				Without mitigation	With mitigation
VH=Very High	H=High	M=Medium	L=Low	VL=Very low	Insig = insignificant
<b>Geophysical surveys:</b>					
<b>Sonar noise</b>				<b>VL</b>	<b>INSIG.</b>
<b>Shore-Based Diver Assisted Mining ("Walpomp")</b>					
<b>Physical disturbance of benthic habitats:</b>					
Supratidal habitats				<b>H</b>	<b>M</b>
Intertidal and shallow subtidal habitats		Rocky		M – H	<b>VL</b>
		Sandy		<b>L</b>	<b>VL</b>
<b>Discharge of tailings and re-suspension of fine sediments:</b>					
Smothering of benthic biota in the supratidal				H - VH	<b>L (neutral)</b>
Increased water turbidity and reduced light penetration in the intertidal and shallow subtidal habitats				Insig.	<b>INSIG.*</b>
<b>Noise from mining operations:</b>					
Mining noise		Masking sounds and communication		<b>VL</b>	<b>VL*</b>
		Behavioural avoidance		Insig.	<b>INSIG.*</b>
<b>Impact on other users of the sea:</b>					
Fishing industry		West Coast rock lobster		<b>M</b>	<b>M</b>
		Abalone ranching		<b>M</b>	<b>M</b>
		Traditional line-fish		<b>VL</b>	<b>VL</b>
		Gill-net fisheries		<b>VL</b>	<b>VL</b>
<b>Coffer dam mining</b>					
<b>Physical disturbance of benthic habitats:</b>					
Supratidal habitats				<b>H</b>	<b>M</b>
Intertidal and shallow subtidal habitats		Cofferdam	Rocky	<b>VH</b>	<b>H</b>
			Sandy	<b>H</b>	<b>M</b>
<b>Redistribution of sediment from coffer dam walls:</b>					
Increased water turbidity and reduced light penetration				<b>M</b>	<b>M*</b>
<b>Impact on other users of the sea:</b>					
Fishing industry		West Coast rock lobster		<b>H</b>	<b>M</b>
		Abalone ranching		<b>H</b>	<b>M</b>
Diamond mining: shore-based and vessel-based diver assisted mining				<b>M</b>	<b>M</b>

Potential impact			Significance	
			Without mitigation	With mitigation
<b>Mobile pump mining</b>				
<b>Physical disturbance of benthic habitats:</b>				
Supratidal habitats			H	M
Intertidal and shallow subtidal habitats			VL	VL
<b>Discharge of tailings and re-suspension of fine sediments:</b>				
Smothering of benthic biota by re-depositing tailings	Intertidal / shallow subtidal habitats		L – M	VL
Increased water turbidity and reduced light penetration			Insig.	INSIG.*
<b>Noise from mining operations:</b>				
Mining noise	Masking sounds and communication		VL	VL*
	Behavioural avoidance		Insig.	INSIG.*
<b>Vessel-based diver assisted mining</b>				
<b>Physical disturbance of benthic habitats:</b>				
Deep-water habitats (> 5m)			M - H	L
<b>Discharge of tailings and re-suspension of fine sediments:</b>				
Smothering of benthic biota by re-depositing tailings	Intertidal / shallow subtidal habitats		L – M	VL
Increased water turbidity and reduced light penetration			Insig.	INSIG.*
<b>Noise from mining operations:</b>				
Mining noise	Masking sounds and communication		VL	VL*
	Behavioural avoidance		Insig.	INSIG.*
<b>Normal vessel operations:</b>				
Discharge of wastes to sea			VL	VL
<b>Impact on other users of the sea:</b>				
Fishing industry	Traditional line-fish		VL	VL
	Gill-net fisheries		VL	VL
<b>Upset conditions:</b>				
Accidental oil spill			L	INSIG.
Lost or discarded equipment			L	INSIG.
<b>Vessel-based remote mining</b>				
<b>Physical disturbance of benthic habitats:</b>				
Deep-water habitats (> 5 m)	Vessel-based remote		M - H	L
	Launching seabed crawler and anchoring		VL	VL
<b>Discharge of tailings and re-suspension of fine sediments:</b>				
Smothering of benthic biota by re-depositing tailings	Deep-water (> 5 m) habitats	Unconsolidated sediments	VL - L	VL
		Rocky outcrops	VL	INSIG.
Increased water turbidity and reduced light penetration			Insig.	INSIG.*
Reduced physiological functioning of marine organisms due to indirect biochemical effects			Insig.	INSIG.*
Toxicity and bioaccumulation effects on marine fauna			Insig.	INSIG.*
<b>Noise from mining operations:</b>				
Mining noise	Masking sounds and communication		VL	VL*
	Behavioural avoidance		Insig.	INSIG.*
Helicopter operations			L	INSIG.
<b>Normal vessel operations:</b>				
Discharge of wastes to sea			VL	INSIG.
Vessel lighting			Insig.	INSIG.*
<b>Impact on other users of the sea:</b>				
Fishing industry	Traditional line-fish		VL	VL
Marine transport routes			Insig.	INSIG.
Petroleum exploration			Insig.	INSIG.
<b>Impact on cultural heritage material:</b>				
Impact on known historical shipwrecks			H	INSIG.
<b>Upset conditions:</b>				
Accidental oil spill during bunkering / refuelling			VL - L	INSIG.
Lost or discarded equipment			VL (neutral)	INSIG. (neutral)
<b>Job Creation and generation of direct revenues</b>				
Local employment and business opportunities			H (+ve)	H (+ve)





# AMENDMENT OF ENVIRONMENTAL MANAGEMENT PROGRAMMES FOR MINING RIGHTS 554MRC, 10025MR, 512MRC AND 513MRC

## Volume 2: Mining Right 554MRC

### TABLE OF CONTENTS

DOCUMENT INFORMATION.....	i
VOLUMES OF THE EMPR AMENDMENT PROCESS .....	iii
EXECUTIVE SUMMARY .....	v
TABLE OF CONTENTS.....	xix
1. INTRODUCTION .....	1-1
1.1 BACKGROUND.....	1-1
1.2 APPROACH TO THE EMPR AMENDMENT PROCESS .....	1-3
1.3 STRUCTURE OF THIS REPORT (VOLUME 2) .....	1-4
2. PROJECT DESCRIPTION .....	2-1
2.1 GENERAL RIGHT HOLDER.....	2-1
2.1.1 Mining right holder .....	2-1
2.1.2 Mining right details .....	2-2
2.1.3 Financial provision .....	2-3
2.2 MINERAL RESOURCE .....	2-4
2.3 HISTORICAL; CURRENT AND FUTURE MINING.....	2-6
2.3.1 Historical mining .....	2-6
2.3.2 Current mining .....	2-6
2.3.3 Potential future mining .....	2-6
2.4 MARINE PROSPECTING METHODS.....	2-11
2.4.1 Geophysical surveys.....	2-11
2.4.1.1 Single beam echo sounder.....	2-11
2.4.1.2 Bottom profiler .....	2-11
2.4.1.3 Multi beam or swath bathymetry .....	2-12
2.4.1.4 Side scan sonar.....	2-12
2.4.1.5 Topas.....	2-13
2.4.1.6 Compressed high intensity radar pulse (chirp).....	2-13
2.4.1.7 Boomer .....	2-14
2.4.1.8 Sparker .....	2-14
2.4.2 Vibrocoring, drop coring and box coring.....	2-14
2.4.2.1 Vibrocoring .....	2-14
2.4.2.2 Drop coring .....	2-15
2.4.2.3 Box coring (grab samples) .....	2-16
2.4.3 Drill sampling .....	2-17
2.4.4 Bulk sampling .....	2-18
2.4.5 Small vessel based diver and mobile pump unit sampling.....	2-19
2.5 MINING METHODS .....	2-20
2.5.1 Cofferdam mining .....	2-20
2.5.2 Shore based diver assisted mining.....	2-22
2.5.3 Mobile pump unit mining.....	2-24
2.5.4 Vessel-based diver assisted mining .....	2-25

2.5.5	Vessel-based remote dredge pump mining .....	2-26
2.5.6	Vessel-based remote airlift mining .....	2-28
2.5.7	Vessel-based remote crawler mining .....	2-29
2.5.8	Vessel-based vertical approach mining .....	2-32
2.6	REHABILITATION .....	2-33
2.6.1	Mid-and deep-water rehabilitation .....	2-33
2.6.2	Coastal zone rehabilitation .....	2-33
2.7	MID-AND DEEP-WATER MONITORING .....	2-34
3.	IMPACT ASSESSMENT .....	3-1
3.1	IMPACT ON THE BIO-PHYSICAL ENVIRONMENT .....	3-1
3.1.1	Physical disturbance of benthic habitats .....	3-1
3.1.2	Discharge of tailings and redistribution of sediment from coffer dam walls .....	3-23
3.1.3	Operational noise.....	3-32
3.1.4	Discharge of waste to sea .....	3-38
3.1.5	Vessel lighting.....	3-41
3.1.6	Unplanned events .....	3-43
3.2	IMPACTS ON THE SOCIO-ECONOMIC ENVIRONMENT .....	3-47
3.2.1	Potential impact on fishing industry .....	3-47
3.2.2	Potential impact on marine transport routes.....	3-50
3.2.3	Potential impact related to job creation and generation of direct revenues .....	3-51
3.2.4	Potential impact on cultural heritage material.....	3-52
3.2.5	Potential impact on other petroleum exploration and production .....	3-53
3.2.6	Potential impact on other marine prospecting/mining operations.....	3-54
3.2.7	Unplanned events: oils spill .....	3-55
3.3	CUMULATIVE IMPACTS .....	3-56
3.4	REHABILITATION OF THE ORANGE RIVER MOUTH ESTUARY .....	3-57
3.4.1	Background.....	3-57
3.4.2	Recommended rehabilitation measures .....	3-57
3.4.3	Impact assessment.....	3-58
3.4.4	Other rehabilitation measures.....	3-58
4.	MITIGATION AND MANAGEMENT PLAN .....	4-1
4.1	SCOPE AND OBJECTIVES.....	4-1
4.2	ORGANISATION ROLES AND RESPONSIBILITIES.....	4-1
4.2.1	Pooling and sharing joint venture .....	4-1
4.2.1.1	Environmental Manager and Environmental Officer .....	4-1
4.2.2	Contractors .....	4-2
4.2.2.1	Environmental Representative .....	4-2
4.3	TRAINING; AWARENESS AND COMPETENCY.....	4-2
4.4	COMPLIANCE VERIFICATION AND CORRECTIVE ACTIONS.....	4-3
4.4.1	Inspection.....	4-3
4.4.2	Monitoring .....	4-3
4.4.3	Auditing .....	4-3
4.4.4	Corrective actions .....	4-4
4.5	MANAGEMENT OF CHANGE .....	4-4
4.6	COMMUNICATION .....	4-4
4.7	DOCUMENT CONTROL AND REPORT .....	4-5
4.7.1	Documentation.....	4-5
4.7.2	Reporting .....	4-5
4.7.3	Performance assessments .....	4-5

4.8	MITIGATION AND MANAGEMENT PLAN .....	4-5
4.8.1	Geophysical surveys.....	4-6
4.8.2	Shore-based diver assisted mining ("Walpomp") .....	4-16
4.8.3	Coffer dam mining .....	4-23
4.8.4	Mobile pump unit mining.....	4-31
4.8.5	Vessel-based diver assisted prospecting and mining .....	4-37
4.8.6	Vessel-based remote prospecting and mining .....	4-43
4.9	HABITAT MONITORING.....	4-53
5.	CLOSURE PLAN.....	5-1
5.1	BACKGROUND.....	5-1
5.2	CLOSURE OBJECTIVES .....	5-1
5.2.1	Orange river.....	5-1
5.2.2	Surf zone.....	5-7
5.2.3	'A' concessions .....	5-8
5.2.4	'B' concessions .....	5-8
5.3	MONITORING COMPLIANCE .....	5-8
5.4	REHABILITATION MEASURES .....	5-9
5.5	IMPACT PREVENTION AND MITIGATION MEASURES .....	5-9
5.6	IMPLEMENTATION SCHEDULE.....	5-9
5.7	MANAGING CLOSURE IMPACTS .....	5-9
5.8	PUBLIC PARTICIPATION PROCESS.....	5-9
5.9	FINANCIAL PROVISION FOR REHABILITATION, CLOSURE AND ON-GOING POST DECOMMISSIONING .....	5-9
5.9.1	Introduction .....	5-9
5.9.2	Annual liability.....	5-10
5.9.3	Final rehabilitation, decommissioning and closure plan .....	5-10
5.9.4	Environmental (latent) risk.....	5-11
6.	REFERENCES .....	6-1

## LIST OF FIGURES

Figure 1.1:	Location map of the PSJV's existing Mining Rights on and off the West Coast of South Africa.....	1-2
Figure 2.1:	Location map of Mining Right 554MRC .....	2-2
Figure 2.2:	Schematic cross section of the mining concession areas .....	2-3
Figure 2.3:	Geophysical survey line coverage in Sea Concession 1b.....	2-5
Figure 2.4:	Historical and current (March 2016 to February 2017) mining areas. ....	2-7
Figure 2.5	Areas of high mineralisation potential along the beach and surf zone adjacent to Sea Concessions 1a, 2a and 3a .....	2-8
Figure 2.6	Areas of high mineralisation in Sea Concessions 1a and 1b .....	2-9
Figure 2.7	Location of known bedrock features occurring in Sea Concession 1a and 1b.....	2-9
Figure 2.8	Vessel using multi-beam depth/echo sounders. (Source: <a href="http://www.gns.cri.nz">http://www.gns.cri.nz</a> ).....	2-12
Figure 2.9	Typical side scan sonar device and resulting information (Source: <a href="https://en.wikipedia.org/wiki/Side-scan_sonar">https://en.wikipedia.org/wiki/Side-scan_sonar</a> ).....	2-13
Figure 2.10	Vibrocorer (Source: <a href="https://www.vibro+coring+marine+sampling&amp;client=firefox">https://www.vibro+coring+marine+sampling&amp;client=firefox</a> ) .....	2-15
Figure 2.11	Piston core operation at the seabed (Source: TDI-Brooks).....	2-15
Figure 2.12	Box corer (Source: <a href="http://en.wikipedia.org/wiki/Box_corer">http://en.wikipedia.org/wiki/Box_corer</a> ) .....	2-16
Figure 2.13	Grab sampler (Source: <a href="http://www.jochemnet.de/fiu/OCB3043_35.html">http://www.jochemnet.de/fiu/OCB3043_35.html</a> ) .....	2-17

Figure 2.14	Large sampling vessel, MV Explorer showing (A) sub-sea mining tool with a 2.5 m diameter drill bit within a drill frame structure, (B) mineral processing plant and (C) deployment schematic (Source: <a href="http://www.imdhgroup.com/mv-explorer.php">http://www.imdhgroup.com/mv-explorer.php</a> ) .....	2-18
Figure 2.15	Large bulk sampling vessel, MV Ya Toivo (A) and it seabed crawler (B) (Source: CCA, 2015) .....	2-17
Figure 2.16	Coffer dam mining operations in Mining Right 554MRC (2017) (Source: GoogleEarth).....	2-20
Figure 2.17	Illustration of sequential coffer dam construction.....	2-21
Figure 2.18	Coffer dam construction showing quarried rock being dumped into the sea (Source: J. Blood) .....	2-21
Figure 2.19	“Walpomp” (beach pumping) mining method (Source: J. Blood).....	2-22
Figure 2.20	Diver with dual dredge pump, underwater at mining face. (Source: Alexkor).....	2-23
Figure 2.21	Example of a rotary classifier (trommel) (Source: J. Blood) .....	2-23
Figure 2.22	Dredging unit mounted on an excavator operating in surf zone (Source: Hannesko).....	2-24
Figure 2.23	Jack up rig or platform operating in surf zone (Source: Namdeb/ADP).....	2-24
Figure 2.24	Typical boat used for vessel-based diver assisted mining (Source: J. Blood) .....	2-25
Figure 2.25	Illustration of remote dredge pump mining. (Source: GEMPR, Alexkor) .....	2-26
Figure 2.26	Process flow diagram (Source: BENCO).....	2-27
Figure 2.27	Illustration of airlift mining (Source: BENCO).....	2-28
Figure 2.28	Air lift mining vessel, MV Ivan Prinsep (Source: Ocean Diamond Mining) .....	2-29
Figure 2.29	MV Ya Toivo (Source: <a href="http://www.imdhgroup.com/mvya-toivo.php">www.imdhgroup.com/mvya-toivo.php</a> ) .....	2-29
Figure 2.30	Illustration of remote crawler mining (Source: De Beers Group / The Washington Post).....	2-30
Figure 2.31	Illustrations of different seabed crawlers (Source: CCA, 2015).....	2-30
Figure 2.32	Deployment of the crawler (Source: <a href="http://www.imdhgroup.com/mvya-toivo.php">www.imdhgroup.com/mvya-toivo.php</a> ).....	2-31
Figure 2.33	Flowchart of marine diamond gravel processing operations (Source: Penney et al., 1999) .....	2-32
Figure 3.1:	Classifier located above the high water mark with tailings heaps accumulated in the supratidal zone (Source: J. Blood).....	3-5
Figure 3.2:	Areas of high mineralisation (green and red) in Sea Concessions 1a, 1b and 1c in relation to benthic and coastal habitats off the West Coast.....	3-8
Figure 3.3:	Areas of high mineralisation potential along the beach and surf zone (red) in Sea Concessions 2a and 3a in relation to benthic and coastal habitats off the West Coast.....	3-9
Figure 3.4:	Areas of high mineralisation potential along the beach and surf zone (red) in Sea Concessions 4a and 4b in relation to benthic and coastal habitats off the West Coast.....	3-10
Figure 3.5:	Physical alteration of a previously sandy beach by non-native rocky material used to construct coffer dam walls. A portion of the sea wall is also still evident (Source: J. Blood) .....	3-15
Figure 3.6	Comparison of noise sources in the ocean (Wenz 1962) .....	3-33
Figure 3.7	Historic structures that have resulted in the degradation of the Orange River Mouth saltmarsh.....	3-59
Figure 3.8	Scrap machinery (“Detroit riprap”) used to anchor the seaward end of the road embankment built in 1964 (Source: S. Lamberth) .....	3-60
Figure 5.1:	Post mining land use (Source: Site Plan 2008) .....	5-2
Figure 5.2:	Orange River portion of Mining Right 554MRC .....	5-6

## LIST OF TABLES

Table 3.1:	Impact on supratidal habitats and biota .....	3-3
Table 3.2:	Impact on intertidal and shallow subtidal habitats and biota due to “walpomp” operations .....	3-7
Table 3.3:	Impact on intertidal and shallow subtidal habitats and biota due to mobile pump unit operations.....	3-13
Table 3.4:	Impact on intertidal and shallow subtidal habitats and biota due to coffer dam mining operations.....	3-16
Table 3.5:	Impact on benthic macrofauna inhabiting the unconsolidated sediments due to vessel-based diver assisted mining .....	3-18
Table 3.6:	Impact on benthic macrofauna inhabiting the unconsolidated sediments due to vessel-based remote prospecting and mining operations .....	3-23
Table 3.7:	Impact of smothering on high shore communities and alteration of habitat .....	3-27
Table 3.8	Impact of smothering on intertidal and nearshore reef communities.....	3-27
Table 3.9	Impact of smothering on deep-water (> 5 m) communities and alteration of habitat .....	3-28
Table 3.10	Impact due to increased water turbidity and reduced light penetration .....	3-29
Table 3.11	Impact due to the development of anoxic conditions in deeper waters .....	3-31
Table 3.12	Impact due to the bioaccumulation of contaminants from tailings in deeper waters .....	3-32
Table 3.13	Impact of geophysical surveying noise on marine fauna.....	3-34
Table 3.14	Impact of sampling/mining noise on marine fauna .....	3-36
Table 3.15	Impact of helicopter noise on marine fauna .....	3-37
Table 3.16	Impact of operational discharges to the sea .....	3-41
Table 3.17	Impact of increased ambient lighting from larger mining vessels .....	3-42
Table 3.18	Impact of operational spills .....	3-45
Table 3.19	Impact of lost or discarded equipment.....	3-46
Table 3.20	Impact of mining on fishing .....	3-49
Table 3.21	Impact of mining on marine traffic.....	3-50
Table 3.22	Annual employment complement as of 31 March 2017 (Source: Alexkor Integrated Annual Report 2017) .....	3-51
Table 3.23	Impact related to job creation and generation of direct revenues.....	3-52
Table 3.24	Impact of mining on cultural heritage material .....	3-53
Table 3.25	Impact of mining on petroleum exploration .....	3-54
Table 3.26	Impact on diver assisted mining.....	3-55
Table 3.27	Impact of operational spills on fishing .....	3-56
Table 5.1:	Post Mining Land Use: Tourism Nodes, Precincts and Linkages (Source: Site Plan 2008) .....	5-3
Table 5.2:	Post Mining Land Use: Tourism Attractions, Facilities and Access Requirements (Source: Site Plan 2008).....	5-4
Table 5.3:	Breakdown of proposed financial provision for Mining Right 554MRC.....	5-10
Table 5.4:	Breakdown of the annual liability quantum for Mining Right 554MRC.....	5-10
Table 5.5:	Breakdown of the final rehabilitation and closure quantum for Mining Right 554MRC .....	5-11
Table 5.6:	Breakdown of quantum for latent risks in Mining Right 554MRC .....	5-12

## LIST OF APPENDICES

Appendix 1:	Generic Environmental Code of Operational Practice for “walpomp” operations
-------------	---



## ACRONYMS AND ABBREVIATIONS

Below a list of acronyms, abbreviations and units used in this report.

Acronyms / Abbreviations	Definition
ACE	African Coast to Europe
AEL	Atmospheric Emission Licence
CBAs	Critical Biodiversity Areas
CBD	Convention of Biological Diversity
CEO	Chief Executive Officer
CITES	Convention on International Trade in Endangered Species
Chirp	Compressed High Intensity Radar Pulse
COGSA	Carriage of Goods by Sea Act, 1986 (No. 1 of 1986)
DAFF	Department of Agriculture, Forestry and Fisheries
DBCM	De Beers Consolidated Mines (Pty) Ltd
DEA	Department of Environmental Affairs
DMR	Department of Mineral Resources
EBSA	Ecologically or Biologically Significant Area
EIA	Environmental Impact Assessment
EEZ	Exclusive Economic Zone
EMFs	Environmental Management Frameworks
EMPR	Environmental Management Programme
EASSy	Eastern Africa Submarine Cable System
GN	Government Notice
I&AP	interested and affected parties
IDPs	Integrated Development Plans
IEM	Integrated Environmental Management
IMO	International Maritime Organisation
IUCN	International Union for the Conservation of Nature
MARPOL	International Convention for the Prevention of Pollution from Ships, 1973/1978
MPA	Marine Protected Area
MPRDA	Mineral and Petroleum Resources Development Act, 2002 (No. 28 of 2002)
MSY	Maximum Sustainable Yield
MWP	Mines and Work Programme
NCMP	National Coastal Management Plan
NEMA	National Environmental Management Act, 1998 (No. 108 of 1998)
NEM:AQA	National Environmental Management: Air Quality Act, 2004 (No. 39 of 2004)
NEM:BA	Environmental Management: Biodiversity Act, 2004 (No. 10 of 2004)
NEM:ICMA	National Environmental Management: Integrated Coastal Management Act, 2008 (No. 24 of 2008)
NEM:PAA	National Environmental Management: Protected Areas Act, 2003 (No. 57 of 2003)
NEM:WA	National Environmental Management: Waste Act, 2008 (No. 59 of 2008)
NHRA	National Heritage Resources Act, 1999 (No. 25 of 1999)
NMMU	Nelson Mandela Metropolitan University
NWA	National Water Act, 1989 (No. 36 of 1998)
ORASEDOM	Orange-Senqu River Commission
PRM	Placer Resource Management (Pty) Ltd
PSJV	Pooling Sharing Joint Venture
RMC	Richtersveld Mining Company (Pty) Ltd
SAFE	South Africa Far East
SAMSA	South African Maritime Safety Association ()
SANBI	South African National Biodiversity Institute

Acronyms / Abbreviations	Definition
SDFs	Spatial Development Frameworks
SLR	SLR Consulting (South Africa) (Pty) Ltd
TAC	Total Allowable Catch
TAE	Total Allowable Effort
UNCLOS	United Nations Convention on Law of the Sea, 1982
WASC	West African Submarine Cable
Unit	Definition
cm	centimetres
cm/s	centimetres per second
dB	Decibel
g/m <sup>2</sup>	Grams per square metre
g/m <sup>3</sup>	Grams per cubic metre
km	Kilometre
kts	Knots
m	Metres
m <sup>2</sup>	Square metres
m <sup>3</sup>	Cubic metre
mg/l	Milligrams per litre
mm	Millimetres
m/s	Metres per second
mT	Metric tons
nm	Nautical mile (1 nm = 1.852 km)
psi	Per square inch
t	Tons
µg	Micrograms
µm	Micrometre
µg/l	Micrograms per litre
µPa	Micro Pascal
°C	Degrees Centigrade
%	Percent
‰	Parts per thousand
<	Less than
>	Greater than
"	Inch



## **AMENDMENT OF ENVIRONMENTAL MANAGEMENT PROGRAMMES FOR MINING RIGHTS 554MRC, 10025MR, 512MRC AND 513MRC**

### **VOLUME 2: MINING RIGHT 554MRC**

## **1 INTRODUCTION**

This chapter describes the project background and the approach and structure of the report and associated volumes.

### **1.1 BACKGROUND**

In 2011, Alexkor SOC Limited (Alexkor) and the Richtersveld Mining Company (Pty) Ltd (RMC) formed a Pooling and Sharing Joint Venture (hereafter referred to as “PSJV”), as per the 2007 Deed of Settlement, in order to oversee all current and future mining activities relating to Alexkor’s mining rights.

The PSJV thus manages an onshore and four marine Mining Rights on and off the West Coast of South Africa. These Mining Rights are roughly located between the Orange River in the north and Kleinsee in the south (see Figure 1-1 and Box 1-1). The mining methods currently employed in these areas include:

- Conventional open cast terrestrial mining;
- Shore-based beach pumping in the shallow surf zone using small-scale diver-assisted suction equipment (referred to locally as “walpomp”);
- Vessel-based diver assisted mining;
- Cofferdam mining; and
- Large vessel mining using airlift or bottom deployed remotely operated mining systems.

The current mining activities are approved and executed under three Environmental Management Programmes (EMPRs), as amended (CSIR, 1994; Site Plan, 2008; Myezo, 2013), two of which are applicable to the marine Mining Rights.

The PSJV is amending its EMPRs for the marine Mining Rights to comply with the current requirements of the National Environmental Management Act, 1998 (No. 108 of 1998) (NEMA) and the Environmental Impact Assessment (EIA) Regulations 2014, as amended, and to ensure alignment with each other, all new legislation, environmental standards, as well as internal PSJV Performance Assessment Reports. The EMPR for the onshore Mining Right 550MRC, which was approved in April 2017, is not being amended as part of this process as agreed to with the Department of Mineral Resources (DMR).

SLR Consulting (South Africa) (Pty) Ltd (“SLR”), in association with Placer Resource Management (Pty) Ltd (“PRM”), has been appointed by the PSJV as the independent environmental consultant to amend the existing EMPRs for marine mining rights in terms of NEMA and the Mineral and Petroleum Resources Development Act, 2002 (No. 28 of 2002) (MPRDA), as amended. PRM is under subcontract to SLR.



**Figure 1-1: Location map of the PSJV's existing Mining Rights on and off the West Coast of South Africa**

**Box 1-1: Alexkor RMC JV's Mining Right areas**

- **Mining Right 550MRC**, comprising:
  - > Farm No.1;
  - > Farm No. 155;
  - > Arrisdraft (Farm No. 616);
  - > Brandkaros (Farm No. 517);
  - > Remainder of Gypsum (Farm No. 5);
  - > Corridor-Wes (Farm No. 2);
  - > Portion 17 (a portion of Portion 8);
  - > Portion 16 (a portion of Portion 9);
  - > Portion 14 (a portion of Portion 12); and
  - > Portion 15 (a portion of Portion 10).
- **Mining Right 554MRC**, comprising:
  - > Centre line of the Orange River, to the bank of along the following properties: Corridor-Wes (Farm No. 2), Portion 17 (a portion of Portion 8), Portion 16 (a portion of Portion 9), Portion 15 (a portion of Portion 10), Arrisdraft (Farm No. 616), Farm No. 1, and Farm Brandkaros (Farm No. 517);
  - > Surf zone along Farm No. 1 and Farm No. 155;
  - > Sea Concession 1a;
  - > Sea Concession 1b;
  - > Sea Concession 2a; and
  - > Sea Concession 3a.
- **Mining Right 10025MR**, comprising Sea Concession 1c;
- **Mining Right 512MRC**, comprising Sea Concession 4a; and
- **Mining Right 513MRC**, comprising Sea Concession 4b.

## 1.2 APPROACH TO THE EMPR AMENDMENT PROCESS

In order to streamline the EMPR amendment processes for the four marine mining right areas, a combined process is being undertaken in order to avoid duplication (specifically public participation and specialist assessments). As a result, some of the information gathered as part of this combined process is applicable to all four amendment applications.

Based on this approach, five separate reports (or volumes) have been prepared. These include:

- **Volume 1: EMPR Amendment Overview**  
This volume includes all supporting information that is applicable to all four marine mining right areas. This volume includes: a summary of the key legislative requirements; public participation process undertaken; description of the receiving environment; and specialist studies.
- **Volume 2: Mining Right 554MRC - this report**  
This volume deals specifically with prospecting and mining operations in the surf zone and Sea Concessions 1a, 2a, 3a and 1c, as well as the management/rehabilitation of the Orange River.
- **Volume 3: Mining Right 10025MR**  
This volume will deal specifically with the marine mining operations pertaining to Sea Concession 1c.
- **Volume 4: Mining Right 512MRC**  
This volume will deal specifically with the marine mining operations pertaining to Sea Concession 4a.
- **Volume 5: Mining Right 513MRC**  
This volume will deal specifically with the marine mining operations pertaining to Sea Concession 4b.

An overview of the structure and content of this report is presented below.

### 1.3 STRUCTURE OF THIS REPORT (VOLUME 2)

An overview of the structure and content of this report is presented below.

Section	Contents
<b>Executive Summary</b>	Provides a comprehensive synopsis of this report.
<b>Chapter 1</b>	<b>Introduction</b> Describes the project background and the approach and structure of the report and associated volumes.
<b>Chapter 2</b>	<b>Project Description</b> Provides general information on the Mineral Right holder and licence area, as well as provides a description of the mineral resource and the historical, current and future prospecting and mining methods.
<b>Chapter 3</b>	<b>Impact Assessment</b> Describes and assesses the significance of potential impacts related to prospecting and mining operations.
<b>Chapter 4</b>	<b>Mitigation and Management Plan</b> Lists the project controls and mitigation measures that shall be implemented to avoid or minimise impacts on the environment from prospecting and mining activities.
<b>Chapter 5</b>	<b>Closure Plan</b> Presents the Closure Plan for mining right.
<b>Chapter 6</b>	<b>References</b> Provides a list of the references used in compiling this report.
<b>Appendices</b>	Appendix 1: Generic Environmental Code of Operational Practice for “walpomp” operations

## 2 PROJECT DESCRIPTION

This chapter provides information on the Mineral Right holder and licence area, as well as provides a description of the mineral resource and the historical, current and future prospecting and mining methods.

### 2.1 GENERAL INFORMATION

#### 2.1.1 MINING RIGHT HOLDER

Company:	Alexkor SOC
Managing Entity:	Pooling Shared Joint Venture (PSJV)
Address:	Alexkor RMC Joint Venture Orange Road Alexander Bay 8290
Responsible Persons:	Mr Mervyn Carstens - Chief Executive Officer (CEO) Ms Leilani Swartbooi - Environmental Manager
Telephone:	+27 27 831 8300
Facsimile:	+27 27 831 1910

#### 2.1.2 MINING RIGHT DETAILS

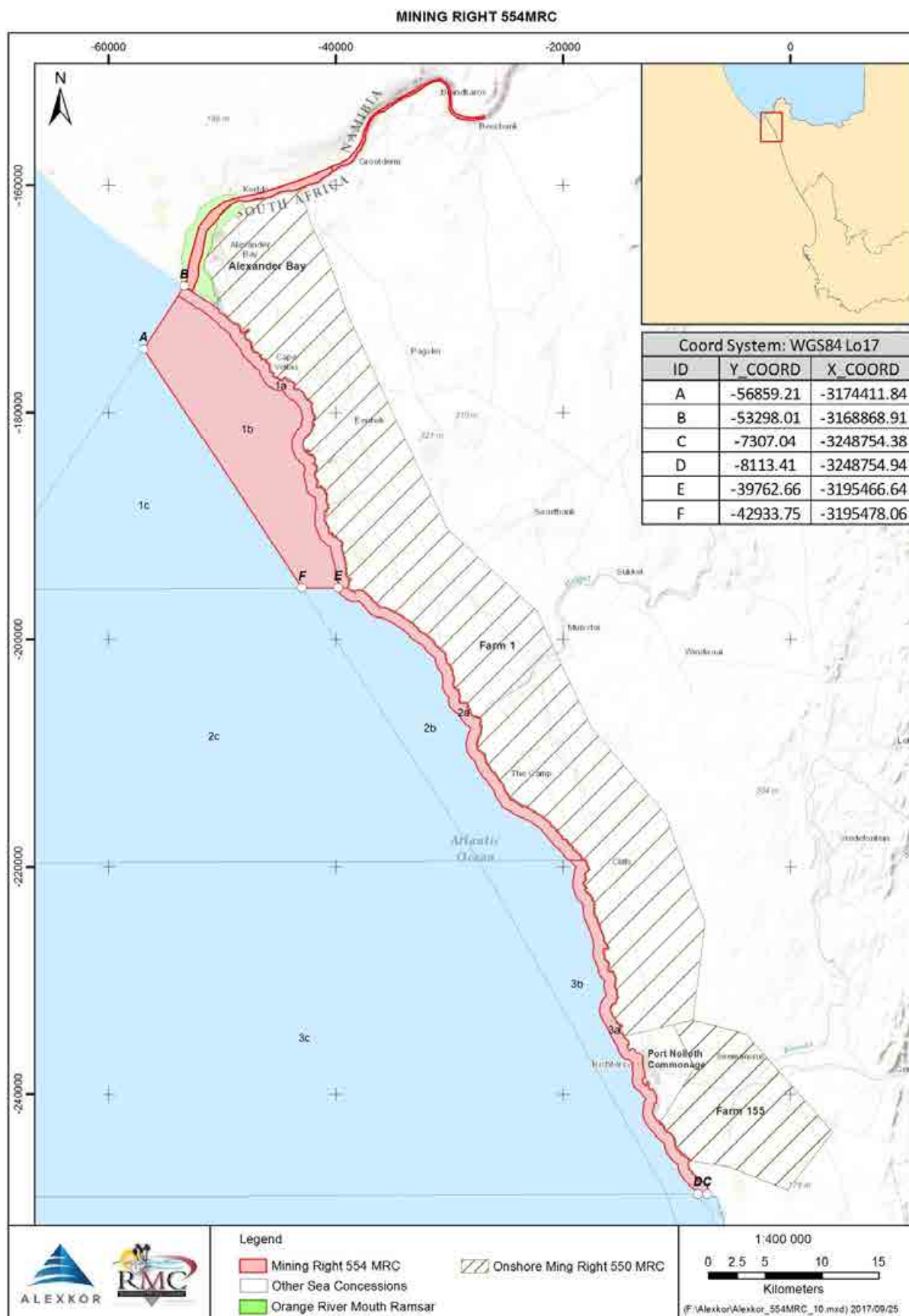
In November 2010 the “old order mining right” was converted to a “new order mining right” (MPT number 118/2010) in terms of the MPRDA, which was granted for a period of 20 years (expiring on 1 July 2030).

The total mining right area is 32 723.59 ha in extent and comprises of the following portions (see Figure 2-1):

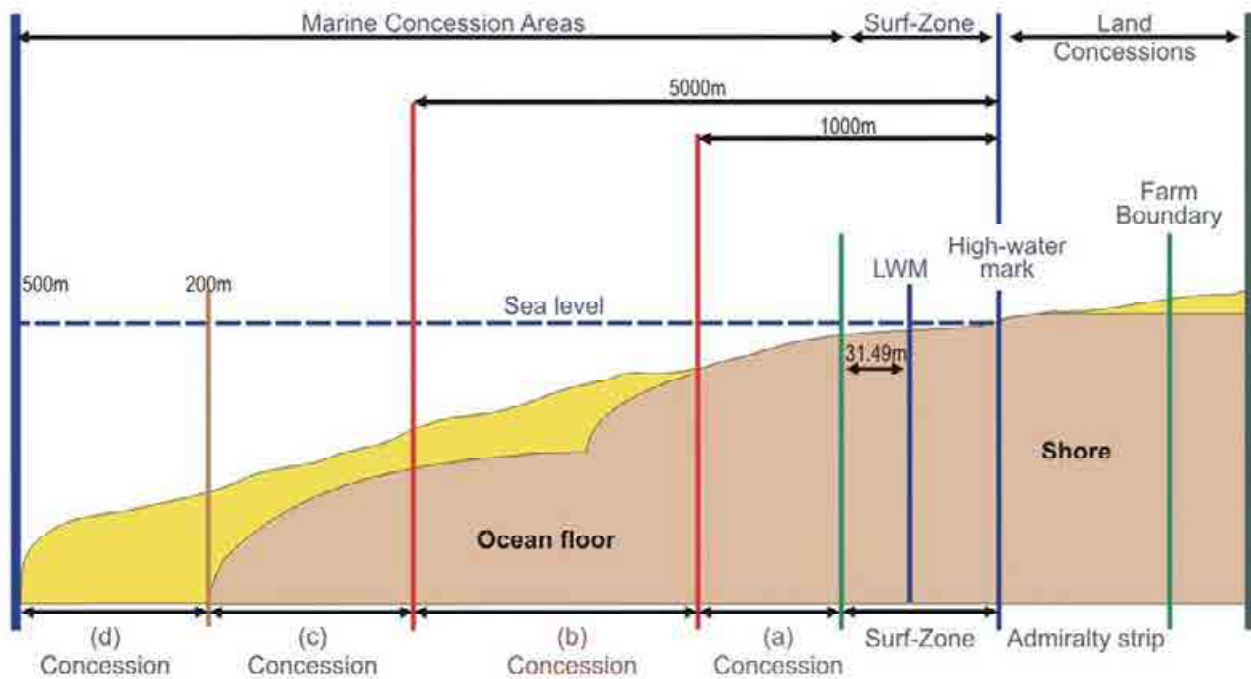
- Middle of the Orange River to the bank of the following properties:
  - > Farm No. 1;
  - > Brandkaros No 517;
  - > Arrisdrijf No. 616; and
  - > Portions 15, 16 & 17 of Corridor-Wes No. 2.
- Surf zone along Farm No. 1 and Farm No. 155<sup>1</sup> up to 31.49 m below low water mark;
- Sea Concession 1a;
- Sea Concession 1b;
- Sea Concession 2a; and
- Sea Concession 3a.

The mining right area extends along approximately 90 km of the Namaqualand coastal zone from the middle of the Orange River in the north to O'Beep Bay, approximately 15 km south of Port Nolloth at its southern extent. The eastern boundary is the high water mark of the surf zone adjacent to Sea Concessions 1a, 2a and 3a (refer to Figure 2-2 for an indication of the surf zone and various sea concessions). The western boundary is located 1 km offshore of the high water mark along Sea Concessions 2a and 3a, and approximately 5 km offshore of the high water mark along the Sea Concession 1b (up to a water depth of approximately 65 m).

<sup>1</sup> The mineral rights (diamond) of these farms are also held by the PSJV under Mining Right 550MRC.



**Figure 2-1: Location map of Mining Right 554MRC**



**Figure 2-2: Schematic cross section of the mining concession areas**

### 2.1.3 FINANCIAL PROVISION

"Financial Provision" means the insurance, bank guarantee, trust fund or cash that must be provided in terms of NEMA guaranteeing the availability of sufficient funds to undertake the:

- rehabilitation of the adverse environmental impacts of the listed or specified activities;
- rehabilitation of the impacts of the prospecting, exploration, mining or production activities;
- decommissioning and closure of the operations;
- remediation of latent or residual environmental impacts, which become known in the future;
- removal of building structures and other objects; or
- remediation of any other negative environmental impacts;

The holder of a mining right is required to make the prescribed financial provision for the rehabilitation and management of negative environmental impacts. To this end and as an operational mine, the PSJV is in compliance with this requirement, as it has in place an approved financial provision in the form of a bank guarantee.

In terms of Section 24P(3) of NEMA, the holder of a mining right must annually:

- assess the environmental liability in the prescribed manner and increase the financial provision to the satisfaction of DMR; and
- submit an audit report to DMR on the adequacy of the financial provision from an independent auditor.

In terms of Section 6 and 11 of the Regulations pertaining to financial provision, the determination of the revised quantum must be through a detailed itemisation of all activities and costs, calculations based on the actual costs of implementation of the measures required for:

- annual rehabilitation, as reflected in the rehabilitation plan ;
- final rehabilitation, decommissioning and closure of the prospecting or mining operations at the end of the life of operations, as reflected in a final rehabilitation, decommissioning and mine closure plan; and



- c. remediation of latent or residual environmental impacts, which may become known in the future, as reflected in an environmental risk assessment report.

Should the review of the financial provision indicate:

- a. a shortfall the holder must increase the financial provision within 90 days of the auditor's report; and
- b. an excess, the amount in excess must be deferred against subsequent assessments.

A review of the financial provision has been undertaken as part of this EMPR amendment. The proposed revised quantum is provided in Closure Plan (refer to Chapter 5).

## 2.2 MINERAL RESOURCE

Placer diamond deposits<sup>2</sup> occurring along the Southern African coast line are referred to as secondary deposits, with the original source of diamonds being the kimberlites, located in the interior of Southern Africa. As the kimberlite pipes were eroded over time, the diamonds were transported towards the coast via glacial and palaeo drainage systems, including the Orange River, the Vaal River, the Olifants River and their tributaries.

At the river mouths, the diamonds were discharged into the ocean where they were then distributed in a mainly northerly direction along the coastline, through a combination of longshore transport, waves, wind and currents. There have been multiple sea level changes since the formation of the Atlantic Ocean over 100 million years ago, and this along with the continued longshore wave action, has resulted in a complex zone of diamond mineralisation existing along the West Coast of South Africa and southern Namibia. In a simplistic explanation, these mineralised deposits are now present onshore as raised terraces and offshore as submerged marine terraces.

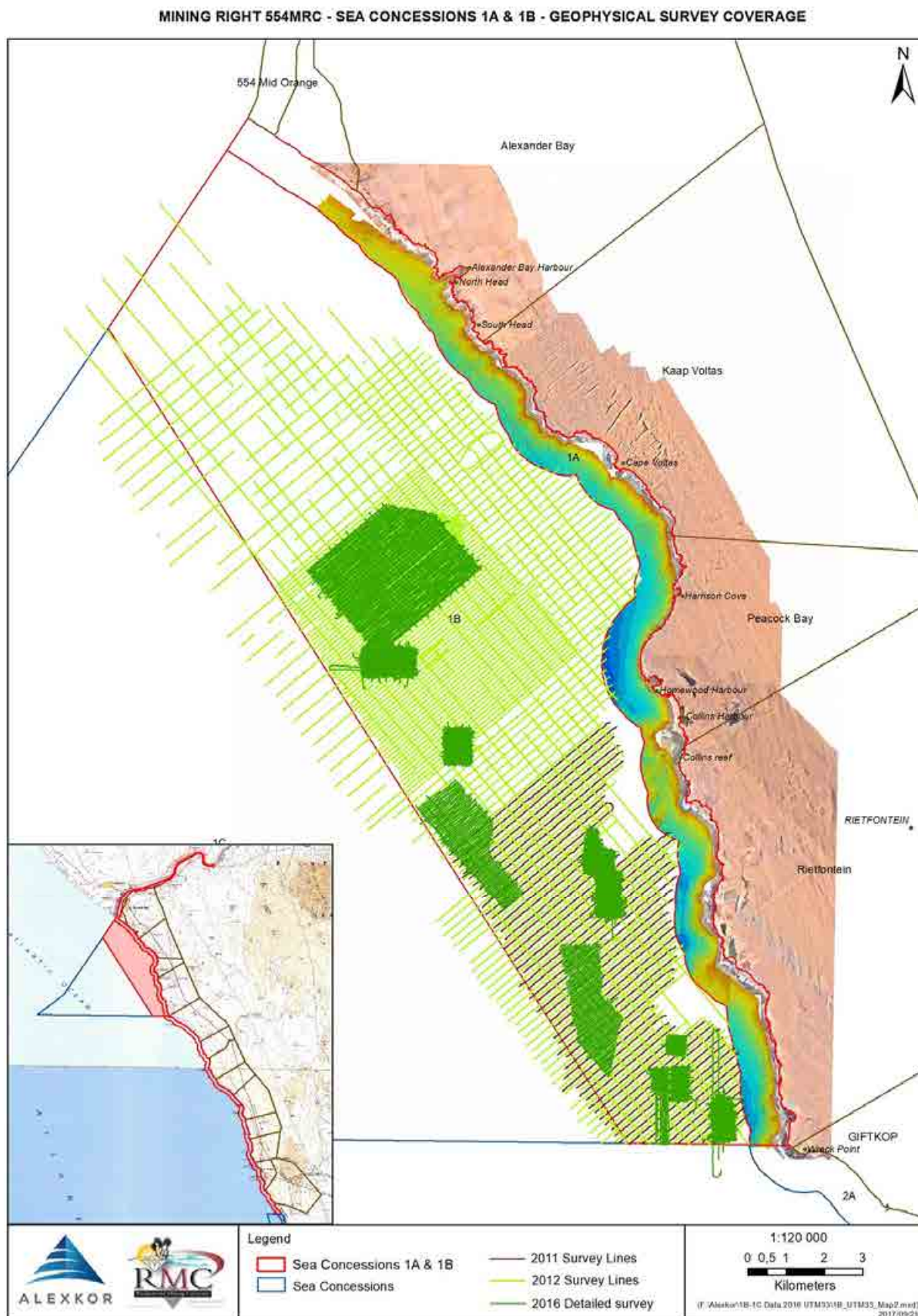
Diamond mineralisation is prevalent over the entire mining right area, but economic concentrations are found in localised trap sites controlled by bedrock morphology, water depth and sediment dynamics. Mineral prospecting off the West Coast is restricted to some extent by ocean conditions (especially in the surf zone). In recent years, shallow water geophysical surveys have been undertaken within concession 1a. In deeper waters (from 12 m to a water depth of approximately 65 m in the western extent of Sea Concession 1b) more sophisticated technology is required to determine the viability of the mineral deposit. A combination of geophysical survey, sampling and geological interpretation have over the years (see Figure 2-3) resulted in the identification of areas of high mineralised potential in Sea Concession 1b (refer to Section 2.3.3).

The interpretations of these survey data sets combined with historical mining data have resulted in the identification of areas of significant mineral resource potential (see Section 2.3.3 for potential future mining areas).

---

<sup>2</sup> A placer deposit is an accumulation of valuable minerals formed by gravity separation during sedimentary processes.





**Figure 2-3: Geophysical survey line coverage in Sea Concession 1b**

## 2.3 HISTORICAL, CURRENT AND FUTURE MINING

### 2.3.1 HISTORICAL MINING

The PSJV's major operations are directed at the recovery of diamonds, predominantly from ancient, recently elevated and submerged marine terrace gravel deposits along the West Coast of South Africa. Mining of intertidal, sub-tidal (including mid- and deep-water) diamondiferous gravels occurs along the coastline within defined licence areas.

Since 1928, when State Alluvial Diggings commenced with mining in the area now managed by the PSJV, approximately 10 million carats have been recovered, of which 95% have been of gem quality. Approximately 20% of the recovered diamonds are from the marine mining right areas, in particular Mining Right 554MRC. Diamond mining along the coast and in the surf zone commenced in 1976. Mining involving divers operating from small vessels commenced in 1980, with the remote recovery of diamonds using larger mining vessels (e.g. *MV Big Red*) commencing in June 1991. Historical mining areas associated with Mining Right 554MRC are indicated in Figure 2-4. Although a portion of the Orange River is included in the mining right, no prospecting or mining have occurred within this location.

### 2.3.2 CURRENT MINING

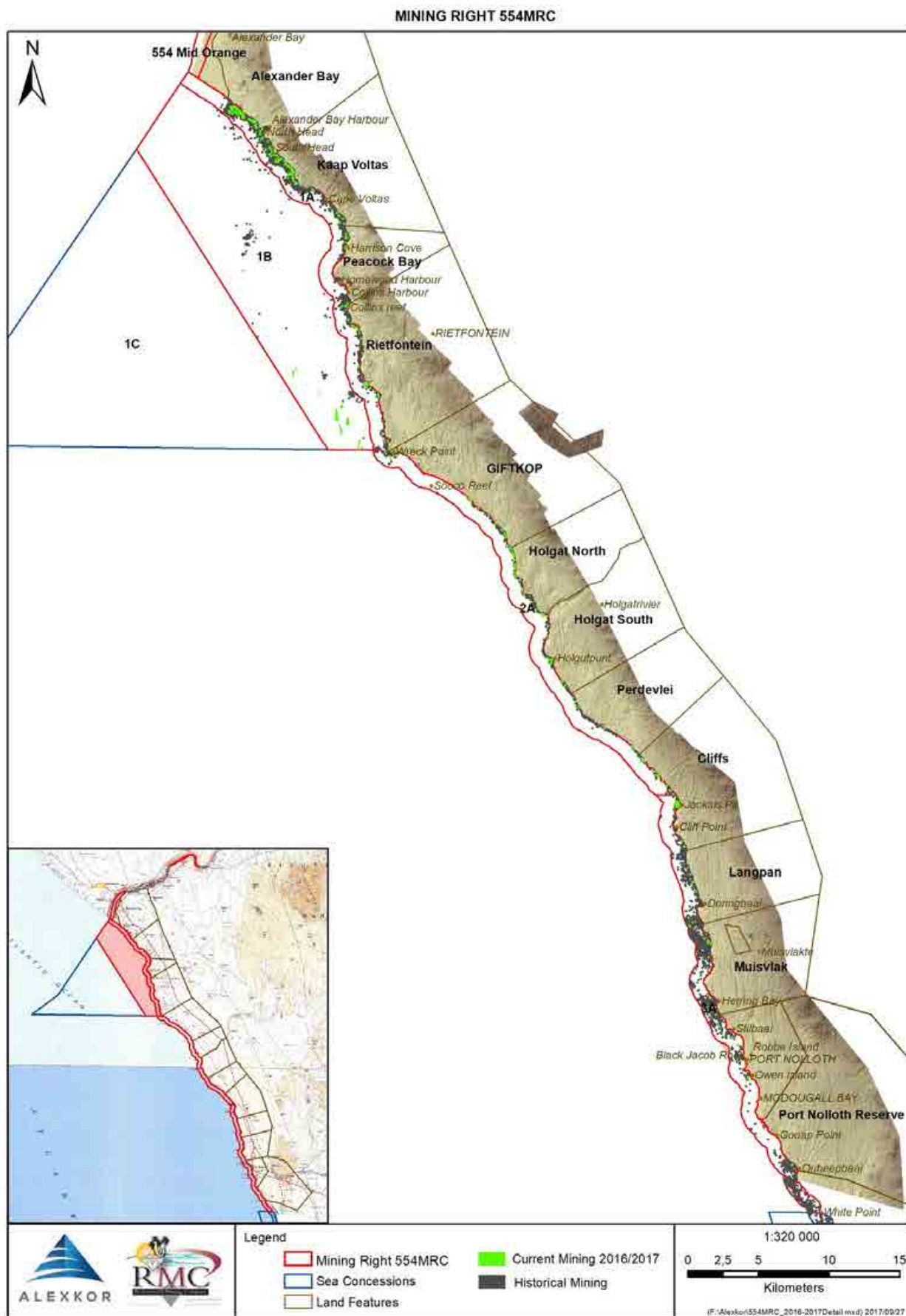
Similar to the onshore operations, the PSJV outsources the majority of the marine prospecting and mining operations to contractors. There are currently (September 2017) five contractors working along the coast in the surf and intertidal zone (coffer dam mining), 64 shore-based diver assisted operators ("walpomp") operating in the shallow water and 24 small vessel-based diver assisted operators registered. Currently, the PSJV undertakes relatively low intensity prospecting and mining in its mid-water and deep-water (> 30 m) concession areas (specifically Sea Concession 1b). The majority of current mining effort is directed at the subtidal concession areas (namely the beach, surf zone and Sea Concessions 1a, 2a and 3a). Current (as of February 2017) mining areas associated with Mining Right 554MRC are indicated in Figure 2-4.

The type and size of mining system and vessel / platform used is primarily governed by the water depth of the deposit. Shallow deposits in the surf zone can be accessed by the simple "walpomp" operations, while the small diver support vessels operate from the surf zone to up to 12 m, which may increase to 17.5 m water depth where decompression chambers are used and the larger mining vessels operate in water depths commonly greater than 30 m. The current (and potential future) prospecting and mining methods are described in Sections 2.4 and 2.5, respectively.

### 2.3.3 POTENTIAL FUTURE MINING

Potential future mining areas associated with Mining Right 554MRC are indicated in Figures 2-5 and 2-6. These areas are indicative and are based on existing prospecting and historical mining data. Thus, other areas may be identified as additional areas are subject to further prospecting and possible mining. Since mining targets unconsolidated gravels, mining is unlikely to occur in areas with exposed bedrock areas (see Figure 2-7 for an indication of known bedrock areas). From Survey data it is calculated that approximately 43% and 30% bedrock is exposed on the seabed of Sea Concessions 1a and 1b respectively, and mining is unlikely in areas with exposed bedrock. Potential future prospecting and mining methods are described in Sections 2.4 and 2.5, respectively.

Although a portion of the Orange River falls within the mining right area, no prospecting or mining activities are being considered for inclusion in this amendment of the EMPR for Mining Right 554MRC.

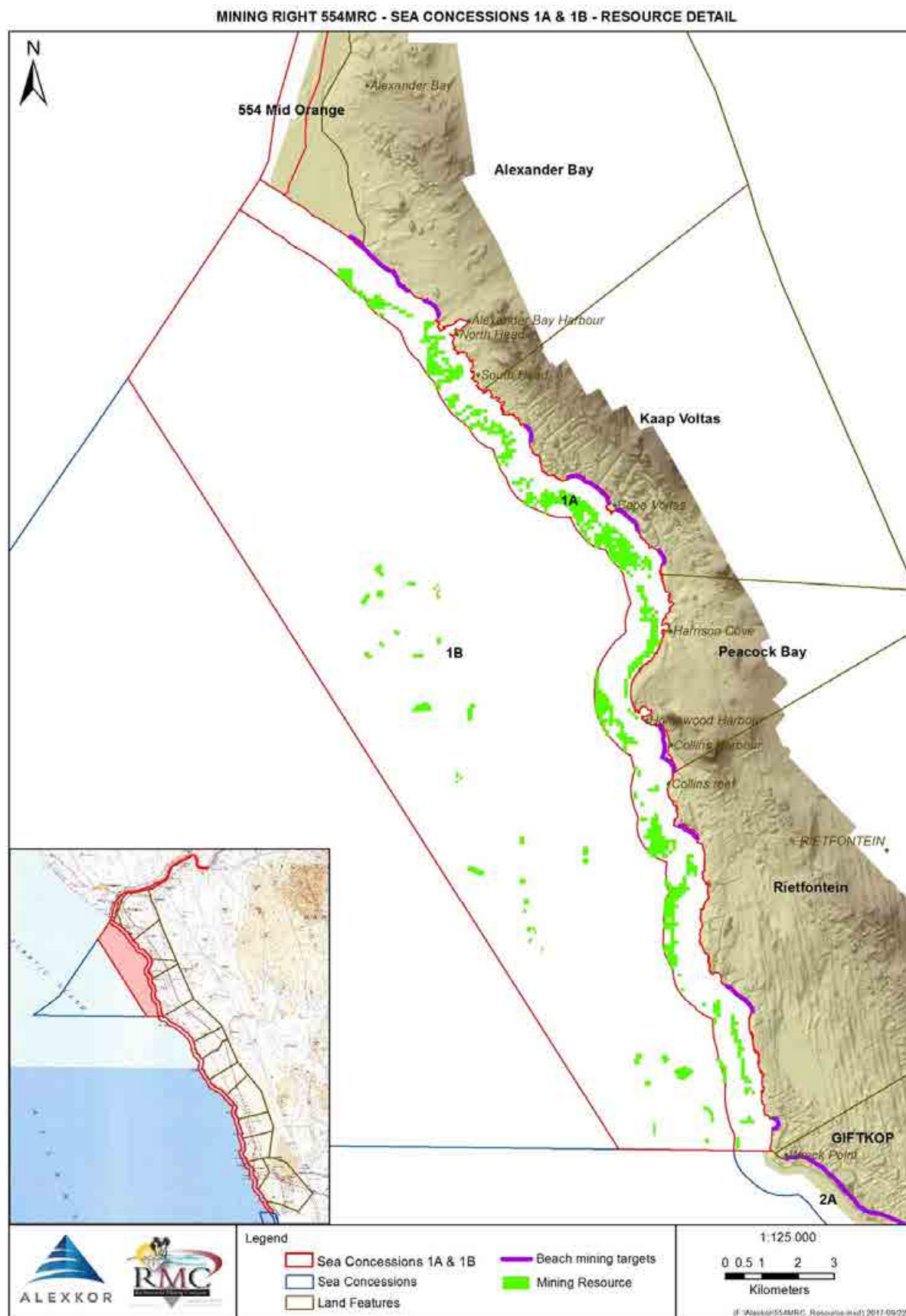


**Figure 2-4: Historic and current (March 2016 to February 2017) mining areas**

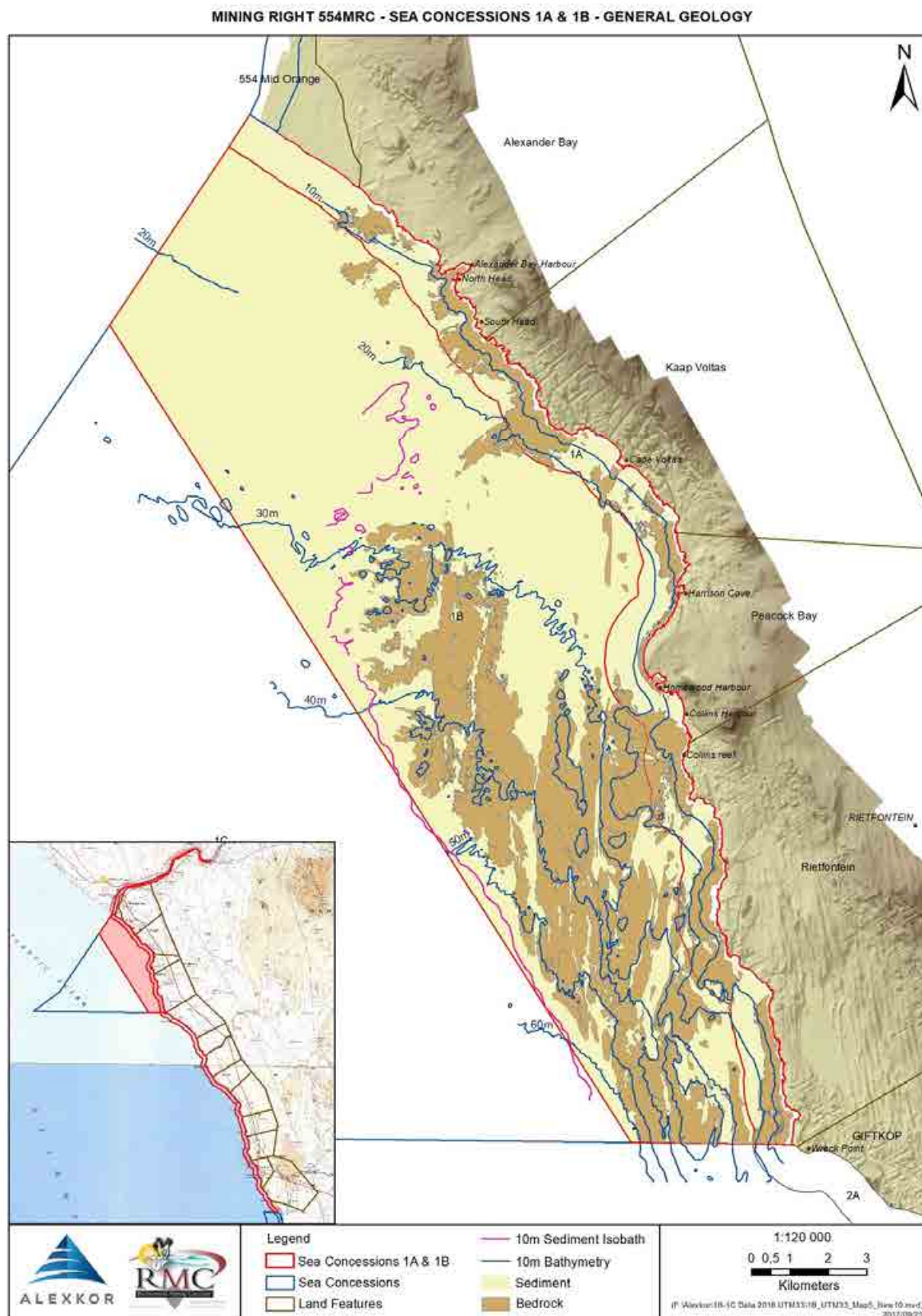




**Figure 2-5: Areas of high mineralisation potential along the beach and surf zone adjacent to Sea Concessions 1a, 2a and 3a**



**Figure 2-6: Areas of high mineralisation in Sea Concessions 1a and 1b**



**Figure 2-7: Location of known bedrock features occurring in Sea Concession 1a and 1b**



## 2.4 MARINE PROSPECTING METHODS

Marine prospecting methods in Mining Right 554MRC may include:

- geophysical surveys;
- vibrocoring, drop (piston) coring and box cores;
- drill sampling using dedicated sampling or mining tools;
- bulk sampling using mining tools; and
- small vessel-based diver assisted and mobile pump unit sampling.

### 2.4.1 GEOPHYSICAL SURVEYS

In order to investigate the structure of seabed sediment layers a number of surveying tools can be used. These are described below.

These surveys can be undertaken from a small ski boat or large ocean going survey vessel, depending primarily on the water depths over which the survey is to be conducted. Shallow water surveys (< 20 m) would be conducted from ski boats, which would return to port daily. Mid- to deep-water surveys (> 20 m) would be undertaken from larger survey vessels that are capable of remaining at sea for several days at a time.

Outputs from these surveys commonly produce detailed images of the seabed, showing topographical features, sediment characterisation (which may subsequently be ground-truthed by obtaining samples from the seabed). Images can also be generated that indicate the sub surface layers below the seabed. From this information set, trap sites (depressions, gully's, ridge and other features) are identified for potential mineral development via prospecting.

The information output from these equipment sets is provided in real time and can thus be viewed on-board the vessel virtually immediately. The data sets are quality assessed on-board, and subsequently interpreted in detail ashore. Detailed maps of the seafloor and sub seafloor are produced, with accuracy to a few centimetres. Geophysical surveys would also identify physical objects, i.e. shipwrecks, anchors and other such items on, or in the seabed.

#### 2.4.1.1 Single beam echo sounder

The majority of hydrographic echo / depth sounders are dual frequency, transmitting a low frequency pulse (typically around 24 kHz) at the same time as a high frequency pulse (typically around 200 kHz). Dual frequency depth / echo sounding has the ability to identify a layer of soft mud on top of a layers consolidate and partially consolidated sediments, which are underlain by footwall or bedrock. The pulse emitted would be for a duration of more than 0.025 seconds and typically produces sound levels in the order of approximately 180 dB re 1  $\mu$ Pa at 1m.

#### 2.4.1.2 Bottom profiler

Bottom profilers are powerful low frequency echo sounders that provide profiles of the upper layers of the ocean floor. A typical bottom profiler emits an acoustic pulse at frequencies ranging from 0.4 to 30 kHz and typically produces sound levels in the order of 200-230 db re 1 $\mu$ Pa at 1m.

### 2.4.1.3 Multi beam or swath bathymetry

The use of multi-beam bathymetry survey allows the operator to produce a digital terrain model of the seafloor (see Figure 2-8).

The survey vessel would be equipped with a multi-beam echo sounder to obtain swath bathymetry and a sub-bottom profiler to image the seabed and the near surface geology. The multi-beam system provides depth sounding information on either side of the vessel's track across a swath width of approximately two times the water depth. Although this type of survey typically does not require the vessel to tow any cables, the vessel is "restricted in its ability to manoeuvre" due to the operational nature of this work.

Typical multi-beam echo sounder emits a fan of acoustic beams from a transducer at frequencies ranging from 10 kHz to 200 kHz and typically produces sound levels in the order of 207 db re 1 $\mu$ Pa at 1m. A typical sub-bottom profiler emits an acoustic pulse from a transducer at frequencies ranging from 3 kHz to 40 kHz and typically produces sound levels in the order of 206 db re 1 $\mu$ Pa at 1m.

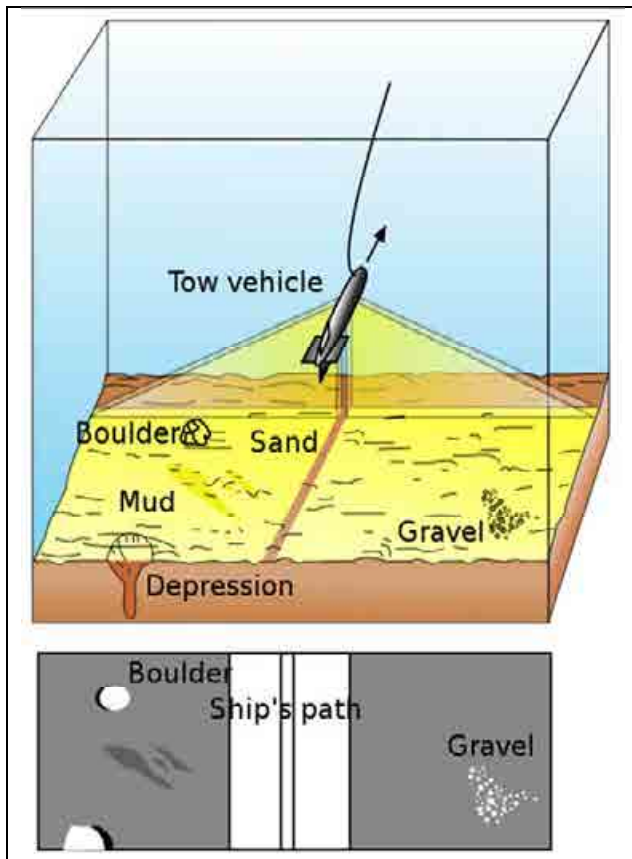


**Figure 2-8: Vessel using multi-beam depth/echo sounders.**  
(Source: <http://www.gns.cri.nz>)

### 2.4.1.4 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. Side-scan uses a sonar device, towed from a surface vessel or mounted on the ship's hull, that emits conical or fan-shaped pulses down toward the seafloor across a wide angle perpendicular to the path of the sensor through the water (see Figure 2-9). Side Scan sonar can also be mounted on Autonomous Underwater Vehicle (AUV), which navigate within the water column at predefined depths, independent of the survey vessel. The intensity of the acoustic reflections from the seafloor of this fan-shaped beam is recorded in a series of cross-track slices. When stitched together along the direction of motion, these slices form an image of the sea bottom within the swath (coverage width) of the beam. A typical side scan sonar emits a pulse at frequencies ranging from 50 to 500 kHz and typically produces sound levels in the order of 220-230 db re 1 $\mu$ Pa at 1m.





**Figure 2-9: Typical side scan sonar device and resulting information**  
 (Source: [https://en.wikipedia.org/wiki/Side-scan\\_sonar](https://en.wikipedia.org/wiki/Side-scan_sonar))

#### 2.4.1.5 Topas

The Topas system is designed for very high spatial resolution sub-bottom profiling in water depths from 2 m to more than 400 m. The parametric signal source has the advantage of generating a low frequency (15 – 100 kHz) signal beam with no distinct sidelobe (distortion) structure, which reduces the possibility of spurious signals due to sidelobes in the received signals. Penetration performance depends on sediment characteristics, water depth, transmitted signature, noise level, etc. Penetration of up to 200 m can be achieved with a sediment resolution of typically 15 cm or better (Kongsberg TOPAS PS 120 marketing brochure).

#### 2.4.1.6 Compressed High Intensity Radar Pulse (Chirp)

Compressed High Intensity Radar Pulse (Chirp) systems emit a 'swept' frequency signal, which means that the transmitted signal is emitted over a period of time and over a set range of frequencies. This repeatable (transmitted) waveform can be varied in terms of pulse length, frequency bandwidth, and phase/amplitude. A matched filter, or correlation process, collapses the swept frequency modulated (FM) received signal into a pulse of short duration, maximising the signal-to-noise-ratio. The reflected signal is received by the same tuned transducer array that generates the outgoing acoustic energy (<https://woodshole.er.usgs.gov>).

Chirp systems enable high-resolution mapping of relatively shallow deposits, and in general, have less penetration than the impulse-type systems (air or water guns, sparker, and boomer). Newer chirp systems are able to penetrate to comparable levels as the boomer, yet yield extraordinary detail or resolution of the section. Penetration depths range from about 3 m in coarse sand to about 200 m in finer-grained sediments,

depending on the frequency range of the outgoing signal and the system employed. Resolution varies from about 4 to 40 cm, depending on the frequency range of the system used and the sediment type (<https://woodshole.er.usgs.gov>).

#### **2.4.1.7 Boomer**

Boomer sound sources are used for shallow water surveys. Boomers are towed in a floating sled behind a survey vessel. A boomer source stores energy in capacitors, but it discharges through a flat spiral coil instead of generating a spark. A copper plate adjacent to the coil flexes away from the coil as the capacitors are discharged. This flexing is transmitted into the water as the seismic pulse (<https://en.wikipedia.org>).

Originally the storage capacitors were placed in a steel container on the survey vessel. The high voltages used (typically 3 000 V) required heavy cables and strong safety containers. Recently, low voltage boomers have become available, which use capacitors on a towed sled, allowing efficient energy recovery, lower voltage power supplies and lighter cables. The low voltage systems are generally easier to deploy and have fewer safety concerns (<https://en.wikipedia.org>).

#### **2.4.1.8 Sparker**

A plasma sound source or sparker is a means of making a very low frequency sonar pulse underwater. For each firing, an electric charge is stored in a large high-voltage bank of capacitors, which is then released in an arc across electrodes in the water. The underwater spark discharge produces a high-pressure plasma and vapour bubble, which expands and then collapses, making a sound. Most of the sound produced is between 20 and 200 Hz and is useful for both seismic and sonar applications (<https://en.wikipedia.org>).

### **2.4.2 VIBROCORING, DROP CORING AND BOX CORING**

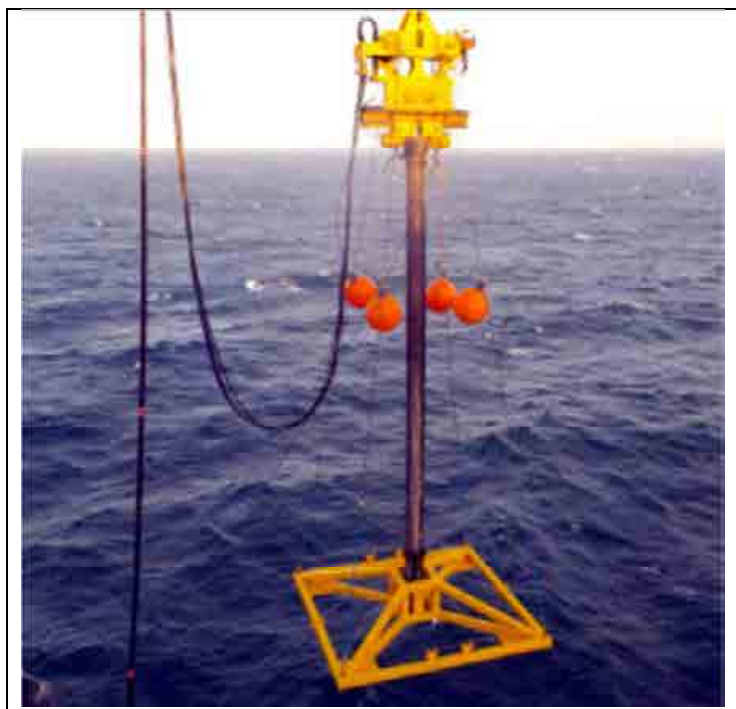
These methods are used to ground-truth geophysical interpretations of unconsolidated sediment.

#### **2.4.2.1 Vibrocoring**

Vibrocoring (or box coring) is a technique for collecting core samples of underwater sediments. The vibrating mechanism (see Figure 2-10) of a vibrocorer operates on hydraulic, pneumatic, mechanical or electrical power from an external source. The attached core tube is driven into sediment by the force of gravity, enhanced by vibration energy (<http://www.vibrocoring.com>).

In general the frequency of vibrations is in the range of 3 000 to 11 000 vibrations per minute (VPM) and the amplitude of movement is in the order of a few millimetres. The vibrations cause a thin layer of material to mobilise along the inner and outer tube wall, reducing friction and easing penetration into the substrate. The liquid spaces in the matrix allow sediment grains to be displaced by the vibrating tube. Vibrocoring works best on unconsolidated, waterlogged, heterogeneous sediments (<http://www.vibrocoring.com>).

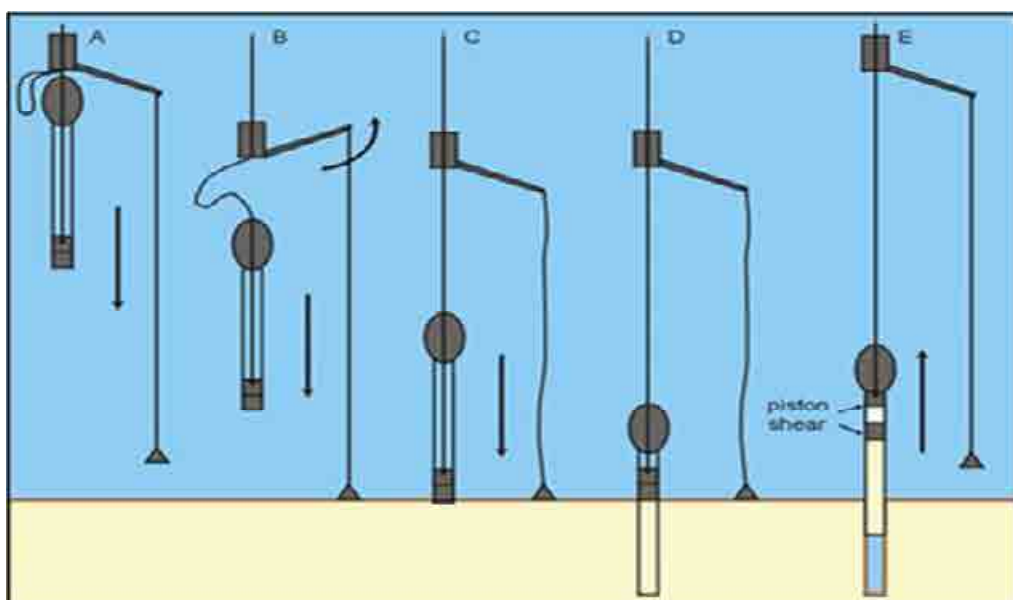
The sample is terminated either due to the full extent of the core tube being released (up to 6 m) or due to impenetrable ground conditions. When the insertion is completed, the vibrocorer is turned off and the tube is withdrawn with the aid of hoist equipment. In order to counteract suction at the lower end is a one-way core catcher, which collapses and prevents sediment from slipping back out. In addition, at the upper tube end is a one-way valve, which seals and maintains suction inside the tube. If the tube was not fully submerged during coring, it contains (besides sediment and water) an elastic column of air, which should be replaced with water and the tube resealed before it is withdrawn (<http://www.vibrocoring.com>).



**Figure 2-10: Vibrocorer**  
(Source: <https://www.vibro+coring+marine+sampling&client=firefox>)

#### 2.4.2.2 Drop coring

Drop or piston coring is one of the more common methods used to collect seabed geochemical samples, with the sequence of operation illustrated in Figure 2-11. The piston coring rig is comprised of a trigger assembly, the coring weight assembly, core barrels, tip assembly and piston. The core barrels are in lengths of 6 to 9 m with a diameter of 10 cm.



**Figure 2-11: Piston core operation at the seabed**  
(Source: TDI-Brooks)

The piston corer is lowered over the side of the survey vessel and allowed to free fall from about 3 m above the seabed to allow good penetration (A). As the trigger weight hits the bottom (B), it releases the weight on the trigger arm and the corer is released to "free-fall" the 3 m distance to the bottom (B & C), forcing the core barrel to travel down over the piston into the sediment (D). The movement of the core barrel over the piston creates suction below the piston and expels the water out the top of the corer. When forward momentum of the core has stopped, a slow pull-out of the winch commences. This suction triggers the separation of the top and bottom sections of the piston (E).

The recovered cores are visually examined at the surface with three sets of sub-samples retained for further geochemical analysis in an onshore laboratory. Any material having geologic or environmental interest would be preserved for further study.

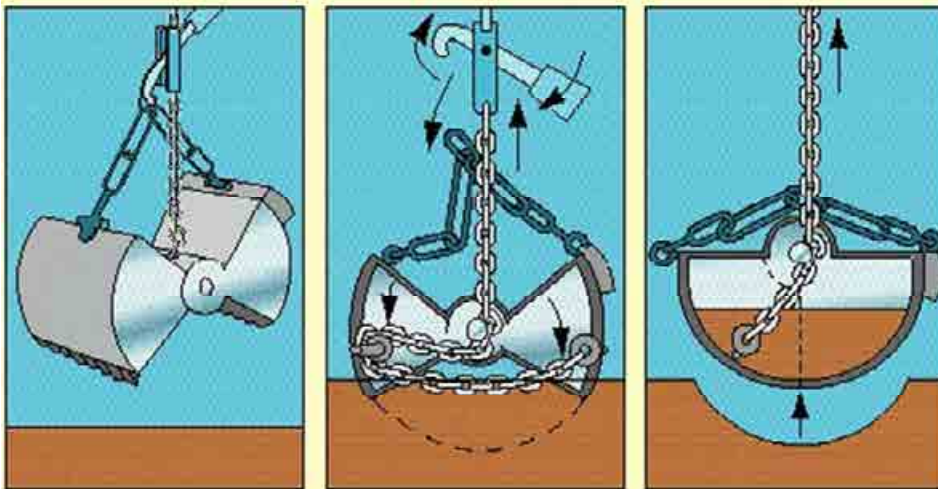
#### 2.4.2.3 Box Coring (Grab Samples)

The box corer (see Figure 2-12) is deployed from a survey vessel by lowering it vertically to the seabed. At the seabed the instrument is triggered by a trip as the main coring stem passes through its frame. The stem has a weight of up to 800 kg to aid penetration. While pulling the corer out of the sediment a spade swings underneath the sample to prevent loss. When hauled back on board, the spade is under the box. The recovered sample is completely enclosed after sampling, reducing the loss of finer materials during recovery. Stainless steel doors, kept open during the deployment to reduce any "bow-wave effect" during sampling, are triggered on sampling and remain tightly closed, sealing the sampled water from that of the water column. On recovery, the sample can be processed directly through the large access doors or via the removal of the box completely, together with its cutting blade. A spare box and spade can then be added, ready for an immediate redeployment.



**Figure 2-12: Box corer**  
(Source: [http://en.wikipedia.org/wiki/Box\\_corer](http://en.wikipedia.org/wiki/Box_corer))

Grab sampling (see Figure 2-13) is the simple process of bringing up surface sediments from the seafloor. This method, however, cannot be used to characterise different sedimentary layers since it is unable to penetrate the ground to depth and a mixture of sediments is produced. Once the grab sampler is launched, the jaws open and it descends to the seafloor. A spring closes the jaws and they trap sediments or loose substrate. The grab sampler is then brought up to the surface where its contents are studied in detail.



**Figure 2-13: Grab sampler**  
(Source: [http://www.jochemnet.de/fiu/OCB3043\\_35.html](http://www.jochemnet.de/fiu/OCB3043_35.html))

### 2.4.3 DRILL SAMPLING

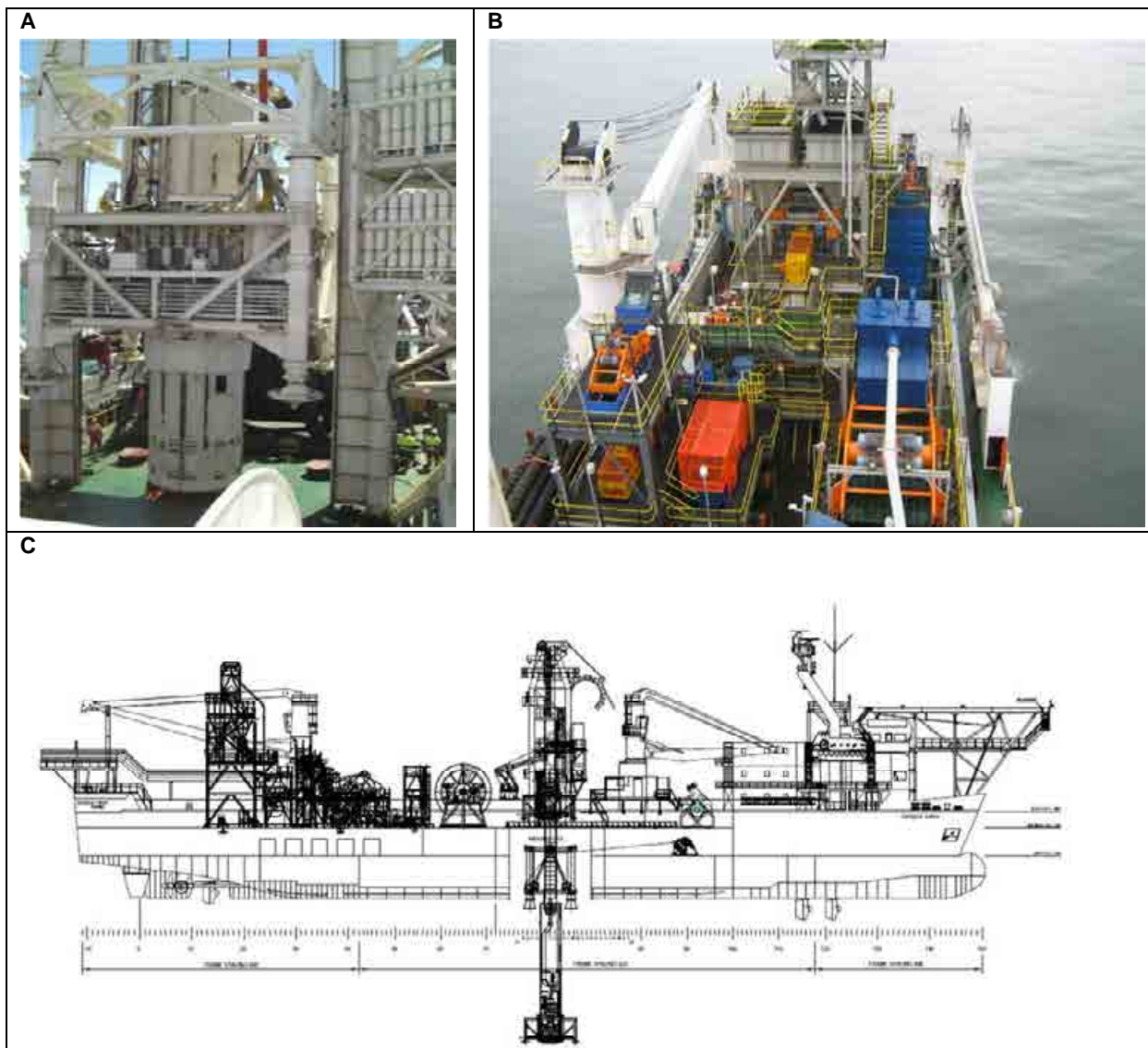
Large vessel-mounted vertical drill tools, deployed through a moon pool (i.e. an opening in the floor and base of hull providing access to the water below), are capable for working in water depths of approximately 40 m to 180 m, with swell conditions up to 3 m. This sampling method can recover sediment to depths of up to 8 m, with a sample area footprint of up to 5 m<sup>2</sup>, and is the most sophisticated sampling technology available presently.

The sampling drill tool is a free standing drill system. The system is build out of a main frame with a dimension of 6.5 by 6.5m and 5.8m high with a total weight of 147 ton in air. In the centre of the frame is the drill tower (casing) installed with a diameter of 2.53 (5 m<sup>2</sup>) surface. Around the drill tower a skirt is installed, which can penetrate 0.8 m in the sediment. The tower length is variable and it can drill in various sediment depths up to a depth of approximately 8 m into the seabed. The drill tower is lowered and lifted on 4 points via hydraulic drive motors and gear boxes (named the rack and pinion drives). At the bottom of the drill tower, the drill bit drive and bit are installed. The drill is hydraulically driven and the bit is equipped with 14 rock cutting units, a row of soft cutting points, jet water and suction mouth. An integrated control system regulates the drill speed in relation to the required torque and drill forces.

An example of such a drill sampling / mining vessel is the *MV Explorer's* "Wirth Drill" (see Figure 2-14), which is capable of sampling up to 40 sites per day depending on sea state, water depth and the seabed geotechnical conditions. The samples are processed on-board through a mineral recovery plant. Indicator minerals and diamonds are evaluated in an on-board diamond evaluation facility.

Other types of the vertical sampling vessels and tools included: the De Beers Marine airlift "Mega Drill" operated from the *MV Douglas Bay* (now decommissioned). The "Mega Drill" has a maximum seabed penetration is 4 m and footprint of 0.72 m<sup>2</sup>. The drill spacing may be a few meters or multiples of 20 m (Spencer. 1999). Samples are also processed on-board through a mineral recovery plant.





**Figure 2-14: Large sampling vessel, *MV Explorer* showing (A) sub-sea mining tool with a 2.5 m diameter drill bit within a drill frame structure, (B) mineral processing plant and (C) deployment schematic**

(Source: <http://www.imdhgroup.com/mv-explorer.php>)

#### 2.4.4 BULK SAMPLING

If initial reconnaissance sampling, where samples are collected over a wide area with a wide inter-sample separation distance, indicates positive results, in-fill bulk sampling may be undertaken. The spacing between the reconnaissance sample locations is reduced by the in-fill sampling, thereby providing a more accurate understanding of the distribution of the prospective deposit. This sampling is typically undertaken by a large mining vessel (e.g. *MV Ya Toivo*), where a series of trenches (up to 22 m wide) are excavated across the prospective deposit.

The *MV Ya Toivo* is equipped with a track-mounted subsea crawler (see Figure 2-15) capable of working to depths up to 200 m below sea level. The crawler, which is fitted with highly accurate acoustic seabed navigation and imaging systems, and equipped with an anterior suction system, is lowered to the seabed and is controlled remotely from the surface support vessel through power and signal umbilical cables. Water

jets in the crawler's suction loosen seabed sediments, and sorting bars filter out oversize boulders. The sampled sediments are pumped to the surface for shipboard processing. The area of seabed to be sampled by crawler can normally only be determined following analysis of drill samples and development of a resource model.



**Figure 2-15: Large bulk sampling vessel, MV Ya Toivo (A) and its seabed crawler (B)**  
(Source: CCA, 2015)

#### 2.4.5 SMALL VESSEL-BASED DIVER AND MOBILE PUMP UNIT SAMPLING

Prospecting in the surf zone and nearshore areas is essentially undertaken by the vessel-based diver operations on trial and error basis. Local knowledge gained from historical mining of coastal structures (e.g. linear features, gullies and ridges) is used for diamond recovery data mapping and projection. The equipment and techniques used by the vessel-based diver operations for prospecting are the same as the equipment used for mining (see Section 2.5.4).

Mobile pump units (e.g. jack-up rigs) could also be used for prospecting in the surf zone and nearshore areas (see Section 2.5.3). This would also involve an initial review of geological information, including detailed review of data obtained from shore-based diver assisted mining (“walpomp”) and vessel-based diver assisted operations.

## 2.5 MINING METHODS

Marine mining methods in Mining Right 554MRC may include:

- coffer dam mining;
- shore-based diver assisted mining (or commonly referred to as “walpomp”);
- mobile pump unit mining;
- vessel-based diver mining;
- vessel-based remote dredge pump mining;
- vessel-based remote airlift mining;
- vessel-based remote crawler mining; and
- vessel-base vertical mining systems

### 2.5.1 COFFER DAM MINING

Beach and surf zone mining using coffer dams occurs from the high-water mark up to potentially 300 m seaward of the low water mark (see Figure 2-16). Cofferdams are temporary structures that have a relatively short design period of 1 to 3 years. This type of mining involves the removal of beach sand overburden by heavy machinery and pumping to access target mineralised gravels overlying the bedrock. Beaches in the mining right area occur as isolated pockets (or pocket beaches) varying in size from tens of meters to over two kilometres in length.



**Figure 2-16: Cofferdam mining operations in Mining Right 554MRC (2017)**  
(Source: GoogleEarth)



The submerged bedrock below the beach sand is commonly below mean sea level, which causes flooding of the excavated area during mining operations. In order to provide protection and restrict the inflow of seawater into the active mining block, a series of linked sea walls (or berms) are constructed and maintained. Cofferdams are considered to be an efficient mining method to recover diamond bearing gravels from areas located below the high-water and the low water mark.

Cofferdams are constructed sequentially as illustrated in Figure 2-17. On the northern and southern boundary of the target area, sea walls (typically consisting of quarried rock) are built by progressively dumping rock from trucks perpendicular to the general wave direction (see Figure 2-18). The sea walls typically have a separation distance of between 100 to 120 m. Once a section within a mining block has been mined to completion, a sea wall is moved progressively seaward as far offshore as local conditions allow until it can no longer withstand the wave forces.



**Figure 2-17: Illustration of sequential coffer dam construction**



**Figure 2-18: Cofferdam construction showing quarried rock being dumped into the sea**  
(Source: J. Blood)

The material used to construct coffer dams typically consists of excavated / quarried rock or material from historic mining stockpiles within the PSJV's onshore mining right area (i.e. 550MRC). The berm material gets progressively coarser towards the outside and is covered by an outer layer of large armour rock. Wave conditions in the mining areas ultimately determine the volume and size of the rock required for the construction of the final sea wall.

Once the coffer dam has been constructed and the mining paddock has been enclosed, the overburden is removed and stockpiled, and the gravel is extracted using standard open-cast mining techniques.

Gravels are transported by truck to an adjacent in-field screening plant, where the gravels are screened using seawater. Screened material is then stockpiled for subsequent transport to the main processing plant and then onto final recovery. Oversize tailings generated by the screening plant accumulate at the plant and is used for sea wall construction or is returned to the mined out paddock.

Post mining, the bulk of the material used to construct the coffer dam is recovered and used to construct adjacent coffer dams. The smaller unrecovered material is redistributed by wave action.

### 2.5.2 SHORE-BASED DIVER ASSISTED MINING

Mining in the surf zone to water depths of up to approximately 5 m can also be shore-based and locally referred to as "walpomp" (beach pumping units).

These mining operations are typically confined to small trap sites. The submerged target gravels are mined by up to two diver-guided suction hoses (8 to 10-inch). The divers operate on surface supplied airlines and guide the distal end of the suction hose into the target material (see Figures 2-19 and 2-20). Divers may need to remove/ move large rocks and boulders, as well as help to facilitate the movement of the suction hoses and airlines. The suction hoses are connected to a tractor that is modified to drive a centripetal pump (see Figure 2-21), which feeds the gravel into a rotary classifier (trommel) generally positioned near the high water mark. In some instances the contractor may construct a gravel platform for the classifier.



**Figure 2-19: "Walpomp" (beach pumping) mining method**  
(Source: J. Blood)



**Figure 2-20: Diver with dual dredge pump, underwater at mining face.**  
(Source: Alexkor)



**Figure 2-21: Example of a rotary classifier (trommel)**  
(Source: J. Blood)

The classifier screens the pumped material and extracts the size fraction of interest (2 to 25 mm). The large size fraction tailings (>25 mm) accumulate around the classifier (being later dispersed during the high tide or mechanically redistributed over the beach), while the fine tailings (<2 mm) are returned directly to the sea as a sediment slurry. The diamond-bearing gravel is bagged and transported daily to the nearest processing facility for diamond recovery.

Mining rates using the “walpomp” mining method are about 5 m<sup>3</sup> of gravel supplied to the classifier per hour. Due to the tidal cycle and weather/sea state (adverse) conditions, units typically operate for less than 6 hours per day and typically for only 2 to 3 days per month. Consequently, each diver/tractor unit may process less than 50 m<sup>3</sup> of gravel per day.



A shore-based diver assisted mining operation typically consists of 2 to 4 divers (working in shifts), assistants to manage the equipment and bag the recovered gravels. At the end of each day, all equipment is moved above the high water mark.

### 2.5.3 MOBILE PUMP UNIT MINING

An alternative mining technique deployed in the intertidal (surf) zone is a dredging unit mounted on a crawler (tracked or wheeled) (see Figure 2-22), modified excavator or specially designed walking platforms, known as jack-up rigs / platforms (see Figure 2-23). These systems make use of a remotely operated articulated dredging arm, which scours / dredges the seafloor recovering sands and gravels of the surf zone. This type of equipment can typically operate in more hostile surf zone conditions compared to the “walpomp” operations.



**Figure 2-22: Dredging unit mounted on an excavator operating in surf zone**  
(Source: Hannesko)



**Figure 2-23: Jack up rig or platform operating in surf zone**  
(Source: Namdeb/ADP)

These systems generally target areas of lower grade, where larger gravel volumes and thicker sand overburden are encountered. Material is pumped from the seafloor and screened through a classifier, which is normally mounted on-board the mining platform or mobile unit. The screened / classified material is then either pumped to shore or bagged and transferred to shore, from where it is transport to the main processing plant and then onto the final diamond recovery facility.

#### 2.5.4 VESSEL-BASED DIVER ASSISTED MINING

The vessel-based diver assisted operations commonly operate in the shallow waters in the 'a' sea concession in water depths typically less than 12 m. Each contractor operates within a "concession area" leased from the PSJV.

A vessel-based diver assisted operation typically consists of a 10 - 12 m vessel (see Figure 2-24) with 6 to 8 operational personnel. These vessels are small enough to operate out of the Alexander Bay harbour or the port at Port Nolloth.



**Figure 2-24: Typical boat used for vessel-based diver assisted mining**  
(Source: J. Blood)

The dredging operations are typically conducted using vessel mounted suction pumps and hoses, which are guided by divers into gullies, potholes and bedrock depressions to retrieve the diamond-bearing gravel. Divers may need to physically move large rocks and boulders, which are too large for the dredge nozzle, into underwater rock piles. The divers operate via a surface supplied airline, with air generated from a vessel based air compressor.

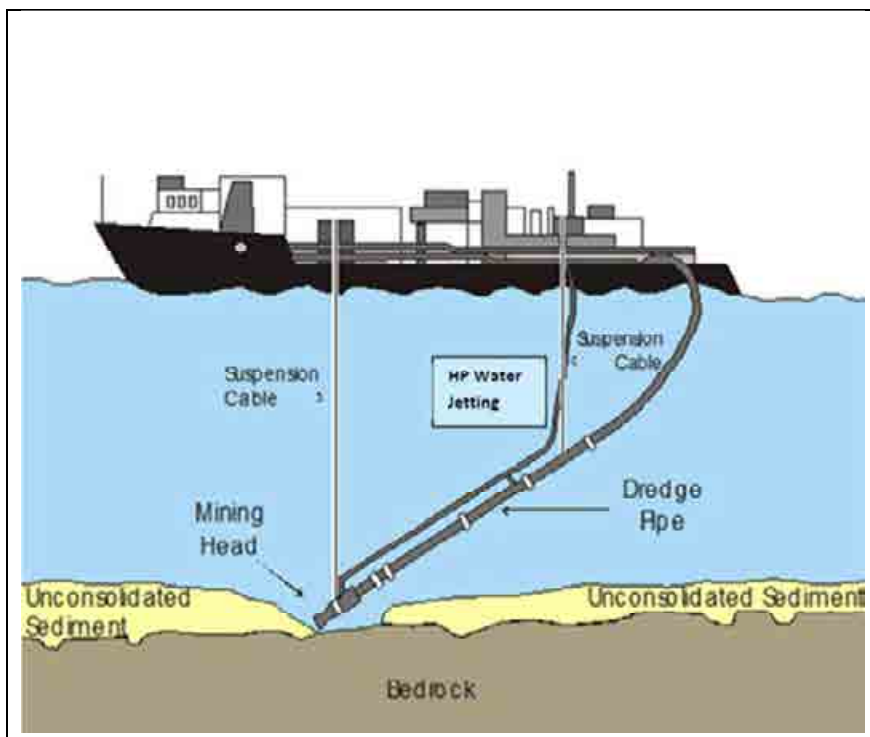
The gravel is pumped up through the hose gravel pump system to the on-board screening system (trommel). Fine material (<2 mm) and oversized material (>20 mm) discharged from the screening unit washes directly back into the sea. The diamond-bearing gravel is bagged, offloaded at the Alexander Bay harbour or Port Nolloth jetty, and transported to the onshore processing plants for further processing and final diamond recovery.

Due to the water depths involved, the bottom-working time is limited by decompression commitments. Contractors are required adhere to a Safe Code of Practice which includes compliance with international diving standards regulations and dive tables. Contractors without decompression chambers are limited to mining to a maximum depth of 12 m, while those with decompression chambers on-board can mine up to maximum of 17.5 m with written consent from the PSJV.

### 2.5.5 VESSEL-BASED REMOTE DREDGE PUMP MINING

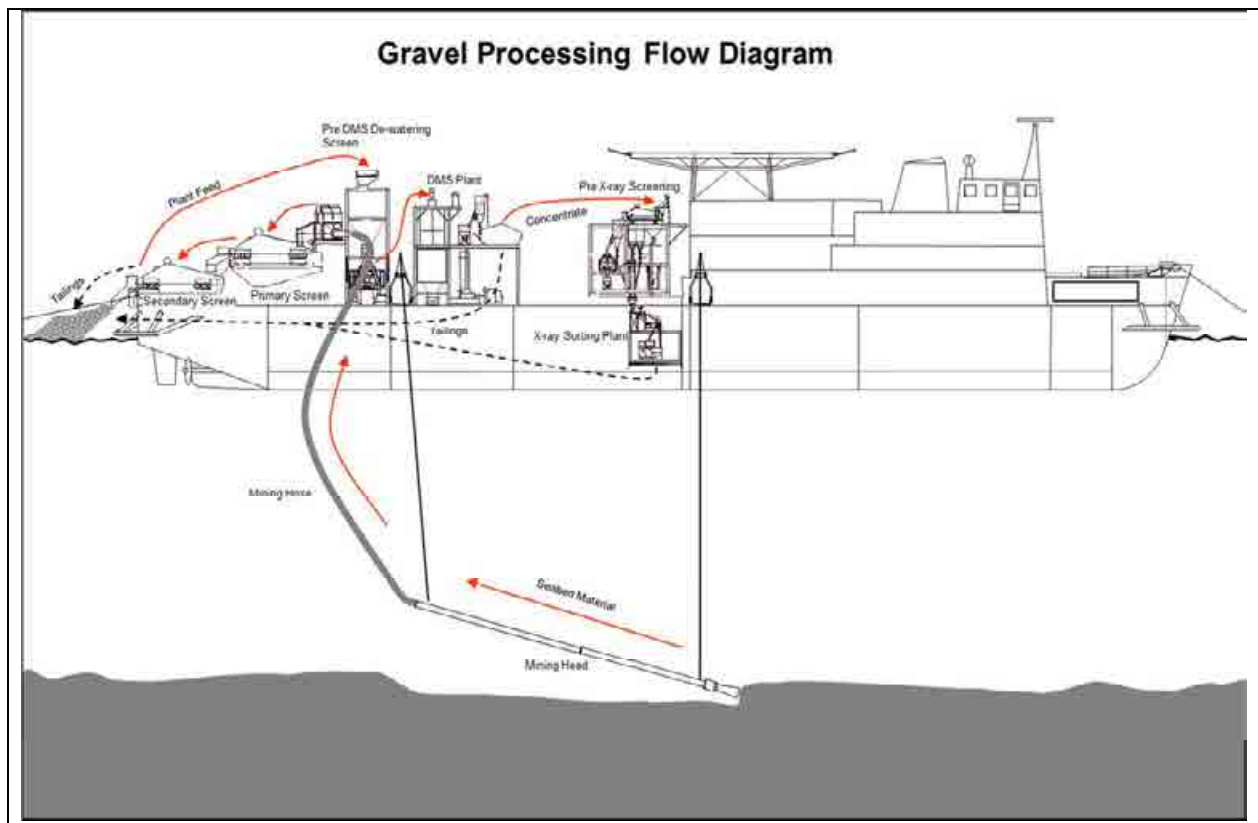
This mining method is typically used in the 'a' and 'b' sea concessions in water depths typically less than 30 m. These vessels are typically smaller than those used in remote airlift and crawler mining (see Sections 2.5.6 and 2.5.7) and can operate out of the port at Port Nolloth and the Alexander Bay harbour.

The mining system typically comprises a suspended steel mining tool, suction hoses (10 – 18 inch diameter) and on-board dredge pumps (see Figure 2-25). The mining tool consists of a steel pipe fitted with a mining head (or digging head), which has an opening fitted with grizzly/cross bars to allow sized gravel to pass through and prevent blockages of the suction hose system. The digging head can also be fitted with high pressure water jetting nozzles to agitate the gravel on the seabed and improve mining efficiency. These jetting nozzles also serve to flush the digging head in the event of it becoming blocked.



**Figure 2-25: Illustration of remote dredge pump mining. (Source: GEMPR, Alexkor)**

The mining tool is suspended from an A-frame situated at the aft end or from davits along either side of the vessel. Some vessels may be fitted with dual mining systems, where mining tools are deployed from both the port and starboard sides. The mining tool suspension cable passes through a hydraulically controlled swell compensator system, which compensates for the vertical movements of the mining tool caused by the digging action. The vessel moves within a four-point anchor mooring system in order to cover the targeted seabed. The dredged material from the seafloor travels through the mining head, delivery hoses, dredge pump and is discharged into the self-contained process plant on board the vessel for processing (refer to Figure 2-26 for a process flow diagram).



**Figure 2-26: Process flow diagram**  
(Source: BENCO)

Process plant typically includes:

- a classifier and / or sizing screen (which can process 20 tonnes per hour);
- screened gravel surge bin;
- crusher and / or flotation jig;
- suitable jet pump;
- 10 - 20 tons / hr dense media separation system (DMS);
- a DMS concentrate surge bin;
- diamond x-ray machines;
- concentrate dryer; and
- diamond picking glove box.

The dredged material is discharged into a vessel mounted gravel classifier or onto a sizing screen. Undersize (< 2 mm) and oversize (> 20 mm) material are discharged directly overboard. The heavier portion settles directly to the seabed, while the finer portion forming a turbid plume, which is dispersed by local currents. The screened fraction (2 to 20 mm) is then fed via a jet pump onto a dewatering screen. Fines from the dewatering screen are discharged overboard. Shell and clay material are fed, via a surge bin, into a crusher unit, where the shell and clay are broken down. The < 2 mm material is washed out (discharged back to the sea) and the target fraction is fed into the mixing box.

Ferrosilicon<sup>3</sup> is added to the target fraction, after which the slurry is pumped, via the cyclone feed-pump, to a separation cyclone (DMS plant). The cyclone separates the heavy concentrate (the fraction of interest) from

<sup>3</sup> An alloy of iron and silicon ground into a fine granular powder.

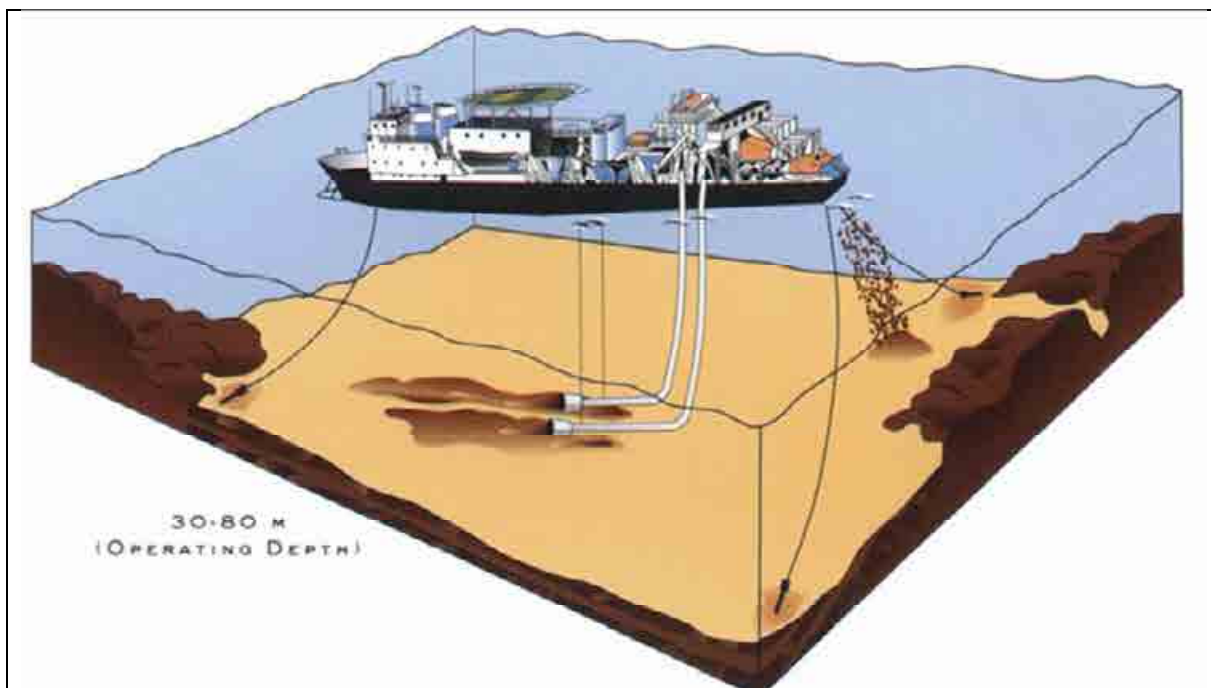
the floating fraction, which is discharged onto a drain and rinse screen and then overboard. Ferrosilicon from the drain and rinse screen is recovered via a magnetic separator and pumped into the heavy medium circuit for reuse. The concentrate from the cyclone is rinsed and discharged into the x-ray feed hopper, where two streams run separately through a wet x-ray machine. The concentrate is then dried and fed into the glove box where the diamonds are recovered, weighed and placed into a drop safe. Glove-box tailings are re-circulated several times before being discharged overboard.

### 2.5.6 VESSEL-BASED REMOTE AIRLIFT MINING

This system is similar in many respects to the dredge pump mining method. However, with the airlift mining method air is pumped down to the digging head, which creates a pressure differential between aerated seawater in the return hose and that of ambient seawater, which in turn draws up the gravel and sediment to the surface. This mining method can operate in greater water depths and is typically used in the 'b' sea concessions in water depths between 30 m and 150 m.

The airlift mining system (see Figures 2-27 and 2-28) typically comprises a suspended steel mining tool (suspended from davits along one or both sides of the vessel), suction hoses (20 – 24 inch diameter) and on-board air compressors to supply air to the air chamber located at the front of the digging head. Similar to the dredge pump mining, the mining tool consists of a steel pipe fitted with a mining head (or digging head), which has an opening fitted with grizzly/cross bars. The digging head can also be fitted with high pressure water jetting nozzles to agitate the gravel on the seabed and improve mining efficiency.

Processing of dredged material occurs in a similar manner to that described for dredge pump mining and is not repeated here (refer to Section 2.5.5).



**Figure 2-27: Illustration of airlift mining**  
(Source: BENCO)





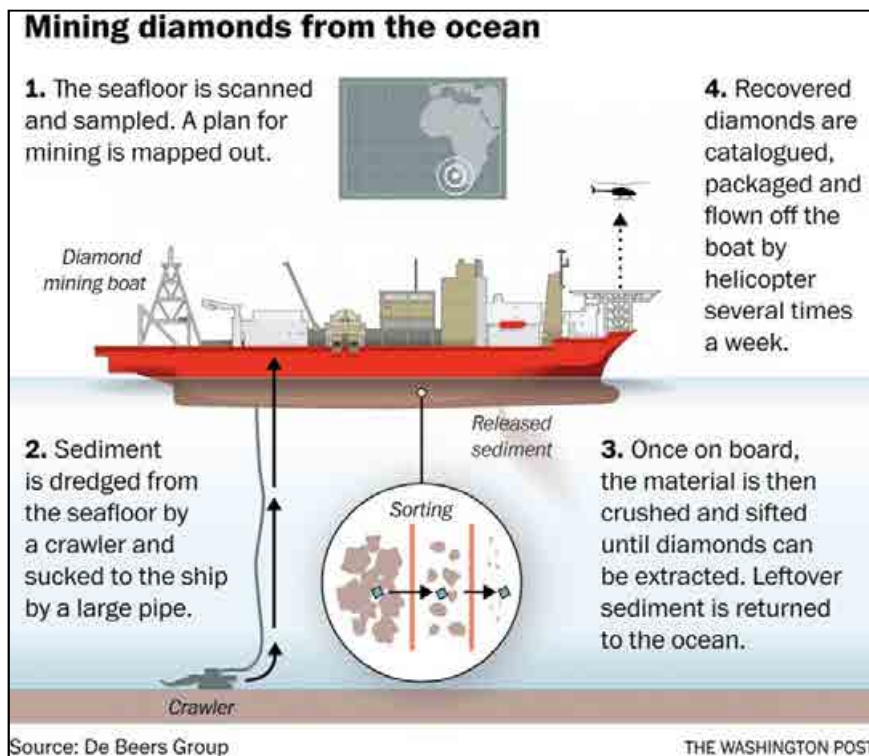
**Figure 2-28: Air lift mining vessel, *MV Ivan Prinsep***  
(Source: Ocean Diamond Mining)

### 2.5.7 VESSEL-BASED REMOTE CRAWLER MINING

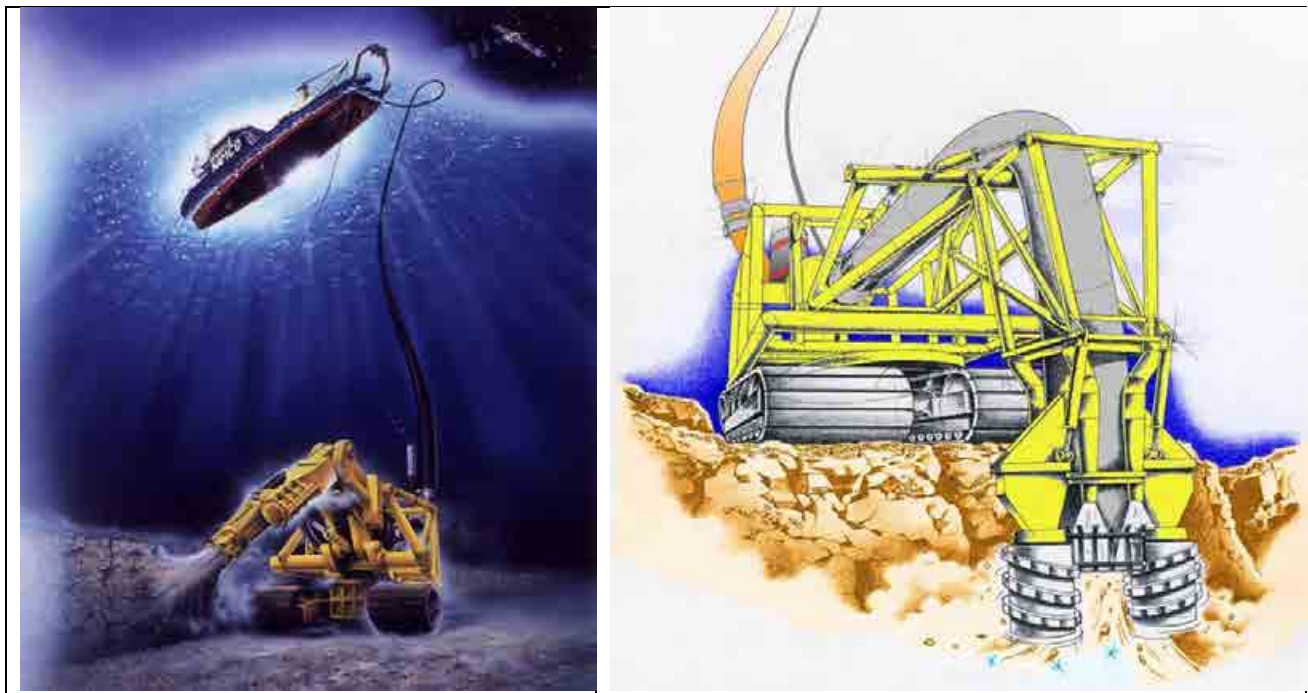
The PSJV currently has a contract with International Mining and Dredging Holding Ltd (IMDH), utilising the *MV Ya Toivo* mining vessel (see Figure 2-29), which uses a remotely operated crawler, to mine in the 'b' and 'c' concessions in water depths greater than 30 m and up to approximately 200 m (see Figures 2-3. and 2-31). These vessels are fully self-contained mining units and can operate 24-hours a day. These vessels are too large to operate out of Port Nolloth and Alexander Bay, and would need to operate out of Cape Town or Saldanha Bay. Vessels are typically equipped on-board desalination plants, which provide potable water (note: seawater is used for processing). Supplies and bunkering are periodically supplied via a supply vessel from Port Nolloth or Alexander Bay. Crew changes are generally made by helicopter.



**Figure 2-29: *MV Ya Toivo***  
(Source: [www.imdhgroup.com/mvya-toivo.php](http://www.imdhgroup.com/mvya-toivo.php))



**Figure 2-30: Illustration of remote crawler mining**  
(Source: De Beers Group / The Washington Post)



**Figure 2-31: Illustrations of different seabed crawlers**  
(Source: CCA, 2015)

The mining vessel operates on a 4-point mooring spread with dynamic positioning to assist the crawler mining operations. Typically all vessels are fitted with swell-compensation systems that allow for mining in swells up to 8 m. Prior to the launching of the seabed crawler (see Figure 2-32), the vessel anchors over a planned mining spread, typically 300 m x 300 m. The mooring system of the vessel is deployed from four large winches, each with 2 500 m of anchor wire and equipped with a 15 tonne anchor. The mooring system is equipped with a wire tension measurement system, which monitors the tension in the anchor wires. If tension exceeds pre-set limits, the dynamic positioning system is activated to relieve the excess tension.



**Figure 2-32: Deployment of the crawler**  
(Source: [www.imdhgroup.com/mvya-toivo.php](http://www.imdhgroup.com/mvya-toivo.php))

The crawler is then lowered to the seabed by a winch system over the stern of the vessel. The seabed crawler is fitted with acoustic seabed navigation and imaging systems that allow for the remote operation of the crawler from the surface support vessel through power and signal umbilical cables. The seabed crawler is track-driven and is equipped with a dredge pump system, hydraulic power pack and a jet-water system to facilitate the agitation and suction of unconsolidated surficial sediments up to the mining vessel (rotary cutting heads may also be fixed to the suction nozzle). The whole structure is operated from the remote control room on-board the mining support vessel.

Once the crawler is deployed, it is able to move within a radius of 60 m to 100 m from the vessel. The crawler can remove seabed sediments to a depth of up to 5 m in a set path within the mine target area. Once the material is dredged to the required depth and specification, the crawler advances forward 1 to 2 m and the dredging process is repeated. The advance rate of the mining is dependent on the overburden thickness; however, with an overburden and ore thickness of 3.5 m, at an average advance rate of 250 m<sup>2</sup>/h, the crawler can deliver approximately 875 m<sup>3</sup>/h material via the riser hose to the vessel based primary processing plant.

Upon completion of a mining lane (commonly 22 m in width and 60 to 100 m long), the crawler would be repositioned at the start of the adjacent lane and commence mining. As mining continues, the seabed crawler creates additional mining lanes adjacent to one another, thereby creating mining blocks. Five lanes are usually mined over a 100 m x 100 m mining block. The average mining rate by the crawler sub-sea mining systems is approximately 5 000 m<sup>2</sup> per day, delivering approximately 17 500 m<sup>3</sup> per day of mined material to the vessels processing plant.

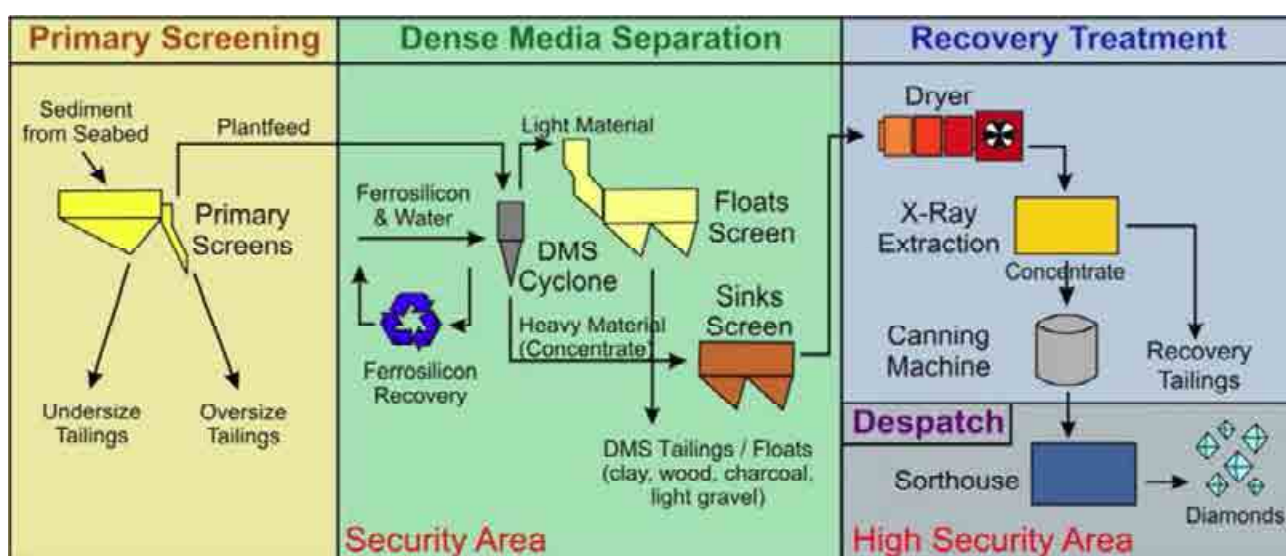
Following the completion of a mining block the vessel would move while still on anchor to the next mining block in the sequence to create a mining spread of 300 m by 300 m for each anchoring location. The sequence in which the mining blocks are mined would be dependent on current and wind conditions at the time. On completion of a mining spread, the mining vessel would raise anchors and move onto the next



mining spread location. It is estimated that the average area which would be mined per day would be in the order of 5 000 m<sup>2</sup>.

A brief overview of the mineral processing methodology is provided below. A flow chart of this process is presented in Figure 2-33.

- As the sediment is removed from the seabed it is pumped to the surface, via large delivery hoses, for primary screening. The sediment is discharged onto a series of screens that separate the oversize (>25 mm) and undersize (<1.4 mm) fractions of material removed from the seafloor. These fractions are immediately discarded back to the sea via a special tailings moonpool system. The heavier portion settles directly to the seabed, while the finer portion forming a turbid plume, which is dispersed by local currents. Plant feed typically constitutes 10% to 25% of the total sediment volume pumped from the seafloor.
- The remaining fraction of interest (plant feed) undergoes processing by means of DMS. The plant feed is fed through a ball mill to break the shell and clay components, before being mixed with ferrosilicon and pumped under pressure into the DMS plant. Low-density materials (floats) are separated from the heavier concentrate material and cleaned of the ferrosilicon before being discarded overboard. The recovered ferrosilicon is reused in a continuous process in the plant. The remaining high-density fraction is also cleaned of the ferrosilicon and sent for recovery treatment. During recovery treatment, the high-density fraction is washed, dried and passed through x-ray sorting machines to separate the diamonds from the other material. The diamonds are stored on board for collection and dispatch.



**Figure 2-33: Flowchart of marine diamond gravel processing operations**  
(Source: Penney et al., 1999)

### 2.5.8 VESSEL-BASED VERTICAL APPROACH MINING

These mining systems are described above (see Section 2.4.3), which discusses these systems application in the context of sampling. These same systems also offer a mining capability as well, the difference being related to the density (and overlap) of the particular vertical cut. In sampling, the drill cut spacing would be wide, whilst in mining the circular drill cuts into the seabed would overlap with one another, progressively extracting all of the sediment in the 50 x 50 mining block.

## **2.6 REHABILITATION**

### **2.6.1 MID- AND DEEP-WATER REHABILITATION**

Swell and wave action, particularly during storm events, coupled with long-shore drift and associated sediment remobilization are the primary agents of rehabilitation of mining disturbance in the marine environment.

The intertidal and subtidal zone is a highly dynamic environment, with significant energy exchanges related to wind, wave and swells impacting on the coastline. Although active rehabilitation of the marine environment below the low water mark is not possible, depending on the location of the mining activity there are mechanical interventions (specifically for coffer dam mining) that can contribute to the natural recovery of habitats disturbed by mining operations. These mechanical interventions coupled with the high productivity and dynamic nature of this environment typically allows for functional recovery of the environment post mining.

For all mining vessels (including dredge airlift, crawler and vessel-based diver assisted mining systems), sediments (gravels and fines) are discharged directly over the side of the vessel. The gravels and sands settle back through the water column onto the seabed, landing typically within 70 m to 150 m from the point of discharge. The size of the tailings footprint depends on the particle size distribution of the tailings and the settling depth of the water column, which relates to the size of the vessel from which mining occurs. The finer material generally forms a turbid plume near the vessel, this plume is carried away and entrained into the water column by ambient currents, it settles out to the seabed further afield.

The vessels and mining systems location are generally orientated such that the discarded tailings are returned to the formerly mined out areas. Local currents and winds tend to orientate these returned sediments in a north-westerly direction parallel to the coast. In addition to the current and winds are the dominant east – west tidal actions and associated swell and wave actions, which results in an on - offshore remobilisation of these sediments. Sediments will preferentially relocate to former mined-out depressions, with rehabilitation (fauna-flora recovery) occurring naturally. Typically, this is by re-colonisation from adjacent areas that have not been mined / disturbed, both within and outside of the mine block and general mine areas.

### **2.6.2 COASTAL ZONE REHABILITATION**

Mining in the coastal zone (including supratidal zone, intertidal zone and surf zone) is conducted from land. This allows for mining to be developed on differing scales, with differing approaches and with different technologies. Rehabilitation in this zone is primarily reliant on the redistribution of the mined sediments by wave action. However, mechanical inputs (removal / redistribution of material) are also required to augment the natural process. “Walpomp” operators who retain their classifiers above the high-water mark or accumulate relatively large tailings piles in the upper reaches of the beach are required to mechanically redistribute these tailings, such that they can subsequently be dispersed by wave action and reintegrate into the sediments.

The construction of coffer dams requires the importation (from local terrestrial sources) of large volumes of rock and its deposition as sea wall / berm structures in this environment. It should be noted that this imported rock is the same as the rock types of the marine environment. A portion of this rock is removed from the coffer dam location at the end of the mining phase. This is either reused for a new coffer dam or is removed from site at the end of the coffer dam construction cycle. Tailings associated with in-field screening plants of the coffer dams are located above the high-water mark. This material is either disposed of to the

sea or returned to former terrestrial mine site excavations. Residual rock will remain at the site of the coffer dam. However, depending on the size of the rock, the majority of this should be redistributed by wave action and be incorporated into the sediments of the intertidal zone in a relatively short period of time. Residual large rocks that are not completely removed may cause stretches of sandy beach to be permanently transformed into mixed and rocky shore habitats, with concomitant changes in the associated benthic biota.

## **2.7 MID- AND DEEP-WATER MONITORING**

The degree and success of natural recovery in mid and deeper waters are currently assessed by undertaking benthic grab surveys. This involves the collection of seabed samples from both mined and unmined areas. The benthic macrofaunal assemblages present in the sediments, and the chemical and textural compositions of the sediments, are used to determine the functional recovery of the benthic communities post mining. Water quality samples are also collected from within the water column during the survey. These benthic surveys are typically collected pre-mining (as a baseline from which change can be determined), possibly during mining (to understand progressive change) and post mine closure (to determine / verify recovery with respect to original baseline conditions). This practice of benthic assessment allows for the tracking of the functional recovery of the mid and deeper water environments. The collection of the baseline data in advance of mining allows for an assessment of the sensitivity of the potentially affected communities and provides for a description of the benthic environment. It also provides a benchmark against which the degree of impact recovery can be assessed.

### 3 IMPACT ASSESSMENT

This chapter describes and assesses the significance of potential impacts related to prospecting and mining operations in Mining Right 554MRC. The methodology used to determine the significance of potential impacts is presented in Volume 1 (refer to Appendix 2.1). Mitigation measures to avoid, reduce, remediate or compensate for potential impacts are provided, as are optimisation measures to enhance the potential benefits. The impacts that remain following mitigation are assessed and presented as residual impacts. The status of all impacts should be considered to be negative unless otherwise indicated.

The following specialist input was obtained to understand the potential impacts of prospecting and mining activities and rehabilitation options for the Orange River Mouth Estuary.

- Marine and Coastal Ecology Assessment (refer Appendix 2.1 in Volume 1).
- Orange River Estuarine Assessment (refer Appendix 2.3 in Volume 1).
- Fisheries Spatial Distribution (refer Appendix 2.4 in Volume 1).

This assessment also used the issues identified in the Generic EMP prepared for marine diamond mining off the West Coast of South Africa (Lane and Carter 1999) and similar studies, as well as data/information from diamond mining monitoring studies.

The assessment of impacts is structured as follows:

- Section 6.1: Impacts on the bio-physical environment;
- Section 6.2: Impact on the socio-economic environment;
- Section 6.3: Cumulative impacts; and
- Section 6.4: Rehabilitation of the Orange River Mouth Estuary.

#### 3.1 IMPACTS ON THE BIO-PHYSICAL ENVIRONMENT

##### 3.1.1 PHYSICAL DISTURBANCE OF BENTHIC HABITATS

Prospecting for and mining of diamonds results in the physical disturbance of the shoreline and seabed. The magnitude and extent of the disturbance is dependent both on the location of the target areas and the mining approach. Each is discussed separately below.

###### 3.1.1.1 Supratidal habitats

###### Description of impact

Physical disturbance of and/or alternation to the supratidal<sup>1</sup> zone and associated biota could result from a number of activities associated with the nearshore prospecting and mining methods (including “walpomp”, mobile pump units and coffer dam mining). Activities include the:

- establishment of tracks and movement of vehicle/machinery in the coastal zone in order to access allocated mining areas;
- establishment of campsites (including caravans, storage areas, parking and process areas) to provide accommodation and shelter in order to facilitate longer operating times during periods of suitable weather;
- poaching of marine resources and illegal collecting of succulents by mining personnel; and
- abandonment and/or retrieval of mining infrastructure and equipment on-site during decommissioning or if the equipment becomes derelict.

<sup>1</sup> The supratidal zone lies above the mean high water spring tide mark and is only occasionally inundated by water during exceptional tides or by tides augmented by storm surges.

Direct impacts are related to the physical disturbance and/or removal of vegetation and associated faunal habitat, as well as the trampling and crushing of relatively immobile/sedentary fauna species through the compaction of soils. Supratidal biota may be further impacted by the potential destabilisation of dunes, soil erosion and loss of topsoil/seedbank, which would ultimately affect the recovery of these habitats.

### Project controls<sup>2</sup>

A generic Environmental Code of Operational Practice (ECOP) has been developed for all “walpomp” operations in the surf-zone and shallow portions of Sea Concessions 1a, 2a and 3a (see Appendix 1). Contractors are required to comply with the environmental specifications pertaining to:

- housekeeping;
- fuel and lubricant storage and management;
- refuelling;
- hydrocarbon contamination;
- solid waste management;
- oil spill procedure and reporting; and
- weekly monitoring.

With regard to coffer dam mining, the Environmental Manager/Officer meets with all contractors on-site prior to mining in order to obtain an understanding of the mining approach and the local environmental sensitivities; after which a project-specific ECOP is compiled for the mining operations.

### Impact assessment

The impact on supratidal habitats depends on the scale of the activity and type of terrain disturbed. The construction of access tracks, campsites and other on-site infrastructure typically result in the localised disturbance and removal of vegetation and associated faunal biota. The removal of vegetation in the supratidal zone can potentially lead to the destabilisation of dunes, soil erosion, loss of topsoil (and seedbank) and creation of blow-outs. While pioneer plant communities are typically dynamic and resilient to disturbance, established plant communities on older, more stable soils are more sensitive and usually only recover over the long-term. Recovery of arid terrestrial ecosystems typical of the area may be further hindered by the continual indiscriminate movement of mining personnel and vehicles through the area, as well as the abandonment of infrastructure and equipment.

Although “walpomp” operations may only impact a very small area at any one time, operations may disturb large areas of supratidal zone in an allocated mining concession area as operations move along the coast. Similarly, coffer dam mining results in the almost total disturbance of the supratidal zone within a mining concession area.

Impacts associated with the disturbance of supratidal habitats are considered to be of high intensity, but remain localised around each contractor site within each allocated mining concession area. However, as prospecting and mining could occur along the majority of the surf-zone and shallow portions of Sea Concessions 1a, 2a and 3a, the extent can be considered regional. Due to the sensitivity of the coastal habitats to disturbance, impacts would persist over the medium- to long-term and be only partially reversible. The potential impact on supratidal habitats and associated biota is thus considered to be of **high** significance without mitigation (see Table 3-1).

### Mitigation

- Demarcate and use only established tracks and roads, as far as possible, to access allocated mining areas. Where mining moves along the coast within a mining concession area and no tracks or roads

---

<sup>2</sup> Project Controls are the physical or procedural controls that are planned as part of the project (i.e. they are embedded into the project design).



exit parallel to the coast, access should be undertaken below the high water mark when on sandy/beach area.

- Close and rehabilitate all duplicate tracks leading to allocated mining concession areas.
- Avoid the establishment of campsites or processing areas within 100 m of the edge of a river channel or estuary mouth.
- Locate campsites or processing areas, as far as possible, in previously disturbed areas or areas of least sensitivity.
- Limit the campsite and processing area to the minimum reasonably required. The extent of the site should be clearly demarcated (e.g. with droppers).
- Refrain from collecting any plants (succulents) within the mining concession or adjacent areas.
- Prepare and implement site-specific ECOPs for each contractor and each allocated mining concession area. The ECOP should include specific details for the following aspects:
  - > Environmental considerations (i.e. identification of sensitive receptors) and establishment of no-go areas.
  - > Access route(s) to allocated mining concession area.
  - > Extent of mining concession area and demarcation of the campsite, processing area(s), and refuelling/maintenance areas.
  - > Housing keeping:
    - Use of drip trays under stationary plant and for refuelling/maintenance activities.
    - Use and maintenance of toilet facilities.
    - Bunding of fuel stores.
  - Waste management.
  - Rehabilitation specification (if necessary), e.g. topsoil management, reshaping, netting, etc.
  - Establishment of a rehabilitation fund.
  - Monitoring.
- Before the commencement of any work on site, the contractor's site staff must attend an environmental awareness-training course presented by the Environmental Manager/Officer. The contractor must keep records of all environmental training sessions, including names of attendees, dates of their attendance and the information presented to them.
- Prior to a contractor leaving a site and/or moving to a new site, the area must be audited by the Environmental Manager/Officer. Only once the Environmental Manager/Officer is satisfied that the area has been suitably cleaned and rehabilitated should the rehabilitations funds be paid back to the contractor.

#### Residual impact

Due to the nature of prospecting and mining operations impacts cannot be avoided. With the implementation of the proposed mitigation measures the residual impact is considered to be of **MEDIUM** significance.

**Table 3-1: Impact on supratidal habitats and biota**

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	Regional	Regional
Duration	Medium- to Long-term	Medium-term
Intensity	High	Medium
Probability	Probable	Probable
Confidence	High	High
Significance	High	<b>MEDIUM</b>
Reversibility	Partially reversible	
Mitigation potential	Very Low	

### 3.1.1.2 Intertidal and shallow subtidal habitats

#### 3.1.1.2.1 “Walpomp” operations

##### Description of impact

Mining targets for “walpomp” operations are located in bedrock features, gullies and small sandy bays below the low water mark to depths of approximately 5 m. During “walpomp” operations intertidal and subtidal organisms may be physically disturbed or crushed in the following ways:

- To access these deposits shore contractors usually locate the mining equipment (including tractor and classifier) as close to the sea as possible in order to minimise suction-hose lengths and pumping pressure gradients. This typically involves driving in and physical damage to the supratidal and intertidal zones, and may require blasting or mechanical damage in the rocky supratidal and intertidal regions to facilitate access to the low shore. Where access is achieved by blasting or mechanical damage, benthic biota in the footprint would be disturbed or crushed by the movement of mining equipment or would be completely eliminated.
- To access the deeper gravel deposits in potholes and gullies, large rocks and boulders may need to be moved by divers with crowbars or dragged from the gully at low tide by tractor and chains to be deposited at higher tidal levels. During the removal and relocation of these large boulders, benthic biota associated with the boulders would be crushed and other benthos may be indirectly dislodged or crushed by the tractors, chains and the boulders themselves.
- To facilitate movement of the suction hoses and airlines in the surf-zone and beyond, divers may cut kelp.
- Divers guide pump nozzles into unconsolidated sediments in small sandy bays or rocky gullies to remove sandy overburden and retrieve the target gravels. Macrofauna within the sediments would be disturbed, damaged or crushed.
- Divers may also purposefully target rock lobsters for consumption purposes.
- The sediments are pumped ashore where they are sorted in a classifier through a series of rotary screens. Oversize tailings (>20 mm) accumulate around the screening units and fines (<1.6 mm) are returned to the sea across the intertidal regions as a sediment slurry.
  - > If the classifier is located below the high water mark during mining, any intertidal biota in the footprint of the tailings heap accumulated around the classifier would be smothered and crushed. Scouring of intertidal organisms in the path of the discharged fine tailings slurry may also occur and the general activities of the contractors around the classifier would result in trampling and crushing of some biota. The redistribution of tailings by wave action over the short- to medium-term would also scour exiting communities.
  - > If the classifier is located above the high water mark (see Figure 3-1), redistribution would not occur and the sterile tailings heaps would persist over the long-term.

##### Project controls

A generic ECOP has been developed for all “walpomp” operations. Although the majority of specification in this ECOP relate to activities in the supratidal zone, it does include a safety strategy for divers operating in the intertidal and shallow subtidal areas.

##### Impact assessment

Studies conducted in other parts of the world have shown that high intensity trampling on rocky shores can result in the removal of most of the intertidal assemblages, although the effects are dependent on the community present, with foliose algae (particularly fucoid species) being more susceptible than algal turfs and barnacles more susceptible than dense patches of mussels (Povey & Keough 1991; Brosnan & Crumrine 1994; Schiel & Taylor 1999). While some of the damage to and physical alteration of the rocky intertidal shoreline cannot be remediated by swell action and can be more or less permanent (e.g. deposition

of large piles of boulders or blasting of intertidal rocks), the re-establishment of rocky intertidal and subtidal communities on available hard substratum is relatively rapid (2-5 years) once persistent disturbances have ceased.



**Figure 3-1: Classifier located above the high water mark with tailings heaps accumulated in the supratidal zone**  
(Source: J. Blood)

The cutting of kelp to facilitate movement of the suction hoses and airlines has a localised impact on the kelp bed community, the severity and duration of which depends on the extent of kelp cut, the frequency and method of kelp cutting and the age of the kelp. Monitoring has found that the harvesting of whole plants of *Ecklonia maxima* increases light penetration into the sub-canopy resulting in the development of a highly diverse understory algal community, which predominates for at least 12 months before kelp sporelings can recruit. However, no effect on the associated faunal species diversity has been established (Simons & Jarman 1981; Kennelly 1987a, 1987b; Christie *et al.* 1998; Levitt *et al.* 2002). A similar increase in floral diversity, particularly of red and green foliose algae was reported in newly cleared *Laminaria* beds, although these macroalgae did not persist for long and were soon out-competed by high densities of recruiting *Laminaria* sporelings (Pisces 2007). Although recovery following kelp cutting is in most cases rapid, long-term changes in kelp forest communities in response to various disturbances have been documented (Dayton *et al.* 1992), with disturbance potentially causing many lag-effects including the outbreak of understory algae, the availability of, and intraspecific competition, for primary space on the substratum, and changes in grazing patterns of herbivores. Kelp-cutting is currently practiced on a small-scale and recovery rates appear to exceed the frequency of cutting in all areas, except the most frequently dived (G. Koeglenberg & Q. Snethlage, diamond divers, *pers. comm.*). At current levels, the impacts associated with kelp-cutting can, therefore, be considered insignificant. However, if the number of shore-based operations increases in the future, the impact of kelp cutting, in combination with increased mining-induced sedimentation, is likely to increase in significance.

Holdfasts of adult kelp plants appear to play an important role in recruitment as kelp sporelings settle most successfully at or near these holdfasts, which provide shelter from grazing (Anderson *et al.* 1997). Thus, a clear-cut area or repeatedly cut area recovers more slowly than an area where only adults are cut and small kelp plants are left behind. Recovery of cut kelp beds can occur within two years (Parkins & Branch 1996; Anderson 2000; Levitt *et al.* 2002; Pisces 2007), but in some areas extensive and repeated kelp cutting by diamond divers and increased sediment mobilisation and deposition as a result of coastal mining operations has resulted in kelp bed habitats being locally eliminated and replaced by extensive stands of mussels

(Engeldow & Bolton 1994) or colonies of the Cape reef worm *Gunnarea gaimardi* (G. Koeglenberg & Q. Snethlage, diamond divers, *pers. comm.*). As a consequence, wave exposure in the affected areas changed from sheltered to semi-exposed, with concomitant changes in intertidal and shallow subtidal community structure. For example, the loss of kelp beds may have knock-on effects on the recruitment success of rock lobsters through reduction of suitable habitat and food sources, which may in turn have implications for West Coast rock lobster fishery.

Poaching and incidental pumping of rock lobster by mining personnel has also been identified as a threat to the severely depleted rock lobster resource in Namaqualand (Barkai and Bergh 1992). However, compared to the annual quota landed by the commercial rock lobster industry, the quantities poached on the few diving days per month are insignificant.

Impacts associated with the cumulative disturbance of rocky intertidal and shallow subtidal habitats by “walpomp” operations are considered to be of medium intensity. However, where operations are undertaken in the endangered<sup>3</sup> Namaqua Mixed Shore habitat (see Area 5 in Figures 3-2 to 3-4) and critically endangered<sup>4</sup> Namaqua Inshore Reef and Namaqua Sheltered Rocky Coast habitats (see Areas 4 and 9 in Figure 3-2 to 4-4) impacts can be considered of high intensity. Although impacts are limited around each individual operation, as shore-based diver operations have been established throughout the surf-zones and shallow portions of Sea Concessions 1a, 2a and 3a, the extent is considered to be regional. Impacts to the rocky intertidal and shallow subtidal biota would persist over the short- to medium-term and be fully reversible, except for critically endangered habitats where impacts may be only partially reversible. The natural redistribution by wave action of tailings heaps discarded on the high shore may, however, only occur over the medium-term. The potential impact on rocky intertidal and shallow subtidal habitats and associated biota by “walpomp” operations is thus considered to be of **medium** (least threatened) to **high** (critically/endangered) significance without mitigation (see Table 3-2).

For operations mining sandy bays off beaches, impacts on macrofaunal communities would likewise be of medium intensity, but these would persist over the very short-term only. The extent of the impact would also be regional, but fully reversible. The potential impact on sandy intertidal and shallow subtidal habitats and associated biota is thus considered to be of **low** significance without mitigation (see Table 3-2).

### Mitigation

- Prohibit mining of any nature in the critically endangered Namaqua Sheltered Rocky Coast and Namaqua Inshore Reef habitats. If, however, prospecting or mining is proposed within these areas an independent assessment of the habitats and associated biota should be undertaken by a suitably qualified marine ecologist to verify the habitat status. Should it be confirmed that the habitats are indeed ecologically unique, these areas should be declared ‘no-go’ areas and any future prospecting or mining there should be prohibited.
- Restrict mining within the endangered Namaqua Mixed Shore habitat, which is represented by more extensive areas off the West Coast, to less than 1% of the available habitat within the mining right area annually, unless the habitat is confirmed to be different by a suitably qualified marine ecologist.
- Prohibit blasting of rocky intertidal habitats and investigate alternative options to provide access to the low water mark.
- Locate classifiers as far down the intertidal zone as possible to facilitate the natural redistribution of coarse tailings by wave action, but definitely below the high water mark.

<sup>3</sup> Endangered: These are habitat types where the area in good condition is less than the identified biodiversity target plus 15% (i.e. 35%). Conceptually, this is a “red flag” category for habitat types that are approaching the point where it is expected that important components of biodiversity pattern and process will be lost (Sink *et al.* 2012).

<sup>4</sup> Critically Endangered: These are habitat types where the area in good condition is less than the identified biodiversity target (20%). Conceptually, these are habitat types where there are very few remaining areas of pristine or natural habitat, and it is expected that important components of biodiversity pattern have been lost and that processes have been heavily modified (Sink *et al.* 2012).

- Remove any tailings stockpiles that have been created on the high shore on a regular basis and re-used for other applications (e.g. dust control around buildings and processing plants, construction of coffer dams, etc.).
- Limit the removal of boulders by tractor and chains. If the relocation of boulders is necessary, these should not be removed to higher tidal levels or accumulated in rock piles.
- Minimise kelp cutting unless diver safety is at stake or it is essential for the operation. Where kelp cutting is deemed necessary, avoid removing the entire plant by cutting the kelp stipes just above the holdfast.
- Avoid removing and/or damaging rock lobsters when operating suction pipes during mining.
- Refrain from collecting any shellfish (including abalone, rock lobster, mussels) or undertaking recreational or subsistence fishing within the allocated mining concession or adjacent areas.
- Prepare and implement site-specific ECOPs for each contractor and each allocated mining concession area (refer to Section 3.1.1 for the contents thereof).
- Prior to a contractor leaving a site and/or moving to a new site, the area must be audited by the PSJV Environmental Manager/Officer. Only once the Environmental Manager/Officer is satisfied that the area has been suitably cleared and rehabilitated (including tailings stockpile removal) should the rehabilitations funds be paid back to the contractor.

#### Residual impact

With the implementation of the proposed mitigation measures and avoidance of endangered and critically endangered Namaqua Sheltered Rocky Coast habitat, the residual impact is considered to be of **VERY LOW** significance for both rocky and sandy habitats.

#### Monitoring

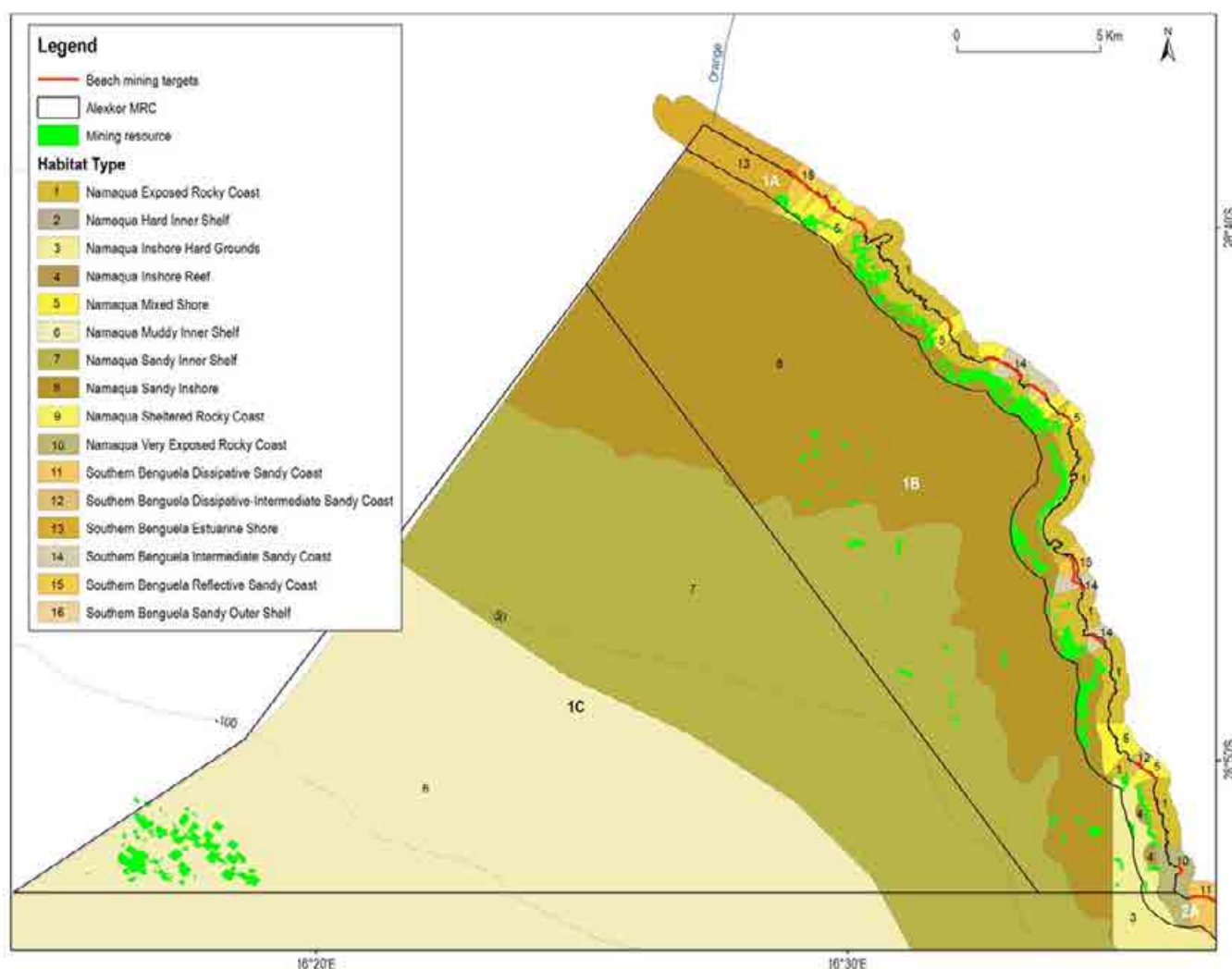
- Incorporate the SANBI benthic habitat map (specifically the endangered and critically endangered habitats) into the PSJV's GIS database so that these vulnerable habitats can be mapped in the preparation of the ECOPs.
- Undertake a biodiversity survey of intertidal rocky shores in Mining Right 554MRC to:
  - > determine the species diversity, percentage cover and abundance of benthic macrofauna and macroalgae; and
  - > investigate the relationship of benthic community structure with time since mining.

Details of the proposed monitoring plan are provided in Section 4.9.

**Table 3-2: Impact on intertidal and shallow subtidal habitats and biota due to “walpomp” operations**

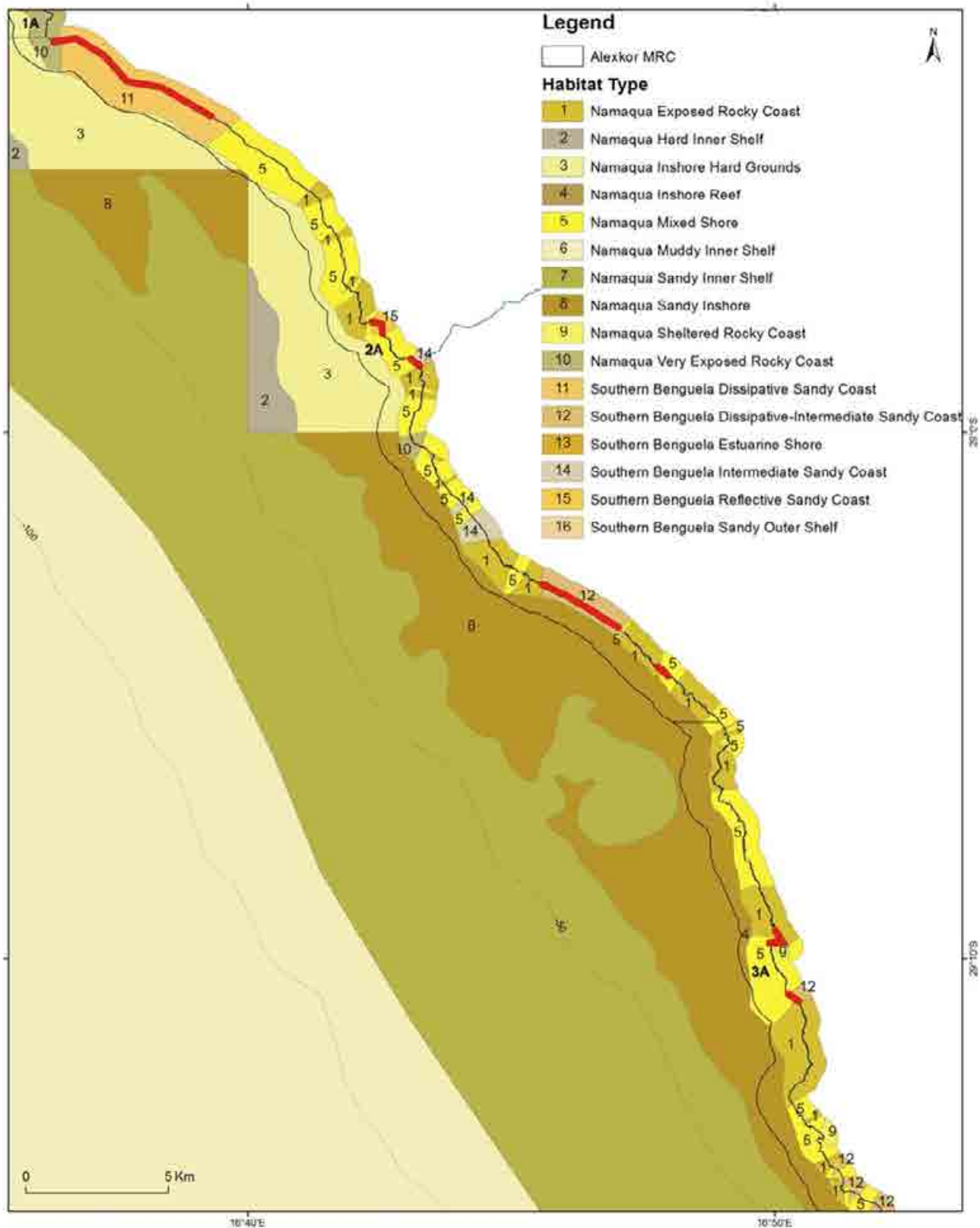
CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
<b><u>Rocky</u> intertidal and shallow subtidal habitats</b>		
<b>Extent</b>	Regional	Regional
<b>Duration</b>	Short- to Medium-term	Short-term
<b>Intensity</b>	Medium (least threatened) to High (critically/endangered)	Low
<b>Probability</b>	Definite	Probable
<b>Confidence</b>	High	High
<b>Significance</b>	<b>Medium</b> (least threatened) to <b>High</b> (critically/endangered)	<b>VERY LOW</b>
<b>Reversibility</b>	Fully reversible (least threatened) to Partially reversible (critically/endangered)	
<b>Mitigation potential</b>	High	

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
<b>Sandy intertidal and shallow subtidal habitats</b>		
Extent	Regional	Regional
Duration	Short-term	Short-term
Intensity	Medium	Low
Probability	Probable	Probable
Confidence	High	High
Significance	<b>Low</b>	<b>VERY LOW</b>
Reversibility	Partially reversible	
Mitigation potential	Very Low	

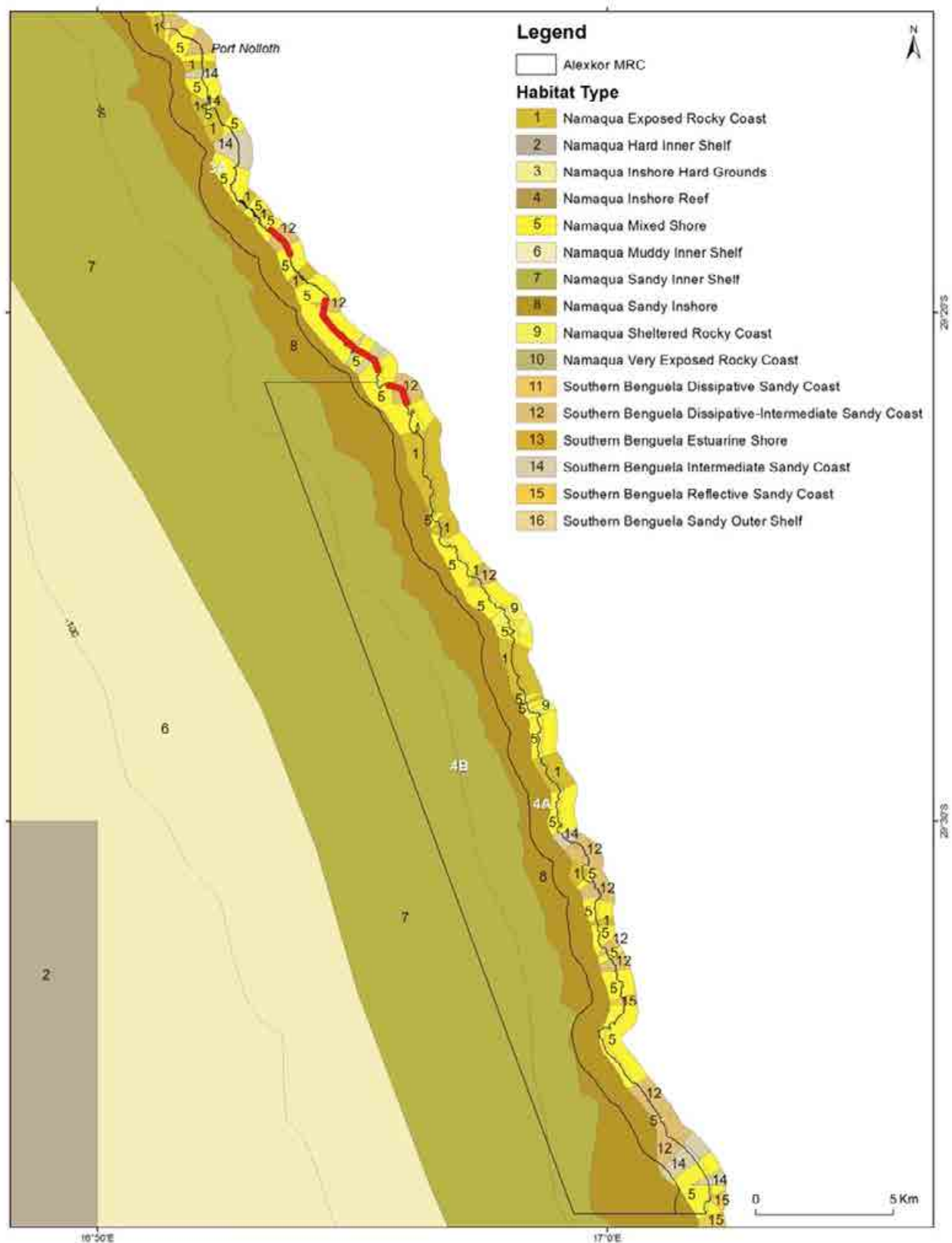


**Figure 3-2: Areas of high mineralisation (green and red) in Sea Concessions 1a, 1b and 1c in relation to benthic and coastal habitats off the West Coast**





**Figure 3-3: Areas of high mineralisation potential along the beach and surf zone (red) in Sea Concessions 2a and 3a in relation to benthic and coastal habitats off the West Coast**



**Figure 3-4: Areas of high mineralisation potential along the beach and surf zone (red) in Sea Concessions 4a and 4b in relation to benthic and coastal habitats off the West Coast**

### 3.1.1.2.2 Mobile pump unit operations (e.g. jack-up rigs)

#### Description of impact

Prospecting and mining operations using mobile pump units could be used in the intertidal and surf-zone regions of sandy beaches, which have thus far been mostly inaccessible to mining. The platforms would be fitted with primary and secondary sampling tools comprising jet pumps (for rapid overburden removal) and suction tubes (to extract gravels from bedrock crevices) and a screening plant. Overburden and marine sands are de-watered and screened on the platform, with the oversize material (>25 mm) and fines (<1.4 mm) being disposed of back into the sea where they are rapidly redistributed by wave action.

Invertebrate macrofauna living in or on the unconsolidated sediments being mined would be disturbed, damaged or killed, and those within the footprint of the platform legs would be crushed.

#### Project controls

Since no mobile pump unit mining has been undertaken to date, no project controls have been put in place.

#### Impact assessment

This prospecting and mining method would primarily be implemented in the surf zone of sandy beaches and shallow sandy bays, none of which have been identified as endangered or critically endangered. Thus, the fauna and flora associated with rocky substrates are unlikely to be affected. While the intertidal area of sandy beaches is characterised by a relatively rich fauna, species abundance typically declines substantially in the surf-zone reaching a minimum at the breakpoint of the waves. Impacts on macrofaunal communities living in the unconsolidated surf-zone sediments would thus be comparatively low. Furthermore, the communities inhabiting this naturally highly dynamic environment are inherently robust and habituated to natural disturbances. On a high-energy coastline, such as in the study area, the recovery of the physical characteristics of intertidal and shallow subtidal unconsolidated sediments to their pre-disturbance state following prospecting or mining using mobile pump units can occur within a few tidal cycles under heavy swell conditions and would typically result in subsequent rapid recovery of the invertebrate epifaunal and infaunal communities to their previous state.

Impacts associated with the disturbance of intertidal and shallow subtidal unconsolidated habitats using mobile pump units would be of medium intensity. Should these 'walk-in' mining units be implemented, they are likely to operate in only a few suitable bays within Sea Concessions 1a, 2a and 3a and any impacts would thus remain localised. The potential impact on sandy intertidal and shallow subtidal habitats and associated biota is thus considered to be of **very low** significance without mitigation (see Table 3-3).

#### Mitigation

- Mining should be prohibited in the critically endangered Namaqua Sheltered Rocky Coast and Namaqua Inshore Reef habitats, subject to verification by a suitably qualified marine ecologist (refer to Section 3.1.1.1).
- Restrict mining within the endangered Namaqua Mixed Shore habitat, which is represented by more extensive areas off the West Coast, to less than 1% of the available habitat within the mining right area annually, unless the habitat is confirmed to be different by a suitably qualified marine ecologist.
- Operate mobile pump units in sandy bays only to avoid damage of shallow water reefs and their associated kelp-bed communities.
- Refrain from collecting any shellfish (including abalone, rock lobster, mussels) or undertaking recreational or subsistence fishing within the allocated mining concession or adjacent areas.
- Prepare and implement site-specific ECOPs for each contractor and each allocated mining concession area (refer to Section 3.1.1 for the contents thereof).

- Prior to a contractor leaving a site and/or moving to a new site, the area must be audited by the Environmental Manager/Officer (see Section 3.1.1.1).

#### Residual impact

With the implementation of the proposed mitigation measures, the residual impact remains of **VERY LOW** significance.

**Table 3-3: Impact on intertidal and shallow subtidal habitats and biota due to mobile pump unit operations**

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	Local	Local
Duration	Short-term	Short-term
Intensity	Medium	Low
Probability	Probable	Probable
Confidence	High	High
Significance	<b>VERY LOW</b>	<b>VERY LOW</b>
Reversibility	Fully reversible	
Mitigation potential	Very Low	

#### 3.1.1.2.3 Cofferdam operations

##### Description of impact

Mining targets for coffer dams are located in bedrock features underlying modern beach sands, extending through the intertidal zone into the immediate nearshore subtidal areas. The diamondiferous deposits are sequentially mined within the confines of extensive sea walls constructed from substantial volumes of rocks, boulders and gravel relocated from inland sources, as well as overburden stripped from the mining block. The sea wall is constantly maintained while the impounded area is pumped dry and the target gravels are extracted by bucket-shovel and stockpiled before being fed into a feed-hopper/classifier. Once a section within a mining block has been mined to completion, the sea wall is moved progressively seaward until it can no longer withstand the wave forces.

The building of coffer dam walls on either sandy or rocky shores effectively smothers and eliminates any supratidal, intertidal and subtidal biota in the footprint of the coffer dam and the target mining block. The use of non-native material for the construction of coffer dam walls can also significantly change the nature of the original shoreline, with concomitant changes in the associated benthic biota.

##### Project controls

Project-specific ECOPs are compiled for coffer dam mining operations. Contractors are required to comply with the environmental specifications pertaining to:

- local environmental considerations;
- site access;
- location of source material;
- topsoil and overburden management;
- rehabilitation method;
- housekeeping;
- fuel and lubricant storage and management;
- solid waste management;
- oil spill procedure;

- maintenance and monitoring; and
- quantum of rehabilitation fund.

#### Impact assessment

The building of coffer dam walls on either sandy or rocky shores effectively smothers and eliminates any supratidal, intertidal and subtidal biota in the footprint of the coffer dam and the target mining block. By introducing large volumes of non-native material into the intertidal zone, the nature of the intertidal area is completely altered thereby resulting in substantial shifts in benthic community structure, with potential knock-on effects on higher order consumers who rely on the intertidal organisms as a food source.

Indirect impacts due to redistribution of sediments eroded from the sea wall would include scouring and smothering of biota in adjacent areas. Further indirect impacts may include changes in longshore wave patterns resulting in increased erosion of the beaches to the north (down current) of the coffer dams. Assuming all non-native material used for dam wall construction is removed at the end of operations, this effect is likely to persist only for as long as the coffer dam walls are left in place and for some time afterwards, until the beach profiles and shorelines regain equilibrium. If large rocks and rock berms are left in place, residual impacts are likely to remain. Although the impacts of coffer dams remain localised by definition, impacts can extend many 100s of metres along the shore and up to 300 m offshore. The impacts of a single coffer dam operation is, therefore, far more extensive than that of “walpomp” and mobile pump unit operations discussed above.

On a high-energy coastline the recovery of the physical characteristics of intertidal and shallow subtidal unconsolidated sediments to their pre-disturbance state following localised coffer dam operations that do not use rocks to stabilise the coffer dam walls, can occur within a few tidal cycles under heavy swell conditions, and will typically result in subsequent rapid recovery of the invertebrate epifaunal and infaunal communities to their previous state. Previous studies on the impact of coffer dam and larger-scale sea wall mining on macrofaunal beach communities identified that the physical state of beaches on the West Coast is entirely driven by natural conditions and is not affected (except during actual mining) by beach mining operations in the medium- to long-term (Pulfrich *et al.* 2004; Pulfrich *et al.* 2015). Removal of beach sands and subsequent extraction of target gravels results in a significant, yet localised and short-term decrease in macrofaunal abundance and biomass. Intertidal beach macrofauna appear to be relatively tolerant to disturbance and re-colonisation of disturbed areas is rapid (van der Merwe & van der Merwe 1991; Brown & Odendaal 1994; Peterson *et al.* 2000; Schoeman *et al.* 2000; Seiderer & Newell 2000; Nel *et al.* 2003). Impacted areas are initially colonised by small, abundant and opportunistic pioneer species with fast breeding responses to tolerable conditions (e.g. crustaceans and polychaetes). If the surface sediment is similar to the original surface material when mining operations cease and the final long-term beach profile has similar contours to the original profile, the addition or removal of layers of sand and gravel does not have enduring adverse effects on the sandy beach benthos (Hurme & Pullen 1988; Nel & Pulfrich 2002; Nel *et al.* 2003). However, the deposition of large volumes of non-native rock during sea wall construction, such as is taking place in Mining Right 554MRC, may result in the physical alteration of the shoreline to an extent that cannot be remediated by swell action. While the rock material may become covered with sand over time as it settles into the beach sediments, the sediment profile may be permanently altered, with potential effects on the associated macrofaunal communities. In extreme cases, where the coffer dam wall material is not completely removed, stretches of sandy beach could be permanently transformed into mixed and rocky shore habitats, with concomitant changes in the associated benthic biota (see Figure 3-5).

The impacts associated with the disturbance of intertidal and shallow subtidal habitats by coffer dam operations would be of high intensity regardless of SANBI benthic habitat classification. Although the impact would remain relatively localised around each mining block, considering the number of mining targets identified for coffer dam operations in Mining Right 554MRC (see Figure 2-5), the extent of the impact is

deemed to be regional. The impacts associated with the construction of coffer dams in rocky intertidal habitats are considered to persist over the medium- to long-term and would be only partially reversible (although the finer sediment will be redistributed, larger rocks would remain where water depth and wave action do not permit removal). The potential impact on rocky intertidal and shallow subtidal habitats and associated biota is thus considered to be of **very high** significance without mitigation (see Table 3-4). The establishment of alternative communities in the altered habitat would, however, occur over the short-term.

In contrast, impacts associated with the construction of coffer dams in sandy habitats would persist over the medium-term and be partially reversible. Although the PSJV require contractors to remove rock, as far as possible, after mining, if rocks remain on the beach these would potentially persist over the long-term and impacts would be only partially reversible. The potential impact on sandy intertidal and shallow subtidal habitats and associated biota is thus considered to be of **high** significance without mitigation (see Table 3-4).



**Figure 3-5: Physical alteration of a previously sandy beach by non-native rocky material used to construct coffer dam walls. A portion of the sea wall is also still evident**  
(Source: J. Blood)

#### Mitigation

- Mining should be prohibited in the endangered Namaqua Mixed Shore and critically endangered Namaqua Sheltered Rocky Coast habitats, subject to verification by a suitably qualified marine ecologist (refer to Section 3.1.1.1).
- Limit the number of coffer dams operational concurrently. Mine each block sequentially to completion, with only two adjacent blocks active concurrently.
- Use materials sourced locally from old tailings dumps for coffer dam construction and avoid using quarried material, where possible.
- Remove coffer dam material to below the low tide level, as far as wave action will allow, as soon as a block has been mined out. It is important to ensure that the least amount of non-native material remains on sandy beached and in gullies and potholes on rocky shores. This material should be re-used during further sea wall construction.
- Refrain from collecting any shellfish (including abalone, rock lobster, mussels) or undertaking recreational or subsistence fishing within the allocated mining concession or adjacent areas.



- Implement site-specific ECOPs for each contractor and each allocated mining concession area.
- Prior to a contractor leaving a site and/or moving to a new site, the area must be audited by the Environmental Manager/Officer (see Section 3.1.1.1).

#### Residual impact

With the implementation of the proposed mitigation measures, the residual impact is considered to be of **HIGH** and **MEDIUM** significance for both rocky and sandy habitats, respectively.

#### Monitoring

- Incorporate the SANBI benthic habitat map (specifically the endangered and critically endangered habitats) into the PSJV's GIS database so that these vulnerable habitats can be mapped in the preparation of the ECOPs.
- Undertake a biodiversity survey of intertidal sandy beaches in Mining Right 554MRC to:
  - > quantify the impact of coffer dam mining on intertidal communities;
  - > determine recovery rates of the affected biota on cessation of mining; and
  - > investigate the relationship of invertebrate macrofaunal communities with time since mining.
- Monitor sand accumulation or erosion from the southern and northern limits of individual coffer dams by measuring the beach profiles on a monthly basis at low spring tide.

Details of the proposed monitoring plan are provided in Section 4.9. The monitoring programme should be used to confirm the significance of the residual impact and, depending on the results, used inform future mining planning and methods.

**Table 3-4: Impact on intertidal and shallow subtidal habitats and biota due to coffer dam mining operations**

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
<u>Rocky</u> intertidal and shallow subtidal habitats		
Extent	Regional	Regional
Duration	Medium- to Long-term	Medium- to Long-term
Intensity	High	Medium to High
Probability	Definite	Definite
Confidence	High	Medium
Significance	Very High	HIGH
Reversibility	Partially reversible	
Mitigation potential	Low	
<u>Sandy</u> intertidal and shallow subtidal habitats		
Extent	Regional	Regional
Duration	Medium-term	Medium-term
Intensity	High	Medium
Probability	Definite	Probable
Confidence	High	High
Significance	High	MEDIUM
Reversibility	Partially reversible	
Mitigation potential	Low	

### 3.1.1.3 Deep-water habitats

#### 3.1.1.3.1 Vessel-based diver assisted mining operations

##### Description of impact

Vessel-based diver assisted mining contractors operating in Sea Concessions 1a, 2a and 3a usually targeting gravel-filled gullies and bedrock features in water depths between 5 - 12 m (up to 17.5 m if a compression chamber is used). The dredging operations are typically conducted using vessel mounted suction pumps and hoses, which are guided by divers into gullies, potholes and bedrock depressions to retrieve the diamond-bearing gravel. Divers may need to physically move large rocks and boulders, which are too large for the dredge nozzle, into underwater rock piles. Fine material (<2 mm) from the classifier washes directly back into the sea, whilst the oversize fraction (>20 mm) is discharged directly overboard. Some vessels are fitted with 'blower' cowlings, which direct the thrust of the propeller downwards to displace the overlying fine sediments, exposing the deeper gravel deposits.

The removal of unconsolidated sediments from bedrock features during mining result in the disturbance and loss of benthic macrofauna inhabiting the unconsolidated sediments.

##### Project controls

No project mining controls currently exist for vessel-based diver assisted operations, however, vessel waste and safety management controls are in place.

##### Impact assessment

Diver-assisted mining at depths <17.5 m specifically targets gravel areas, which are naturally barren or sparsely inhabited by infauna or commercially important species such as rock lobsters. The removal of unconsolidated sediments results in the disturbance and loss of benthic macrofauna inhabiting the unconsolidated sediments. Such effects are largely confined to the mined gully and, therefore, highly localised. Adjacent benthic communities and rock lobsters within metres of the impacted area remain unaffected by any mining-induced disturbance.

The removal of overlying gravel exposes expanses of previously embedded boulders. Initially, these newly exposed boulder areas are uninhabited and clearly distinguishable (in terms of benthic community) from unmined areas. However, the exposed boulders and rock gradually become colonised by crustose coralline algae, encrusting sponges, hydroids and anemones, and within a year the taxonomic diversity of boulder beds exposed by mining resembles adjacent unmined reef areas (Barkai & Bergh 1992; Parkins & Branch 1995, 1996, 1997; Pulfrich 1998a, 1998b, 2004a; Pulfrich & Penney 2001; Pulfrich *et al.* 2003c). Although the biodiversity may increase on previously buried and uninhabited rocky surfaces, the structure of the developing communities (species composition) remains distinguishable from adjacent unmined reef communities. By exposing highly structured habitat, diver-assisted mining also appears to create suitable habitat for rock lobsters. However, as near-bottom sediment transport within the wave base is primarily swell-driven, the excavated gullies and potholes are filled in by mobilised sediments over the short-term, with lobsters moving out of the gullies and back onto the adjacent reef.

The impacts associated with the removal of seabed sediments and their associated biota by vessel-based diver assisted operations would be of high intensity, but remain relatively localised within each mining target. However, considering the number of vessels operational in the a-concessions, the extent of the impact is considered to be regional. As infill rates in the dynamic wave-base is rapid, impacts to the biota would persist over the short-term and would be fully reversible. However, if mining occurs in endangered habitats (the Namaqua Mixed Shore) or critically endangered habitats (including the Namaqua Inshore Hard Grounds, Namaqua Inshore Reefs, Namaqua Sandy Inshore) (refer to Figures 3-2 to 3-4), which

cumulatively include large areas of the a- and b- concessions, impacts to the biota may persist over the medium-term and be only partially reversible. The potential impact on invertebrate macrofauna by vessel-based diver-assisted mining is thus considered to be of **medium** (least threatened) to **high** (critically/endangered) significance without mitigation (see Table 3-5). The establishment of alternative communities in the altered habitat would, however, occur over the short-term.

#### Mitigation

- Mining should be prohibited in the critically endangered Namaqua Inshore Reef habitat, subject to verification by a suitably qualified marine ecologist (refer to Section 3.1.1.1).
- Restrict mining within the endangered Namaqua Mixed Shore and critically endangered Namaqua Inshore Hard Grounds and Namaqua Sandy Inshore habitats, which are represented by more extensive areas off the West Coast, to less than 1% of the available habitat within the mining right area annually, unless the habitats are confirmed to be different by a suitably qualified marine ecologist.
- Refrain from collecting any shellfish (including abalone, rock lobster, mussels) or undertaking recreational or subsistence fishing within the allocated mining concession or adjacent areas.
- Position vessel in such a way that tailings are discharged back into mined out gullies or into areas of unconsolidated sediment adjacent to mining targets.
- Prepare and implement site-specific ECOPs for each contractor and each allocated mining concession area. The ECOP should include details for the following aspects:
  - > Environmental considerations (i.e. identification of endangered and critically endangered habitats and other sensitive receptors) and establishment of no-go areas.
    - Waste management (including the discharge of tailings).
    - Refuelling.
    - Oil spill procedure and reporting.
- Before the commencement of any mining, the contractor's vessel personnel must attend an environmental awareness-training course presented by the Environmental Manager/Officer. The contractor must keep records of all environmental training sessions, including names of attendees, dates of their attendance and the information presented to them.

#### Residual impact

With the implementation of the proposed mitigation measures, the residual impact is considered to be of **LOW** significance.

#### Monitoring

Incorporate the SANBI benthic habitat map (specifically the endangered and critically endangered habitats) into the PSJV's GIS database so that these vulnerable habitats can be mapped in the preparation of the ECOPs.

**Table 3-5: Impact on benthic macrofauna inhabiting the unconsolidated sediments due to vessel-based diver assisted mining**

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	Regional	Regional
Duration	Short- (least threatened) to Medium-term (critically/endangered habitats)	Short-term
Intensity	High	Medium
Probability	Definite	Probable
Confidence	High	High
Significance	<b>Medium</b> (least threatened) to <b>High</b> (critically/endangered habitats)	<b>LOW</b>
Reversibility	Fully reversible(least threatened) to Partially reversible (critically endangered habitats)	
Mitigation potential	Low to Medium	

### 3.1.1.3.2 Vessel-based remote prospecting and mining operations

#### Description of impact

During vessel-based operations benthic macrofauna inhabiting the unconsolidated sediments may be physically disturbed or crushed in the following ways:

- During prospecting in the deeper portions of Sea Concession 1a, 2a, 3a and 1b sampling tools (e.g. vibrocorers, drop core, Mega drill, Wirth drill or similar drill systems) and mining tools (e.g. dredge pump, airlift systems or seabed crawler) may be used to obtain samples of unconsolidated seabed sediments. The excavated sediments would be airlifted or pumped onto the sampling vessel where they are screened, classified and sorted, with all fines, oversize and screened waste-gravel being returned directly to the sea. Note: dredge pump operations are restricted to water depths of approximately 12 to 30 m, while airlift and crawler operations operate to a minimum depth of approximately 30 m.
- Test-mining (bulk sampling) and mining in Sea Concession 1b may involve the removal of unconsolidated seabed sediments using dredge pump, airlift systems or seabed crawlers. Dredge pump and airlift dredging systems can excavate up to 3 m of unconsolidated sediments from the seabed, creating trenches typically 10 m long by 1.6 m wide. Rocks and boulders rejected by the primary sorting bars remain on the mined footwall. All excavated sediments are brought to the surface are screened, classified and sorted, with fines, oversize and screened waste-gravel being returned directly to the sea.
- Test-mining (bulk sampling) and mining using large-diameter drills (e.g. Wirth or Mega drill) may also potentially be undertaken in Sea Concession 1b in water depths >30 – 130 m. The Wirth drill-head comprises a large-diameter circular disc fitted with wheel cutters and hardened steel scrapers, which is lowered vertically to the seabed on an extendable drill string. The drill can penetrate about 2 - 3 m of sediment and partially consolidated conglomerate or calcareous sandstone in water depths up to 150 m. Sediments are excavated in a systematic pattern of overlapping circles in the 50 m x 50 m mining block. Rocks and boulders rejected by the primary sorting bars remain on the mined footwall. Loosened rocks and sediment are pumped to the surface through the drill string for on-board processing with fines, oversize and screened waste-gravel being returned directly to the sea.
- Test-mining (bulk sampling) and mining using a seabed crawler may potentially be undertaken in Sea Concession 1b in water depths >30 m. The seabed crawler is track-driven and is equipped with a dredge pump system, hydraulic power pack and a jet-water system to facilitate the agitation and suction of unconsolidated surficial sediments up to the mining vessel. The seabed crawler can remove seabed sediments to a depth of up to 5 m in a set path 22 m wide within the mine target area.

Excavated sediment is pumped to the surface through the suction hose for on-board processing with fines, oversize and screened waste-gravel being returned directly to the sea.

Regardless of the prospecting or mining approach, the removal of unconsolidated sediments during mining results in the disturbance and loss of macrofauna living on and within the sediments.

#### Project controls

No project controls currently exist for vessel-based remote prospecting and mining operations.

#### Impact assessment

Deep-water mining operations target areas of unconsolidated sediments and gravels, typically avoiding areas of hard ground and reefs. In Concession 1a mineable sediment areas comprise approximately 48% of the total concession area, whereas in Concession 1b the mineable area comprises approximately 49% (see Figure 2-7).

Sands and muds provide a favourable substratum for invertebrate macrofauna, but gravels tend to be naturally barren or sparsely inhabited by infauna, particularly in the wave-based regime. Benthic macrofauna typically inhabit the top 20 - 30 cm of sediment, thus the removal of the upper 50 cm is likely to be sufficient to completely eliminate the benthos in the mining path (Newell *et al.* 1998) regardless of the mining approach. As the remote mining tools remove not only the overburden but also the underlying gravels, it can safely be assumed that all benthic infaunal and epifaunal biota in the path of the mining tool would be impacted as a direct result of the mining process. As many of the macrofaunal species serve as a food source for demersal and epibenthic fish and crustaceans, cascade effects on higher order consumers may result. For offshore habitats identified Least Threatened (including the Namaqua Sandy Inner Shelf and Namaqua Muddy Inner Shelf) this reduction in benthic biodiversity and impact on higher order consumers can be considered negligible due to the available area of similar habitat on the continental shelf of the West Coast.

The extraction of the surficial sediments results in the exposure of different seabed sediments than those present prior to prospecting or mining and/or reduced depth of the original sediment remaining on the seabed. Research has shown that sediment removal due to offshore mining or dredging operations can be expected to result in an 25 - 70% reduction of species diversity, 45 - 95% reduction in abundance and a similar reduction in biomass (Hyllerberg & Nateewathana 1984; Poiner & Kennedy 1984; Kenny & Rees 1994; Morton 1996; Schriever *et al.* 1997; De Grave & Whitaker 1999; Desprez 2000; Shirayama *et al.* 2001). Observed differences in community structure between mined and unmined areas are primarily due to mining-induced changes in physical sediment composition and organic content in mined areas, as these generally tend to have higher proportions of gravel than unmined sites (Parkins & Field 1998; Steffani 2010, 2012; Biccard & Clark 2016).

Research has also shown that these differences persist in the medium- to long-term, with the recovery (recolonization) rate of the impacted community depending on (1) the magnitude of the disturbance, (2) the nature of the impacted substrate, (3) the type of community inhabiting the sediments, (4) the extent to which the community is naturally adapted to high levels of sediment disturbances, (5) the sediment character (grain size) that remains following the disturbance and (6) physical factors such as depth and exposure (waves, currents), which affect the sediment infill rate (Newell *et al.* 1998; Parkins & Field 1998; Pulfrich & Penney 1999; Penney & Pulfrich 2004; Steffani 2007a, 2007b, 2009, 2010, 2012). Provided enough of the original sediment remains in the disturbed area, recolonization generally commences rapidly after a mining disturbance and the number of individuals (*i.e.* species density) may recover within short periods (weeks). Opportunistic species may recover their previous densities within months. However, long-lived species (*e.g.* molluscs and echinoderms) would take longer to re-establish the natural age and size structure of the

population. Biomass can, therefore, remain reduced for several years (Kenny & Rees 1994, 1996; Kenny *et al.* 1998). At depths beyond the wave base (>40 m) mining excavations would have slow infill rates and may persist for extended periods (years). Long-term or permanent changes in grain size characteristics of sediments may thus occur, potentially resulting in a shift in community structure. Research has, however, found that off the southern African West Coast the physical disturbance resulting from sampling or mining may be no more stressful than the regular natural disturbances (e.g. low-oxygen events, Orange River floods) characterising the continental shelf area of the Benguela ecosystem (Pulfrich & Penney 1999; Biccard *et al.* 2016; Biccard & Clark 2016).

The impacts associated with the removal of seabed sediments and their associated biota would be of medium intensity, but remain relatively localised within each mining block. In the critically endangered Namaqua Inshore Hard Grounds and Namaqua Sandy Inshore habitats (see Areas 3 and 8 in Figures 3-2 to 3-4), impacts are, however, be considered of high intensity. In low-energy, deep-water environments where infill rates are slower, natural recovery of communities would occur over the medium- to long-term and impacts may thus be only partially reversible with the establishment of alternative communities in the short- to medium term. The impact on invertebrate macrofauna due to deep-water mining is considered of **medium** (least threatened) **to high** (critically endangered) significance without mitigation (see Table 3-6).

Some disturbance or loss of benthic biota adjacent to the mining footprint can also be expected as a result of the launching of the seabed crawler and anchoring. In setting the anchors, benthic epifauna and infauna are likely to be crushed and subsequent tensioning or dragging of the anchors/chains, macrofauna would be disturbed, thereby resulting in a reduction in benthic biodiversity. The potential area of seabed disturbed would vary with the number of anchors used, the proportion of anchor chain that lies on the seabed, the forces applied and the duration of mining activities. Crushing of organisms in the impact depressions and scars is likely to primarily affect soft-bodied species as some molluscs and crustaceans may be robust enough to survive. Considering the available area of similar habitat on the continental of the West Coast (even in critically endangered habitats), the reduction in benthic biodiversity through crushing by crawlers and anchors can be considered negligible. The impacts would be of low intensity but highly localised, and short-term, as recolonization would occur rapidly from adjacent undisturbed sediments. The potential impact is consequently deemed to be of **VERY LOW** significance (see Table 3-6).

### Mitigation

- Restrict mining within the critically endangered Namaqua Inshore Hard Grounds and Namaqua Sandy Inshore habitats, which are represented by more extensive areas off the West Coast, to less than 1% of the available habitat within the mining right area annually, unless the habitats are confirmed to be different by a suitably qualified marine ecologist.
- Avoid mining unconsolidated habitats in the close proximity of rocky outcrop areas. This should include a suitable buffer zone (> 500 m) around identified sensitive areas to ensure that these are not affected indirectly by tailings impacts.
- Prepare and implement site-specific ECOPs for each contractor and each allocated mining concession area. The ECOP should include specific details for the following aspects:
  - > Environmental considerations (i.e. identification of endangered and critically endangered habitats and other sensitive receptors) and establishment of no-go areas.
    - Waste management (including the discharge of tailings).
    - Refuelling.
    - Oil spill procedure and reporting
- Before the commencement of any mining, the contractor's vessel personnel must attend an environmental awareness-training course presented by the Environmental Manager/Officer. The contractor must keep records of all environmental training sessions, including names of attendees, dates of their attendance and the information presented to them.



### Residual impact

With the implementation of the proposed mitigation measures, the residual impact of prospecting and mining in deep-water habitats is considered to be of **LOW** significance. The residual impact related to crawler launching and anchoring remains of **VERY LOW** significance.

### Monitoring

- Incorporate the SANBI benthic habitat map (specifically the endangered and critically endangered habitats) into the PSJV's GIS database so that these vulnerable habitats can be mapped in the preparation of the ECOPs. In addition, incorporate the PSJV contractor survey data into the GIS database for further identification of habitat sensitivities.
- Implement a monitoring programme in order to demonstrate natural recovery processes by means of pre- and post-mining seabed and benthic faunal community surveys. Details of the proposed monitoring plan are provided in Section 4.9.

**Table 3-6: Impact on benthic macrofauna inhabiting the unconsolidated sediments due to vessel-based remote prospecting and mining operations**

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Prospecting and mining		
Extent	Local	Local
Duration	Medium- to Long-term	Medium-term
Intensity	Medium (least threatened) to High (critically endangered)	Medium
Probability	Definite	Probable
Confidence	High	High
Significance	Medium (least threatened) to High (critically endangered)	LOW
Reversibility	Fully reversible to Partially reversible (critically endangered habitats)	
Mitigation potential	Low to Medium	
Launching seabed crawler and anchoring		
Extent	Local	Local
Duration	Short-term	Short-term
Intensity	Low	Low
Probability	Definite	Definite
Confidence	High	High
Significance	Very Low	VERY LOW
Reversibility	Fully reversible	
Mitigation potential	None	

### **3.1.2 DISCHARGE OF TAILINGS AND REDISTRIBUTION OF SEDIMENT FROM COFFER DAM WALLS**

#### Description of impact

The following project activities generate tailings:

- Shore-based "walpomp" operations in the surf-zones and shallow portions of Sea Concessions 1a, 2a and 3a pump the mined gravel ashore to classifiers located in the intertidal zone. Oversize tailings (>20 mm) accumulate around the screening units and fines (<1.6 mm) are returned to the sea across the intertidal regions as a sediment slurry.

- Sampling and test-mining (bulk sampling) operations by mobile pump units in the surf-zones and shallow portions of Sea concessions 1a, 2a and 3a would involve on-board screening with the oversize material (>25 mm) and fines (<1.4 mm) being disposed of back into the sea.
- Vessel-based diver assisted mining operations in Sea Concessions 1a, 2a and 3a pump gravels to on-board classifiers. Fine material from the classifier washes directly back into the sea, whilst the oversize fraction (>20 mm) is discharged directly overboard. Some vessels are fitted with 'blower' cowlings, which direct the thrust of the propeller downwards to displace the overlying fine sediments.
- Test-mining (bulk sampling) and mining in the deeper portions of Sea Concession 1a, 2a and 3a, as well as Sea Concession 1b involves the excavation of unconsolidated seabed sediments using either fixed-head trenching tools, vertical drills (Wirth or Mega drills) or seabed crawlers. All excavated sediments are brought to the surface, where they are screened, classified and sorted, with fines, oversize and screened waste-gravel being returned directly to the sea.

Another form of sedimentation is related to the construction and maintenance of coffer dams. Cofferdam operations in the surf-zone and shallow portions of Sea Concessions 1a, 2a and 3a requires the constant maintenance of the sea wall with non-native sediments, as finer materials are constantly eroded and redistributed by wave action.

The discharge of tailings and the redistribution of sediment from coffer dam walls can result in the following impacts:

- smothering of benthic biota by re-depositing tailings;
- increased water turbidity and reduced light penetration;
- reduced physiological functioning of marine organisms due to indirect biochemical effects; and
- toxicity and bioaccumulation effects on marine fauna.

#### Project controls

No project mining controls currently exist for offshore vessel operations, however, vessel waste and safety management controls are in place.

#### Impact Assessment

The assessment of potential impacts related to the discharge of tailing and the redistribution of sediment from coffer dams is presented in Sections 3.1.2.1 to 3.1.2.4 below.

##### **3.1.2.1 Smothering of benthic biota by re-depositing tailings**

All mining methods would discharge tailings overboard, except for the "walpomp" operations, where the oversize tailings accumulate around the screening units and fines return to the sea across the intertidal regions as a sediment slurry. Where tailings are discharged overboard they settle back onto the seabed largely beneath the vessel or mobile pump unit within the previously mined area. However, some of the processed sediments could impact on adjacent unmined areas, where they could smother benthic communities. Smothering involves physical crushing, a reduction in nutrients and oxygen, clogging of feeding apparatus, as well as affecting choice of settlement site and post-settlement survival.

The effects of smothering on the receiving benthic macrofauna are determined by (1) the depth of burial; (2) the tolerance of species (life habitats, escape potential, tolerance to hypoxia, etc.); (3) the nature of the depositing sediments; (4) duration of burial; and (5) the nature of the receiving environment.

Since the location of the target areas and nature of the receiving environment is one of the key considerations, these are discussed separately below.

### 3.1.2.1.1 *Supratidal habitats*

In shore-based “walpomp” operations, coarse tailings accumulate around the classifiers smothering and crushing underlying biota. If classifiers are located above the high water mark, tailings would not be redistributed by wave action and the tailings heaps would persist over the long-term or would be permanent.

The discharge of tailings around classifiers located in the high shore would be of medium intensity. If tailings discards occur in endangered (Namaqua Mixed Inshore) or critically endangered habitats (Namaqua Sheltered Rocky Coast), the intensity would be high. Although impacts would be highly localised around each operation, “walpomp” operations could be established throughout the surf-zones and shallow portions of Sea Concessions 1a, 2a and 3a; thus the extent is considered regional. The significance of the impact of discarding tailings in the high shore is thus considered to be **high** (least threatened) **to very high** (critically / endangered) without mitigation (see Table 3-7).

### 3.1.2.1.2 *Intertidal and shallow subtidal habitats*

Studies investigating the discharge of the oversize tailings during vessel-based diver assisted mining operations found that impacts on shallow-water and nearshore benthic reef communities persisted over the short-term only (Pulfrich & Penney 2001). It was also found that if overburden gravels and coarse tailings were discarded directly back into mined out gullies, smothering effects were negligible. However, if discards occurred on reefs, the nature of the seabed is physically altered and benthic communities in the affected areas were found to be significantly different from those on adjacent reefs not affected by tailings. These effects are extremely localised and ephemeral, as tailings are rapidly redistributed by swell action and any resultant impacts are negligible when seen in context with the high levels of natural disturbance in the nearshore environment. In more sheltered gullies, however, accumulated overburden and tailings act as traps for particulate detritus, resulting in the attraction of detritus feeders, such as brittle stars and sea cucumbers.

Impacts associated with the discard of tailings in the intertidal habitat are considered to be of medium intensity, persisting over the short-term only as they would be rapidly redistributed by wave action. If tailings discards occur in endangered (Namaqua Mixed Shore) or critically endangered (Namaqua Inshore Reef, Namaqua Inshore Hard Ground and Namaqua Sheltered Rocky Coast) habitats the intensity would be high. Although impacts would be limited to a scale of a few 10s of metres around each individual operation, vessel-based diver assisted operations can occur throughout the surf-zones and shallow portions of Sea Concessions 1a, 2a and 3a; thus, the extent is considered regional. The impact of tailings discharged in the intertidal zone and in nearshore waters is considered to be of **low** (least threatened) **to medium** (critically / endangered) significance without mitigation (see Table 3-8).

### 3.1.2.1.3 *Deep-water (> 5 m) habitats*

In deeper water beyond the wave base, the deposition of the coarser tailings fraction has more of an impact on soft bottom benthic communities compared to the gradual sedimentation of fine sediments, to which benthic organisms are adapted and able to respond. Typically, the coarse tailings accumulate within a few 100 m of the mining vessel, although depending on the strength of prevailing current, some may disperse further as a sediment plume. The deposition of the coarse tailings on unmined seabed communities beyond the mining block, they could effectively change the benthic habitat from one dominated by unconsolidated sediments to one dominated by gravel and boulders, with concomitant changes in benthic community structure. The fine fraction would be dispersed over a wider area by prevailing currents and settle gradually as a thinner mantle over the seabed. This deposition would have less of an impact on the soft bottom benthic community, as macrofauna off the Orange River mouth are adapted to respond to natural gradual sedimentation.

Deep-water fauna inhabiting unconsolidated sediments usually comprising fast-growing species able to rapidly recruit into disturbed areas. 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 disturbed areas of seabed (Maurer *et al.* 1979, 1981a, 1981b, 1982, 1986; Ellis 2000; Schratzberger *et al.* 2000; but see Harvey *et al.* 1998; Blanchard & Feder 2003). Impacts on highly mobile invertebrates and fish are likely to be negligible since they can move away from areas subject to smothering. In contrast, sedentary and relatively immobile species on hard substrata that occur in waters beyond the influence of aeolian and riverine inputs would be more susceptible to smothering by both rapid and gradual deposition of sediment. Vulnerable communities of concern include deep-water corals, which are known to occur on the continental shelf off the West Coast). Based on video footage from Child's Bank, which has identified vulnerable communities, the potential occurrence of such sensitive deep-water communities in Sea Concession 1b cannot be excluded. However, considering the proximity of the Orange River to Sea Concession 1b, any biota occurring on hard substrata would be expected to be adapted to elevated suspended sediment concentration.

The smothering impacts on benthic macrofauna in unconsolidated sediments in deeper water (>5 m) due to the discard of tailings from mining vessels would be of medium intensity (regardless of the threat status of the benthic habitat), but remain relatively localised within each mining target area. Impacts would persist over the short-term for operations in Sea Concession 1a where tailings would be rapidly redistributed by wave action, but medium-term where mining occurs in deeper water beyond the wave base (e.g. in Sea Concession 1b). In shallower water impacts would be fully reversible, whereas in deeper water impacts may be only partially reversible. The impact on invertebrate macrofauna of unconsolidated sediments due to tailings discharges is considered of **very low to low** significance without mitigation (see Table 3-9).

Impacts associated with the discard of tailings from offshore remote mining operations on deep-water reefs adjacent to mining targets would be of medium intensity, but remaining relatively localised within and around each mining target area. In low-energy deep-water environments, impacts could persist over the medium-term and potentially be only partially reversible. The impact on invertebrate macrofauna on rocky outcrops due to tailings discharges is considered of **very low** significance without mitigation (see Table 3-9).

#### Mitigation

- Mining should be prohibited in the endangered Namaqua Mixed Shore (for coffer dam mining only) and critically endangered Namaqua Inshore Reef and Namaqua Sheltered Rocky Coast habitats (all mining methods), subject to verification by a suitably qualified marine ecologist (refer to Section 3.1.1.1).
- Restrict mining within the endangered Namaqua Mixed Shore (for diver assisted mining and mobile pump unit operations) and critically endangered Namaqua Inshore Hard Grounds and Namaqua Sandy Inshore habitats (for vessel-based diver assisted and remote mining), which are represented by more extensive areas off the West Coast, to less than 1% of the available habitat within the mining right area annually, unless the habitats are confirmed to be different by a suitably qualified marine ecologist.
- Position vessel (used for diver-assisted mining) in such a way that tailings are discharged back into mined out gullies or into areas of unconsolidated sediment adjacent to mining targets.
- Use existing geophysical data to conduct a pre-mining geohazard analysis of the seabed to map potentially vulnerable habitats (to be included in site-specific ECOPs) and mining should avoid these vulnerable areas.
- Mining should avoid unconsolidated habitats in the close proximity of rocky outcrop areas in Sea Concession 1b. This should include a suitable buffer zone (> 500 m) around identified sensitive areas to ensure that these are not affected indirectly by tailings impacts.

- Prepare and implement site-specific ECOPs for each contractor and each allocated mining concession area.

#### Residual impact

With the implementation of the proposed mitigation measures, the residual impacts of smothering are as follows:

- Supratidal habitats: **LOW (neutral)** significance.
- Intertidal and shallow subtidal: **VERY LOW** significance.
- Deep-water (> 5 m) habitats:
  - > Unconsolidated sediments: **VERY LOW** significance.
  - > Rocky outcrop communities: **INSIGNIFICANT**.

#### Monitoring

- Implement a monitoring programme in order to demonstrate natural recovery processes by means of pre- and post-mining seabed and benthic faunal community surveys.
- Undertake a biodiversity survey of intertidal sandy beaches in Mining Right 554MRC to:
  - > quantify the impact of coffer dam mining on intertidal communities;
  - > determine recovery rates of the affected biota on cessation of mining; and
  - > investigate the relationship of invertebrate macrofaunal communities with time since mining.
- Monitor sand accumulation or erosion from the southern and northern limits of individual coffer dams by measuring the beach profiles on a monthly basis at low spring tide.

Details of the proposed monitoring plan are provided in Section 4.9.

**Table 3-7: Impact of smothering on high shore communities and alteration of habitat**

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
<b>Prospecting and mining</b>		
<b>Extent</b>	Regional	Regional
<b>Duration</b>	Permanent	Short-term
<b>Intensity</b>	Medium (least threatened) to High (critically endangered)	Medium
<b>Probability</b>	Definite	Probable
<b>Confidence</b>	High	High
<b>Significance</b>	<b>High</b> (least threatened) to <b>Very High</b> (critically endangered)	<b>LOW (neutral)</b>
<b>Reversibility</b>	Irreversible	
<b>Mitigation potential</b>	High	

**Table 3-8: Impact of smothering on intertidal and nearshore reef communities**

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
<b>Prospecting and mining</b>		
<b>Extent</b>	Regional	Regional
<b>Duration</b>	Short-term	Short-term
<b>Intensity</b>	Medium (least threatened) to High (critically/endangered)	Low
<b>Probability</b>	Probable	Probable
<b>Confidence</b>	High	High
<b>Significance</b>	<b>Low</b> (least threatened) to <b>Medium</b> (critically/endangered)	<b>VERY LOW</b>
<b>Reversibility</b>	Fully reversible	
<b>Mitigation potential</b>	Medium	

**Table 3-9: Impact of smothering on deep-water (> 5 m) communities and alteration of habitat**

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Unconsolidated sediment communities		
Extent	Local	Local
Duration	Short-term (inshore) to Medium-term (offshore)	Short-term
Intensity	Medium	Low
Probability	Probable	Probable
Confidence	High	High
Significance	<b>Very Low</b> (inshore) to <b>Low</b> (offshore)	<b>VERY LOW</b>
Reversibility	Fully reversible (inshore) to Partially reversible (offshore)	
Mitigation potential	Low	
Rocky outcrop communities		
Extent	Local	Local
Duration	Medium-term	Short-term
Intensity	Medium	Low
Probability	Possible	Improbable
Confidence	High	High
Significance	<b>Very Low</b>	<b>INSIGNIFICANT</b>
Reversibility	Partially reversible	
Mitigation potential	Low	

### 3.1.2.2 Increased water turbidity and reduced light penetration

Suspended sediment plumes are generated by all mining operations, regardless of the mining approach. These occur near the seabed through re-suspension of fine sediments by the mining tool, by the discharge of fine sediments from classifiers and on-board processing plants into the sea and by the constant erosion of finer materials from coffer dam walls by wave action.



The finer components of surface discharges generate a plume in the upper water column, which is dispersed away from the mining vessel by prevailing currents, diluting rapidly to background levels at increasing distances from the point of discharge. Distribution and re-deposition of suspended sediments are the result of a complex interaction between oceanographic processes, sediment characteristics and engineering variables that ultimately dictate the distribution and dissipation of the plumes in the water column. Ocean currents are important in distribution of suspended sediments. Turbulence generated by surface waves can also increase plume dispersion by maintaining the suspended sediments in the upper water column.

Increased concentrations of suspended sediments and consequent increase in turbidity would result in a reduction in light penetration through the water column resulting in potential adverse effects on the photosynthetic capability of phytoplankton and macrophytes. Poor visibility may also inhibit pelagic visual predators. However, due to the rapid dilution and widespread dispersion of settling particles, any adverse effects in the water column would be ephemeral and highly localised.

Turbid water is a natural occurrence along the southern African West Coast, resulting from aeolian and riverine inputs, resuspension of seabed sediments in the wave-influenced nearshore areas and seasonal phytoplankton production in the upwelling zones. The development of invertebrate and fish eggs and/or larvae may be impaired through high sediment loading, but as the major spawning areas are all located on the continental shelf, south of the concession area (see Figure 5-16 in Volume 1), any potential effects of turbid water plumes generated during tailings disposal on phytoplankton and ichthyoplankton production, fish migration routes and spawning areas, or on benthic and demersal species in the area would thus be negligible.

Increased turbidity of near-bottom waters through resuspension of fine sediments by mining tools may place transient stress on sessile and mobile benthic organisms, by negatively affecting filter-feeding efficiency of suspension feeders or through disorientation due to reduced visibility. However, in most cases sub-lethal or lethal responses occur only at concentrations well in excess of those anticipated at the seabed and in the water column. Furthermore, as benthic communities in the Benguela region are frequently exposed to naturally elevated suspended-sediment levels, they can be expected to have behavioural and physiological mechanisms for coping with this feature of their habitat.

The impact of increased turbidity in the water column due to the discharge of tailings and elevated suspended sediment concentrations at the seabed around the mining tool would thus be of low intensity, persisting only over the very short term (days), and would be localised (<20 km radius of the mine site). Any possible adverse effects on sessile benthos, or on the feeding, spawning and recruitment of mobile predators will be fully reversible. The biochemical impact of reduced water quality through increased turbidity can thus confidently be rated as being **insignificant** without mitigation (see Table 3-10).

In the case of sediments eroded from coffer dams, however, the impacts of increased turbidity and mobilised sediments in the surf-zone would be of medium intensity, persisting for as long as the coffer dam walls are maintained (short-term by definition). As turbidity plumes can become trapped in the surf-zone, impacts could probably extend regionally. Impacts should, however, be fully reversible once coffer dam operations cease. The biochemical impact of reduced water quality due to eroded sediments from coffer dam operations would thus be rated as being of **medium** significance without mitigation (see Table 3-10).

#### Mitigation

No mitigation measures are possible for the discharge of tailings from the mining vessel or the erosion of coffer dam materials by wave action.

### Residual impact

With no mitigation possible, impacts due to increased water turbidity and reduced light penetration remain **INSIGNIFICANT** (discharge of tailings) and of **MEDIUM** significance (redistribution from coffer dams).

**Table 3-10: Impact due to increased water turbidity and reduced light penetration**

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
<b>Discharge of tailings</b>		
<b>Extent</b>	Local	No mitigation is considered possible
<b>Duration</b>	Short-term	
<b>Intensity</b>	Low	
<b>Probability</b>	Possible	
<b>Confidence</b>	High	
<b>Significance</b>	<b>Insignificant</b>	
<b>Reversibility</b>	Fully reversible	
<b>Mitigation potential</b>	None	
<b>Redistribution of sediment from coffer dam walls</b>		
<b>Extent</b>	Regional	No mitigation is considered possible
<b>Duration</b>	Short-term	
<b>Intensity</b>	Medium	
<b>Probability</b>	Probable	
<b>Confidence</b>	High	
<b>Significance</b>	<b>Medium</b>	
<b>Reversibility</b>	Fully reversible	
<b>Mitigation potential</b>	None	

### 3.1.2.3 Reduced physiological functioning of marine organisms due to indirect biochemical effects

A further indirect impact associated with tailings disposal in the deeper waters of Sea Concession 1b is the potential development of hypoxic conditions in the near-surface sediment layers through bacterial decomposition of organic matter. Biodegradable organic matter in tailings piles on the seabed often has a greater effect than sediment texture and deposition rate on the structure and function of benthic communities (Hartley *et al.* 2003). Bacterial decomposition of organic matter may deplete oxygen in the near-surface sediment layers, thereby changing the chemical properties of the sediments by generating potentially toxic concentrations of sulfide and ammonia (Wang and Chapman 1999; Gray *et al.* 2002; Wu 2002). Organically enriched sediments are often hypoxic or anoxic, and consequently harbour markedly different benthic communities to oxygenated sediments (Pearson and Rosenberg 1978; Gray *et al.* 2002). Where inputs of organic matter are pulsed, their concentrations in the sediments would decrease with time in response to microbial degradation, and oxygen concentration in the surface-sediment layers would again recover leading to succession in the benthic community structure toward a more stable state. In shallower waters (Sea Concessions 1a, 2a and 3a), where sediments are constantly re-suspended by wave action, the development of hypoxic sediments following tailings disposal is highly unlikely.

Marine organisms respond to hypoxia by first attempting to maintain oxygen delivery, then by conserving energy and, upon exposure to prolonged hypoxia, organisms eventually resort to anaerobic respiration (Wu 2002). Hypoxia reduces growth and feeding, which may eventually affect individual fitness. Many fish and marine organisms can detect, and actively avoid, hypoxia. Some macrobenthos may leave their burrows and move to the sediment surface during hypoxic conditions, rendering them more vulnerable to

predation. However, hypoxia may eliminate sensitive species, thereby causing changes in species composition of benthic, fish and phytoplankton communities. Decreases in species diversity and species richness are well documented, and changes in trophodynamics and functional groups have also been reported. Under hypoxic conditions, there is a general tendency for suspension feeders to be replaced by deposit feeders, demersal fish by pelagic fish and macrobenthos by meiobenthos. Further anaerobic degradation of organic matter by sulphate-reducing bacteria may additionally result in the production of hydrogen sulphide, which is detrimental to marine organisms (Brüchert *et al.* 2003).

The bulk of the seawater in the study area comprises South Atlantic Central Water, which has depressed oxygen concentrations in bottom waters (40 - 80% saturation value). The Orange River Bight area is also recognised as one of the two main areas of low-oxygen water formation in the southern Benguela region. Thus, benthic communities in the mining right area will be adapted to low oxygen conditions and will be characterised either by species able to survive chronic hypoxia or by colonising and fast-growing species able to rapidly recruit into areas that have suffered oxygen depletion.

Development of anoxic conditions beneath re-deposited tailing in the deeper waters of Sea Concession 1b is highly unlikely due to the low deposition thicknesses anticipated in the tailings fallout footprint. However, should anoxic conditions develop, these would have an impact of low intensity on the benthic macrofauna, with recovery expected within a few months (fully reversible). The impact is thus considered to be **INSIGNIFICANT** without mitigation (see Table 3-11).

#### Mitigation

No mitigation measures are considered possible.

#### Residual impact

With no mitigation possible, the impact due to the development of anoxic conditions remains **INSIGNIFICANT**.

**Table 3-11: Impact due to the development of anoxic conditions in deeper waters**

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	Local	No mitigation is considered possible
Duration	Short-term	
Intensity	Low	
Probability	Improbable	
Confidence	Medium	
Significance	Insignificant	
Reversibility	Fully reversible	
Mitigation potential	None	

#### **3.1.2.4 Toxicity and bioaccumulation effects on marine fauna**

A number of historical studies suggested that recently deposited sediments in specific areas on the continental shelf of the southern African West Coast may be characterised by high levels of heavy metals of marine and/or terrestrial origin (Calvert & Price 1970; Chapman & Shannon 1985; Bremner & Willis 1990). Unpublished data by Bremner & Willis (cited in Environmental Evaluation Unit 1996) found high levels of cobalt, manganese and nickel associated with suspended sediments during the 1988 Orange River floods, suggesting the Orange River catchment area is a significant source of these contaminants. Measurements of metal concentrations from vibrocore samples taken off south Namibia confirm high levels of metals in

sediments (Environmental Evaluation Unit 1996). The re-suspension of sediments during mining can release these trace metals into the water column.

Although contaminant levels in plumes from deep-water mining vessels operational to the south (Steffani & Pulfrich 2004; Carter 2008) and to the north of the Orange River mouth (CSIR 2006) found that heavy metal concentrations did not exceed the South African chronic water quality guidelines or the “prohibition limit” imposed by the London Convention, trace metal analysis of sediments indicated that levels of cobalt, iron, vanadium, nickel, copper, cadmium and arsenic were in excess of recommended guideline levels required to sustain natural ecosystem functioning (Mostert *et al.* 2016).

Metal bio-availability and eco-toxicology is complex. Although dissolved forms are regarded as the most bio-available, many of these are not readily utilisable by aquatic organisms. Consequently, those forms that are ultimately bio-available and potentially toxic to marine organisms usually constitute only a fraction of the total concentration. Trace metal uptake by organisms may occur through direct absorption from solution, by uptake of suspended matter and/or via their food source. Toxic effects on organisms may be exerted over the short-term (acute toxicity) or longer term through bioaccumulation.

Plumes generated during mining and dredging are highly dynamic and any contaminants therein would be rapidly diluted and impacts would thus be of low intensity. Furthermore, as potentially susceptible organisms are highly mobile pelagic species, neither acute effects nor bioaccumulation are likely to be of concern. The impacts associated with the release of contaminants from disturbed sediments in Sea Concession 1b would remain localised, persisting only over the short-term. The likelihood of impacts occurring is considered improbable, and as these would be fully reversible, any potential adverse impact is considered to be **insignificant** without mitigation (see Table 3-12).

#### Mitigation

No mitigation measures are considered possible.

#### Residual impact

With no mitigation possible, the impact due to the bioaccumulation of contaminants from tailings remains **INSIGNIFICANT**.

**Table 3-12: Impact due to the bioaccumulation of contaminants from tailings in deeper waters**

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	Local	No mitigation is considered possible
Duration	Short-term	
Intensity	Low	
Probability	Improbable	
Confidence	Medium	
Significance	<b>Insignificant</b>	
Reversibility	Fully reversible	
Mitigation potential	None	

### 3.1.3 OPERATIONAL NOISE

#### 3.1.3.1 Prospecting and mining noise

##### Description of impact

Geophysical surveys (e.g. multi-beam, echo sounders, bottom profilers, side scan sonar, etc.), mining/survey vessels and sampling/mining tools would generate a range of underwater noises that may potentially contribute to and/or exceed ambient noise levels in the area.

Elevated noise levels could impact marine fauna by:

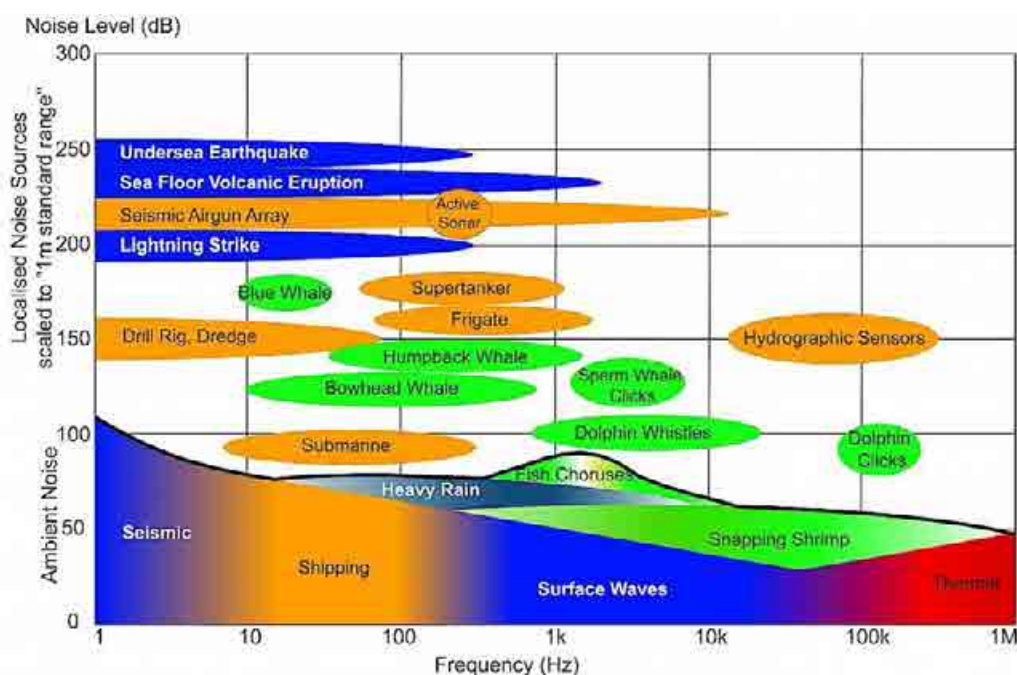
- causing direct physical injury to hearing or other organs;
- masking or interfering with other biologically important sounds (e.g. communication, echolocation, signals and sounds produced by predators or prey); and
- causing disturbance to the receptor resulting in behavioural changes or displacement from important feeding or breeding areas.

##### Project controls

No project controls currently exist for offshore operations.

##### Impact assessment

The ocean is a naturally noisy place and marine animals are continually subjected to both physically produced sounds from sources such as wind, rainfall, breaking waves and natural seismic noise, or biologically produced sounds generated during reproductive displays, territorial defence, feeding, or in echolocation. Such acoustic cues are thought to be important to many marine animals in the perception of their environment as well as for navigation purposes, predator avoidance, and in mediating social and reproductive behaviour. Anthropogenic sound sources in the ocean can thus be expected to interfere directly or indirectly with such activities thereby affecting the physiology and behaviour of marine organisms (NRC 2003). Of all human-generated sound sources, the most persistent in the ocean is the noise of shipping. Figure 3-6 provides an overview of the noise levels produced by various natural and anthropogenic sources, relative to typical background or ambient noise levels in the ocean.



**Figure 3-6: Comparison of noise sources in the ocean (Wenz 1962)**

The impacts associated with geophysical surveying and mining are assessed separately in Section 3.1.3.1.1 and 3.1.3.1.2 below.

#### 3.1.3.1.1 *Geophysical surveying noise*

The noise generated by the acoustic equipment utilised during geophysical surveys falls within the hearing range of most fish and marine mammals and at sound levels of between 190 to 220 dB re 1  $\mu$ Pa at 1 m, would be audible for considerable distances (in the order of tens of km) before attenuating to below threshold levels (Findlay 2005). However, unlike the noise generated by airguns during seismic surveys, underwater noise from geophysical surveys is not considered to be of sufficient amplitude to cause auditory or non-auditory trauma in marine animals in the region. Thus, despite having similar sound levels to seismic surveys, the higher frequency emissions utilised in geophysical surveying operations tend to be dissipated to safe levels over a relatively short distance. The anticipated radius of influence of geophysical surveys would thus be significantly less than that for a seismic airgun array. Hence the most likely scenario for injury to an animal by acoustic equipment would be if the equipment were turned on full power while the animal was close to it. As most pelagic species likely to be encountered during surveying are highly mobile, they would be expected to flee and move away from the sound source before trauma could occur.

The impact on marine fauna (i.e. physiological injury) due to noise generated during geophysical surveying operations is considered to be of medium intensity, and restricted to the survey area in the short-term (i.e. duration of the survey). The impact is thus considered to be of **very low** significance (see Table 3-13).

#### Mitigation

Despite the very low significance of potential impacts, the following mitigation measures, which are based on the Joint Nature Conservation Committee (JNCC) guidelines, are recommended for any proposed geophysical surveys:

- Undertake geophysical surveying, as far as possible, from the beginning of December to end of May in order to avoid the main cetacean migration period (particularly baleen whales).
- Commence surveying only once it has been confirmed for a 15-minute period (visually during the day) that there is no cetacean activity within 500 m of the vessel. The pre-survey scan is to be undertaken by an independent on-board Marine Mammal Observer (MMO).
- If the source level is greater than 210 dB re 1  $\mu$ Pa at 1 m the following is recommended:
  - > Implement a “soft-start” procedure, after the pre-survey visual scan, for a minimum period of 20 minutes to allow cetaceans to move out of the survey area and thus avoid potential physiological injury. However, if after a period of 15 minutes small cetaceans (particularly dolphins) are still within 500 m of the vessel, the normal “soft-start” procedure should be allowed to commence.
  - > “Soft-starts” should, as far as possible, be planned so that they commence within daylight hours.
  - > “Soft-start” procedures must also be implemented after breaks in surveying (for whatever reason) of longer than 20 minutes. Breaks of shorter than 20 minutes should be followed by a “soft-start” of similar duration.
  - > If surveying between the beginning of June and end of November cannot be avoided, passive acoustic monitoring (PAM) technology must be implemented.
- Terminate the survey if cetaceans show obvious negative behavioural changes within 500 m of the survey vessel or equipment. The survey should be terminated until such time it is confirmed that cetaceans have moved to a point that is more than 500 m from the source or despite continuous observation 15 minutes has elapsed since the last sighting of the cetaceans within 500 m of the source.



### Residual impact

The generation of noise from geophysical surveys cannot be eliminated. However, with the implementation of the above-mentioned mitigation measures, the residual impact on marine fauna is considered to be **INSIGNIFICANT**.

**Table 3-13: Impact of geophysical surveying noise on marine fauna**

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	Local: limited to mining site	Local
Duration	Short-term: for duration of operations	Short-term
Intensity	Medium	Low
Probability	Probable	Possible
Confidence	High	High
Significance	Very Low	<b>INSIGNIFICANT</b>
Reversibility	Fully reversible	
Mitigation potential	None	

#### 3.1.3.1.2 Mining noise

Noise from the mining vessels is likely to be no higher than those from other shipping vessels in the region. The sound level generated by seabed crawler operations fall within the 120-190 dB re 1  $\mu$ Pa range at the mining vessel, with main frequencies less than 0.2 kHz (Findlay 2005). Noise levels from hydrocarbon drilling units range from 170 – 190 dB re 1  $\mu$ Pa (Croft and Li 2017) attenuating to below median ambient background level (100 dB re 1 $\mu$ Pa) within a distance of 14 - 32 km from the drill site, depending on the specific vessels used and the number of support vessels operating. Noise levels from shallow-water operations have not been measured, but are expected to fall below those for cutterhead dredgers working in comparatively shallow environments where peak source levels of 100-110 dB re 1 $\mu$ Pa with main frequencies ranging from 100 – 500 Hz have been reported (US Army Corps 2015). The noise generated by offshore mining operations falls within the hearing range of most fish and marine mammals, and would be audible for considerable ranges (in the order of tens of kms) before attenuating to below threshold levels. The extent of the noise impacts would, however, also depend on the variation in the background noise level with weather, wave action and with the proximity of other vessel traffic (not associated with mining in the mining right area).

Although not considered to be of sufficient amplitude to cause direct physical injury or mortality to marine life, even at close range, the underwater noise from mining operations may, however, induce localised behavioural changes or masking of biologically relevant sounds in some marine fauna. There is, however, no evidence of significant behavioural changes that may impact on the wider ecosystem (Perry 2005). In a study evaluating the potential effects of vessel-based diamond mining on the marine mammals community off the southern African West Coast, Findlay (1996) concluded that the significance of the impact is likely to be minimal based on an elevated noise level radius of approximately 20 km around the mining vessel. Research has found that the responses of cetaceans to noise sources are often dependent on the perceived motion of the sound source, as well as the nature of the sound itself. For example, many whales are more likely to tolerate a stationary source than they are one that is approaching them (Watkins 1986; Leung-Ng and Leung 2003), or are more likely to respond to a stimulus with a sudden onset than to one that is continuously present (Malme et al. 1985).

Key sensitive receptors in the study area that may be influenced by underwater noise from mining include the seal colonies at Bucchu Twins (Sea Concession 1a) and Kleinzee (just south of Sea Concession 4a), resident odontocetes and diving seabirds roosting in the Orange River mouth wetlands. Cetaceans, turtles,

large pelagic fish and pelagic seabirds associated with Child's Bank (approximately 250 km south-southwest of Sea Concession 4b) and Tripp Seamount (situated approximately 230 km to the west-southwest of the Sea Concession 1b) are unlikely to be affected by prospecting and mining-related noise.

The impact of underwater noise generated during mining on marine fauna is considered to be of low intensity in the mining area and for the duration of the sampling/mining campaign. It is probable that underwater noise may mask biologically significant sounds, while disturbance and behavioural changes are possible. Noise impacts would be fully reversible once sampling/mining operations are completed. The impact of underwater noise potentially masking biologically significant sounds is considered of **very low** significance without mitigation, whereas the impact of underwater noise resulting in avoidance of feeding and/or breeding area is considered **insignificant** without mitigation (see Table 3-14).

#### Mitigation

No mitigation is considered necessary.

#### Residual impact

With no mitigation considered necessary, the impact of mining noise remains **VERY LOW** (masking sounds and communication) and **INSIGNIFICANT** (behavioural avoidance).

**Table 3-14: Impact of sampling/mining noise on marine fauna**

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Masking sounds and communication		
Extent	Local	No mitigation is considered possible
Duration	Short-term	
Intensity	Low	
Probability	Probable	
Confidence	High	
Significance	Very Low	
Reversibility	Fully reversible	
Mitigation potential	None	
Behavioural avoidance		
Extent	Regional	No mitigation is considered possible
Duration	Short-term	
Intensity	Low	
Probability	Possible	
Confidence	High	
Significance	Insignificant	
Reversibility	Fully reversible	
Mitigation potential	None	

### **3.1.3.2 Noise from helicopter operations**

#### Description of impact

Helicopters operating from Alexander Bay may be used to transfer personnel to and from the larger remote mining vessels operating in Sea Concession 1b. These operations could result in localised disturbance of fauna (e.g. seal and seabird colonies or breeding/calving cetaceans).

### Project controls

No project controls currently exist for helicopter operations.

### Impact assessment

Helicopters flying between the mining vessel and Alexander Bay may fly over sensitive receptors, such as bird and seal colonies or breeding/calving cetaceans. The noise generated by the helicopters may temporarily disturb marine fauna, which may result in the abandonment of nests or young, injury to individuals or impact breeding activities.

Seals may experience severe disturbance from low-flying aircraft usually reacting by showing a startle response and moving rapidly into the water. Although any observed response is usually short-lived, disturbance of breeding seals can lead to pup mortalities through abandonment or injury by fleeing, frightened adults. The Bucchu Twins seal colony in the surf-zone opposite Sea Concession 1a potentially lies in the flight path of helicopter operations depending on the location of sampling or mining.

Similarly, low altitude flights over bird breeding colonies could result in temporary abandonment of nests and exposure of eggs and chicks leading to increased predation risk. The nearest seabird colony is at Elephant Rocks well to the south of the mining right area. The Orange River Mouth wetland, an Important Bird Area (IBA), serves as an important habitat for a wide variety of waders and coastal birds, and flight paths would need to be planned to avoid this area.

Low altitude flights (especially near the coast) can have a significant disturbance impact on cetaceans during their breeding and mating season. The level of disturbance would depend on the distance and altitude of the aircraft from the animals (particularly the angle of incidence to the water surface) and the prevailing sea conditions. The disturbance of large migratory cetaceans (e.g. Southern Right whale) is unlikely, as the nearest known calving and nursery sites are at Elizabeth Bay in Namibia approximately 230 km north of the Orange River mouth and St Helena Bay approximately 360 km south of Kleinsee. It should also be noted that in terms of the Marine Living Resources Act, 1998 (No. 18 of 1998), it is illegal for any vessel or aircraft to, without a permit or exemption, approach to within 300 m of whales within South African waters.

Although exposure would be limited and be of a temporary nature while the helicopter passes overhead, indiscriminate or direct flying over seabird and seal colonies or the Orange River mouth estuary could have a significant disturbance impact on behaviour and breeding success. The level of disturbance would depend on the distance and altitude of the aircraft from the animals (particularly the angle of incidence to the water surface) and the prevailing sea conditions. Although such impacts would be local in the area of the colony, they may have wider ramifications over the range of affected species and are deemed to range from low to high intensity. The significance of impact is considered to be **low** without mitigation (see Table 3-15).

### Mitigation

- Implement relevant policies and procedures to manage flight paths for helicopters.
- Ensure that all flight paths avoid flying over coastal reserves (MacDougall's Bay), seal colonies (Bucchu Twins) or Important Bird Areas (Orange River Mouth wetlands).
- Ensure flight paths between Alexander Bay and mining vessel are perpendicular to the coast.
- Avoid extensive low-altitude coastal flights (<2 500 ft and within 1 nm of the shore), particularly during the winter/spring (June to December) whale migration period and during the November to January seal breeding season.
- Comply with aviation and authority guidelines and rules.
- Brief all pilots on the ecological risks associated with flying at a low level along the coast or above marine mammals.

### Residual impact

With the implementation of the above-mentioned mitigation measures, the residual impact on marine fauna is considered to be **INSIGNIFICANT**.

**Table 3-15: Impact of helicopter noise on marine fauna**

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
<b>Masking sounds and communication</b>		
<b>Extent</b>	Local	Local
<b>Duration</b>	Short-term	Short-term
<b>Intensity</b>	Low to High	Low
<b>Probability</b>	Probable	Possible
<b>Confidence</b>	High	High
<b>Significance</b>	<b>Low</b>	<b>INSIGNIFICANT</b>
<b>Reversibility</b>	Fully reversible	
<b>Mitigation potential</b>	None	

### 3.1.4 DISCHARGE OF WASTE TO SEA

#### Description of impact

Normal discharges to the marine environment would occur during both the smaller vessel-based diver assisted and larger remote mining operations.

Small-scale contractors operating in Sea Concessions 1a, 2a and 3a typically mine from converted fishing boats or purpose-built vessels of 10 - 22 m in length. Mining operations are typically limited to daylight hours for 3 - 10 diving days per month when sea conditions are favourable. The smaller vessels typically return to port at night, whereas some of the larger vessels can operate on a 24-hour basis and can thus stay at sea for longer. On-board facilities on the smaller mining vessels are limited and, in most cases, they are not required to be MARPOL compliant, with deck drainage, sewage and galley wastes all being discharged overboard. Sewage on certain of these smaller mining vessels is held in a header tank prior to dilution with seawater and discharge (Gavin Craythorne *pers comm*). Sewage from vessels without header tanks is discharged directly overboard.

The larger remote mining vessels operating in mid- to deep-water (Sea Concession 1b) range from 1 000 - 6 000 gross registered tons and up to 150 m in length. These ships are typically fully self-contained mining units with a processing facility on board, potentially able to operate 24-hours a day. Discharges from these vessels are described below:

- **Deck drainage:** Deck drainage consists of liquid waste resulting from rainfall, sea spray, deck and equipment washing (using water and an approved detergent). Deck drainage would be variable depending on the vessel characteristics, deck activities and rainfall amounts.
- **Machinery space drainage:** Vessels would occasionally discharge treated bilge water. Bilge water is drainage water that collects in a ship's bilge space (the bilge is the lowest compartment on a ship, below the waterline, where the two sides meet at the keel).
- **Sewage:** Discharges of sewage would occur from vessels intermittently throughout the mining period and would vary according to the number of persons on board.
- **Galley wastes:** Galley wastes, comprising mostly of biodegradable food waste, generated on board the project vessels would be discharged over board.

- Cooling water: Electrical generation on mining vessels is typically provided by large diesel-fired engines and generators, which are cooled by pumping water through heat exchangers. The cooling water is then discharged overboard.

These discharges would result in the local reduction in water quality, which could impact marine fauna in a number of different ways:

- Physiological effects: Ingestion of hydrocarbons, detergents and other waste could have adverse effects on marine fauna, which could ultimately result in mortality;
- Increased food source: The discharge of galley waste and sewage would result in an additional food source for opportunistic feeders, speciality pelagic fish species; and
- Increased predator - prey interactions: Predatory species, such as sharks and pelagic seabirds, may be attracted to the aggregation of pelagic fish attracted by the increased food source.

Although solid waste would not be discharge to sea, the accidental release of solid waste comprising non-biodegradable domestic waste, packaging and operational industrial waste into the sea could pose a further hazard to marine fauna, may contain contaminant chemicals and could end up as visual pollution at sea, on the seashore or on the seabed.

#### Project controls

No project controls currently exist for vessel-based diver assisted mining operations.

The larger remote mining vessels (>500 GRT) would be required to comply with the applicable requirements in MARPOL 73/78, as summarised below.

- Sewage and grey water discharges from vessels are regulated by MARPOL 73/78 Annex IV, which specifies the following:
  - > Vessels must have a valid International Sewage Pollution Prevention Certificate, as required by vessel class;
  - > Discharge of sewage beyond 12 nm requires no treatment. However, sewage effluent must not produce visible floating solids in, nor cause the discolouration of, the surrounding water;
  - > Sewage must be comminuted and disinfected for discharges between 3 nm ( $\pm 6$  km) and 12 nm ( $\pm 22$  km) from the coast. This would require an onboard sewage treatment plant or a sewage comminuting and disinfecting system; and
  - > Disposal of sewage originating from holding tanks must be discharged at a moderate rate while the ship is proceeding *en route* at a speed not less than 4 knots.
- The discharge of biodegradable wastes from vessels is regulated by MARPOL 73/78 Annex V, which stipulates that:
  - > No disposal to occur within 3 nm ( $\pm 5.5$  km) of the coast; and
  - > Disposal between 3 nm ( $\pm 5.5$  km) and 12 nm ( $\pm 22$  km) needs to be comminuted to particle sizes smaller than 25 mm.
- Discharges of water (deck drainage and bilge) to the marine environment are regulated by MARPOL 73/78 Annex I, which stipulates that vessels must have:
  - > A valid International Oil Pollution Prevention Certificate, as required by vessel class;
  - > Equipment for the control of oil discharge from machinery space bilges and oil fuel tanks, e.g. oil separating/filtering equipment and oil content meter. Oil in water concentration must be less than 15 ppm prior to discharge overboard;
  - > Oil residue holding tanks; and
  - > Oil discharge monitoring and control system.

The larger remote mining vessels would also be required to carry a Shipboard Oil Pollution Emergency Plan (SOPEP) for vessels with a gross tonnage of  $\geq 400$  t.

#### Impact assessment

The discharge of wastes to sea from mining vessels operational in Sea Concessions 1a, 2a, 3a and 1b has the potential to create local reductions in water quality both during transit and at the mining site. The majority of the discharged wastes are not unique to the project vessels, but rather common to the numerous vessels (mainly fishing) that operate in or pass through southern African coastal waters daily.

Compliance with MARPOL 73/78 would ensure that discharges from larger remote mining vessels introduce relatively small amounts of hydrocarbons, nutrients and organic material to oxygenated surface waters. Waste discharges are also expected to disperse rapidly and there is no potential for accumulation of wastes leading to any detectable long-term impact. Impacts related to discharges from larger vessels remain highly localised for as long as the vessel is operational in the area (typically short-term). The significance of the potential impacts for the remote mining vessels is, therefore, considered to be **very low** without mitigation (see Table 3-16).

Discharges from the smaller vessel-based diver assisted operations, although not required to be MARPOL compliant, would be small due to the low number of personnel on board and as a result of most vessels returning to port at night. Dispersion is also expected to be rapid, especially in the turbulent intertidal and shallow subtidal habitats as a result of surface waves. As a result of the small volumes and dispersion rate, any impacts would be of low intensity and limited to the mining location over the short-term. This impact is considered to be fully reversible as waste discharges and the potential impact would cease after mining in an area has been completed. The significance of the potential impacts related to discharges from the smaller vessels is, therefore, also considered to be **very low** without mitigation (see Table 3-16).

#### Mitigation

- General
  - > Prepare and implement a waste management system for all mining vessels that addresses all wastes generated. This should include separation of wastes at source and the shore-based recycling and re-use of wastes where possible.
  - > Ensure all process areas are bunded so that drainage water flows into the closed drainage system.
  - > Undertake training and awareness of crew in spill management to minimise contamination.
  - > Use low-toxicity biodegradable detergents and reusable absorbent cloths in cleaning of all deck spillage.
  - > Maintain all hydraulic systems.
  - > Ensure drip trays are used to collect run-off from equipment that is not contained within a bunded area.
  - > Ensure the disposal of waste (solid and hazardous) onshore is in accordance with the appropriate laws and ordinances.
- Small vessel-based diver assisted mining operations:
  - > Return all wastes (including galley wastes) generated on the vessel to shore for disposal at a licenced waste disposal site.
  - > Ensure all mining vessels that stay out overnight have sewage holding tanks, and that sewage is diluted with seawater prior to discharge.
  - > Consider installing chemical toilets on smaller vessels without holder tanks.
- Large vessel-based remote mining operations:
  - > Ensure compliance with MARPOL 73/78 standards.



- > Ensure all hazardous wastes are brought to shore for disposal at a licence hazardous waste site.
- > Ensure no waste is incinerated, unless an Atmospheric Emissions Licence is in place.
- > Ensure dechlorinate sewage effluents and cooling water meets World Bank standards for residual chlorine (i.e. 0.2 mg/l at the point of discharge prior to dilution).

#### Residual impact

With the implementation of the proposed mitigation measures, the residual impact from the discharge of waste from the larger remote mining vessels is considered to be **INSIGNIFICANT**. The residual impact for smaller vessels remains of **VERY LOW** significance.

**Table 3-16: Impact of operational discharges to the sea**

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Small vessel-based diver assisted mining operations		
Extent	Local	Local
Duration	Short-term	Short-term
Intensity	Low	Low
Probability	Definite	Probable
Confidence	High	High
Significance	Very Low	VERY LOW
Reversibility	Fully reversible	
Mitigation potential	None	
Large vessel-based remote mining operations		
Extent	Local	Local
Duration	Short-term	Short-term
Intensity	Low	Low
Probability	Probable	Possible
Confidence	High	High
Significance	Very Low	INSIGNIFICANT
Reversibility	Fully reversible	
Mitigation potential	Low	

### **3.1.5 VESSEL LIGHTING**

#### Description of impact

The operational lighting of larger remote mining vessels during transit and operation can be a significant source of artificial light in the offshore environment. Increased ambient lighting may disturb and disorientate pelagic seabirds feeding in the area. Operational lights may also result in physiological and behavioural effects of fish and cephalopods as these may be drawn to the lights at night where they may be more easily preyed upon by other fish and seabirds.

As the smaller vessel-based diver assisted operators typically return to port at night, vessel lighting is not an issue.

#### Project controls

No project controls currently exist for offshore operations.

### Impact assessment

Seabirds, fish, cephalopods (squids), seals, turtles and cetaceans may be attracted to the strong operating lights required during drilling activities and to flaring during any flow testing. Many seabird species forage at night on bioluminescent plankton prey and any light would result in obvious attraction. Potential attraction may increase during fog when greater illumination is caused by refraction of light by moisture droplets.

Most of the seabird species along the West Coast feed relatively close inshore (10-30 km). Cape gannets, however, are known to forage up to 140 km offshore (Dundee 2006; Ludynia 2007). However, the nearest nesting ground for Cape Gannets is at Bird Island in Lambert's Bay, which is approximately 300 km to the south of the mining right area. Most of the pelagic seabird species in the region reach highest densities offshore of the shelf break (200 to 500 m depth), which is offshore of the mining right area. As Sea Concessions 1a, 2a, 3a and 1b fall within 30 km of the coast, encounters with seabirds are highly likely.

Although little can be done on mining vessels to prevent seabird collisions, reports of collisions or death of seabirds on drilling units are rare. It is expected that seabirds and marine mammals in the area would become accustomed to the presence of the installations within a few days, thereby making the significance of the overall impact on these populations negligible. The significance to the populations of fish and squid of increased predation as result of being attracted to an installation's lights is deemed to be insignificant.

Seals are highly mobile animals with a general foraging area covering the continental shelf up to 120 nm (approximately 220 km) offshore. Since the Bucchu Twins seal colony occurs within Sea Concession 1a, numbers can be expected to be high.

The extent of impact is likely to be limited to the visual stimulus of the mining vessels for as long as the vessel is operational in the area (typically short-term). The intensity of impact is likely to range from low (altered distribution and behaviour) to high (mortality) for individuals, the intensity of the impact on the population is expected to be very low. The significance of impact is deemed **insignificant** without mitigation (see Table 3-17).

### Mitigation

- Minimise non-essential lighting on all vessels to reduce nocturnal attraction.
- Shield operational lights, where feasible, in such a way as to minimise their spill out to sea.
- Keep disorientated, but otherwise unharmed, seabirds in dark containers for subsequent release during daylight hours.
- Euthanise of injured birds humanly.

### Residual impact

With the implementation of the proposed mitigation measures, the residual impact remains **INSIGNIFICANT**.

### Monitoring

- Implementing a monitoring programme of faunal attraction where any seabird injuries and mortalities are logged.
- Report ringed/banded birds to the appropriate ringing/banding scheme (details are provided on the ring).

**Table 3-17: Impact of increased ambient lighting from larger mining vessels**

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	Local	Local
Duration	Short-term	Short-term
Intensity	Very Low	Very Low
Probability	Possible	Possible
Confidence	High	High
Significance	Insignificant	INSIGNIFICANT
Reversibility	Fully reversible	
Mitigation potential	None	

### 3.1.6 UNPLANNED EVENTS

Unplanned events are not an intended part of an operation, but may conceivably occur as a result of accidents or abnormal operating conditions. Impacts may result from small operation spills (e.g. during bunkering), vessel accidents or loss of equipment offshore. This section assesses the impacts from unplanned events.

#### 3.1.6.1 Operations spills

##### Description of impact

Small instantaneous spills of marine diesel and/or hydraulic fluid in the supratidal/intertidal zone or at the surface of the sea can potentially occur during mining. Such spills are usually of a low volume and occur accidentally during fuel bunkering or as a result of hydraulic pipe leaks or ruptures. Larger volume spills of marine diesel would occur in the event of a vessel collision or vessel accident.

Diesel, hydraulic fluid and/or oil spilled in the marine environment would have an immediate detrimental effect on water quality, with the toxic effects potentially resulting in mortality (e.g. suffocation and poisoning) of marine fauna or affecting faunal health (e.g. respiratory damage). Sub-lethal and long-term effects can include disruption of physiological and behavioural mechanisms, reduced tolerance to stress and incorporation of carcinogens into the food chain. If the spill reaches the coast, it can result in the smothering of sensitive coastal habitats.

##### Project controls

As noted in Section 3.1.1.1, a generic ECOP has been developed for all “walpomp” operations in the surf-zone and shallow portions of Sea Concessions 1a, 2a and 3a, which includes specifications for oil spill procedure and reporting. Project-specific ECOPs are also compiled for coffer dam mining.

The larger vessel remote mining vessels would be required to comply with the applicable requirements in MARPOL 73/78, including the requirement to carry a SOPEP for vessels with a gross tonnage of  $\geq 400$  t.

##### Impact assessment

Diesel tends to penetrate porous sediments quickly and spills in the supratidal and intertidal area would result in soil contamination. However, if spilled in the intertidal zone, it would be washed off by waves and tidal flushing.

Diesel is a light oil that, when spilled on water, spreads very quickly to a thin film and evaporates or naturally disperses within a few days or less, even in cold water. Diesel oil can be physically mixed into the water column by wave action, where it adheres to fine-grained suspended sediments, which can subsequently

settle out on the seafloor. As it is not very sticky or viscous, diesel is washed off surfaces quickly by waves and tidal flushing. In the case of a spill, shoreline clean-up is thus usually not needed. Diesel oil is degraded by naturally occurring microbes within one to two months.

Nonetheless, in terms of toxicity to marine organisms, diesel is considered to be one of the most acutely toxic oil types. Many of the compounds in petroleum products are known to smother organisms, lower fertility and cause disease. In the case of a vessel wreckage on the coast, intertidal invertebrates and seaweed that come in direct contact with the diesel spill may suffer mortality. Fish mortality, however, has never been reported for small spills in open water as the diesel dilutes so rapidly. Due to differential uptake and elimination rates, filter-feeders (particularly mussels) can bio-accumulate hydrocarbon contaminants. Crabs and shellfish can be tainted from small diesel spills in shallow, nearshore areas. Small diesel spills can also affect marine birds by direct contact. The nearest nesting ground for Cape Gannets is at Bird Island in Lambert's Bay, while the nearest African Penguins nesting sites are at the Saldanha Bay Islands and Dassen Island. As these are all extended distances from the mining right area, the likelihood of these seabird species being present in the mining right area in large numbers is extremely low. Numerous cormorant species are, however, present in the Orange River Mouth estuary and may be affected by a nearshore operational spill from vessels.

The larger remote mining vessels carry in the order of 1 000 m<sup>3</sup> of marine diesel, so under the worse-case scenario of a vessel grounding or sinking, this volume could be lost to the marine environment. The results of an oil spill modelling study undertaken for an 87 ton (approximately 74 000 litres) operational spill at 130 m depth and approximately 50 km offshore of the Holgat River (PRDW 2014) identified that a spill would travel in a north-westerly direction away from the coast and there was thus minimal chance of the diesel reaching the shoreline. The intensity of the potential impact of an operational spill of this size varies depending on the faunal group affected, ranging from zero for benthic macrofauna, low for pelagic fish and larvae, marine mammals and turtles, to high for seabirds, persisting only over the short-term (days).

If a spill occurs in port while bunkering/loading the impact would most likely be easily managed and the risk/impact would be low. Similarly, operational spills or grounding and sinking of a smaller diver-assisted mining vessel would involve low volumes of marine diesel, which would be rapidly dispersed along the wave-exposed coastline.

The significance of the impact of an operational spill is dependent on the biota likely to be affected and where the spill occurs. In most cases the impacts can be considered of **very low** significance for offshore spills and of **low** significance for nearshore spills, with the exception of seabirds, where the impact is considered to be of **low** significance for both offshore and nearshore spills. Impacts, should they occur, would be fully reversible (see Table 3-19).

#### Mitigation

- General
  - > Ensure personnel are adequately trained in both accident prevention and immediate response.
  - > Inspect and maintain all fuel containers.
  - > Prepare and implement an Emergency Response Plan.
  - > Use dispersants cautiously and only with the permission of the Department of Environmental Affairs (DEA).
  - > Ensure all process areas are bunded and drip trays are used to collect run-off from non-bunded equipment.
- Small vessel-based diver assisted mining operations:
  - > Undertake refuelling within the port limits only.
- Large vessel-based remote mining operations:

- > Enforce the 500 m safety/exclusion zone around mining vessels. Support vessels with appropriate radar and communications would be used during the drilling operation to warn vessels that are in danger of breaching the safety/exclusion zone.
- > Notify relevant authorities and fisheries associations regarding proposed activities, including details on timing and location.
- > Issue navigational warnings (via the South Africa Navy Hydrographic office) throughout the sampling/mining period.
- > Use of navigational aids (e.g. radar, multi-frequency, radio signals, lights and markings) on mining vessels.
- > Avoid offshore bunkering in the following circumstances:
  - Wind force and sea state conditions of 6 or above on the Beaufort Wind Scale;
  - During any workboat or mobilisation boat operations;
  - During helicopter operations;
  - During the transfer of in-sea equipment; and
  - At night or times of low visibility.

#### Residual impact

With the implementation of the above-mentioned mitigation, the residual impacts associated with a small operational spill on marine fauna would be **INSIGNIFICANT**.

**Table 3-18: Impact of operational spills**

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Spill in supratidal and nearshore		
Extent	Local	Local
Duration	Short-term	Short-term
Intensity	Medium to High	Very Low
Probability	Possible	Improbable
Confidence	High	High
Significance	Low	INSIGNIFICANT
Reversibility	Fully reversible	
Mitigation potential	Medium	
Spill offshore		
Extent	Local	Local
Duration	Short-term	Short-term
Intensity	Low to High	Low
Probability	Possible	Possible
Confidence	High	High
Significance	Very Low to Low	INSIGNIFICANT
Reversibility	Fully reversible	
Mitigation potential	Low to Medium	

#### **3.1.6.2 Loss and discard of equipment**

##### Description of impact

Small boat-based diver operators may mark mining sites with buoys, which may subsequently be abandoned within the mining area. Lost or discarded buoyed cables and ropes could present an entanglement hazard to marine mammals and turtles, which could lead to drownings.

Equipment from smaller mining vessels (such as anchors and mining tools) may also occasionally be lost on the seabed. The larger remote mining vessels may similarly occasionally lose anchors and mining tools on the seabed. Materials and supplies may also be transported by supply vessels to mining vessels. As with any transfer operation there is a risk of dropped objects. Dropped objects may include drums/containers of oil, fuel, chemicals, paint, sacks, pallets, equipment, skips, garbage, etc.

Any benthic fauna present on the seabed and in the sediment in the disturbance footprint would potentially be disturbed or crushed, resulting in injury or mortality. The availability of hard substrata on the seabed also provides opportunity for colonisation by sessile benthic organisms and provides shelter for demersal fish and mobile invertebrates; thereby potentially increasing the benthic biodiversity and biomass in the continental slope region.

#### Project controls

No project controls currently exist for offshore operations.

#### Impact assessment

Buoyed cables and ropes abandoned or lost from nearshore mining operations pose an entanglement hazard to marine mammals and turtles and could lead to drowning of these animals. Although the weight of biofouling would sink the floating structures in the short-term, every effort should be made to remove foreign objects from the water column. The impact related to the entanglement of marine fauna is conserved to be localised, of medium intensity over the short-term. This impact is thus considered to be of **low** significance without mitigation.

Any benthic fauna present on the seabed and in the sediment in the disturbance footprint of dropped equipment would potentially be disturbed or crushed, resulting in injury or mortality. However, this is considered to be insignificant compared to the physical disturbance caused by actual mining. Although every effort is normally made to retrieve anchors and mining tools from larger mining vessels due to the size and cost, abandoned or lost equipment would effectively increase the availability of hard substrate for colonisation by sessile benthic organisms, thereby locally altering community structure and increasing biodiversity and biomass. This may have positive implications to certain fish species (e.g. kingklip and jacobever, which show a preference for structural seabed features). The increase in biodiversity due to the presence of abandoned subsea structures would be considered a secondary impact of very low intensity. The impact is highly localised, but would be permanent if the equipment remains on the seafloor. The impact is considered to be of **very low (neutral)** significance without mitigation (see Table 3-20).

#### Mitigation

- Remove marker buoys once a mining block has been mined out.
- Retrieve any lost equipment, where practicable, after assessing safety and metocean conditions before performing any retrieval operations.
- Undertake frequent checks to ensure items and equipment are stored and secured safely on board each vessel.

#### Residual impact

With the implementation of the proposed mitigation measures, impacts related to lost or abandoned equipment is considered to be **INSIGNIFICANT**.

#### Monitoring

Establish a hazards database of all lost equipment, including date of loss, location and, where applicable, the dates of retrieval.



**Table 3-19: Impact of lost or discarded equipment**

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Entanglement		
Extent	Local	Local
Duration	Short-term	Short-term
Intensity	Medium	Very Low
Probability	Probable	Improbable
Confidence	Medium	Medium
Significance	Low	INSIGNIFICANT
Reversibility	Fully reversible	
Mitigation potential	Medium	
Disturbance and increased hard substrate		
Extent	Local	Local
Duration	Permanent	Short-term
Intensity	Very Low	Very Low
Probability	Probable	Possible
Confidence	Medium	Medium
Significance	Very Low (neutral)	INSIGNIFICANT (neutral)
Reversibility	Fully reversible	
Mitigation potential	Low	

## 3.2 IMPACTS ON THE SOCIO-ECONOMIC ENVIRONMENT

### 3.2.1 POTENTIAL IMPACT ON FISHING INDUSTRY

#### Description of impact

Under the Convention on the International Regulations for Preventing Collisions at Sea (COLREGS, 1972, Part B, Section II, Rule 18), a vessel that is engaged in dredging, surveying or underwater operations is defined as a “vessel restricted in its ability to manoeuvre” which requires that power-driven and sailing vessels give way to a vessel restricted in her ability to manoeuvre. Vessels engaged in fishing are required to, so far as possible, keep out of the way of the well drilling operation. Furthermore, under the Marine Traffic Act, 1981 (No. 2 of 1981), any vessel used in prospecting for or mining of any substance falls under the definition of an “offshore installation” and as such it is protected by a 500 m safety zone. It is an offence for an unauthorised vessel to enter the safety zone.

The enforcement of the 500 m safety zone around the larger mining vessels would effectively exclude fisheries from the safety zone, which would reduce fishing grounds, which in turn could potentially result in a loss of catch and/or increased fishing effort. In addition, particularly in the nearshore environments, increased sedimentation, habitat disturbance and poaching of marine resources may have an impact on effort and catch, specifically for the West Coast rock lobster and abalone ranching sectors.

#### Project controls

No project controls currently exist for offshore operations.

#### Impact assessment

The commercial sectors that could be affected by mining in Sea Concessions 1a, 2a, 3a and 1b are discussed below.

### *West Coast rock lobster*

The West Coast rock lobster catch from Management Area 1 between 2006 and 2017 in relation to the marine mining right areas is shown in Figure 5-32 and Table 5-7 in Volume 1. Over the period 2006 and 2017, the fishery landed an average of 14.1 tons of West Coast rock lobster per year within Mining Right 544MRC (i.e. 3.2% of national catch). Over the same period, the fishery set an average of 5 790 traps year (i.e. 9.8% of national effort).

Although poaching and incidental pumping of rock lobster by mining personnel has been identified as a threat to the severely depleted rock lobster resource in Namaqualand (Barkai and Bergh 1992), this is considered to be insignificant compared to the annual quota landed by the commercial rock lobster industry. However, the potential alteration of the benthic habitat due to mining (removal of sediment and kelp cutting) could have a more significant impact on the lobster resource. Extensive and repeated kelp cutting by “walpomp” divers and increased sediment mobilisation and deposition as a result of coastal mining operations can result in kelp bed habitats being locally eliminated and replaced by extensive stands of mussels (Engeldow & Bolton 1994) or colonies of the Cape reef worm *Gunnarea gaimardi* (G. Koeglenberg & Q. Snethlage, diamond divers, *pers. comm.*). As a consequence, wave exposure in the affected areas changed from sheltered to semi-exposed, which may have knock-on effects on the recruitment success of rock lobsters through reduction of suitable habitat and food sources.

Vessel-based diver assisted mining target gravel areas, which are naturally barren or sparsely inhabited by infauna or commercially important species such as rock lobsters. By exposing highly structured habitat, diver-assisted mining also appears to create suitable habitat for rock lobsters. However, as near-bottom sediment transport within the wave base is primarily swell-driven, the excavated gullies and potholes are filled in by mobilised sediments over the short-term, with lobsters moving out of the gullies and back onto the adjacent reef.

The potential impact on the West Coast rock lobster sector is considered to be of medium intensity, regional in extent and short- to medium term (for “walpomp”) and medium- to long-term (for coffer dams). Taking this into consideration, the significance of impact is thus considered to be **medium to high** without mitigation (see Table 3-21). Mining with mobile pump units is unlikely to impact this sector, as this method would primarily be implemented in the surf zone of sandy beaches.

### *Abalone ranching*

Sea Concessions 1a, 2a and 3a overlap with ranching Concession Areas 1 and 2 (see Figure 5-33 in Volume 1). As described above, mining within the intertidal and shallow sub-tidal would alter the benthic habitat, as well as crush sessile filter feeders (e.g. mussels) and grazers (e.g. abalone) in the mining footprint, which would impact possible future abalone ranching along the coast. Although there has been no seeding in Areas 1 and 2 to date (partly due to the uncertainty relating to user conflict), the potential impact on future abalone ranching is as assessed for the West Coast rock lobster sector above, i.e. **medium to high** significance without mitigation (see Table 3-21). Mining with mobile pump units is unlikely to impact this sector, as it would primarily be implemented in the surf zone of sandy beaches.

### *Traditional line-fish*

Fishing vessels generally range up to a maximum of 40 nm offshore, although fishing at the outer limit of this range is sporadic. The traditional line-fish catch between 2000 and 2015 in relation to the marine mining right areas is shown in Figure 5-29 in Volume 1. Over the period 2000 and 2015, the fishery landed an average of 2.7 tons of tuna per year within the mining right areas (i.e. 0.02 – 0.04% of national catch).

Since access to the coastal area along Sea Concessions 1a, 2a and 3a is restricted, it is the vessel-based diver assisted and the larger remote mining vessels that could impact this sector. The potential impact of

exclusion from fishing ground is considered to be regional and of short-term duration (at any one locality). The intensity of the potential impact of exclusion from fishing grounds is considered to be low, based on the low proportion of national catch and effort taken from the mining right area, as well as that fishing could continue in adjacent areas. The significance of impact on the traditional line-fish sector is thus considered to be **very low** without mitigation (see Table 3-21).

#### *Beach-seine and gill-net fisheries*

The beach-seine fishery operates primarily between False Bay and Port Nolloth. Fishing effort is coastal and net depth may not exceed 10 m. Three of the 28 right holders operate within Mining Right 554MRC. However, since nets are hauled to shore and the onshore mining right area (i.e. 550MRC) has restricted access, effort can be expected to occur closer to Port Nolloth. Thus, impacts on this sector are unlikely.

The gill-net fishery also operates on the West Coast from Yzerfontein to Port Nolloth. Gill-nets are set in waters shallower than 50 m. Four of the 162 right holders operate within Mining Right 554MRC. The combined landings by the gill-net and beach-seine in the vicinity of Port Nolloth accounts for less than 10% of the national netfish landings (Steve Lamberth, DAFF, *pers. comm.*). Since access to the coastal area along Sea Concessions 1a, 2a and 3a is restricted, it is the vessel-based diver assisted vessels that could impact this sector. The potential impact of exclusion from fishing ground is considered to be regional and of short-term duration (at any one locality). The intensity of the potential impact of exclusion from fishing grounds is considered to be low, as well as that fishing could continue in adjacent areas. The significance of impact on the traditional line-fish sector is thus considered to be **very low** without mitigation (see Table 3-21).

#### Mitigation

The mitigation for the “walpomp” and coffer dam operations is as specified in Sections 3.1.1.2.1 and 3.1.1.2.3, respectively. Mitigation for the larger remote mining operations is as follows:

- Notify relevant fisheries associations (including South African Tuna Long-Line Association, South African Tuna Association, Fresh Tuna Exporters Association, South African Commercial Line-Fish Association, Northern Cape Fishing Forum, South African Marine Line-Fish Management Association and South African Fishing Industry Association) regarding proposed activities, including details on timing and location.
- Issue navigational warnings (via the South Africa Navy Hydrographic office) throughout the sampling/mining period.
- Notify any fishing vessels at a radar range of 24 nm from the mining vessel via radio regarding the safety requirements.
- Ensure the mining vessels are fully illuminated during twilight and night.

#### Residual impact

With the implementation of the above-mentioned mitigation measures, the residual impact on the West Coast rock lobster sector and abalone ranching is considered to be of **MEDIUM** significance, while the impact on the traditional line-fish would remain of **VERY LOW** significance.

#### Monitoring

Implement a grievance mechanism in case of disruption to fishing.

**Table 3-20: Impact of mining on fishing**

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
West Coast Rock Lobster Sector and Abalone Ranching		
Extent	Regional	Regional
Duration	Short- to Medium-term (“walpomp”) to Medium- to Long-term (coffer dams)	Short- to Medium-term
Intensity	Medium (“walpomp”) to High (coffer dams)	Medium
Probability	Probable	Probable
Confidence	Medium	Medium
Significance	Medium (“walpomp”) to High (coffer dams)	Medium
Reversibility	Partially reversible	
Mitigation potential	Low	
Traditional Line-Fish and Beach-Seine and Gill-Net Sectors		
Extent	Regional	Regional
Duration	Short-term	Short-term
Intensity	Low	Low
Probability	Probable	Probable
Confidence	Medium	Medium
Significance	Very Low	Very Low
Reversibility	Fully reversible	
Mitigation potential	None	

### 3.2.2 POTENTIAL IMPACT ON MARINE TRANSPORT ROUTES

#### Description of impact

The presence of the mining and/or support vessel(s) in Sea Concession 1b could interfere with shipping or other marine traffic in the area.

#### Project controls

No project controls currently exist for offshore operations.

#### Impact assessment

The majority of shipping traffic is located on the outer edge of the continental shelf, which is situated well to the west of the mining right area (see Figure 5-33 in Volume 1). Thus, it is unlikely that these shipping transport routes would be affected by mining activities in Sea Concession 1b.

The inshore traffic of the continental shelf along the West Coast is largely comprised of fishing and other mining vessels, especially between Kleinzee and Oranjemund. Mining vessels operating in the mining right area and other vessels (fishing and mining) would be able to avoid each other with minimal effort, and if the normal laws of the sea are followed the impact associated with mining vessels is considered **insignificant** (see Table 3-22).

#### Mitigation

Recommendations to mitigate the potential impacts on marine transport routes are similar to those recommended for fishing (refer to Section 3.2.1).

Residual impact

With the implementation of the above-mentioned mitigation measures, the residual impact is considered to remain **INSIGNIFICANT**.

**Table 3-21: Impact of mining on marine traffic**

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	Local	Local
Duration	Short-term	Short-term
Intensity	Low	Very Low
Probability	Possible	Improbable
Confidence	High	High
Significance	Insignificant	INSIGNIFICANT
Reversibility	Fully reversible	
Mitigation potential	Very Low	

### 3.2.3 POTENTIAL IMPACT RELATED TO JOB CREATION AND GENERATION OF DIRECT REVENUES

Description of impact

Mining creates a number of local employment and business opportunities. There are approximately 1 200 people employed based on current mining activities, most of whom reside in Port Nolloth and Alexander Bay (see Table 3-23). Direct revenues are also generated as a result of current mining activities operations. Revenue generating activities are related to the actual mining operations and includes refuelling, equipment / vessel repair, etc. and local employment and business opportunities.

**Table 3-22: Annual employment complement as of 31 March 2017 (Source: Alexkor Integrated Annual Report 2017)**

	March '16	March '17
<b>Alexkor RMC JV</b>		
Permanent employees	290	312
Temporary and casual employees	44	51
<b>Sub-total</b>	<b>334</b>	<b>363</b>
<b>Alexkor SOC</b>		
Permanent employees	38	36
Temporary and casual employees	24	1
<b>Sub-total</b>	<b>62</b>	<b>37</b>
<b>Contractors</b>		
Marine contractors – shallow water	431	499
Beach and land mining	155	218
Other	99	106
<b>Sub-total</b>	<b>685</b>	<b>826</b>
<b>TOTAL</b>	<b>1 081</b>	<b>1 226</b>

Project controls

The PSJV has various project controls for staff, contractors and suppliers, e.g. Employment Equity Policy, Supply Chain Management Protocols, Disciplinary Code of Conduct, Skills development, Personal Protective Equipment (PPE) requirements, etc.

Impact assessment

During the 2016/2017 financial year period under review, PSJV staff salaries amounted to R 63 802 128, while payments to the marine, land-based and other contractors for the same period amounted to R 158 299 317 (Alexkor Integrated Annual Report 2017).

The overall positive impact on the economy related to job creation and generation of direct revenues is considered to be regional (specifically the towns of Port Nolloth and Alexander Bay), of medium intensity over the long-term (related to the 20-year validity period of mining right). Thus, the potential impact of employment and the generation of direct revenues is considered to be of **high (positive)** significance (see Table 3-24).

#### Mitigation

No mitigation is considered necessary.

#### Residual impact

The residual impact remains of **HIGH (positive)** significance.

**Table 3-23: Impact related to job creation and generation of direct revenues**

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	Regional	Regional
Duration	Long-term	Long-term
Intensity	Medium	Medium
Probability	Definite	Definite
Confidence	Medium	Medium
Significance	High (positive)	HIGH (positive)
Reversibility	Partially reversible (should mining stop)	
Mitigation potential	None	

### 3.2.4 POTENTIAL IMPACT ON CULTURAL HERITAGE MATERIAL

#### Description of impact

Mining activities could disturb cultural heritage material on the seabed, particularly palaeontological and rare geological objects, and historical shipwrecks.

#### Project controls

No project controls currently exist for offshore operations.

#### Impact assessment

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). Table 5-11 (in Volume 1) contains a list of 25 known shipwreck sites occurring near Alexander Bay, Port Nolloth and Kleinsee. The majority of the wrecks found in the vicinity of the mining right areas were boats that sunk in the 19<sup>th</sup> century. It is, however, noted that the precise location of all these wrecks is unknown as they have been documented only through survivor accounts, archival descriptions and eyewitness reports recorded in archives and databases.

The likelihood of disturbing a shipwreck is expected to be very small considering the vast size of the South African offshore area. Should shipwreck sites be disturbed during mining activities, the impact could be at

the national level, permanent and of high intensity. The impact significance is consequently assessed to be **high** without mitigation (see Table 3-25).

Various sites comprising fossilised forests have been found during previous marine diamond exploration and/or mining activities with Sea Concessions 2c to 5c in water depths of 100 to 150 m. These sites are situated to the south and offshore of the mining right area. Thus, **no impact** can be expected on these fossilised forests.

#### Mitigation

- Exclude any shipwreck or fossil sites identified during prospecting (e.g. geophysical surveying) from the mining operation area.
- If palaeontological or shipwreck material is encountered during the course of mining, the following mitigation measure should be applied:
  - > Work in the directly affected area should cease until the South African Heritage Resources Agency (SAHRA) has been notified and the contractor/PSJV has complied with any additional mitigation as specified by SAHRA.
  - > Recover, where possible, any artefacts and take photographs of them, noting the date, time, location and types of artefacts found.

#### Residual impact

With the implementation of mitigation, it is expected that the impact on any unidentified shipwreck sites could be avoided or would be **INSIGNIFICANT**.

**Table 3-24: Impact of mining on cultural heritage material**

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	National	Local
Duration	Permanent	Permanent
Intensity	High	Zero to Very Low
Probability	Improbable	Improbable
Confidence	Medium	Medium
Significance	<b>High</b>	<b>INSIGNIFICANT</b>
Reversibility	Irreversible	
Mitigation potential	High	

### **3.2.5 POTENTIAL IMPACT ON OTHER PETROLEUM EXPLORATION AND PRODUCTION**

#### Description of impact

The proposed mining activities could affect petroleum exploration and future production activities that overlap with the concession areas, and vice versa.

#### Project controls

No project controls currently exist for offshore operations.

#### Impact assessment

The mining right area overlap with Block 1 held by Cairn South Africa (Pty) Ltd (Cairn) (with 40% interest in the block being held by the Petroleum Oil and Gas Corporation of South Africa (Pty) Ltd [PetroSA]) (refer to Figure 5-36 in Volume 1). As the mining right area falls within the eastern inshore area of Block 1, where Cairn has received authorisation to drill up to five exploration wells, an impact is possible, although highly



unlikely. The intensity of the impact on petroleum exploration is considered to be medium and local in extent for the duration of sampling/mining activities (short-term in the offshore areas of the mining right). The significance of this impact is consequently is considered to be **insignificant** without mitigation (see Table 3-26).

No production currently occurs of the West Coast of South Africa. Thus, at this stage, there would be **no impact** on production.

#### Mitigation

Notify Cairn (and PetroSA) prior to the commencement of any offshore activities (in Sea Concession 1b).

#### Residual impact

With the implementation of the above-mentioned mitigation measures, the residual impact is considered to remain **INSIGNIFICANT**.

**Table 3-25: Impact of mining on petroleum exploration**

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	Local	Local
Duration	Short-term	Short-term
Intensity	Medium	Low
Probability	Improbable	Improbable
Confidence	High	High
Significance	<b>Insignificant</b>	<b>INSIGNIFICANT</b>
Reversibility	Fully reversible	
Mitigation potential	Very Low	

### **3.2.6 POTENTIAL IMPACT ON OTHER MARINE PROSPECTING/MINING OPERATIONS**

#### Description of impact

The presence of mining vessels and mining could interfere with other marine prospecting or mining operations targeting other minerals in the same sea concessions. In addition, contractors mining for diamonds within the same concession area, but using different technologies, can impact one another. For example, the indirect impact on shore-based and vessel-based diver assisted mining due to redistribution of sediments eroded from coffer dam sea walls, which settle in adjacent mining areas and result in increased mining effort.

#### Project controls

No project controls currently exist for marine mining operations.

#### Impact assessment

A number of prospecting areas for gold, heavy minerals, platinum group metals and sapphires (held by De Beers Consolidated Mines) and glauconite and phosphorite/phosphate (held by Green Flash Trading) are located off the West Coast, although none overlap with the mining right area. Thus currently **no impact** is expected on other marine prospecting or mining operations.

The settlement of material from the redistribution of finer sediments from coffer dams sea walls would potentially increase the overburden layer (primarily to the north of any coffer dam based on the dominant current and wind direction), thereby increasing the effort required by miners using shore- and vessel-based

techniques to access the targeted diamond-bearing gravels. The impact of coffer dam mining on diver assisted mining in the 'a' concessions is considered to be regional (based on the number of mining targets identified for coffer dam operations in Mining Right 554MRC), of medium to high intensity over the short-term (as suspended sediments will continually be redistributed northwards). Thus, the potential impact on diver assisted mining is considered to be of **medium** significance (see Table 3-27).

#### Mitigation

No mitigation is considered possible, as finer material will continually erode from coffer dam walls. The PSJV must manage the exploitation of the resource in a manner that optimises resource management and the contractors that they contract to extract these resources.

#### Residual impact

The residual impact remains of **MEDIUM** significance.

**Table 3-26: Impact on diver assisted mining**

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Extent	Regional	
Duration	Short-term	
Intensity	Medium to High	
Probability	Definite	
Confidence	Medium	
Significance	<b>MEDIUM</b>	
Reversibility	Partially reversible	
Mitigation potential	None	

### **3.2.7 UNPLANNED EVENTS: OILS SPILL**

As noted previously, unplanned events are not an intended part of an operation, but may conceivably occur as a result of accidents or abnormal operating conditions.

#### Description of impact

As noted in Section 3.1.6.1, a small instantaneous spill of marine diesel and/or hydraulic fluid at the surface would have an immediate detrimental effect on water quality, with the toxic effects potentially resulting in mortality of marine fauna. This could in turn result in several indirect impacts on fishing. These include:

- exclusion of fisheries from polluted areas and displacement of targeted species from normal feeding/fishing areas, both of which could potentially result in a loss of catch and/or increased fishing effort; and
- mortality of animals (including eggs and larvae) leading to reduced recruitment and loss of stock (e.g. mariculture).

Oil contamination could potentially have the greatest impact on commercial fisheries for rock lobster and sessile filter feeders (e.g. mussels) and grazers (e.g. abalone). Mortality is expected to be high on filter feeders and, to a lesser extent, grazers. These species have low mobility and no means to escape contamination and ultimately mortality. Thus, mariculture facilities or ranching operations could be impacted if a spill extended into these areas.

#### Project controls

No project controls currently exist for offshore operations.

### Impact assessment

Diesel when spilled on water spreads very quickly to a thin film and evaporates or naturally disperses within a few days or less. Nonetheless, in terms of toxicity to marine organisms, diesel is considered to be one of the most acutely toxic oil types. In the case of a spill or vessel wreckage on the coast, intertidal invertebrates and seaweed that come in direct contact with the diesel spill may suffer mortality. Fish mortality, however, has never been reported for small spills in open water as the diesel dilutes so rapidly. Due to differential uptake and elimination rates, filter-feeders (particularly mussels) can bio-accumulate hydrocarbon contaminants. Crabs and shellfish can be tainted from small diesel spills in shallow, nearshore areas.

Thus, a spill in the nearshore areas could have an impact on the West Coast rock lobster sector and abalone ranching due to the mortality to animals. The potential impact on these sectors is considered to be localised, of high intensity in the medium-term (if stock is affected). Thus, this impact of a spill in the nearshore area (surf zone and a-concessions) is considered to be of **low** significance before mitigation (see Table 3-28).

As noted in Section 3.1.6.1, a spill further offshore has minimal chance of reaching the shore due to the dominant wave and wind conditions, which would move a spill in a north-westerly direction. A spill in the offshore environment of Sea Concession 1b could impact the traditional line-fish sector, which could result in a localised impact of low intensity in the short-term. Thus, this impact is considered to be of **insignificant** significance before mitigation (see Table 3-28).

### Mitigation

Refer to Section 3.1.6.1 for mitigation measures.

### Residual impact

With the implementation of the proposed mitigation measures, the residual impact on the West Coast rock lobster sector and abalone ranching from a spill in the nearshore environment is considered to be of **VERY LOW** significance. The residual impact related on the traditional line-fish sector remains **insignificant**.

**Table 3-27: Impact of operational spills on fishing**

CRITERIA	WITHOUT MITIGATION	WITH MITIGATION
Nearshore spill – West Coast Rock Lobster Sector and Abalone Ranching		
Extent	Local	Local
Duration	Medium-term	Medium-term
Intensity	High	Medium
Probability	Possible	Improbable
Confidence	Medium	Medium
Significance	Low	VERY LOW
Reversibility	Partially reversible (in the case of lost stock)	
Mitigation potential	Low	
Offshore Spill – Traditional Line-Fish		
Extent	Local	Local
Duration	Short-term	Short-term
Intensity	Low	Very Low
Probability	Possible	Possible
Confidence	Medium	Medium
Significance	Insignificant	Insignificant
Reversibility	Fully reversible	
Mitigation potential	Very Low	

### 3.3 CUMULATIVE IMPACTS

The primary impacts associated with mining of marine diamonds in the Namaqua Bioregion on the West Coast of South Africa, relate to physical disturbance of the seabed, discharges of tailings to the benthic environment and associated contractor presence (shore units, coffer dams and vessels).

Although the areas of seabed targeted for mining amounts to only a fraction of the total mining area, the cumulative impact of years of mining by an increasing number of contractors applying progressively modern techniques to locate and access diamond deposits must be kept in mind. Considering the prevalence of endangered and critically endangered habitat types in the marine mining right areas and the decades of uncontrolled operations these cumulative impacts are considered to be of **MEDIUM** significance. Detailed records of annual and cumulative areas sampled and mined should be maintained and submitted to the authorities so that future informed decisions can be made regarding disturbance limits to benthic habitat types in the Namaqua Bioregion.

### 3.4 REHABILITATION OF THE ORANGE RIVER MOUTH ESTUARY

#### 3.4.1 BACKGROUND

The Orange River has been significantly impacted by anthropogenic activities along its banks and within its floodplain (including historic mining and associated activities). The present situation is that the Orange River mouth has become increasingly estuarine in character and, except for two brief periods of a few days each, the mouth has been consistently open since December 1993. A major consequence of this is the degradation of the desiccated saltmarsh on the south side of the estuary (see Figure 5-45 in Volume 1).

Key mining- and agricultural-related structures (see Figure 3-7) that have contributed to the degradation of the saltmarsh include:

- Road embankment: The construction of a road embankment in 1964 isolated approximately a third of the estuary from the active system. In 1997 the seaward end of this embankment was breached in an attempt to re-activate the saltmarsh in the area. This was partially successful, but the breach was too small to permit large volumes of water to enter the saltmarsh.
- Scrap machinery ("Detroit riprap"): The seaward end of the embankment was "anchored" or "pinned" in position by means of scrap machinery being embedded in the beach berm (see Figure 3-8). The scrap machinery has prevented the mouth from migrating southwards to its fullest possible extent and thus has also limited the ingress of seawater into the saltmarsh.
- Dunvlei dyke: The construction of the dyke to protect the Dunvlei Farm and extend agricultural land blocked the southernmost channel feeding the saltmarsh in the south-western corner of the estuary. This has contributed significantly to the degradation of the saltmarsh.
- Sewage oxidation ponds: Sewage oxidation ponds were also constructed in the floodplain, which also blocked the southernmost channel feeding the saltmarsh. Although the ponds have been decommissioned, the river channel against the south bank has not yet been rehabilitated.

Although the PSJV has a right to prospect and mine in the Orange River, no prospecting or mining activities are being considered for inclusion in the amendment of the EMPR for 554MRC. However, measures are deemed necessary to manage the estuary in light of the Orange River Mouth Estuarine Management Plan and the proposal by the Department of Environmental Affairs to declare it a protected area in terms of the National Environmental Management: Protected Areas Act, 2003 (No. 57 of 2003).



**Figure 3-7: Historic structures that have resulted in the degradation of the Orange River Mouth saltmarsh**



**Figure 3-8: Scrap machinery (“Detroit riprap”) used to anchor the seaward end of the road embankment built in 1964**  
(Source: S. Lamberth)

### 3.4.2 RECOMMENDED REHABILITATION MEASURES

The following rehabilitation measures are recommended, for the implementation by the PSJV, in order to restore the connection between the saltmarsh and the estuary basin.

- Remove road embankment: The objective of removing the approximately 3 km road embankment is to eliminate a major obstruction to the ingress of water from the river and estuary basin into the saltmarsh during periods of high water levels. The following actions are proposed:
  - > Survey the embankment to determine the amount of material to be removed to restore the saltmarsh area to its natural geomorphological state.
  - > Identify a suitable site for the disposal of the embankment material within the PSJV mine property (preferably a historically disturbed area).
  - > Ensure no embankment material is disposed of within the estuary or on the beach.
  - > Re-open the flood channel inlet immediately downstream of the former sewage oxidation pond site.
- Removal of scrap machinery (“Detroit riprap”): The removal of this material would enable the mouth of the river to move further south, which would be of benefit to the presently desiccated saltmarsh on the south bank. Removal of the scrap machinery will be dependent on tidal and sea-state conditions and may have to be spread over some time (months or even 1 – 2 years). The following actions are proposed:
  - > Determine the volume of, and area containing, the scrap machinery by a geomagnetic survey in order to accurately define the extent of the machinery.
  - > Access site along the beach in order to avoid any temporary infilling within the floodplain, specifically where the embankment was breached in 1997.
- Remove sewage oxidation ponds: The following actions are proposed:
  - > Remove and rehabilitate former sewage oxidation ponds to facilitate the rehabilitation of the floodplain and eliminate obstructions to the ingress of water into the saltmarsh.

Since the above-mentioned rehabilitation measures are included in and form part of the Orange River Mouth Estuarine Management Plan, these have not been carried over into the Mitigation and Management Plan (see Chapter 4).

### 3.4.3 IMPACT ASSESSMENT

Should the PSJV successfully implement the recommended remedial actions, the overall positive impact of the Orange River Mouth saltmarsh and associated biota is considered to be **HIGH (positive)** significance.

### 3.4.4 OTHER REHABILITATION MEASURES

Full recovery of the degraded saltmarsh would depend on additional measure being implemented. These include:

- Restoring the upstream river channel: In order to restore the estuarine wetlands to their pre-1960 condition consideration should be given to the removal of the protective dyke around Dunvlei Farm and to re-open the river channel running along the south bank. This action would require a separate feasibility study and consultation process with the community to determine whether Dunvlei Farm should be restored to full agricultural production or whether it should be decommissioned and the original wetland restored to full functionality.
- Management the estuary mouth closure regime: Management of the estuary should aim to ensure that closures occur for a period of 4 to 6 weeks, every 2 to 3 years. After mouth closure the water level in the system should be allowed to rise and back-flood the saltmarsh areas. River flow would have to be reduced to ca. 5 m<sup>3</sup>/sec to permit the estuary mouth to close. A back-flood level of >1.5 m would inundate more than 70% of the saltmarsh area. The proposed management of mouth closure would require the cooperation of Orange-Senqu River Commission, DEA and Northern Cape Provincial Department of Environmental Affairs and Nature Conservation.

The combined effect of the PSJV's remedial actions and the correct mouth closure/back-flooding regime could result in the recovery of the Orange River Estuary such that it is removed from the Montreux Record and restored to full Ramsar Site status.

The implementation of these additional measures would increase the significance of the impact to **VERY HIGH (positive)**.



## 4 MITIGATION AND MANAGEMENT PLAN

This chapter lists the project controls and mitigation measures that shall be implemented to avoid or minimise impacts on the environment from prospecting and mining activities.

### 4.1 SCOPE AND OBJECTIVES

This Mitigation and Management Plan has been prepared as part of the EMPR amendment process undertaken for the PSJV's prospecting and mining operations in marine Mining Right 554MRC. The significance of residual impacts are contingent on PSJV's (and any third parties) commitment to fully implement the measures in the Mitigation and Management Plan. This Mitigation and Management Plan has the following objectives:

- Promoting compliance with South African legislation, international law and standards and the PSJV's own corporate standards.
- Impact prevention and, where they cannot be prevented, minimisation.
- Providing an implementation mechanism for mitigation measures and commitments identified in the EMPR amendment process.
- Establishing a monitoring programme and record-keeping protocols against which the PSJV's and its contractor's/sub-contractor's performance can be measured and to allow for corrective actions or improvements to be implemented when needed.
- Protocols for dealing with unforeseen circumstances such as unplanned events or ineffective mitigation measures.

### 4.2 ORGANISATION ROLES AND RESPONSIBILITIES

#### 4.2.1 POOLING AND SHARING JOINT VENTURE

Although the PSJV outsources the majority of the prospecting and mining operations to contractors, it is accountable for the management of the environmental and social commitments. The PSJV will ensure that:

- commitments are implemented in all material respects;
- prospecting and mining environmental and social performance complies in all material respects with applicable legal, regulatory and policy standards;
- pertinent environmental and social information will be freely shared with interested stakeholders; and
- all work will be carried out by a third party in a manner satisfactory to the PSJV.

##### 4.2.1.1 Environmental Manager and Environmental Officer

The Environmental Manager and Environmental Officer(s) shall act as the PSJV's on-site implementing agents. They will be responsible for:

- preparing a site-specific Environmental Code of Operational Practice (ECOP) for each contractor and each allocated mining area;
- ensuring that contractors are informed and understand environmental requirements before the commencement of activities on site (Environmental Awareness Training);
- environmental matters and for seeing that prospecting and mining activities are carried out safely and in accordance with the requirements of the EMPR and ECOP;
- verifying that environmental requirements are implemented in full, both by the PSJV and its contractors;
- verifying that there are adequate plans and sufficient resources in place for worker health care and contingency plans to respond to workplace accidents;

- ensuring that all operations permissions (including relevant permits, licences and necessary approvals from the relevant authorities) are valid prior to commencing activities on site;
- monitoring the contractor's compliance with the EMPR and ECOP during weekly site inspections, including the preparation of weekly environmental checklists;
- advising the contractor on environmental issues within defined mining areas;
- recommending additional environmental protection measures should this be necessary;
- preparing monthly reports and providing feedback at Executive Committee meetings; and
- undertaking final site audit before the contractor leaves site and preparing the Final Audit Report.

#### **4.2.2 CONTRACTORS**

Contractor(s) entity refers to any company or individual that is allocated a mining site area or contracted by the PSJV to undertake any prospecting and/or mining in the mining right area. The EMPR shall be the overarching contractual document for all environmental and social management requirements to which all contractor (and any subcontractor) plans and documents must be aligned. The EMPR (or relevant section depending on the mining method used) shall be provided to all contractors, who shall be required to include the following provisions to ensure that the EMP is effective:

- clearly defined roles, responsibilities and reporting lines for the execution of the EMPR;
- ensure that all staff are familiar with the EMPR and the measures with it and they sign off that they have read and understood the document;
- appropriate reporting and remedial action procedures to ensure that any incidents are reported promptly and dealt with effectively; and
- approximate monitoring and auditing actions.

##### **4.2.2.1 Environmental Representative**

The Environmental Representative, appointed by the Contractor, shall be responsible for monitoring, reviewing and verifying the Contractor's compliance with the EMPR. Duties shall include:

- monitoring and verifying that the EMPR and ECOP are adhered to at all times and taking action if specifications are not followed;
- monitoring and verifying that environmental impacts are kept to a minimum;
- inspecting the site (onshore) or vessel on a daily basis with regard to compliance with the EMPR and ECOP;
- completing weekly checklists of these inspections;
- assisting PSJV's Environmental Manager/Officer in finding environmentally responsible solutions to problems;
- keeping a record of on-site incidents and accidents and how these were dealt with; and
- reporting any incidents of non-compliance with the EMPR to the Environmental Manager/Officer.

#### **4.3 TRAINING, AWARENESS AND COMPETENCY**

The PSJV recognises that it is important that contractor, including staff at all levels, is aware of the PSJV's environmental and social policy; potential impacts of their activities; and roles and responsibilities in achieving conformance with the policy and procedures.

The PSJV (Environmental Manager and Environmental Officer) will subject all the contractor's site staff to annual environmental awareness training to ensure effective implementation of the EMPR and procedures for which they have responsibilities. This training would include awareness and competency with respect to:

- General awareness relating to prospecting and mining activities, including environmental and social impacts that could potentially arise from these activities.

- Legal requirements in relation to environmental performance.
- Necessity of conforming to the requirements of the EMP and ECOP, including reporting and monitoring requirements (i.e. such as incident reporting).
- Activity-specific training (i.e. waste management practices).
- Roles and responsibilities to achieve compliance, including change management and emergency response.

Training will take cognisance of the level of education, designation and language preferences of the personnel.

#### **4.4 COMPLIANCE VERIFICATION AND CORRECTIVE ACTIONS**

Inspections, monitoring and auditing will be undertaken to confirm appropriate implementation of the EMPR and ECOP, as well as the effectiveness of mitigation measures. Corrective actions include those intended to improve performance, non-compliances and non-conformances.

##### **4.4.1 INSPECTION**

Contractors will be required to conduct inspections on a weekly basis, on an *ad hoc* basis (internally) and formally once every month in an effort to monitor compliance and implement conditions stipulated in this EMPR and ECOP. The results of the inspection and monitoring activities shall be documented and reported to the PSJV (Environmental Manager or Environmental Officer) on a weekly basis or more frequently if requested.

##### **4.4.2 MONITORING**

Monitoring will be conducted to:

- ensure compliance with regulatory and EMPR requirements;
- evaluate the effectiveness of operational controls and mitigation measures and provide a basis for recommending additional or alternative measures;
- verify predictions made in the EMPR amendment process by obtaining real time measurements;
- identify changes in existing physical, biological and social characteristics of the environment, compared to the baseline;
- verify that all project management plans are appropriate and relevant to their respective project activities and phases;
- quantify the impacts of mining on various benthic habitats; and
- Provide accountability and a sense of ownership through the project lifecycle.

Monitoring requirements for each of the prospecting and mining methods are provided in Sections 4.8.1 to 4.8.6. Requirements for habitat monitoring are provided in Section 4.9.

##### **4.4.3 AUDITING**

A final audit will be performed by the Environmental Manager/Officer to ensure the site has been rehabilitated and is in a satisfactory state before the contractor leaves site or moved to a new mining area.

Findings will be documented in a Final Audit Report, which shall be submitted to the contractor for action and follow-up.

#### 4.4.4 CORRECTIVE ACTIONS

The PSJV will implement a formal non-compliance and corrective action tracking procedure for investigating cause and identifying corrective actions in response to accidents, environmental and/or social non-compliances.

Where corrective actions are deemed necessary, specific measures will be developed, with designated responsibility and timing, and implemented. In this way, continuous improvement in performance would be achieved.

The Environmental Manager/Officer will be responsible for keeping records of corrective actions and for overseeing the modification of environmental or social protection procedures and/or training programmes to avoid repetition of non-conformances and non-compliances.

#### 4.5 MANAGEMENT OF CHANGE

The development and implementation of the EMPR is an ongoing process that is iterative in nature. This document must thus be seen as a 'living' document and amendments may need to be implemented during the course of the project. Typical changes that can affect the EMPR include:

- A material design change that occurs after the EMPR has been compiled and approved.
- Changes in the feasibility/availability of specific mitigation measures sometimes following a period of monitoring.
- Material personnel changes on the project.

The following scenarios may apply:

- Minor changes to the EMPR that are not considered to be materially significant departures or material to the findings of the EMPR amendment process can be implemented by the PSJV.
- Any significant revisions to the EMPR that are considered to be materially significant departures from the mitigation measures listed in the EMPR must be undertaken in accordance with the relevant legislative requirements and must be approved by DMR before the amended EMPR is implemented.
- Any changes to the prospecting and mining methods or areas that are considered to be material to the findings of the EMPR amendment process may require further approval from DMR (namely further EMPR amendment process, including further possible public consultation).

A register of changes to the EMPR shall be kept with an approval sign off sheet.

#### 4.6 COMMUNICATION

Channels of communication will be established between the PSJV, the contractor(s) and external stakeholders.

A grievance procedure will be established and maintained to record any complaints or comments received from the contractors and public. The grievance procedure will be underpinned by the following principles and commitments:

- Disseminate key information to directly interested and impacted stakeholders.
- Seek to resolve all grievances timeously.
- Maintain full written records of each grievance case and the associated process of resolution and outcome.

The responsibility for resolution of grievances will lie with the PSJV.

## 4.7 DOCUMENT CONTROL AND REPORTING

### 4.7.1 DOCUMENTATION

The PSJV will control all environmental related documentation, including project licences, approvals, permits, ECOPs, checklists, forms and reports, through a formal procedure.

Contractors will be required to develop a system for maintaining and controlling its own documentation.

### 4.7.2 REPORTING

Following any environmental incidents, the PSJV will conduct an incident investigation and prepare a report detailing the events and corrective and preventative measures implemented as a result. Significant incidents will be reported to the competent authority (e.g. DME, DEA, Department of Water and Sanitation, etc.).

### 4.7.3 PERFORMANCE ASSESSMENTS

In compliance with Section 55 of MPRDA, the PSJV (or an independent consultant) will undertake a Performance Assessment every two years (or as specified by DMR) for submission to DMR.

Performance Assessments will focus on:

- evaluating compliance with the EMPR and the requirements of the relevant legislation;
- assessing the continued appropriateness and adequacy of the EMPR (including the effectiveness of rehabilitation measures);
- identifying additional mitigation measures to address any non-compliances or deficiencies;
- presenting the results of the habitat monitoring programme (see Section 4.9); and
- evaluating whether the closure objective are being met.

## 4.8 MITIGATION AND MANAGEMENT PLAN

This section details the specific management commitments that will be implemented to prevent, minimise or manage significant negative impacts. In order to facilitate implementation, these commitments have been made specific to each prospecting and mining method, and are presented in the sections listed below. Since each section has been developed as a standalone plan, overlap exists between each of the various prospecting and mining methods.

4.8.1	GEOPHYSICAL SURVEYS
4.8.2	SHORE-BASED DIVER ASSISTED MINING ("WALPOMP")
4.8.3	COFFER DAM MINING
4.8.4	MOBILE PUMP UNIT MINING
4.8.5	VESSEL-BASED DIVER ASSISTED PROSPECTING AND MINING
4.8.6	VESSEL-BASED REMOTE PROSPECTING AND MINING

The requirements for Habitat Monitoring are presented in Section 4.9. As noted in Chapter 3, the recommended rehabilitation measures required to remediate historical mining-related impacts relating to the Orange River Mouth Estuary are included in and form part of the Orange River Mouth Estuarine Management Plan, and thus have not been included in this Mitigation and Management Plan.

#### 4.8.1 GEOPHYSICAL SURVEYS

GEOPHYSICAL SURVEYS						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
<b>4.8.1.1 PLANNING / ESTABLISHMENT PHASE</b>						
4.8.1.1.1	Compliance with EMPR	Operator and contractor to commit to adherence to EMPR	<ul style="list-style-type: none"> <li>Include a copy of the approved EMPR (or part thereof) and associated approvals in the contractor's contract document.</li> <li>Ensure a copy of the approved EMPR is on board the survey vessel during the operation.</li> </ul>	PSJV	Prior to commencement of operation	Signed contract document
4.8.1.1.2	Finalisation of survey programme	Mitigate impact on marine fauna (specifically cetaceans)	Undertake geophysical surveying, as far as possible, from the beginning of December to end of May in order to avoid the main cetacean migration period (particularly baleen whales).	Contractor	Prior to commencement of operation	
4.8.1.1.3	Appointment of independent observers		Make provision for placing a MMO on board the survey vessel. They must have experience in seabird, turtle and marine mammal identification and observation techniques.	Contractor	Prior to commencement of operation	MMO close-out report
4.8.1.1.4			Make provision for a PAM operator on board the survey vessel if the source level is greater than 210 dB re 1 µPa at 1 m and the survey is undertaken between the beginning of June and end of November.	Contractor	Prior to commencement of operation	PAM operator close-out report
4.8.1.1.5	Preparation of subsidiary plans	Preparation for any emergency that could result in an environmental impact	<p>Ensure the following plans are prepared and in place:</p> <ul style="list-style-type: none"> <li>Shipboard Oil Pollution Emergency Plan (SOPEP), as required by MARPOL.</li> <li>Emergency Response Plan.</li> <li>Waste Management Plan.</li> </ul> <p>In addition,</p> <ul style="list-style-type: none"> <li>ensure that the survey vessel's seaworthiness certificate and/or classification stamp are in place; and</li> <li>maintain adequate Protection and Indemnity (P&amp;I) Insurance Cover to allow for clean-ups in the event of a hydrocarbon spill and other eventualities.</li> </ul>	Contractor	Prior to commencement of operation	Confirm compliance and justify any omissions

GEOPHYSICAL SURVEYS						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.1.1.6	General notification of presence of survey vessel and exclusion zone	Minimise interaction with other vessels	<p>Notify key stakeholders of the survey programme (including navigational co-ordinates of survey area, timing and duration of activities) and the likely implications thereof (specifically the 500 m exclusion zone). Stakeholders include:</p> <ul style="list-style-type: none"> <li>&gt; Fishing industry / associations: <ul style="list-style-type: none"> <li>- South African Tuna Long-Line Association.</li> <li>- South African Tuna Association.</li> <li>- Fresh Tuna Exporters Association.</li> <li>- South African Commercial Line-Fish Association.</li> <li>- Northern Cape Fishing Forum.</li> <li>- South African Marine Line-Fish Management Association.</li> <li>- South African Fishing Industry Association.</li> </ul> </li> <li>&gt; Local fishing operators.</li> <li>&gt; South African Hydrographic office (HydroSAN).</li> <li>&gt; South African Maritime Association (SAMSA).</li> <li>&gt; Department of Agriculture, Forestry and Fisheries (DAFF), including the fisheries research managers.</li> <li>&gt; Transnet National Ports Authority (ports of Cape Town and / or Saldanha Bay).</li> </ul>	Contractor	30 days prior to commencement of operations	Copies of all correspondence
<b>4.8.1.2 OPERATION PHASE</b>						
4.8.1.2.1	Environmental awareness training	Ensure personnel are appropriately trained	<ul style="list-style-type: none"> <li>• Undertake Environmental Awareness Training to ensure the vessel's personnel are appropriately informed of the purpose and requirements of the EMPR, including emergency procedures, spill management, etc.</li> <li>• Ensure that responsibilities are allocated to personnel.</li> <li>• Establish training and exercise programmes to ensure that the response activities can be effectively executed.</li> </ul>	PSJV (Environmental Manager/Officer)	At commencement of operation	Copy of attendance register and training records



GEOPHYSICAL SURVEYS						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.1.2.2	Stakeholder consultation and notification and presence of survey vessel	Minimise interaction with other vessel	Request, in writing, HyrdoSAN to release Radio Navigation Warnings for the duration of the survey.	Contractor	7 days prior to establishment at survey area site and throughout survey period	Confirm that request was sent to the SAN Hydrographic office
4.8.1.2.3			Distribute a Notice to Mariners to fishing companies. The notice should give notice of: <ul style="list-style-type: none"><li>the co-ordinates of survey area;</li><li>an indication of the survey timeframes; and</li><li>an indication of the 500 m safety zone around the survey vessel.</li></ul>	Contractor		Copies of all correspondence
4.8.1.2.4			Display correct signals by day and lights by night (including twilight).	Contractor	Throughout operation at night	Provide record of any incidents and interaction with other vessels
			Enforce the 500 m safety/exclusion zone around survey vessel.	Contractor	During surveying	
4.8.1.2.5			Maintain visual radar watch for approaching vessels during the survey and warn by radio, if required.	Contractor		
4.8.1.2.6	Geophysical surveying - Source levels less than 210 dB re 1 µPa at 1 m	Reduce disturbance of marine fauna, particularly cetaceans (whales and dolphins), seals, seabirds (particularly penguins) and turtles	<ul style="list-style-type: none"><li>Commence surveying only once it has been confirmed for a 15-minute period (visually during the day) that there is no cetacean activity within 500 m of the vessel.</li></ul>	MMO	Prior to and during surveys	MMO close-out report
4.8.1.2.7			<ul style="list-style-type: none"><li>Terminate the survey if cetaceans show obvious negative behavioural changes within 500 m of the survey vessel or equipment.</li><li>The survey should be terminated until such time it is confirmed that cetaceans have moved to a point that is more than 500 m from the source or despite continuous observation 15 minutes has elapsed since the last sighting of the cetaceans within 500 m of the source.</li></ul>	Contractor when instructed by MMO	As required	
4.8.1.2.8	Geophysical surveying - Source levels greater than 210 dB re 1 µPa at 1 m	Reduce disturbance of marine fauna, particularly cetaceans (whales and dolphins), seals, seabirds (particularly penguins) and turtles	<ul style="list-style-type: none"><li>Implement PAM technology if surveying between the beginning of June and end of November cannot be avoided.</li></ul>	Contractor	During surveying (between beginning of June and end of November)	PAM operator close-out report
4.8.1.2.9			<ul style="list-style-type: none"><li>Commence surveying only once it has been confirmed for a 15-minute period (visually during the day or using PAM technology if surveying between June and November) that there is no cetacean activity within 500 m of the vessel.</li></ul>	MMO (daytime) and PAM operator (Jun-Nov)	During surveying	MMO and PAM operator close-out report, as applicable

GEOPHYSICAL SURVEYS						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.1.2.10	Geophysical surveying - Source levels greater than 210 dB re 1 µPa at 1 m	Reduce disturbance of marine fauna, particularly cetaceans (whales and dolphins), seals, seabirds (particularly penguins) and turtles	<ul style="list-style-type: none"> <li>Implement a “soft-start” procedure, after the pre-survey visual scan, for a minimum period of 20 minutes to allow cetaceans to move out of the survey area and thus avoid potential physiological injury. However, if after a period of 15 minutes small cetaceans (particularly dolphins) are still within 500 m of the vessel, the normal “soft-start” procedure should be allowed to commence.</li> <li>Soft-starts” should, as far as possible, be planned so that they commence within daylight hours.</li> <li>“Soft-start” procedures must also be implemented after breaks in surveying (for whatever reason) of longer than 20 minutes. Breaks of shorter than 20 minutes should be followed by a “soft-start” of similar duration.</li> </ul>	Contractor	At start up	MMO and PAM operator close-out report, as applicable
4.8.1.2.11			<ul style="list-style-type: none"> <li>Terminate the survey if cetaceans show obvious negative behavioural changes within 500 m of the survey vessel or equipment.</li> <li>The survey should be terminated until such time it is confirmed that cetaceans have moved to a point that is more than 500 m from the source or despite continuous observation 15 minutes has elapsed since the last sighting of the cetaceans within 500 m of the source.</li> </ul>	Contractor when instructed by MMO or PAM operator	As required	MMO and PAM operator close-out report, as applicable

GEOPHYSICAL SURVEYS						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.1.2.12	Discharge of waste to sea	Minimise discharges and ensure discharges from vessels are in accordance with MARPOL 73/78 standards	Implement the following plans and certificates: <ul style="list-style-type: none"> <li>Waste Management Plan.</li> <li>SOPEP.</li> </ul>	Contractor	Throughout operation, during discharges	Copy of all plans
4.8.1.2.13			Sewage: <ul style="list-style-type: none"> <li>Ensure vessels have: <ul style="list-style-type: none"> <li>&gt; an onboard sewage treatment plant;</li> <li>&gt; a sewage comminuting and disinfecting system, and/or</li> <li>&gt; a sewage holding tank.</li> </ul> </li> <li>Sewage discharge to comply with the following: <ul style="list-style-type: none"> <li>&gt; Discharge of sewage beyond 12 nm requires no treatment. However, no visible floating solids must be produced or discolouration of the surrounding water must occur.</li> <li>&gt; Sewage must be comminuted and disinfected for discharges between 3 nm and 12 nm from the coast.</li> <li>&gt; Disposal of sewage from holding tanks must be discharged at a moderate rate while the ship is proceeding <i>on route</i> at a speed not less than 4 knots.</li> </ul> </li> <li>Ensure dechlorinate sewage effluents and cooling water meets World Bank standards for residual chlorine (i.e. 0.2 mg/l at the point of discharge prior to dilution).</li> </ul>	Contractor	Throughout operation, during discharges	Ensure correct operation of sewage treatment system (compliance with MARPOL 73/78 standards)
4.8.1.2.14			Galley waste <ul style="list-style-type: none"> <li>Discharges to comply with the following: <ul style="list-style-type: none"> <li>&gt; No disposal to occur within 3 nm of the coast.</li> <li>&gt; Disposal between 3 nm and 12 nm needs to be comminuted to particle sizes smaller than 25 mm.</li> <li>&gt; Discharge beyond 12 nm requires no treatment.</li> </ul> </li> <li>Minimise the discharge of waste material should obvious attraction of fauna be observed.</li> </ul>	Contractor	Throughout operation, during discharges	Ensure correct operation of macerator  Volume of waste discharged and discharge location

GEOPHYSICAL SURVEYS						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.1.2.15	Discharge of waste to sea	Minimise discharges and ensure discharges from vessels are in accordance with MARPOL 73/78 standards	Deck and machinery drainage: <ul style="list-style-type: none"> <li>• Ensure all deck and machinery drainage is routed to:               <ul style="list-style-type: none"> <li>&gt; equipment for the control of oil discharge from machinery space bilges and oil fuel tanks, e.g. oil separating/filtering equipment and oil content meter;</li> <li>&gt; oil residue holding tanks; and</li> <li>&gt; Oil discharge monitoring and control system.</li> </ul> </li> <li>• Oil in water concentration must be less than 15 ppm prior to discharge overboard.</li> <li>• Ensure all process areas are bunded and drip trays are used to collect run-off from non-bunded equipment.</li> <li>• Use low-toxicity biodegradable detergents and reusable absorbent cloths in cleaning of all deck spillage.</li> </ul>	Contractor	Throughout operation, during discharges	Ensure correct operation of oil separating/filtering equipment and oil content meter (compliance with MARPOL 73/78 standards)
4.8.1.2.16			General waste: <ul style="list-style-type: none"> <li>• No disposal overboard.</li> <li>• Ensure on-board solid waste storage is secure.</li> <li>• Transport ashore for disposal/recycling or incinerate (if in possession of an Atmospheric Emissions Licence).</li> </ul>	Contractor	Throughout operation	Volume of waste generated Volume transferred for onshore disposal/incinerated Waste receipts Atmospheric Emissions Licence
4.8.1.2.17			Hazardous waste (incl. oil and medical): <ul style="list-style-type: none"> <li>• Segregate, classify and store all hazardous waste in suitable receptacles on board in order to ensure the safe containment and transportation of waste.</li> <li>• Provide a specific waste management storage and segregation area at the onshore logistics base.</li> <li>• Dispose of hazardous waste at a facility that is appropriately licensed and accredited.</li> </ul>	Contractor	Throughout operation	Record types and volumes of chemical and hazardous wastes and destination thereof Waste receipts

GEOPHYSICAL SURVEYS						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.1.2.18	Vessel lighting	Minimise disturbance of marine fauna by increased ambient lighting in the offshore environment	Reduce lighting to a minimum compatible with safe operations whenever and wherever possible by: <ul style="list-style-type: none"> <li>Minimising the number of lights and the intensity of the lights.</li> <li>Automatically or manually controlling lighting in areas where it is not a continuous requirement through the process control system.</li> <li>Positioning light sources in places where emissions to the surrounding environment are minimised.</li> </ul>	Contractor	During operation, at night	
4.8.1.2.19			<ul style="list-style-type: none"> <li>Keep disorientated, but otherwise unharmed, seabirds in dark containers for subsequent release during daylight hours.</li> <li>Euthanise of injured birds humanly.</li> <li>Report ringed/banded birds to the appropriate ringing/banding scheme (details are provided on the ring).</li> </ul>	MMO	During operation	Record information on patterns of bird reaction to lights and real incidents of injury/death, including stray land birds resting on the vessel, during the operation
4.8.1.2.20	Bunkering / refuelling at sea	Ensure that the necessary safeguards are in place and avoid any accidental oil / fuel spills	<ul style="list-style-type: none"> <li>Transfer of oil at sea is not permitted within the economic zone (i.e. 200 nm from the coast) without the permission of SAMSA. In terms of the Marine Pollution (Control and Civil Liability) Act, 1981 a Pollution Safety Certificate must be obtained before commencement of operations.</li> <li>Submit an application in terms of Regulation 14 (Regulation under the Prevention and Combating of Pollution of the Sea by Oil Act) to SAMSA (Principal Officer) at the port nearest to where the transfer is to take place.</li> <li>Inform SAMSA of location, supplier and timing, 5 days prior to refuelling at sea.</li> </ul>	Contractor	As required, 5 days prior to refuelling	SAMSA approval

GEOPHYSICAL SURVEYS						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.1.2.21	Oil spills	Minimise damage to the environment by implementing response procedures efficiently	Inspect and maintain all fuel containers.	Contractor	During operation	Record of all spills (Spill Record Book), including spill reports; emergency exercise reports; audit reports. Incident log Copies of all correspondence Record of all spills (Spill Record Book), including spill reports; emergency exercise reports; audit reports. Incident log
4.8.1.2.22			Implement SOPEP.	Contractor	In event of spill	
4.8.1.2.23			Notify SAMSA about wrecked vessels (safety and pollution). Give location details to HydroSAN.	Contractor		
4.8.1.2.24			In the event of an oil spill immediately implement emergency plans (refer to Section 4.8.1.1.5) and notify (a) the Principal Officer of the nearest SAMSA office, (b) the DEA's Chief Directorate of Marine & Coastal Pollution Management in Cape Town and (c) Smit Amandla Marine. Information that should be supplied when reporting a spill includes: <ul style="list-style-type: none"> <li>Name and contact details of person reporting the incident;</li> <li>The type and circumstances of incident, ship type, port of registry, nearest agent representing the ships company;</li> <li>Date and time of spill;</li> <li>Location (co-ordinates), source and cause of pollution;</li> <li>Type and estimated quantity of oil spilled and the potential and probability of further pollution;</li> <li>Weather and sea conditions; and</li> <li>Action taken or intended to respond to the incident.</li> </ul>	Contractor		
4.8.1.2.25			Attempt to control and contain the spill at sea, as far as possible and whenever the sea state permits, using suitable recovery techniques to reduce the spatial and temporal impact of the spill.	Contractor		

GEOPHYSICAL SURVEYS						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.1.2.26	Oil spills	Minimise damage to the environment by implementing response procedures efficiently	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.	Contractor	In event of spill	Record of all spills (Spill Record Book), including spill reports; emergency exercise reports; audit reports. Incident log
4.8.1.2.27			<ul style="list-style-type: none"> <li>Use low toxicity dispersants that rapidly dilute to concentrations below most acute toxicity thresholds.</li> <li>Use dispersants only with the permission of DEA.</li> </ul>	Contractor	In event of spill	DEA approval
4.8.1.2.28			Dispersants should not be used: <ul style="list-style-type: none"> <li>On diesel or light fuel oil.</li> <li>On heavy fuel oil.</li> <li>On slicks &gt; 0.5 cm thick.</li> <li>On any oil spills within 5 nautical miles offshore or in depths &lt; 30 m.               <ul style="list-style-type: none"> <li>In areas far offshore where there is little likelihood of oil reaching the shore.</li> </ul> </li> </ul>	Contractor	In event of spill	
4.8.1.2.29	Dropped equipment	Minimise hazards left on the seabed or floating in the water column	Undertake frequent checks to ensure items and equipment are stored and secured safely on board each vessel.	Contractor	As required	
4.8.1.2.30			Retrieve any dropped equipment, where practicable, after assessing safety and metocean conditions before performing any retrieval operations.	Contractor	As required	Establish a hazards database listing: <ul style="list-style-type: none"> <li>the type of gear left on the seabed</li> <li>date of abandonment / loss</li> <li>location; and</li> <li>where applicable, the dates of retrieval.</li> </ul>
4.8.1.2.31			Notify SANS and HydroSAN when any items that constitute a seafloor or navigational hazard are lost on the seabed, or in the sea.	Contractor	As required	Copies of all correspondence



GEOPHYSICAL SURVEYS						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
<b>4.8.1.3 DEMOBILISATION PHASE</b>						
4.8.1.3.1	Stakeholder consultation and notification of survey completion	Ensure that relevant parties are aware that the survey is complete	Inform all key stakeholders (see Section 4.8.1.1.6) that the mining vessel is off location.	Contractor	Within two weeks after completion of prospecting/mining	Copies of all correspondence
4.8.1.3.2	Final waste disposal	Minimise pollution and ensure correct disposal of waste	Dispose all waste retained onboard at a licensed waste site using a licensed waste disposal contractor.	Contractor	When vessel is in port	Waste receipts

## 4.8.2 SHORE-BASED DIVER ASSISTED MINING (“WALPOMP”)

SHORE-BASED DIVER ASSISTED MINING (“WALPOMP”)						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
<b>4.8.2.1 PLANNING / ESTABLISHMENT PHASE</b>						
4.8.2.1.1	Finalisation of mining area / concession	Minimise disturbance to sensitive coastal habitats	<ul style="list-style-type: none"> <li>Prohibit mining of any nature in the critically endangered Namaqua Sheltered Rocky Coast and Namaqua Inshore Reef habitats.               <ul style="list-style-type: none"> <li>If, however, prospecting or mining is proposed within these areas an independent assessment of the habitats and associated biota should be undertaken by a suitably qualified ecologist to verify the habitat status.</li> <li>Should it be confirmed that the habitats are indeed ecologically unique, these areas should be declared ‘no-go’ areas and any future prospecting or mining there should be prohibited.</li> </ul> </li> <li>Restrict mining within the endangered Namaqua Mixed Shore habitat, which are represented by more extensive areas off the West Coast, to less than 1% of the available habitat within the mining right area annually, unless the habitat is confirmed to be different by a suitably qualified ecologist.</li> </ul>	PSJV and independent ecologist	Prior to commencement of operation	Incorporate the SANBI benthic habitat map into the PSJV's GIS database  Ecological assessment (if applicable)
4.8.2.1.2	Protection of heritage and cultural features	Reduce risk to cultural heritage material	Exclude any shipwrecks identified during prospecting from the mining operation area.	PSJV	Prior to commencement of operation	
4.8.2.1.3	Establishment of campsite and processing areas	Minimise disturbance to sensitive coastal habitats	Avoid the establishment of campsites or processing areas within 100 m of the edge of a river channel or estuary mouth.	Contractor	During campsite establishment	Final campsite location and extent to be specified in ECOP
4.8.2.1.4			Locate campsites or processing areas, as far as possible, in previously disturbed areas or areas of least sensitivity.	Contractor		
4.8.2.1.5			<ul style="list-style-type: none"> <li>Limit the campsite and processing area to the minimum reasonably required.</li> <li>Clearly demarcate the extent of the campsite (e.g. with droppers).</li> </ul>	Contractor		

SHORE-BASED DIVER ASSISTED MINING ("WALPOMP")						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.2.1.6	Preparation of site-specific Environmental Code of Operational Practice (ECOP)	Minimise disturbance to sensitive coastal habitats	Prepare site-specific ECOP for each contractor and each allocated mining concession area. The ECOP should include specific details for the following aspects: <ul style="list-style-type: none"> <li>• Environmental considerations (i.e. identification of sensitive receptors) and establishment of no-go / restricted areas.</li> <li>• Access route(s) to allocated mining concession area.</li> <li>• Extent of mining concession area and demarcation of the campsite, processing area(s), and refuelling/maintenance areas.</li> <li>• Housing keeping:               <ul style="list-style-type: none"> <li>&gt; Use of drip trays under stationary plant and for refuelling/maintenance activities.</li> <li>&gt; Adequate provision and maintenance of toilet facilities (chemical toilets).</li> <li>&gt; Bunding of fuel stores.</li> </ul> </li> <li>• Waste management plan.</li> <li>• Rehabilitation specification (if necessary), e.g. topsoil management, reshaping, netting, etc.</li> <li>• Establishment of a rehabilitation fund.</li> <li>• Monitoring.</li> </ul>	PSJV (Environmental Manager/Officer)	Prior to commencement of operation	Copy of ECOP
4.8.2.1.7			Appoint an Environmental Representative to ensure that all environmental specifications in the EMPR and ECOP are met at all times.	Contractor	Prior to commencement of operation	Weekly audit reports/ checklists
4.8.2.1.8	Compliance with EMPR and ECOP	Operator and contractor to commit to adherence to EMPR and ECOP	<ul style="list-style-type: none"> <li>• Include a copy of the approved EMPR (or part thereof) and associated approvals in the contractor's contract document.</li> <li>• Ensure that a copy of the approved EMPR (or part thereof) and ECOP is on site during the operation.</li> </ul>	PSJV	Prior to commencement of operation	Signed contract document
4.8.2.1.9	Disposal of waste	Minimise pollution and maximise recycling by implementing and maintain pollution control and waste management procedures at all times	Establish a solid waste control and removal system that is acceptable to PSJV in order to prevent the spread of waste in, and beyond, the mining area.	Contractor	Prior to commencement of operation	

SHORE-BASED DIVER ASSISTED MINING ("WALPOMP")						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
<b>4.8.2.2 OPERATION PHASE</b>						
4.8.2.2.1	Environmental awareness training	Ensure personnel are appropriately trained	<ul style="list-style-type: none"> <li>Undertake Environmental Awareness Training to ensure mining personnel are appropriately informed of the purpose and requirements of the EMPR and ECOP, including emergency procedures, spill management, etc.</li> <li>Ensure that responsibilities are allocated to personnel.</li> <li>Establish training and exercise programmes to ensure that the response activities can be effectively executed.</li> </ul>	PSJV (Environmental Manager/Officer)	At commencement of operation	Copy of attendance register and training records
4.8.2.2.2	Site access	Minimise disturbance to sensitive coastal habitats	Demarcate and use only established tracks and roads, as far as possible, to access allocated mining concession areas.	Contractor	At commencement of operation	Weekly audit reports/ checklists
4.8.2.2.3			Prohibit blasting of rocky intertidal habitats and investigate alternative options to provide access to the low water mark.	Contractor	During operations	Weekly audit reports/ checklists
4.8.2.2.4			Where mining moves along the coast within a mining concession area and no tracks or roads exit parallel to the coast, access should be undertaken below the high water mark when on sandy/beach area.	Contractor	During operation	Weekly audit reports/ checklists
4.8.2.2.5	Kelp cutting	Minimise disturbance to kelp forests and maximise recovery rate	<ul style="list-style-type: none"> <li>Minimise kelp cutting unless diver safety is at stake or it is essential for the operation.</li> <li>Where kelp cutting is deemed necessary, avoid removing the entire plant by cutting the kelp stipes just above the holdfast.</li> <li>Where extensive kelp cutting is required, notify relevant kelp harvesting permit holders to collect the cut kelp.</li> </ul>	Contractor	During operation	PSJV monitoring
4.8.2.2.6	Removal of boulders	Limit the removal of boulders by tractor and chains and minimise the crushing of benthic fauna	<ul style="list-style-type: none"> <li>Limit the removal of boulders by tractor and chains.</li> <li>If the relocation of boulders is necessary, these should not be removed to higher tidal levels or accumulated in rock piles.</li> </ul>	Contractor	During operation	Weekly audit reports/ checklists
4.8.2.2.7	Operation of suction hoses	Minimise impact on West coast rock lobsters	Avoid removing and/or damaging rock lobsters when operating suction pipes during mining.	Contractor	During operation	

SHORE-BASED DIVER ASSISTED MINING ("WALPOMP")						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.2.2.8	Processing and location of classifiers	Minimise disturbance to sensitive coastal habitats	<ul style="list-style-type: none"> <li>Locate classifiers as far down the intertidal zone as possible to facilitate the natural redistribution of coarse tailings by wave action, but definitely below the high water mark.</li> <li>Limit the processing area to the minimum reasonably required.</li> </ul>	Contractor	During operation	Weekly audit reports/ checklists
4.8.2.2.9	Processing and discharge of tailings	Minimise disturbance to sensitive coastal habitats	Remove any tailings stockpiles that have been created on the high shore on a regular basis and re-used for other applications (e.g. dust control around buildings and processing plants, construction of coffer dams, etc.).	Contractor	Regularly during operation	Weekly audit reports/ checklists
4.8.2.2.10	Storage of hazardous substances	Reduce risk of spillages and associated impacts	Store all fuel and oil in suitable containers in adequately bunded areas within the campsite.	Contractor	During operation	Weekly audit reports/ checklists
4.8.2.2.11			Provide suitable fire-fighting equipment in the hazardous substances storage area.	Contractor	During operation	
4.8.2.2.12	Storage of equipment	Reduce area of disturbance and risk of spillages	Store all plant, vehicles or other items within the campsite.	Contractor	During operation	Weekly audit reports/ checklists
4.8.2.2.13			Provide drip trays for stationary plant (such as compressors, pumps, generators, etc.) and for "parked" plant (e.g. mechanised equipment).	Contractor	During operation	
4.8.2.2.14	Refuelling	Minimise the risk of biophysical impacts	Inspect and maintain all fuel containers.	Contractor	During operation	Weekly audit reports/ checklists
4.8.2.2.15			Use drip trays when refuelling plant and/or vehicles.	Contractor	During refuelling	
4.8.2.2.16			<ul style="list-style-type: none"> <li>Ensure there is always a supply of absorbent material readily available to absorb/breakdown spills and where possible is designed to encapsulate minor hydrocarbon spillage.</li> <li>The quantity of such materials shall be able to handle the total volume of the hydrocarbon/hazardous substance stored on site.</li> </ul>	Contractor	During refuelling	
4.8.2.2.17			Refuelling is to take place above the high water mark > and/or 30 m of any watercourse.	Contractor	During refuelling	
4.8.2.2.18	Maintenance	Minimise the risk of pollution and associated biophysical impacts	Keep all vehicles and equipment in good working order and serviced regularly.	Contractor	During maintenance	
4.8.2.2.19			Repair leaking equipment immediately or removed from the site.	Contractor	During maintenance	
4.8.2.2.20			Restrict vehicle maintenance to the maintenance yard area, except in emergencies when the beach area may be used if absolutely necessary.	Contractor	During maintenance	

SHORE-BASED DIVER ASSISTED MINING ("WALPOMP")						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.2.2.21	Maintenance	Minimise the risk of pollution and associated biophysical impacts	Use drip trays when servicing equipment for the collection of waste oil and other lubricants.	Contractor	During maintenance	
4.8.2.2.22	Disposal of general waste	Minimise pollution and maximise recycling by implementing and maintain pollution control and waste management procedures at all times	Implement Waste Management Plan in ECOP.	Contractor	During operation	Record types and volumes of general wastes  Waste receipts
4.8.2.2.23			Provide waste storage containers (bins) that are covered, tip-proof, weatherproof and scavenger proof.	Contractor	During operation	
4.8.2.2.24			Empty bins on a weekly basis.	Contractor	During operation	
4.8.2.2.25			Ensure that the site is kept free of litter.	Contractor	During operation	
4.8.2.2.26			No waste material or litter shall be burnt or buried on site.	Contractor	During operation	
4.8.2.2.27			Dispose of all solid waste offsite at an approved landfill site.	Contractor	During operation	
4.8.2.2.28	Disposal of hazardous waste		Segregate, classify and store all hazardous waste in suitable receptacles in order to ensure the safe containment and transportation of waste.	Contractor	During operation	Record types and volumes of hazardous wastes  Waste receipts
4.8.2.2.29			Dispose of hazardous waste at a facility that is appropriately licensed and accredited.	Contractor	During operation	
4.8.2.2.30			No hydrocarbon and hazardous waste shall be burnt or buried on site.	Contractor	During operation	
4.8.2.2.31	Accidental spills and leaks	Minimise the risk of spills and leaks and associated biophysical impacts	Ensure site staff are aware of the procedure to be followed for dealing with spills and leaks.	Contractor	In event of spill	Copy of attendance register and training records
4.8.2.2.32			Use absorbent material to absorb / breakdown spills.	Contractor	In event of spill	Record of all spills
4.8.2.2.33			<ul style="list-style-type: none"> <li>Report any accidental spill and/or leak to PSJV's Environmental Manager/Officer so that the best remediation method can be quickly implemented.</li> <li>Report major spills that may cause significant harm to the environment, human life or property to DEA in terms of Section 30 of NEMA.</li> </ul>	Contractor	In event of spill	Weekly audit reports/ checklists
4.8.2.2.34	Protection of natural features, flora and fauna	Minimise biophysical impacts	Refrain from collecting any plants (succulents) within the mining concession or adjacent areas.	Contractor	During operation	
4.8.2.2.35			Refrain from collecting any shellfish (including abalone, rock lobster, mussels) or undertaking recreational or subsistence fishing within the allocated mining site or adjacent areas.	Contractor	During operation	

SHORE-BASED DIVER ASSISTED MINING ("WALPOMP")						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.2.2.36	Protection of natural features, flora and fauna	Minimise biophysical impacts	Restrict fires/braais to properly constructed facilities and provide firewood.	Contractor	During operation	
4.8.2.2.37	Protection of heritage and cultural features	Reduce risk to cultural heritage material	<p>If palaeontological or shipwreck material is encountered during the course of mining, the following mitigation measure should be applied:</p> <ul style="list-style-type: none"> <li>Work in the directly affected area should cease until the South African Heritage Resources Agency (SAHRA) has been notified and the contractor/PSJV has complied with any additional mitigation as specified by SAHRA.</li> <li>Recover, where possible, any artefacts and take photographs of them, noting the date, time, location and types of artefacts found.</li> </ul>	Contractor	During operation	Copies of all correspondence
<b>4.8.2.3 DEMOBILISATION PHASE</b>						
4.8.2.3.1	Final waste disposal	Minimise pollution and ensure correct disposal of waste	Dispose all waste (including derelict equipment) at a licensed waste site.	Contractor	Prior to leaving site	Waste receipts
4.8.2.3.2	Rehabilitation	Maximise rate of vegetation and habitat recovery	Adhere to ECOP.	Contractor	Prior to leaving site	Final audit report
4.8.2.3.3			Remove all tailings stockpiles that have been created on the high shore and reshape back as close to the original profile as possible.	Contractor	Prior to leaving site	
4.8.2.3.4			Close (with rock barrier or fence) and rehabilitate all tracks leading to allocated mining concession areas.	Contractor	Prior to leaving site	
4.8.2.3.5			Remove all artificial constructions or beach modifications (e.g. tracks, berms, stockpiles, etc.), structures, equipment (including derelict), materials, waste, debris, rubble, etc. from site.	Contractor	Prior to leaving site	
4.8.2.3.6			Scarify access tracks and campsite area to a depth of 100 mm to break up any compacted soil. This may, however, not be necessary in very sandy areas or where hard calcrete is found at the surface.	Contractor	Prior to leaving site	



SHORE-BASED DIVER ASSISTED MINING ("WALPOMP")						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.2.3.7	Rehabilitation	Maximise rate of vegetation and habitat recovery	Protect areas susceptible to erosion by installing necessary temporary erosion control measures (e.g. netting) to the satisfaction of PSJV's Environmental Manager/Officer.	Contractor	Prior to leaving site	
4.8.2.3.8	Final site audit	Ensure corrective action and compliance and contribute towards improvement of EMPr implementation	Audit allocated mining area in terms of compliance with EMPR and ECOP.	PSJV (Environmental Manager/Officer)	Prior to contractor leaving and/or moving to a new site	Final audit report
4.8.2.3.9			Return the rehabilitation funds to the contractor once the Environmental Manager/Officer is satisfied that the area has been suitably cleaned and rehabilitated.	PSJV (Environmental Manager/Officer)	Prior to contractor leaving and/or moving to a new site	
4.8.2.3.10	Monitoring		<ul style="list-style-type: none"> <li>Monitoring of the success of passive<sup>1</sup> rehabilitation.</li> <li>If rehabilitation is not seen to be successful, implement additional rehabilitation measures to improve the restoration process (e.g. netting, seeding, etc.).</li> </ul>	PSJV	Annual, until deemed stable	Environmental performance report

<sup>1</sup> Passive restoration' is where minimal activities are undertaken and the disturbed area is allowed to re-establish on its own. This would involve the reshaping of the disturbed area and the replacement of topsoil (and associated seedbank).

### 4.8.3 COFFER DAM MINING

COFFER DAM MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
<b>4.8.3.1 PLANNING / ESTABLISHMENT PHASE</b>						
4.8.3.1.1	Implement pre biodiversity survey of intertidal sandy beaches	<ul style="list-style-type: none"> <li>To quantify the impact of coffer dam mining on intertidal communities</li> <li>To determine recovery rates of the affected biota on cessation of mining</li> <li>To investigate the relationship of invertebrate macrofaunal communities with time since mining</li> </ul>	Refer to Section 4.9.	PSJV, in collaboration with Contractor	Annually, at the same time of year, for two consecutive years prior to mining, at suitable spring low tide periods	
4.8.3.1.2	Finalisation of mining area / concession	Minimise disturbance to sensitive coastal habitats	<ul style="list-style-type: none"> <li>Prohibit mining of any nature in the:               <ul style="list-style-type: none"> <li>&gt; Endangered Namaqua Mixed Shore habitat.</li> <li>&gt; Critically endangered Namaqua Sheltered Rocky Coast habitat.</li> </ul> </li> <li>If, however, prospecting or mining is proposed within these areas an independent assessment of the habitats and associated biota should be undertaken by a suitably qualified ecologist to verify the habitat status.</li> <li>Should it be confirmed that the habitats are indeed ecologically unique, these areas should be declared 'no-go' areas and any future prospecting or mining there should be prohibited.</li> </ul>	PSJV and independent ecologist	Prior to commencement of operation	Incorporate the SANBI benthic habitat map into the PSJV's GIS database  Ecological assessment (if applicable)
4.8.3.1.3	Protection of heritage and cultural features	Reduce risk to cultural heritage material	Exclude any shipwrecks identified during prospecting from the mining operation area.	PSJV	Prior to commencement of operation	

COFFER DAM MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.3.1.4	Establishment of campsite and processing areas	Minimise disturbance to sensitive coastal habitats	Avoid the establishment of campsites or processing areas within 100 m of the edge of a river channel or estuary mouth.	Contractor	During campsite establishment	Final campsite location and extent to be specified in ECOP
4.8.3.1.5			Locate campsites or processing areas, as far as possible, in previously disturbed areas or areas of least sensitivity.	Contractor		
4.8.3.1.6			<ul style="list-style-type: none"> <li>Limit the campsite and processing area to the minimum reasonably required.</li> <li>Clearly demarcate the extent of the campsite (e.g. with droppers).</li> </ul>	Contractor		
4.8.3.1.7	Preparation of site-specific Environmental Code of Operational Practice (ECOP)	Minimise disturbance to sensitive coastal habitats	Prepare site-specific ECOP for each contractor and each allocated mining concession area. The ECOP should include specific details for the following aspects: <ul style="list-style-type: none"> <li>Environmental considerations (i.e. identification of sensitive receptors) and establishment of no-go areas.</li> <li>Access route(s) to allocated mining concession area.</li> <li>Extent of mining concession area and demarcation of the campsite, processing area(s), and refuelling/maintenance areas.</li> <li>Housing keeping:               <ul style="list-style-type: none"> <li>Use of drip trays under stationary plant and for refuelling/maintenance activities.</li> <li>Adequate provision and maintenance of toilet facilities (chemical toilets).</li> <li>Bunding of fuel stores.</li> </ul> </li> <li>Waste management plan.</li> <li>Rehabilitation specification (if necessary), e.g. topsoil management, reshaping, netting, etc.</li> <li>Establishment of a rehabilitation fund.</li> <li>Monitoring.</li> </ul>	PSJV (Environmental Manager/Officer)	Prior to commencement of operation	Copy of ECOP
4.8.3.1.8			Appoint an Environmental Representative to ensure that all environmental specifications in the EMPR and ECOP are met at all times.	Contractor		Weekly audit reports/ checklists

COFFER DAM MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.3.1.9	Compliance with EMPR and ECOP	Operator and contractor to commit to adherence to EMPR and ECOP	<ul style="list-style-type: none"> <li>Include a copy of the approved EMPR (or part thereof) and associated approvals in the contractor's contract document.</li> <li>Ensure that a copy of the approved EMPR (or part thereof) and ECOP is on site during the operation.</li> </ul>	PSJV	Prior to commencement of operation	Signed contract document
4.8.3.1.10	Disposal of waste	Minimise pollution and maximise recycling by implementing and maintain pollution control and waste management procedures at all times	Establish a solid waste control and removal system that is acceptable to PSJV in order to prevent the spread of waste in, and beyond, the mining area.	Contractor	Prior to commencement of operation	
<b>4.8.3.2 OPERATION PHASE</b>						
4.8.3.2.1	Environmental awareness training	Ensure personnel are appropriately trained	<ul style="list-style-type: none"> <li>Undertake Environmental Awareness Training to ensure mining personnel are appropriately informed of the purpose and requirements of the EMPR and ECOP, including emergency procedures, spill management, etc.</li> <li>Ensure that responsibilities are allocated to personnel.</li> <li>Establish training and exercise programmes to ensure that the response activities can be effectively executed.</li> </ul>	PSJV (Environmental Manager/Officer)	At commencement of operation	Copy of attendance register and training records
4.8.3.2.2	Site access	Minimise disturbance to sensitive coastal habitats	Demarcate and use only established tracks and roads, as far as possible, to access allocated mining concession areas.	Contractor	At commencement of operation	Weekly audit reports/ checklists
4.8.3.2.3	Coffer dam construction and phasing	Minimise use of quarried rock and disturbance to sensitive coastal habitats	Use materials sourced locally from old tailings dumps and existing sea walls for coffer dam construction and avoid using quarried material, where possible.	Contractor	During construction	
4.8.3.2.4		Minimise disturbance to sensitive coastal habitats	<ul style="list-style-type: none"> <li>Limit the number of coffer dams operational concurrently.</li> <li>Mine each block sequentially to completion, with only two adjacent blocks active concurrently.</li> </ul>	Contractor	During construction	Weekly audit reports/ checklists
4.8.3.2.5			Backfill all coastal excavations with the excavated material as mining progresses in such a way as to maintain the original beach profile as far as possible.	Contractor	During construction and operation	

COFFER DAM MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.3.2.6	Mineral Processing and tailings discharge	Facilitate natural recovery	Confine stockpiles and processing of ore to mineral processing areas and limit the separation process to a specific controlled area.	Contractor	During operation	
4.8.3.2.7			Backfill all tailings generated in mined out blocks.	Contractor	During operation	
4.8.3.2.8	Storage of hazardous substances	Reduce risk of spillages and associated impacts	Store all fuel and oil in suitable containers in adequately bunded areas within the campsite.	Contractor	During operation	Weekly audit reports/ checklists
4.8.3.2.9			Provide suitable fire-fighting equipment in the hazardous substances storage area.	Contractor	During operation	
4.8.3.2.10	Storage of equipment	Reduce area of disturbance and risk of spillages	Store all plant, vehicles or other items within the campsite.	Contractor	During operation	Weekly audit reports/ checklists
4.8.3.2.11			Provide drip trays for stationary plant (such as compressors, pumps, generators, etc.) and for "parked" plant (e.g. mechanised equipment).	Contractor	During operation	
4.8.3.2.12	Refuelling	Minimise the risk of biophysical impacts	Inspect and maintain all fuel containers.	Contractor	During operation	Weekly audit reports/ checklists
4.8.3.2.13			Use drip trays when refuelling plant and/or vehicles.	Contractor	During refuelling	
4.8.3.2.14			<ul style="list-style-type: none"> <li>Ensure there is always a supply of absorbent material readily available to absorb/breakdown spills and where possible is designed to encapsulate minor hydrocarbon spillage.</li> <li>The quantity of such materials shall be able to handle the total volume of the hydrocarbon/hazardous substance stored on site.</li> </ul>	Contractor	During refuelling	
4.8.3.2.15			Refuelling is to take place above the high water mark > and/or 30 m of any watercourse.	Contractor	During refuelling	
4.8.3.2.16	Maintenance	Minimise the risk of pollution and associated biophysical impacts	Keep all vehicles and equipment in good working order and serviced regularly.	Contractor	During maintenance	
4.8.3.2.17			Repair leaking equipment immediately or removed from the site.	Contractor	During maintenance	
4.8.3.2.18			Restrict vehicle maintenance to the maintenance yard area, except in emergencies when the beach area may be used if absolutely necessary.	Contractor	During maintenance	
4.8.3.2.19			Use drip trays when servicing equipment for the collection of waste oil and other lubricants.	Contractor	During maintenance	

COFFER DAM MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.3.2.20	Disposal of general waste	Minimise pollution and maximise recycling by implementing and maintain pollution control and waste management procedures at all times	Implement Waste Management Plan in ECOP.	Contractor	During operation	Record types and volumes of general wastes  Waste receipts
4.8.3.2.21			Provide waste storage containers (bins) that are covered, tip-proof, weatherproof and scavenger proof.	Contractor	During operation	
4.8.3.2.22			Empty bins on a weekly basis.	Contractor	During operation	
4.8.3.2.23			Ensure that the site is kept free of litter.	Contractor	During operation	
4.8.3.2.24			No waste material or litter shall be burnt or buried on site.	Contractor	During operation	
4.8.3.2.25			Dispose of all solid waste offsite at an approved landfill site.	Contractor	During operation	
4.8.3.2.26	Disposal of hazardous waste	Minimise pollution and maximise recycling by implementing and maintain pollution control and waste management procedures at all times`	Segregate, classify and store all hazardous waste in suitable receptacles on board in order to ensure the safe containment and transportation of waste.	Contractor	During operation	Record types and volumes of hazardous wastes  Waste receipts
4.8.3.2.27			Provide a specific waste management storage and segregation area at the onshore logistics base.	Contractor	During operation	
4.8.3.2.28			Dispose of hazardous waste at a facility that is appropriately licensed and accredited.	Contractor	During operation	
4.8.3.2.29			No hydrocarbon and hazardous waste shall be burnt or buried on site.	Contractor	During operation	
4.8.3.2.30	Accidental spills and leaks	Minimise the risk of spills and leaks and associated biophysical impacts	Ensure site staff are aware of the procedure to be followed for dealing with spills and leaks.	Contractor	In event of spill	Copy of attendance register and training records
4.8.3.2.31			Use absorbent material to absorb / breakdown spills.	Contractor	In event of spill	Record of all spills (Spill Record Book), including spill reports; emergency exercise reports.  Weekly audit reports/ checklists
4.8.3.2.32			<ul style="list-style-type: none"> <li>Report any accidental spill and/or leak to PSJV's Environmental Manager/Officer so that the best remediation method can be quickly implemented.</li> <li>Report major spills that may cause significant harm to the environment, human life or property to DEA in terms of Section 30 of NEMA.</li> </ul>	Contractor	In event of spill	
4.8.3.2.33	Protection of natural features, flora and fauna	Minimise biophysical impacts	Refrain from collecting any plants (succulents) within the mining concession or adjacent areas.	Contractor	During operation	
4.8.3.2.34			Refrain from collecting any shellfish (including abalone, rock lobster, mussels) or undertaking recreational or subsistence fishing within the allocated mining concession or adjacent areas.	Contractor	During operation	
4.8.3.2.35			Restrict fires/braais to properly constructed facilities and provide firewood.	Contractor	During operation	

COFFER DAM MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.3.2.36	Protection of heritage and cultural features	Reduce risk to cultural heritage material	<p>If palaeontological or shipwreck material is encountered during the course of mining, the following mitigation measure should be applied:</p> <ul style="list-style-type: none"> <li>Work in the directly affected area should cease until the South African Heritage Resources Agency (SAHRA) has been notified and the contractor/PSJV has complied with any additional mitigation as specified by SAHRA.</li> <li>Recover, where possible, any artefacts and take photographs of them, noting the date, time, location and types of artefacts found.</li> </ul>	Contractor	During operation	Copies of all correspondence
4.8.3.2.37	Monitor sand accumulation or erosion from the southern and northern limits of individual coffer dams	To determine the extent of sand accumulation or erosion to the north and south of individual coffer dams	Refer to Section 4.9.	PSJV	Monthly, at spring low tide	Monitoring results to be included in Performance Assessments in order to confirm the significance of the residual impact and, depending on the results, inform future mining planning and methods
<b>4.8.3.3 DEMOBILISATION PHASE</b>						
4.8.3.3.1	Final waste disposal	Minimise pollution and ensure correct disposal of waste	Dispose all waste (including derelict equipment) at a licensed waste site.	Contractor	Prior to leaving site	Waste receipts
4.8.3.3.2	Rehabilitation	Maximise rate of habitat recovery	<ul style="list-style-type: none"> <li>Remove coffer dam material to below the low tide level, as far as wave action will allow, as soon as a block has been mined out.</li> <li>It is important to ensure that the least amount of non-native material remains on sandy beached and in gullies and potholes on rocky shores.</li> <li>This material should be re-used during further sea wall construction.</li> </ul>	Contractor	Prior to leaving site	



COFFER DAM MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.3.3.3	Rehabilitation	Maximise rate of habitat recovery	Reshape beach and supratidal area back as close to the original profile as possible.	Contractor	Prior to leaving site	Final audit report
4.8.3.3.4			Remove all artificial constructions or beach modifications (e.g. tracks, berms, stockpiles, etc.), structures, equipment (including derelict), materials, waste, debris, rubble, etc. from site.	Contractor	Prior to leaving site	
4.8.3.3.5			Scarify campsite area to a depth of 100 mm to break up any compacted soil. This may, however, not be necessary in very sandy areas or where hard calcrete is found at the surface.	Contractor	Prior to leaving site	
4.8.3.3.6			Close (with rock barrier or fence) and rehabilitate all tracks leading to allocated mining concession areas.	Contractor	Prior to leaving site	
4.8.3.3.7			Protect areas susceptible to erosion by installing necessary temporary erosion control measures (e.g. netting) to the satisfaction of PSJV's Environmental Manager/Officer.	Contractor	Prior to leaving site	
4.8.3.3.8			Rehabilitate any onshore quarries in terms of onshore EMPR.	Contractor	Prior to leaving site	
4.8.3.3.9	Final site audit	Ensure corrective action and compliance and contribute towards improvement of EMPr implementation	Audit allocated mining area in terms of compliance with EMPR and ECOP.	PSJV (Environmental Manager/Officer)	Prior to contractor leaving and/or moving to a new site	Final audit report
4.8.3.3.10			Return the rehabilitations funds to the contractor once the Environmental Manager/Officer is satisfied that the area has been suitably cleaned and rehabilitated.	PSJV (Environmental Manager/Officer)	Prior to contractor leaving and/or moving to a new site	
4.8.3.3.11	Monitoring of supratidal zone	Ensure corrective action and compliance and contribute towards improvement of EMPr implementation	<ul style="list-style-type: none"> <li>Monitoring of the success of passive<sup>2</sup> rehabilitation.</li> <li>If rehabilitation is not seen to be successful, implement additional rehabilitation measures to improve the restoration process (e.g. netting, seeding, etc.).</li> </ul>	PSJV	Annual, for at least three years	

<sup>2</sup> Passive restoration' is where minimal activities are undertaken and the disturbed area is allowed to re-establish on its own. This would involve the reshaping of the disturbed area and the replacement of topsoil (and associated seedbank).

COFFER DAM MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.3.3.12	Implement post mining biodiversity survey of intertidal sandy beaches	<ul style="list-style-type: none"> <li>To quantify the impact of coffer dam mining on intertidal communities</li> <li>To determine recovery rates of the affected biota on cessation of mining</li> <li>To investigate the relationship of invertebrate macrofaunal communities with time since mining</li> </ul>	Refer to Section 4.9.	PSJV, in collaboration with Contractor	Annually at the same time of the year for the first three years; and then again at year 5 and 7 (i.e. when communities are expected to reach at least 80% of the measured pre-impact baseline levels)	Monitoring results to be included in Performance Assessments in order to confirm the significance of the residual impact and, depending on the results, inform future mining planning and methods

#### 4.8.4 MOBILE PUMP UNIT MINING

MOBILE PUMP UNIT MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
<b>4.8.4.1 PLANNING / ESTABLISHMENT PHASE</b>						
4.8.4.1.1	Finalisation of mining area / concession and mining method	Minimise disturbance to sensitive coastal habitats	<ul style="list-style-type: none"> <li>Prohibit mining of any nature in the critically endangered Namaqua Sheltered Rocky Coast and Namaqua Inshore Reef habitats.               <ul style="list-style-type: none"> <li>If, however, prospecting or mining is proposed within these areas an independent assessment of the habitats and associated biota should be undertaken by a suitably qualified ecologist to verify the habitat status.</li> <li>Should it be confirmed that the habitats are indeed ecologically unique, these areas should be declared 'no-go' areas and any future prospecting or mining there should be prohibited.</li> </ul> </li> <li>Restrict mining within the endangered Namaqua Mixed Shore habitat, which are represented by more extensive areas off the West Coast, to less than 1% of the available habitat within the mining right area annually, unless the habitat is confirmed to be different by a suitably qualified ecologist.</li> </ul>	PSJV and independent ecologist	Prior to commencement of operation	Incorporate the SANBI benthic habitat map into the PSJV's GIS database  Ecological assessment (if applicable)
4.8.4.1.2			Operate mobile pump units in sandy bays only to avoid damage of shallow water reefs and their associated kelp-bed communities.	PSJV/Contractor	Prior to commencement of operation	
4.8.4.1.3	Protection of heritage and cultural features	Reduce risk to cultural heritage material	Exclude any shipwrecks identified during prospecting from the mining operation area.	PSJV	Prior to commencement of operation	
4.8.4.1.4	Establishment of campsite and processing areas	Minimise disturbance to sensitive coastal habitats	Avoid the establishment of campsites or processing areas within 100 m of the edge of a river channel or estuary mouth.	Contractor	During campsite establishment	Final campsite location and extent to be specified in ECOP
4.8.4.1.5			Locate campsites or processing areas, as far as possible, in previously disturbed areas or areas of least sensitivity.	Contractor		

MOBILE PUMP UNIT MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.4.1.6	Establishment of campsite and processing areas	Minimise disturbance to sensitive coastal habitats	<ul style="list-style-type: none"> <li>Limit the campsite and processing area to the minimum reasonably required.</li> <li>Clearly demarcate the extent of the campsite (e.g. with droppers).</li> </ul>	Contractor	During campsite establishment	
4.8.4.1.7	Preparation of site-specific Environmental Code of Operational Practice (ECOP)	Minimise disturbance to sensitive coastal habitats	<p>Prepare site-specific ECOP for each contractor and each allocated mining concession area. The ECOP should include specific details for the following aspects:</p> <ul style="list-style-type: none"> <li>Environmental considerations (i.e. identification of sensitive receptors) and establishment of no-go / restricted areas.</li> <li>Access route(s) to allocated mining concession area.</li> <li>Extent of mining concession area and demarcation of the campsite, processing area(s), and refuelling/maintenance areas.</li> <li>Housing keeping: <ul style="list-style-type: none"> <li>Use of drip trays under stationary plant and for refuelling/maintenance activities.</li> <li>Adequate provision and maintenance of toilet facilities (chemical toilets)</li> <li>Bunding of fuel stores.</li> </ul> </li> <li>Waste management plan.</li> <li>Rehabilitation specification (if necessary), e.g. topsoil management, reshaping, netting, etc.</li> <li>Establishment of a rehabilitation fund.</li> <li>Monitoring.</li> </ul>	PSJV (Environmental Manager/Officer)	Prior to commencement of operation	Copy of ECOP
4.8.4.1.8			Appoint an Environmental Representative to ensure that all environmental specifications in the EMPR and ECOP are met at all times.	Contractor	Prior to commencement of operation	Weekly audit reports/ checklists
4.8.4.1.9	Compliance with EMPR and ECOP	Operator and contractor to commit to adherence to EMPR and ECOP	<ul style="list-style-type: none"> <li>Include a copy of the approved EMPR (or part thereof) and associated approvals in the contractor's contract document.</li> <li>Ensure that a copy of the approved EMPR (or part thereof) and ECOP is on site during the operation.</li> </ul>	PSJV	Prior to commencement of operation	Signed contract document

MOBILE PUMP UNIT MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.4.1.10	Disposal of waste	Minimise pollution and maximise recycling by implementing and maintain pollution control and waste management procedures at all times	Establish a solid waste control and removal system that is acceptable to PSJV in order to prevent the spread of waste in, and beyond, the mining area.	Contractor	Prior to commencement of operation	
<b>4.8.4.2 OPERATION PHASE</b>						
4.8.4.2.1	Environmental awareness training	Ensure personnel are appropriately trained	<ul style="list-style-type: none"> <li>Undertake Environmental Awareness Training to ensure mining personnel are appropriately informed of the purpose and requirements of the EMPR and ECOP, including emergency procedures, spill management, etc.</li> <li>Ensure that responsibilities are allocated to personnel.</li> <li>Establish training and exercise programmes to ensure that the response activities can be effectively executed.</li> </ul>	PSJV (Environmental Manager/Officer)	At commencement of operation	Copy of attendance register and training records
4.8.4.2.2	Site access	Minimise disturbance to sensitive coastal habitats	Demarcate and use only established tracks and roads, as far as possible, to access allocated mining concession areas.	Contractor	At commencement of operation	Weekly audit reports/ checklists
4.8.4.2.3			Prohibit blasting of rocky intertidal habitats and investigate alternative options to provide access to the low water mark.	Contractor	During operations	Weekly audit reports/ checklists
4.8.4.2.4			Where mining moves along the coast within a mining concession area and no tracks or roads exit parallel to the coast, access should be undertaken below the high water mark when on sandy/beach area.	Contractor	During operation	Weekly audit reports/ checklists
4.8.4.2.5	Storage of hazardous substances	Reduce risk of spillages and associated impacts	Store all fuel and oil in suitable containers in adequately bunded areas within the campsite.	Contractor	During operation	Weekly audit reports/ checklists
4.8.4.2.6			Provide suitable fire-fighting equipment in the hazardous substances storage area.	Contractor	During operation	
4.8.4.2.7	Storage of equipment	Reduce area of disturbance and risk of spillages	Store all plant, vehicles or other items within the campsite.	Contractor	During operation	Weekly audit reports/ checklists
4.8.4.2.8			Provide drip trays for stationary plant (such as compressors, pumps, generators, etc.) and for "parked" plant (e.g. mechanised equipment).	Contractor	During operation	

MOBILE PUMP UNIT MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.4.2.9	Refuelling	Minimise the risk of biophysical impacts	Inspect and maintain all fuel containers.	Contractor	During operation	Weekly audit reports/ checklists
4.8.4.2.10			Use drip trays when refuelling plant and/or vehicles.	Contractor	During refuelling	
4.8.4.2.11			<ul style="list-style-type: none"> <li>Ensure there is always a supply of absorbent material readily available to absorb/breakdown spills and where possible is designed to encapsulate minor hydrocarbon spillage.</li> <li>The quantity of such materials shall be able to handle the total volume of the hydrocarbon/hazardous substance stored on site.</li> </ul>	Contractor	During refuelling	
4.8.4.2.17			Refuelling is to take place above the high water mark > and/or 30 m of any watercourse.	Contractor	During refuelling	
4.8.4.2.18	Maintenance	Minimise the risk of pollution and associated biophysical impacts	Keep all vehicles and equipment in good working order and serviced regularly.	Contractor	During maintenance	
4.8.4.2.19			Repair leaking equipment immediately or removed from the site.	Contractor	During maintenance	
4.8.4.2.20			Restrict vehicle maintenance to the maintenance yard area, except in emergencies when the beach area may be used if absolutely necessary.	Contractor	During maintenance	
4.8.4.2.21			Use drip trays when servicing equipment for the collection of waste oil and other lubricants.	Contractor	During maintenance	
4.8.4.2.22	Disposal of general waste	Minimise pollution and maximise recycling by implementing and maintain pollution control and waste management procedures at all times	Implement Waste Management Plan in ECOP.	Contractor	During operation	Record types and volumes of general wastes  Waste receipts
4.8.4.2.23			Provide waste storage containers (bins) that are covered, tip-proof, weatherproof and scavenger proof.	Contractor	During operation	
4.8.4.2.24			Empty bins on a weekly basis.	Contractor	During operation	
4.8.4.2.25			Ensure that the site is kept free of litter.	Contractor	During operation	
4.8.4.2.26			No waste material or litter shall be burnt or buried on site.	Contractor	During operation	
4.8.4.2.27			Dispose of all solid waste offsite at an approved landfill site.	Contractor	During operation	
4.8.4.2.28	Disposal of hazardous waste	Minimise pollution and maximise recycling by implementing and maintain pollution control and waste management procedures at all times`	Segregate, classify and store all hazardous waste in suitable receptacles on board in order to ensure the safe containment and transportation of waste.	Contractor	During operation	Record types and volumes of hazardous wastes  Waste receipts
4.8.4.2.29			Provide a specific waste management storage and segregation area at the onshore logistics base.	Contractor	During operation	
4.8.4.2.30			Dispose of hazardous waste at a facility that is appropriately licensed and accredited.	Contractor	During operation	
4.8.4.2.31			No hydrocarbon and hazardous waste shall be burnt or buried on site.	Contractor	During operation	

MOBILE PUMP UNIT MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.4.2.32	Accidental spills and leaks	Minimise the risk of spills and leaks and associated biophysical impacts	Ensure site staff are aware of the procedure to be followed for dealing with spills and leaks.	Contractor	In event of spill	Copy of attendance register and training records
4.8.4.2.33			Use absorbent material to absorb / breakdown spills.	Contractor	In event of spill	Record of all spills (Spill Record Book), including spill reports; emergency exercise reports. Weekly audit reports/ checklists
4.8.4.2.34			<ul style="list-style-type: none"> <li>Report any accidental spill and/or leak to PSJV's Environmental Manager/Officer so that the best remediation method can be quickly implemented.</li> <li>Report major spills that may cause significant harm to the environment, human life or property to DEA in terms of Section 30 of NEMA.</li> </ul>	Contractor	In event of spill	
4.8.4.2.35	Protection of natural features, flora and fauna	Minimise biophysical impacts	Refrain from collecting any plants (succulents) within the mining concession or adjacent areas.	Contractor	During operation	
4.8.4.2.36			Refrain from collecting any shellfish (including abalone, rock lobster, mussels) or undertaking recreational or subsistence fishing within the allocated mining concession or adjacent areas.	Contractor	During operation	
4.8.4.2.37			Restrict fires/braais to properly constructed facilities and provide firewood.	Contractor	During operation	
4.8.4.2.38	Protection of heritage and cultural features	Reduce risk to cultural heritage material	<p>If palaeontological or shipwreck material is encountered during the course of mining, the following mitigation measure should be applied:</p> <ul style="list-style-type: none"> <li>Work in the directly affected area should cease until the South African Heritage Resources Agency (SAHRA) has been notified and the contractor/PSJV has complied with any additional mitigation as specified by SAHRA.</li> <li>Recover, where possible, any artefacts and take photographs of them, noting the date, time, location and types of artefacts found.</li> </ul>	Contractor	During operation	Copies of all correspondence
<b>4.8.4.3 DEMOBILISATION PHASE</b>						
4.8.4.3.1	Final waste disposal	Minimise pollution and ensure correct disposal of waste	Dispose all waste (including derelict equipment) at a licensed waste site.	Contractor	Prior to leaving site	Waste receipts
4.8.4.3.2	Rehabilitation	Maximise rate of vegetation and habitat recovery	Close (with rock barrier or fence) and rehabilitate all tracks leading to allocated mining concession areas.	Contractor	Prior to leaving site	Final audit report



MOBILE PUMP UNIT MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.4.3.3	Rehabilitation	Maximise rate of vegetation and habitat recovery	Remove all artificial constructions or beach modifications (e.g. tracks, berms, stockpiles, etc.), structures, equipment (including derelict), materials, waste, debris, rubble, etc. from site.	Contractor	Prior to leaving site	Final audit report
4.8.4.3.4			Scarify campsite area to a depth of 100 mm to break up any compacted soil. This may, however, not be necessary in very sandy areas or where hard calcrete is found at the surface.	Contractor	Prior to leaving site	
4.8.4.3.5			Protect areas susceptible to erosion by installing necessary temporary erosion control measures (e.g. netting) to the satisfaction of PSJV's Environmental Manager/Officer.	Contractor	Prior to leaving site	
4.8.4.3.6	Final site audit	Ensure corrective action and compliance and contribute towards improvement of EMPr implementation	Audit allocated mining area in terms of compliance with EMPR and ECOP.	PSJV (Environmental Manager/Officer)	Prior to contractor leaving and/or moving to a new site	Final audit report
4.8.4.3.7			Return the rehabilitations funds to the contractor once the Environmental Manager/Officer is satisfied that the area has been suitably cleaned and rehabilitated.	PSJV (Environmental Manager/Officer)	Prior to contractor leaving and/or moving to a new site	
4.8.4.3.8	Monitoring		<ul style="list-style-type: none"> <li>Monitoring of the success of passive<sup>3</sup> rehabilitation.</li> <li>If rehabilitation is not seen to be successful, implement additional rehabilitation measures to improve the restoration process (e.g. netting, seeding, etc.).</li> </ul>	PSJV	Annual, until deemed stable	

<sup>3</sup> Passive restoration' is where minimal activities are undertaken and the disturbed area is allowed to re-establish on its own. This would involve the reshaping of the disturbed area and the replacement of topsoil (and associated seedbank).

#### 4.8.5 VESSEL-BASED DIVER ASSISTED PROSPECTING AND MINING

VESSEL-BASED DIVER ASSISTED PROSPECTING AND MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
<b>4.8.5.1 PLANNING / ESTABLISHMENT PHASE</b>						
4.8.5.1.1	Finalisation of mining area / concession	Minimise disturbance to sensitive coastal habitats, including rocky outcrop communities	<ul style="list-style-type: none"> <li>Prohibit mining of any nature in the critically endangered Namaqua Sheltered Rocky Coast and Namaqua Inshore Reef habitats.               <ul style="list-style-type: none"> <li>If, however, prospecting or mining is proposed within these areas an independent assessment of the habitats and associated biota should be undertaken by a suitably qualified ecologist to verify the habitat status.</li> <li>Should it be confirmed that the habitats are indeed ecologically unique, these areas should be declared 'no-go' areas and any future prospecting or mining there should be prohibited.</li> </ul> </li> <li>Restrict mining within the endangered Namaqua Mixed Shore habitat and critically endangered Namaqua Inshore Hard Grounds and Namaqua Sandy Inshore habitats, which are represented by more extensive areas off the West Coast, to less than 1% of the available habitat within the mining right area annually, unless the habitat is confirmed to be different by a suitably qualified ecologist.</li> </ul>	PSJV and independent ecologist	Prior to commencement of operation	Incorporate the SANBI benthic habitat map into the PSJV's GIS database  Ecological assessment (if applicable)
4.8.5.1.2			<ul style="list-style-type: none"> <li>Use existing geophysical data to conduct a pre-mining geohazard analysis of the seabed to map potentially vulnerable habitats (to be included in site-specific ECOPs – see below).</li> <li>Mining should avoid these vulnerable areas.</li> </ul>	PSJV	Prior to commencement of operation	
4.8.5.1.3	Protection of heritage and cultural features	Reduce risk to cultural heritage material	Exclude any shipwrecks identified during prospecting from the mining operation area.	PSJV	Prior to commencement of operation	

VESSEL-BASED DIVER ASSISTED PROSPECTING AND MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.5.1.4	Preparation of site-specific Environmental Code of Operational Practice (ECOP)	Minimise disturbance to marine fauna and sensitive habitats	<p>Prepare site-specific ECOP for each contractor and each allocated mining concession area. The ECOP should include specific details for the following aspects:</p> <ul style="list-style-type: none"> <li>Environmental considerations (i.e. identification of endangered and critically endangered habitats and other sensitive receptors) and establishment of no-go / restricted areas.</li> <li>Waste management plan (including the discharge of tailings).</li> <li>Refuelling.</li> <li>Oil spill procedure and reporting.</li> </ul>	PSJV (Environmental Manager/Officer)	Prior to commencement of operation	Copy of ECOP
4.8.5.1.5	Compliance with EMPR and ECOP	Operator and contractor to commit to adherence to EMPR and ECOP	<ul style="list-style-type: none"> <li>Include a copy of the approved EMPR (or part thereof) and associated approvals in the contractor's contract document.</li> <li>Ensure that a copy of the approved EMPR (or part thereof) and ECOP is on board the mining vessel during the operation.</li> </ul>	PSJV	Prior to commencement of operation	Signed contract document
4.8.5.1.6	Preparation of subsidiary plans	Preparation for any emergency that could result in an environmental impact and minimise pollution by implementing and maintain pollution control and waste management procedures at all times	<p>Ensure the following plan is prepared and in place:</p> <ul style="list-style-type: none"> <li>Emergency Response Plan, including the establish a solid waste control and removal system that is acceptable to PSJV in order to prevent the disposal of waste in the ocean.</li> </ul>	Contractor	Prior to commencement of operation	Confirm compliance and justify any omissions
<b>4.8.5.2 OPERATION PHASE</b>						
4.8.5.2.1	Environmental awareness training	Ensure personnel are appropriately trained	<ul style="list-style-type: none"> <li>Undertake Environmental Awareness Training to ensure the vessel's personnel are appropriately informed of the purpose and requirements of the EMPR and ECOP, including emergency procedures, spill management, etc.</li> <li>Ensure that responsibilities are allocated to personnel.</li> <li>Establish training and exercise programmes to ensure that the response activities can be effectively executed.</li> </ul>	PSJV (Environmental Manager/Officer)	At commencement of operation	Copy of attendance register and training records

VESSEL-BASED DIVER ASSISTED PROSPECTING AND MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.5.2.2	Processing and discharge of tailings	Minimise discharge of tailings onto unmined areas and the smothering of benthic fauna	Position vessel in such a way that tailings are discharged back into mined out gullies or into areas of unconsolidated sediment adjacent to mining targets.	Contractor	During tailings discharge	
4.8.5.2.3	Disposal of waste	Minimise pollution by implementing and maintain pollution control and waste management procedures at all times	Implement the Waste Management Plan in ECOP.	Contractor	Throughout operations	Copy of all plan
4.8.5.2.4			Sewage: <ul style="list-style-type: none"> <li>Ensure all mining vessels that stay out overnight have sewage holding tanks, and that sewage is diluted with seawater prior to discharge.</li> <li>Consider installing chemical toilets on smaller vessels without holder tanks.</li> </ul>	Contractor	Throughout operation, during discharges	Waste receipts
4.8.5.2.5			Galley waste <ul style="list-style-type: none"> <li>Return all galley wastes generated on the vessel to shore for disposal at a licenced waste disposal site.</li> </ul>	Contractor	Throughout operation	Waste receipts
4.8.5.2.6			Deck and machinery drainage: <ul style="list-style-type: none"> <li>Ensure all process areas are bunded and drip trays are used to collect run-off from non-bunded equipment.</li> <li>Use low-toxicity biodegradable detergents and reusable absorbent cloths in cleaning of all deck spillage.</li> <li>Divert run-off, where possible, to a conservancy tank.</li> </ul>	Contractor	Throughout operation	
4.8.5.2.7			General waste: <ul style="list-style-type: none"> <li>No disposal overboard.</li> <li>Return all wastes generated on the vessel to shore for disposal at a licenced waste disposal site.</li> <li>Ensure on-board solid waste storage is secure.</li> </ul>	Contractor	Throughout operation	Volume of waste generated Volume transferred for onshore disposal Waste receipts
4.8.5.2.8			Hazardous waste (incl. oil and medical): <ul style="list-style-type: none"> <li>Segregate, classify and store all hazardous waste in suitable receptacles on board in order to ensure the safe containment and transportation of waste.</li> <li>Provide a specific waste management storage and segregation area at the onshore logistics base.</li> <li>Dispose of hazardous waste at a facility that is appropriately licensed and accredited.</li> </ul>	Contractor	Throughout operation	Record types and volumes of hazardous wastes Waste receipts

VESSEL-BASED DIVER ASSISTED PROSPECTING AND MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.5.2.9	Protection of heritage and cultural features	Reduce risk to cultural heritage material	<p>If palaeontological or shipwreck material is encountered during the course of mining, the following mitigation measure should be applied:</p> <ul style="list-style-type: none"> <li>Work in the directly affected area should cease until the South African Heritage Resources Agency (SAHRA) has been notified and the contractor/PSJV has complied with any additional mitigation as specified by SAHRA.</li> <li>Recover, where possible, any artefacts and take photographs of them, noting the date, time, location and types of artefacts found.</li> </ul>	Contractor	During operation	Copies of all correspondence
4.8.5.2.10	Bunkering / refuelling	Ensure that the necessary safeguards are in place and avoid any accidental oil / fuel spills	Undertake refuelling within the port limits only	Contractor		
4.8.5.2.11	Oil spills	Minimise damage to the environment by implementing response procedures efficiently	Inspect and maintain all fuel containers.	Contractor	During operation	
4.8.5.2.12			Implement Emergency Response Plan.	Contractor	In event of spill	Record of all spills (Spill Record Book) Incident log
4.8.5.2.13			Notify SAMSA about wrecked vessels (safety and pollution). Give location details to HydroSAN.	Contractor or PSJV		Copies of all correspondence

VESSEL-BASED DIVER ASSISTED PROSPECTING AND MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.5.2.14	Oil spills	Minimise damage to the environment by implementing response procedures efficiently	In the event of an oil spill immediately implement Emergency Response Plan and notify (a) the Principal Officer of the nearest SAMSA office, (b) the DEA's Chief Directorate of Marine & Coastal Pollution Management in Cape Town and (c) Smit Amandla Marine. Information that should be supplied when reporting a spill includes: <ul style="list-style-type: none"> <li>Name and contact details of person reporting the incident;</li> <li>The type and circumstances of incident, ship type, port of registry, nearest agent representing the ships company;</li> <li>Date and time of spill;</li> <li>Location (co-ordinates), source and cause of pollution;</li> <li>Type and estimated quantity of oil spilled and the potential and probability of further pollution;</li> <li>Weather and sea conditions; and</li> <li>Action taken or intended to respond to the incident.</li> </ul>	Contractor	In event of spill	Record of all spills (Spill Record Book), including spill reports Incident log
4.8.5.2.15			Attempt to control and contain the spill at sea, as far as possible and whenever the sea state permits, using suitable recovery techniques to reduce the spatial and temporal impact of the spill.	Contractor		
4.8.5.2.16			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.	Contractor		Record of all spills (Spill Record Book), including spill reports; emergency exercise reports; audit reports. Incident log
4.8.5.2.17			<ul style="list-style-type: none"> <li>Use low toxicity dispersants that rapidly dilute to concentrations below most acute toxicity thresholds.</li> <li>Use dispersants only with the permission of DEA.</li> </ul>	Contractor		DEA approval

VESSEL-BASED DIVER ASSISTED PROSPECTING AND MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.5.2.18	Oil spills	Minimise damage to the environment by implementing response procedures efficiently	Dispersants should not be used: <ul style="list-style-type: none"> <li>On diesel or light fuel oil.</li> <li>On heavy fuel oil.</li> <li>On slicks &gt; 0.5 cm thick.</li> <li>On any oil spills within 5 nautical miles offshore or in depths &lt; 30 m.</li> <li>In areas far offshore where there is little likelihood of oil reaching the shore.</li> </ul>	Contractor	In event of spill	
4.8.5.2.19	Dropped equipment	Minimise hazards left on the seabed or floating in the water column	Undertake frequent checks to ensure items and equipment are stored and secured safely on board each vessel.	Contractor	As required	
4.8.5.2.20			Retrieve any dropped equipment, where practicable, after assessing safety and metocean conditions before performing any retrieval operations.	Contractor	As required	Establish a hazards database listing: <ul style="list-style-type: none"> <li>the type of gear left on the seabed</li> <li>date of abandonment / loss</li> <li>location; and</li> <li>where applicable, the dates of retrieval.</li> </ul>
4.8.5.2.21	Protection of natural features, flora and fauna	Minimise biophysical impacts	Refrain from collecting any shellfish (including abalone, rock lobster, mussels) or undertaking recreational or subsistence fishing within the allocated mining concession or adjacent areas.	Contractor	During operation	
<b>4.8.5.3 DEMOBILISATION PHASE</b>						
4.8.5.3.1	Retrieval of equipment	Minimise entanglement of marine fauna	Remove marker buoys once a mining block has been mined out.	Contractor	Prior to leaving site	
4.8.5.3.2	Final waste disposal	Minimise pollution and ensure correct disposal of waste	Dispose all waste retained onboard at a licensed waste site.	Contractor	When vessel is in port	Waste receipts

#### 4.8.6 VESSEL-BASED REMOTE PROSPECTING AND MINING

VESSEL-BASED REMOTE PROSPECTING AND MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
<b>4.8.6.1 PLANNING / ESTABLISHMENT PHASE</b>						
4.8.6.1.1	Implement pre-mining seabed and benthic fauna monitoring programme	<ul style="list-style-type: none"> <li>To quantify the spatial and temporal impact of mining on benthic invertebrate macrofauna community composition</li> <li>To demonstrate natural recovery processes</li> </ul>	Refer to Section 4.9.	PSJV, in collaboration with Contractor	Collect baseline data at the same time of year, annually for two years prior to the commencement of offshore mining	
4.8.6.1.2	Finalisation of mining area / concession	Minimise disturbance to sensitive habitats (rocky outcrop communities)	Restrict mining within the critically endangered Namaqua Inshore Hard Grounds and Namaqua Sandy Inshore habitats, which are represented by more extensive areas off the West Coast, to less than 1% of the available habitat within the mining right area annually, unless the habitats are confirmed to be different by a suitably qualified ecologist.	PSJV	Prior to commencement of operation	Incorporate the following into the PSJV's GIS database for the identification of sensitive habitats: <ul style="list-style-type: none"> <li>SANBI benthic habitat map.</li> <li>the existing PSJV contractor survey data.</li> </ul>
4.8.6.1.3			<ul style="list-style-type: none"> <li>Use existing geophysical data to conduct a pre-mining geohazard analysis of the seabed to map potentially vulnerable habitats (to be included in site-specific ECOPs – see below).</li> <li>Avoid mining unconsolidated habitats in the close proximity of rocky outcrop areas in Sea Concession 1b.</li> <li>Establish a suitable buffer zone (&gt; 500 m) around identified sensitive areas to ensure that these are not affected indirectly by tailings impacts.</li> </ul>	PSJV	Prior to commencement of operation	
4.8.6.1.4	Protection of heritage and cultural features	Reduce risk to cultural heritage material	Exclude any shipwrecks identified during prospecting from the mining operation area.	PSJV	Prior to commencement of operation	



VESSEL-BASED REMOTE PROSPECTING AND MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.6.1.5	Preparation of site-specific Environmental Code of Operational Practice (ECOP)	Minimise disturbance to marine fauna and sensitive habitats	<p>Prepare site-specific ECOP for each contractor and each allocated mining concession area. The ECOP should include specific details for the following aspects:</p> <ul style="list-style-type: none"> <li>Environmental considerations (i.e. identification of identification of endangered and critically endangered habitats and other sensitive receptors) and establishment of no-go / restricted areas.</li> <li>Waste management (including the discharge of tailings).</li> <li>Refuelling.</li> <li>Oil spill procedure and reporting.</li> </ul>	PSJV (Environmental Manager/Officer)	Prior to commencement of operation	Copy of ECOP
4.8.6.1.6	Preparation of subsidiary plans	Preparation for any emergency that could result in an environmental impact	<p>Ensure the following plans are prepared and in place:</p> <ul style="list-style-type: none"> <li>Shipboard Oil Pollution Emergency Plan (SOPEP), as required by MARPOL.</li> <li>Emergency Response Plan.</li> <li>Waste Management Plan.</li> </ul> <p>In addition, ensure that the survey vessel's seaworthiness certificate and/or classification stamp are in place.</p>	Contractor	Prior to commencement of operation	Confirm compliance and justify any omissions
4.8.6.1.7	Compliance with EMPR	Operator and contractor to commit to adherence to EMPR	<ul style="list-style-type: none"> <li>Include a copy of the approved EMPR (or part thereof) and associated approvals in the contractor's contract document.</li> <li>Ensure that a copy of the approved EMPR (or part thereof) and ECOP is on board the mining vessel during the operation.</li> </ul>	PSJV	Prior to commencement of operation	Signed contract document

VESSEL-BASED REMOTE PROSPECTING AND MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.6.1.8	General notification of presence of prospecting/mining vessel unit and exclusion zone	Minimise interaction with other vessels	<p>Notify key stakeholders of the prospecting/mining programme (including navigational co-ordinates of area, timing and duration of activities) and the likely implications thereof (specifically the 500 m exclusion zone). Stakeholders include:</p> <ul style="list-style-type: none"> <li>&gt; Fishing industry / associations: <ul style="list-style-type: none"> <li>- South African Tuna Long-Line Association.</li> <li>- South African Tuna Association.</li> <li>- Fresh Tuna Exporters Association.</li> <li>- South African Commercial Line-Fish Association.</li> <li>- Northern Cape Fishing Forum.</li> <li>- South African Marine Line-Fish Management Association.</li> <li>- South African Fishing Industry Association.</li> </ul> </li> <li>&gt; Local fishing operators.</li> <li>&gt; Adjacent licence holders (incl. Cairn and PetroSA).</li> <li>&gt; South African Hydrographic office (HydroSAN).</li> <li>&gt; South African Maritime Association (SAMSA).</li> <li>&gt; Department of Agriculture, Forestry and Fisheries (DAFF), including the fisheries research managers, Deon Durholtz (DeonD@daff.gov.za) and Janet Coetzee (JanetC@daff.gov.za).</li> <li>&gt; Transnet National Ports Authority (ports of Cape Town and / or Saldanha Bay).</li> </ul>	Contractor	30 days prior to commencement of operations	Copies of all correspondence

VESSEL-BASED REMOTE PROSPECTING AND MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.6.2 OPERATION PHASE						
4.8.6.2.1	Environmental awareness training	Ensure personnel are appropriately trained	<ul style="list-style-type: none"><li>Undertake Environmental Awareness Training to ensure the vessel's personnel are appropriately informed of the purpose and requirements of the EMPR, including emergency procedures, spill management, etc.</li><li>Ensure that responsibilities are allocated to personnel.</li><li>Establish training and exercise programmes to ensure that the response activities can be effectively executed.</li></ul>	PSJV (Environmental Manager/Officer)	At commencement of operation	Copy of attendance register and training records
4.8.6.2.2	Stakeholder consultation and notification and presence of survey vessel	Minimise interaction with other vessel	Request, in writing, HyrdoSAN to release Radio Navigation Warnings for the duration of the survey.	Contractor	7 days prior to establishment at prospecting/mine site and throughout operation	Confirm that request was sent to the SAN Hydrographic office
4.8.6.2.3			Distribute a Notice to Mariners to fishing companies and directly onto vessels where possible. The notice should give notice of: <ul style="list-style-type: none"><li>the co-ordinates of survey area;</li><li>an indication of the survey timeframes; and</li><li>an indication of the 500 m safety zone around the survey vessel.</li></ul>	Contractor		Copies of all correspondence
4.8.6.2.4			Display correct signals by day and lights by night (including twilight).	Contractor	Throughout operation at night	
4.8.6.2.5			Enforce the 500 m safety/exclusion zone around survey vessel.	Contractor	During surveying	Provide record of any incidents and interaction with other vessels
			Maintain visual radar watch for approaching vessels during the survey and warn by radio, if required.	Contractor		
4.8.6.2.6	Discharge of waste to sea	Minimise discharges and ensure discharges from vessels are in accordance with MARPOL 73/78 standards	Implement the following plans and certificates: <ul style="list-style-type: none"><li>Waste Management Plan.</li><li>SOPEP.</li></ul>	Contractor	Throughout transit, during discharges	Copy of all plans

VESSEL-BASED REMOTE PROSPECTING AND MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.6.2.7	Discharge of waste to sea	Minimise discharges and ensure discharges from vessels are in accordance with MARPOL 73/78 standards	Sewage: <ul style="list-style-type: none"> <li>• Ensure vessels have:               <ul style="list-style-type: none"> <li>&gt; an onboard sewage treatment plant;</li> <li>&gt; a sewage comminuting and disinfecting system, and/or</li> <li>&gt; a sewage holding tank.</li> </ul> </li> <li>• Sewage discharge to comply with the following:               <ul style="list-style-type: none"> <li>&gt; Discharge of sewage beyond 12 nm requires no treatment. However, no visible floating solids must be produced or discolouration of the surrounding water must occur.</li> <li>&gt; Sewage must be comminuted and disinfected for discharges between 3 nm and 12 nm from the coast.</li> <li>&gt; Disposal of sewage from holding tanks must be discharged at a moderate rate while the ship is proceeding <i>on route</i> at a speed not less than 4 knots.</li> </ul> </li> <li>• Ensure dechlorinate sewage effluents and cooling water meets World Bank standards for residual chlorine (i.e. 0.2 mg/l at the point of discharge prior to dilution).</li> </ul>	Contractor	Throughout operation, during discharges	Ensure correct operation of sewage treatment system (compliance with MARPOL 73/78 standards)
4.8.6.2.8			Galley waste <ul style="list-style-type: none"> <li>• Discharges to comply with the following:               <ul style="list-style-type: none"> <li>&gt; No disposal to occur within 3 nm of the coast.</li> <li>&gt; Disposal between 3 nm and 12 nm needs to be comminuted to particle sizes smaller than 25 mm.</li> <li>&gt; Discharge beyond 12 nm requires no treatment.</li> </ul> </li> <li>• Minimise the discharge of waste material should obvious attraction of fauna be observed.</li> </ul>	Contractor	Throughout operation, during discharges	Ensure correct operation of macerator Volume of waste discharged and discharge location

VESSEL-BASED REMOTE PROSPECTING AND MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.6.2.9	Discharge of waste to sea	Minimise discharges and ensure discharges from vessels are in accordance with MARPOL 73/78 standards	Deck and machinery drainage: <ul style="list-style-type: none"> <li>• Ensure all deck and machinery drainage is routed to:               <ul style="list-style-type: none"> <li>&gt; equipment for the control of oil discharge from machinery space bilges and oil fuel tanks, e.g. oil separating/filtering equipment and oil content meter;</li> <li>&gt; oil residue holding tanks; and</li> <li>&gt; Oil discharge monitoring and control system.</li> </ul> </li> <li>• Oil in water concentration must be less than 15 ppm prior to discharge overboard.</li> <li>• Ensure all process areas are bunded and drip trays are used to collect run-off from non-bunded equipment.</li> <li>• Use low-toxicity biodegradable detergents and reusable absorbent cloths in cleaning of all deck spillage.</li> </ul>	Contractor	Throughout operation, during discharges	Ensure correct operation of oil separating/filtering equipment and oil content meter (compliance with MARPOL 73/78 standards)
4.8.6.2.10			General waste: <ul style="list-style-type: none"> <li>• No disposal overboard.</li> <li>• Ensure on-board solid waste storage is secure.</li> <li>• Transport ashore for disposal/recycling or incinerate (if in possession of an Atmospheric Emissions Licence).</li> </ul>	Contractor	Throughout operation	Volume of waste generated Volume transferred for onshore disposal/incinerated Waste receipts Atmospheric Emissions Licence
4.8.6.2.11			Hazardous waste (incl. oil and medical): <ul style="list-style-type: none"> <li>• Segregate, classify and store all hazardous waste in suitable receptacles on board in order to ensure the safe containment and transportation of waste.</li> <li>• Provide a specific waste management storage and segregation area at the onshore logistics base.</li> <li>• Dispose of hazardous waste at a facility that is appropriately licensed and accredited.</li> </ul>	Contractor	Throughout operation	Record types and volumes of chemical and hazardous Waste receipts

VESSEL-BASED REMOTE PROSPECTING AND MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.6.2.12	Vessel lighting	Minimise disturbance of marine fauna by increased ambient lighting in the offshore environment	Reduce lighting to a minimum compatible with safe operations whenever and wherever possible by: <ul style="list-style-type: none"> <li>Minimising the number of lights and the intensity of the lights.</li> <li>Automatically or manually controlling lighting in areas where it is not a continuous requirement through the process control system.</li> <li>Positioning light sources in places where emissions to the surrounding environment are minimised.</li> </ul>	Contractor	During operation, at night	
4.8.6.2.13			<ul style="list-style-type: none"> <li>Keep disorientated, but otherwise unharmed, seabirds in dark containers for subsequent release during daylight hours.</li> <li>Euthanise of injured birds humanly.</li> <li>Report ringed/banded birds to the appropriate ringing/banding scheme (details are provided on the ring).</li> </ul>	Contractor (only a trained crew member)	During operation	Record information on patterns of bird reaction to lights and real incidents of injury/death, including stray land birds resting on the rig, during the operation
4.8.6.2.14	Bunkering / refuelling at sea	Ensure that the necessary safeguards are in place and avoid any accidental oil / fuel spills	<ul style="list-style-type: none"> <li>Transfer of oil at sea is not permitted within the economic zone (i.e. 200 nm from the coast) without the permission of SAMSA. In terms of the Marine Pollution (Control and Civil Liability) Act, 1981 a Pollution Safety Certificate must be obtained before commencement of operations.</li> <li>Submit an application in terms of Regulation 14 (Regulation under the Prevention and Combating of Pollution of the Sea by Oil Act) to SAMSA (Principal Officer) at the port nearest to where the transfer is to take place.</li> <li>Inform SAMSA of location, supplier and timing, 5 days prior to refuelling at sea.</li> </ul>	Contractor	As required, 5 days prior to refuelling	SAMSA approval

VESSEL-BASED REMOTE PROSPECTING AND MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.6.2.15	Helicopter operations	Minimise disturbance / damage to marine and coastal fauna.	Ensure that all flight paths: <ul style="list-style-type: none"> <li>avoid flying over coastal reserves (MacDougall's Bay), seal colonies (Bucchu Twins) or Important Bird Areas (Orange River Mouth wetlands); and</li> <li>between Alexander Bay and mining vessel are perpendicular to the coast.</li> </ul>	Helicopter operator	During flights between vessel and airport	Flight path / log Report deviations from set flight plans.
4.8.6.2.16			Avoid extensive low-altitude coastal flights (<2 500 ft and within 1 nm of the shore), particularly during the winter/spring (June to December) whale migration period and during the November to January seal breeding season.			
4.8.6.2.17			Comply with aviation and authority guidelines and rules.			
4.8.6.2.18			Brief all pilots on ecological risks associated with flying at a low level along the coast or above marine mammals.			Copy of attendance register and training records
4.8.6.2.19	Oil spills	Minimise damage to the environment by implementing response procedures efficiently	Inspect and maintain all fuel containers.	Contractor	During operation	
4.8.6.2.20			Notify SAMSA about wrecked vessels (safety and pollution). Give location details to HydroSAN.	Contractor or PSJV	In event of a wreck	Copies of all correspondence
4.8.6.2.21			In the event of an oil spill immediately implement emergency plans (refer to Section 4.8.6.1.6) and notify (a) the Principal Officer of the nearest SAMSA office, (b) the DEA's Chief Directorate of Marine & Coastal Pollution Management in Cape Town and (c) Smit Amandla Marine. Information that should be supplied when reporting a spill includes: <ul style="list-style-type: none"> <li>Name and contact details of person reporting the incident;</li> <li>The type and circumstances of incident, ship type, port of registry, nearest agent representing the ships company;</li> <li>Date and time of spill;</li> <li>Location (co-ordinates), source and cause of pollution;</li> <li>Type and estimated quantity of oil spilled and the potential and probability of further pollution;</li> <li>Weather and sea conditions; and</li> </ul>	Contractor	In event of spill	Record of all spills (Spill Record Book), Incident log

VESSEL-BASED REMOTE PROSPECTING AND MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
			<ul style="list-style-type: none"> <li>Action taken or intended to respond to the incident.</li> </ul>			
4.8.6.2.22	Oil spills	Minimise damage to the environment by implementing response procedures efficiently	Attempt to control and contain the spill at sea, as far as possible and whenever the sea state permits, using suitable recovery techniques to reduce the spatial and temporal impact of the spill.	Contractor		
4.8.6.2.23			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.	Contractor	In event of spill	Record of all spills (Spill Record Book), including spill reports; emergency exercise reports; audit reports. Incident log
4.8.6.2.24			<ul style="list-style-type: none"> <li>Use low toxicity dispersants that rapidly dilute to concentrations below most acute toxicity thresholds.</li> <li>Use dispersants only with the permission of DEA.</li> </ul>	Contractor	In event of spill	DEA approval
4.8.6.2.25			Dispersants should not be used: <ul style="list-style-type: none"> <li>On diesel or light fuel oil.</li> <li>On heavy fuel oil.</li> <li>On slicks &gt; 0.5 cm thick.</li> <li>On any oil spills within 5 nautical miles offshore or in depths &lt; 30 m.               <ul style="list-style-type: none"> <li>In areas far offshore where there is little likelihood of oil reaching the shore.</li> </ul> </li> </ul>	Contractor	In event of spill	
4.8.6.2.26	Dropped equipment	Minimise hazards left on the seabed or floating in the water column	Undertake frequent checks to ensure items and equipment are stored and secured safely on board each vessel.	Contractor	As required	
4.8.6.2.27			Retrieve any dropped equipment, where practicable, after assessing safety and metocean conditions before performing any retrieval operations.	Contractor	As required	Establish a hazards database listing: <ul style="list-style-type: none"> <li>the type of gear left on the seabed</li> <li>date of abandonment / loss</li> <li>location; and</li> <li>where applicable, the dates of retrieval.</li> </ul>



VESSEL-BASED REMOTE PROSPECTING AND MINING						
Ref. No.	Activity	Environmental and social objective	Mitigation and Management actions	Responsibility	Timing / Frequency	Monitoring and record keeping requirements
4.8.6.2.28	Dropped equipment	Minimise hazards left on the seabed or floating in the water column	Notify SAMSA and HydroSAN when any items that constitute a seafloor or navigational hazard are lost on the seabed, or in the sea.	Contractor	As required	Copies of all correspondence
<b>4.8.6.3 DEMOBILISATION PHASE</b>						
4.8.6.3.1	Stakeholder consultation and notification of survey completion	Ensure that relevant parties are aware that the prospecting/mining operation is complete	Inform all key stakeholders (see Section 4.8.6.1.8) that the mining vessel is off location.	Contractor	Within two weeks after completion of prospecting/mining	Copies of all correspondence
4.8.6.3.2	Final waste disposal	Minimise pollution and ensure correct disposal of waste	Dispose all waste retained onboard at a licensed waste site using a licensed waste disposal contractor.	Contractor	When vessel is in port	Waste receipts
4.8.6.3.3	Implement post-mining seabed and benthic fauna monitoring programme	<ul style="list-style-type: none"> <li>To quantify the spatial and temporal impact of mining on benthic invertebrate macrofauna community composition</li> <li>To demonstrate natural recovery processes</li> </ul>	Refer to Section 4.9.	PSJV, in collaboration with Contractor	Commence within three years of last sampling. Sample every third year to year 12 (i.e. when communities are expected to reach at least 80% of the measured pre-impact baseline levels)	Monitoring results to be included in Performance Assessments

## 4.9 HABITAT MONITORING

HABITAT MONITORING						
Ref. No.	Activity	Habitat	Monitoring objective	Monitoring details	Responsibility	Timing / Frequency
4.9.1	Undertake a biodiversity survey of intertidal rocky shores	Intertidal rocky shores	<ul style="list-style-type: none"> <li>To determine the species diversity, percentage cover and abundance of benthic macrofauna and macroalgae</li> <li>To investigate the relationship of benthic community structure with time since mining.</li> </ul>	<ul style="list-style-type: none"> <li>Ten representative sites per concession area (1a, 2a and 3a).</li> <li>Sample at unmined, currently mined and historically mined sites.</li> <li>At each site,               <ul style="list-style-type: none"> <li>survey six quadrats placed equidistantly along each of five transects set perpendicular to the shore from mean low water spring to mean high water spring-tide levels; and</li> <li>record species as primary and secondary cover, and count all rare and mobile species.</li> </ul> </li> </ul>	PSJV in collaboration with Contractor	<p>Initial survey, at suitable spring low tide periods</p> <p>Follow-up survey, five years after initial survey, at suitable spring low tide periods</p>
4.9.2	Undertake a biodiversity survey of intertidal sandy beaches	Intertidal sandy beaches	<ul style="list-style-type: none"> <li>To quantify the impact of coffer dam mining on intertidal communities</li> <li>To determine recovery rates of the affected biota on cessation of mining</li> <li>To investigate the relationship of invertebrate macrofaunal communities with time since mining</li> </ul>	<ul style="list-style-type: none"> <li>Adopt a before-after/control-impact (BACI) sampling approach, if possible, that provides spatial replication within each beach and temporal replication at different times after mining.               <ul style="list-style-type: none"> <li>Two sites per mining target and two control sites that will remain undisturbed for the duration of the monitoring programme.</li> <li>At each site:                   <ul style="list-style-type: none"> <li>measure beach gradient, particle size, wave height and frequency, effluent-line crossings and surf zone width;</li> <li>take replicate samples at each of 10 stations equidistantly spaced between the drift line to the low water mark along three transects; and</li> <li>identify macrofauna to species level (where possible) and determine the species diversity, and the abundance and biomass for each species.</li> </ul> </li> </ul> </li> </ul>	PSJV in collaboration with Contractor	<p>Initial pre-mining survey: Annually, at the same time of year, for two consecutive years prior to mining, at suitable spring low tide periods. Where mining is planned for 2017/18/19, representative concurrent surveys should be undertaken</p> <p>Post-mining survey: Annually at the same time of the year for the first three years; and then again at year 5 and 7<sup>4</sup>.</p>

<sup>4</sup> Communities are expected to reach at least 80% of the measured pre-impact baseline levels and remain at this level for at least three consecutive years before a site can be considered 'recovered'. This is expected to be achieved within 7 years after cessation of mining.

HABITAT MONITORING						
Ref. No.	Activity	Habitat	Monitoring objective	Monitoring details	Responsibility	Timing / Frequency
				<ul style="list-style-type: none"> <li>If, the BACI approach is not possible (i.e. control sites cannot remain undisturbed for the duration of the monitoring programme), then sample at unmined, currently mined and historically mined sites throughout the licence area.               <ul style="list-style-type: none"> <li>&gt; Sample eight representative sites, of which two much be unmined.</li> <li>&gt; At each site: as for BACI approach described above.</li> </ul> </li> </ul>		Annually, at the same time of year, for at least two consecutive years, at suitable spring low tide periods
4.9.3	Monitor sand accumulation or erosion from the southern and northern limits of individual coffer dams	Supratidal and intertidal sandy beaches	To determine the extent of sand accumulation or erosion to the north and south of individual coffer dams	<ul style="list-style-type: none"> <li>Measure the beach profiles to the south and north of individual coffer dams.</li> </ul>	PSJV	Monthly, at spring low tide
4.9.4	Implement pre- and post-mining seabed and benthic fauna monitoring programme	Offshore unconsolidated sediments	<ul style="list-style-type: none"> <li>To quantify the spatial and temporal impact of mining on benthic invertebrate macrofauna community composition</li> <li>To demonstrate natural recovery processes</li> </ul>	<ul style="list-style-type: none"> <li>Adopt a before-after/control-impact (BACI) sampling approach to quantify the spatial and temporal impact of mining on benthic invertebrate macrofauna community composition.</li> <li>The number of monitoring sites will depend on the final mine plan configuration.</li> <li>Baseline monitoring:               <ul style="list-style-type: none"> <li>&gt; Collect biological baseline information on the spatial distribution and variability of the benthic macrofaunal communities and sediment structure in and around mining target areas, prior to the commencement of mining.</li> <li>&gt; At each site,                   <ul style="list-style-type: none"> <li>- collect 10 replicate samples with a Van Veen grab deployed off a suitable survey vessel; and</li> <li>- Estimate the volume of each grab and remove a sediment sample for granulometry, organic matter (carbon) and trace metal analyses.</li> </ul> </li> <li>&gt; Identify organisms to the lowest taxonomic level possible and the abundance and biomass of each species recorded.</li> </ul> </li> </ul>	PSJV, in collaboration with Contractor	<p>Collect baseline data at the same time of year, annually for two years prior to the commencement of offshore mining</p> <p>Since marine benthic samples only have a validity period of three-years, sampling should be repeated every three years until mining is complete.</p>

HABITAT MONITORING						
Ref. No.	Activity	Habitat	Monitoring objective	Monitoring details	Responsibility	Timing / Frequency
				<ul style="list-style-type: none"> <li>• Post mining recovery monitoring:               <ul style="list-style-type: none"> <li>&gt; Collect biological recovery information on the spatial distribution and variability of the benthic macrofaunal communities and sediment structure from impacted and control sites in and around mining target areas.</li> <li>&gt; At each site,                   <ul style="list-style-type: none"> <li>- collect 10 replicate samples with a Van Veen grab deployed off a suitable survey vessel; and</li> <li>- Estimate the volume of each grab and remove a sediment sample for granulometry, organic matter (carbon) and trace metal analyses.</li> </ul> </li> <li>&gt; Identify organisms to the lowest taxonomic level possible and the abundance and biomass of each species recorded.</li> </ul> </li> </ul>		Commence within three years of last sampling. Sample every third year to year 12 <sup>5</sup>

<sup>5</sup> Communities are expected to reach at least 80% of the measured pre-impact baseline levels and remain at this level for at least 3 consecutive years. This is expected to be achieved within 12 years after cessation of mining.



## 5 CLOSURE PLAN

This chapter presents the Closure Plan for Mining Right 544MRC. This plan has been compiled in compliance with Appendix 5 of the EIA Regulations 2014.

### 5.1 BACKGROUND

The approved EMPR for the onshore Mining Right 550MR, which provided for the rehabilitation of historic (pre-2008) and future (post-2008) mining activities, provided a framework for the development of a post mining land use plan for the region (see Figure 5-1). The post mining land use plan considered the following categories:

- Tourism nodes, precincts and linkages (see Table 5-1); and
- Tourism attraction, facilities and access requirements (see Table 5-2).

The post mining land use plan (or closure plan) was defined and driven by the wider social, economic, physical and biological context within which the mine is situated. The objective was to follow a holistic approach by understanding the broader environment, into which mine closure was integrated. This planning included the development of a social and labour plan, which was aimed at managing a mine towards the post-closure scenario. While the PSJV has an important role to play in contributing to a sustainable post-closure scenario, it is neither possible nor the PSJV's sole responsibility to achieve this, as it requires multi-stakeholder partnerships where risks, responsibilities and opportunities are shared.

### 5.2 CLOSURE OBJECTIVES

The closure objectives aim to set out the long-term goals for closure outcomes. The objectives are based on the proposed post-mining land use (see Figure 5-1) and are as specific as possible so as to provide a clear indication of what the PSJV commits to achieving at closure.

The four main overarching objectives for closure include:

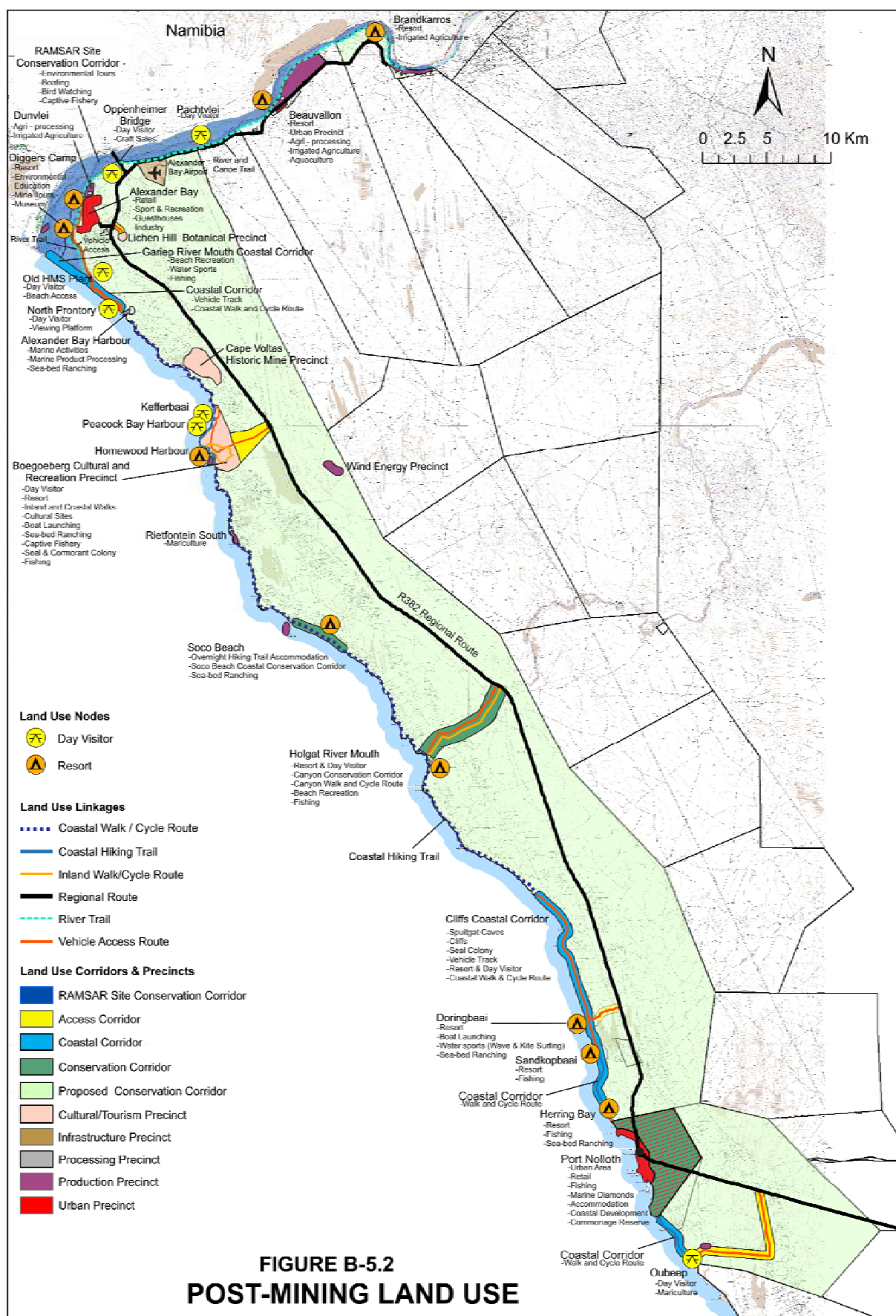
1. safe to humans, domestic livestock and wildlife;
2. alleviate or eliminate environmental damage;
3. achieve a productive use of the land, or return to its original condition or an acceptable alternative; and
4. able to sustain an agreed post-mining land use.

The closure objectives for the differing environments (including the Orange River and Surf Zone) and sea concessions (1a, 2a, 3a and 1b) over which the right is allocated is provided below.

#### 5.2.1 ORANGE RIVER

The mining right includes approximately 1 471 ha of the lower Orange River (river and estuary area), extending from the Farm Arrisdraft in the east to the river mouth in the west; covering a distance of approximately 40 km (Figure 5-2).

The Orange River has been significantly impacted by anthropogenic activities along its banks and within its floodplain (including historic mining, dams and agriculture). The present situation is that the Orange River mouth has become increasingly estuarine in character and, except for two brief periods of a few days each, the mouth has been consistently open since December 1993. A major consequence of this is the degradation of the desiccated saltmarsh on the south side of the estuary (see Figure 5-45 in Volume 1).



**Figure 5-1: Post mining land use**  
(Source: Site Plan 2008)



**Table 5-1: Post Mining Land Use: Tourism Nodes, Precincts and Linkages (Source: Site Plan 2008)**

Place / Location	Day Visitor Nodes	Resort Node	Tourist Precinct	Linkages
(i) Brandkaros		Tourist resort with overnight accommodation		<ul style="list-style-type: none"> <li>R382 regional link</li> <li>River trail (i.e. on-land and canoe trail) to Gariep River Mouth</li> </ul>
(ii) Beauvallon (Farm) Beauvallon (Village)		Tourist overnight accommodation Tourist overnight accommodation (e.g. guesthouse, B&B's)		<ul style="list-style-type: none"> <li>R382 regional link</li> <li>River trail (i.e. on-land and canoe trail) to Gariep River Mouth and Brandkaros</li> </ul>
(iii) Oppenheimer Bridge	Day visitor view point of transfrontier gateway with commercial opportunities (e.g. tourist curios)			<ul style="list-style-type: none"> <li>R382 regional link and entry-point to Namibia</li> </ul>
(iv) Pachtvlei	Riverside day picnic area			<ul style="list-style-type: none"> <li>R382 regional link</li> <li>River trail (i.e. on-land and canoe trail) to Gariep River Mouth and Brandkaros</li> </ul>
(v) Diggers Camp Multi-Purpose Resource Centre (Delwerskamp - (Alexander Bay South)	Day visitor programmes Information desk Mine tours Environmental education Mine museum	Tourist overnight accommodation		<ul style="list-style-type: none"> <li>Pedestrian trail to RAMSAR Site and Old HMS Plant/Gariep River Mouth</li> <li>Vehicular access to Old HMS Plant day picnic area and Gariep Estuary beach</li> </ul>
(vi) Alexander Bay town	Library Retail Sports facilities	Overnight accommodation (e.g. Guesthouses, B & B's), Restaurants		<ul style="list-style-type: none"> <li>Access via Oranjeweg off regional route R382</li> </ul>
(vii) Old HMS Plant	Day picnic and beach access – recreation			<ul style="list-style-type: none"> <li>Pedestrian route to Gariep Estuary Beach and RAMSAR Site</li> <li>Vehicular access to Alexander Bay</li> <li>Coastal vehicle track and walking trail to Alexander Bay Harbour (North Promontory)</li> </ul>
(viii) Alexander Bay Harbour (North Promontory)	Day visitor view point			<ul style="list-style-type: none"> <li>Walking trail and vehicle track to Old HMS Plant day picnic area</li> </ul>
(ix) Boegoeberg Cultural Precinct. <ul style="list-style-type: none"> <li>Kefferbaai</li> <li>Homewood Harbour</li> <li>Peacock Bay Harbour</li> </ul>	Coastal day picnic area Coastal day picnic area Coastal day picnic area and boat launching	Tourist overnight accommodation	Boegoeberg Cultural Precinct including Boegoeberg Twins, grave site, cliffed coastline, seal colony, and coastal bays and harbours (e.g. Kefferbaai, Homewood Harbour, Peacock Harbour)	<ul style="list-style-type: none"> <li>Access corridor to R382</li> <li>Inland vehicle access road and walking trail to grave site and Boegoeberg Twins</li> <li>Vehicle access road to Kefferbaai, Homewood Harbour, Peacock Bay Harbour and Seal Colony</li> <li>Coastal walking trail from Kefferbaai to Seal Colony</li> </ul>
(x) Soco Beach		Overnight accommodation		<ul style="list-style-type: none"> <li>Coastal hiking trail</li> </ul>
(xi) Holgat River Mouth	Day picnic area	Overnight accommodation		<ul style="list-style-type: none"> <li>Access corridor to R382</li> </ul>
(xii) Doringbaai	Day picnic area and boat launching	Overnight accommodation		<ul style="list-style-type: none"> <li>Access corridor to R382</li> <li>Coastal trail (walking, cycling and vehicle track) in coastal corridor from Cliffs to Herring Bay</li> </ul>
(xiii) Sandkopbaai	Day picnic area	Overnight accommodation		<ul style="list-style-type: none"> <li>Access via coastal trail (i.e. walking, cycling and vehicle track) to Doringbaai. Share access to R382 from Doringbaai via access corridor</li> </ul>

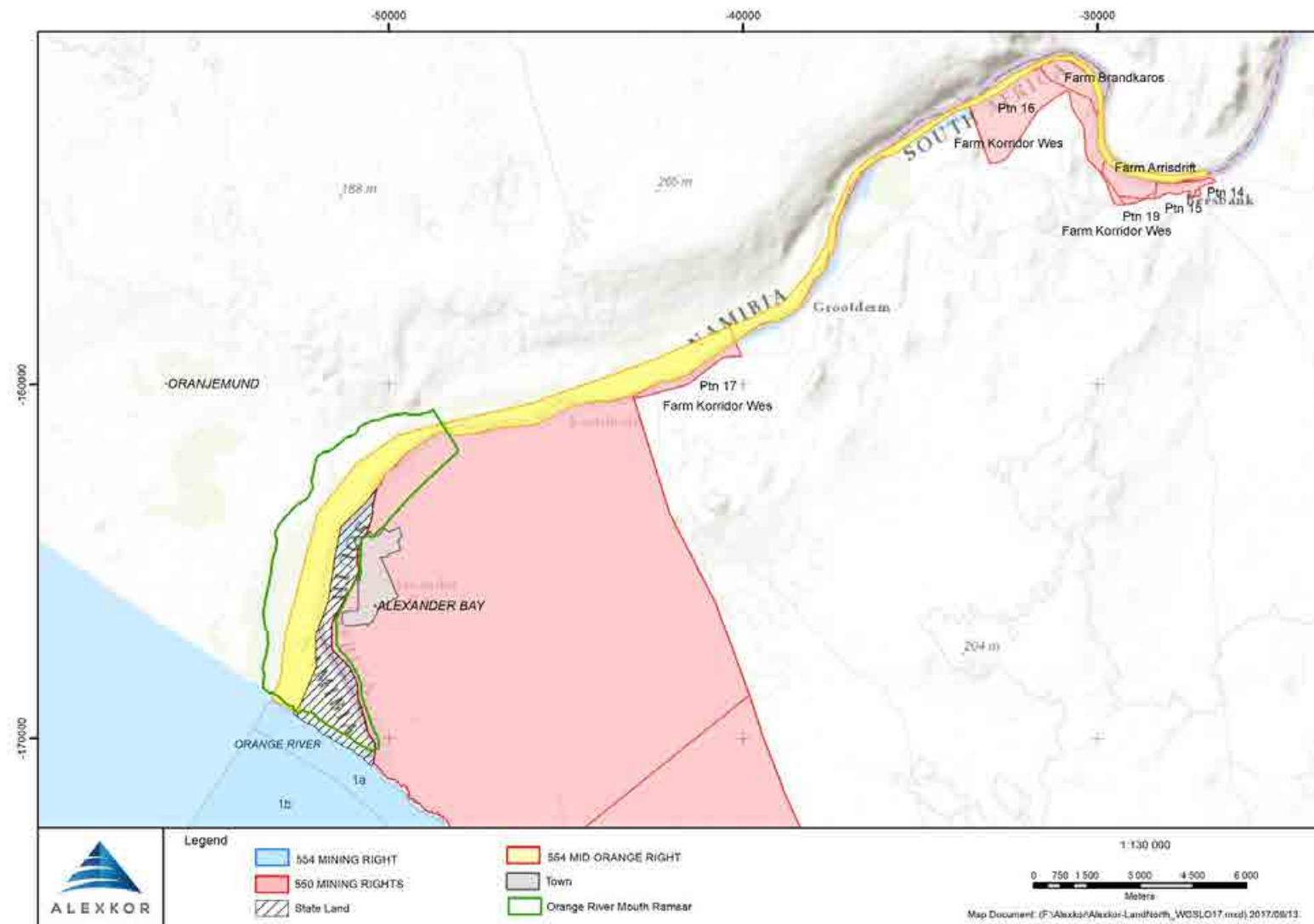


Place / Location	Day Visitor Nodes	Resort Node	Tourist Precinct	Linkages
(xiv) Herring Bay	Day picnic area	Overnight accommodation		<ul style="list-style-type: none"> <li>Access via Stilbaai and Port Nolloth Commonage to R382</li> <li>Coastal trail (only walking and cycling) to Sandkopbaai</li> </ul>
(xv) O'Beep	Day picnic area			<ul style="list-style-type: none"> <li>Access via existing access road to R382</li> <li>Coastal trail (only walking and cycling) to McDougal's Bay</li> </ul>

**Table 5-2: Post Mining Land Use: Tourism Attractions, Facilities and Access Requirements (Source: Site Plan 2008)**

Place/Location	Attraction	Facilities	Access/Route
(i) Gariep River	<ul style="list-style-type: none"> <li>Canoe trail/tours</li> <li>Agri-tourism</li> <li>Farm-stays and overnight accommodation</li> <li>Fishing</li> <li>Birdwatching</li> <li>Namib landscape scenery north of Gariep River</li> <li>Old fort site at Arriesdrift</li> </ul>	<ul style="list-style-type: none"> <li>Camping (e.g. Beauvallon)</li> <li>Overnight accommodation (e.g. Brandkaros)</li> <li>Canoe rental, launching, instruction and guided tours</li> <li>Bird watching points</li> </ul>	<ul style="list-style-type: none"> <li>R382 regional route</li> </ul>
(ii) Oppenheimer Bridge	<ul style="list-style-type: none"> <li>Transfrontier gateway to Namibia</li> <li>Gariep River and RAMSAR Site</li> </ul>	<ul style="list-style-type: none"> <li>Day visitor view point</li> <li>Information board</li> <li>Regional and local product sales</li> </ul>	<ul style="list-style-type: none"> <li>R382 regional route</li> <li>Gariep River</li> </ul>
(iii) Mine Museum Diggers Camp Multi-Purpose Resource Centre (Delwerskamp)	<ul style="list-style-type: none"> <li>Mine history</li> <li>Mine artefacts</li> <li>Diamond panning</li> <li>Archaeological finds</li> <li>Environmental displays and information</li> <li>Environmental education</li> <li>Mine tours</li> </ul>	<ul style="list-style-type: none"> <li>Information desk</li> <li>Overnight accommodation</li> <li>Mine tour embarkation point</li> <li>Environmental education centre</li> </ul>	<ul style="list-style-type: none"> <li>R382 regional route via Oranjeweg</li> </ul>
(iv) Gariep River Estuary	<ul style="list-style-type: none"> <li>RAMSAR Site</li> <li>Birdwatching</li> <li>Gariep River Mouth and beach</li> <li>Sunset cruises</li> </ul>	<ul style="list-style-type: none"> <li>Day picnic and visitor facilities (Old HMS Plant)</li> <li>RAMSAR Site, estuary and beach tours/walks</li> <li>Boat launching</li> </ul>	<ul style="list-style-type: none"> <li>Vehicle route from Alexander Bay</li> <li>Walking routes from day picnic and visitor site at Old HMS Plant, as well as from Delwerskamp</li> </ul>
(v) Old HMS Plant	<ul style="list-style-type: none"> <li>Historical mine plant and buildings</li> <li>Beach access and activities</li> <li>Non-motorized watersports</li> </ul>	<ul style="list-style-type: none"> <li>Adjacent day picnic and visitor facilities</li> <li>Boardwalks to beach and RAMSAR Site</li> <li>Information board</li> </ul>	<ul style="list-style-type: none"> <li>Vehicle route from Alexander Bay</li> <li>Walking route from Alexander Bay and Delwerskamp</li> </ul>
(vi) Coastal trail (Old HMS Plant to Harbour) and Alexander Bay Harbour (North Promontory)	<ul style="list-style-type: none"> <li>Commanding coastal views (North Promontory viewpoint)</li> <li>Alexander Bay Harbour, including diamond boat activity</li> </ul>	<ul style="list-style-type: none"> <li>Coastal walk, cycle and vehicle route</li> <li>View point and visitor facility at north promontory of Alexander Bay Harbour</li> <li>Information board</li> </ul>	<ul style="list-style-type: none"> <li>Access from day picnic/visitor node at Old HMS Plant</li> </ul>

(vii) Mine Tour	<ul style="list-style-type: none"> <li>• Land and sea diamond mining</li> <li>• Voltas mine</li> <li>• Mega trench</li> <li>• Walpomp beach diamond recovery (diver)</li> <li>• Sea diamond recovery (boats)</li> <li>• Historic Hans Merensky diamond recovery plant and fossil oyster terraces</li> <li>• Current diamond recovery plant</li> <li>• Oyster Farm</li> </ul>	<ul style="list-style-type: none"> <li>• Tour office and departure point</li> <li>• Tour transport</li> </ul>	<ul style="list-style-type: none"> <li>• Guided mine tours within mine security area</li> </ul>
(viii) Lichen Hill	<ul style="list-style-type: none"> <li>• Botanical and landscape feature; lichen fields and gravel plain flora</li> </ul>	<ul style="list-style-type: none"> <li>• Information board</li> </ul>	<ul style="list-style-type: none"> <li>• R382 regional route</li> </ul>



**Figure 5-2: Orange River portion of Mining Right 554MRC**

Key mining- and agricultural-related structures (see Figure 3-7) that have contributed to the degradation of the saltmarsh include:

- **Road embankment:** The construction of a road embankment in 1964 isolated approximately a third of the estuary from the active system. In 1997 the seaward end of this embankment was breached in an attempt to re-activate the saltmarsh in the area. This was partially successful, but the breach was too small to permit large volumes of water to enter the saltmarsh.
- **Scrap machinery (“Detroit riprap”):** The seaward end of the embankment was “anchored” or “pinned” in position by means of scrap machinery being embedded in the beach berm. The scrap machinery has prevented the mouth from migrating southwards to its fullest possible extent and thus has also limited the ingress of seawater into the saltmarsh.
- **Dunvlei dyke:** The construction of the dyke to protect the Dunvlei Farm and extend agricultural land blocked the southernmost channel feeding the saltmarsh in the south-western corner of the estuary. This has contributed significantly to the degradation of the saltmarsh.
- **Sewage oxidation ponds:** Sewage oxidation ponds were also constructed in the floodplain, which also blocked the southernmost channel feeding the saltmarsh. Although the ponds have been decommissioned, the river channel against the south bank has not yet been rehabilitated.

Although these activities predate the PSJV’s involvement and management, it is responsible for remediating some of these historic mining-related impacts. The structures/areas requiring remediation by the PSJV include:

- **Road embankment:** The objective of removing the approximately 3 km road embankment is to eliminate a major obstruction to the ingress of water from the river and estuary basin into the saltmarsh during periods of high water levels.
- **Scrap machinery:** The removal of this material would enable the mouth of the river to move further south, which would be of benefit to the presently desiccated saltmarsh on the south bank.
- **Sewage oxidation ponds:** The removal and rehabilitation of former sewage oxidation ponds will facilitate the rehabilitation of the floodplain and eliminate obstructions to the ingress of water into the saltmarsh.
- **Rehabilitation of onshore mining activities:** The objective is to limit the impacts related to windblown sediments and saline water from adjacent mining operations in order to facilitate the recovery of the degraded saltmarsh area.

The PSJV has commitment to attend to these historic rehabilitation requirements in consultation with DEA, and these requirements are detailed in the Orange River Mouth Estuarine Management Plan (Plan prepared by the DEA). The rehabilitation requirements pertaining to mining Right 554MRC have been included in the Mitigation and Management Plan (see Section 4.8.7).

### 5.2.2 SURF ZONE

The surf zone occurs along the western boundary of Farm No. 1 and Farm No. 155, covering a total of approximately 888 ha, and extends from the high water mark to a distance of 31.49 m seawards of the low water mark (see Figure 2-2). Mining activities in the surf zone include coffer dam, “walpomp” and mobile pump unit operations (see Section 2.5).

The closure objective for any mine site in the surf zone is to restore disturbed areas as close as possible to its original state (i.e. the pre-mining land use condition) through rehabilitation. Although rehabilitation to some extent takes place naturally by waves, currents, winds, etc., mechanical intervention by the contractor / operator is required to assist with the post mining rehabilitation. This primarily relates to:

- **Removal of imported rock (in the case of coffer dam mining).**

- Removal of all artificial constructions or beach modifications (e.g. tracks, berms, stockpiles, etc.), structures, equipment (including derelict), materials, waste, debris, rubble, etc. from site.
- Removal of all tailings stockpiles that have been created on the high shore.
- Reshaping beach and supratidal area back as close to the original profile as possible.
- Closing and rehabilitation of all tracks leading to allocated mining concession areas.

### 5.2.3 'A' CONCESSIONS

Mining Right 554MRC includes three 'a' concessions, namely 1a, 2a and 3a (see Figure 2-1), which have a combined area of approximately 9 672 ha. The 'a' concessions start at a distance of 31.49 m seawards of the low water mark and extend to a distance of 1 000 m offshore, as measured from the high water mark. Minimum and maximum water depths in the 'a' sea concessions are approximately 5 m and 25 m, respectively. Mining activities within the 'a' concessions are typically undertaken by divers from small boats (see Section 2.5.4). However, coffer dams and mobile pump units may also mine out into water depths of the 'a' concession area.

The closure objective for mining in 'a' concessions is to allow disturbed areas to return naturally to its original pre-mining state. In order to minimise the impact during mining, it is recommended that boat and vessel operations are positioned in such a way that tailings are discharged back into mined out gullies or into areas of unconsolidated sediment adjacent to mining targets. Active (mechanical) rehabilitation of mined out (excluding coffer dam mining) is not practical, possible or considered necessary, as seabed sediments are remobilised and redistributed by waves and currents, particularly during storm events.

### 5.2.4 'B' CONCESSIONS

Mining Right 554MRC includes the '1b' concession area (see Figure 2-1), which has an area of approximately 20 693 ha. The 'b' concessions start from the end of the 'a' concession (i.e. 1 000 m offshore from the high water mark) to a distance of 5 000 m offshore of the high water mark. Minimum and maximum water depths in the '1b' sea concession are approximately 18 m and 64 m, respectively. Mining activities within the '1b' concession is typically from larger vessels deploying remote mining systems (see Sections 2.5.5 to 2.5.7).

The closure objective for mining in the 'b' concession is as for the 'a' concessions, i.e. allow disturbed areas to return naturally to its original pre-mining state. Active (mechanical) rehabilitation of mined out is not practical, possible or considered necessary, as seabed sediments are remobilised and redistributed by waves and currents, particularly during storm events.

## 5.3 MONITORING COMPLIANCE

The closure of individual mining concessions within the larger mining right area is undertaken concurrently with the mining operation. Contractors are required to rehabilitate disturbed areas with the aim of achieving the closure objectives prior to leaving and/or moving to a new site.

The requirements for monitoring and reporting are thus detailed in the Mitigation and Management Plan (refer to Sections 4.4 and 4.7, respectively). A Final Performance Assessment will be prepared, prior to closure, to ensure:

- the requirements of the relevant legislation have been complied with;
- the closure objectives as described in the EMPR have been met; and

- all residual environmental impacts have been identified and the risks of latent impacts, which may occur, have been identified, quantified and arrangements for the management thereof have been assessed.

## **5.4 REHABILITATION MEASURES**

Rehabilitation measures that will be implemented to achieve the closure objectives are presented in the Mitigation and Management Plan (refer to Section 4.8).

## **5.5 IMPACT PREVENTION AND MITIGATION MEASURES**

Management and mitigation measures that will be implemented to avoid or minimise impacts (including pollution) associated with mining activities and closure thereof are presented in the Mitigation and Management Plan (refer to Section 4.8).

## **5.6 IMPLEMENTATION SCHEDULE**

The closure of individual mining concessions within the larger mining right area is undertaken concurrently with the mining operation. Contractors are required to rehabilitate disturbed areas with the aim of achieving the closure objectives prior to leaving and/or moving to a new site. The Mitigation and Management Plan specifies the frequency and timing for the implementation of various specifications (refer to Section 4.8).

## **5.7 MANAGING CLOSURE IMPACTS**

Impacts resulting from closure are expected to be minimal. Since the closure of individual mining concessions is undertaken concurrently with the mining operation, any impacts associated with closure will be managed in terms of the EMPR (refer to Section 4.8).

## **5.8 PUBLIC PARTICIPATION PROCESS**

A Public Participation Process was undertaken as part of the EMPR amendment process in terms of Section 31 of the EIA Regulation 2014. The details of the Public Participation Process are presented in Volume 1 (refer to Chapter 3).

## **5.9 FINANCIAL PROVISION FOR REHABILITATION, CLOSURE AND ON-GOING POST DECOMMISSIONING**

### **5.9.1 INTRODUCTION**

The Regulations pertaining to the Financial Provision for Prospecting, Exploration, Mining or Production Operations (GN R1147) requires the holder of mining right to determine and make financial provision to guarantee the availability of sufficient funds to undertake rehabilitation and remediation of the adverse environmental impacts of prospecting, exploration, mining or production operations. The financial provision is to be determined through a detailed itemisation of all activities and costs, calculated based on the actual costs of implementation of the measures required for:

- Annual rehabilitation liability (Appendix 3 of GN No. R1147).
- Final rehabilitation, decommissioning and mine closure liability (Appendix 4 of GN No. R1147).
- Liability related to residual or latent risks post closure (Appendix 5 GN No. R1147).

The financial provision calculated for Mining Right 554MRC based on the three categories mentioned above is **R 8 525 118**. A breakdown of this quantum is provided in Table 5-3 and in Sections 5.9.2 to 5.9.4.

This quantum does not take into consideration the amount required for the remediation of historic mining-related impacts relating to the Orange River Mouth Estuary as these requirements are included in and form part of the Orange River Mouth Estuarine Management Plan, for which a provisional quantum of R 22.5 million has been identified.

**Table 5-3: Breakdown of proposed financial provision for Mining Right 554MRC**

1.	Annual liability	R 2 305 850
2.	Final rehabilitation and mine closure	R 4 978 908
3.	Latent risk	R 1 240 360
4.	<b>Total</b>	<b>R 8 525 118</b>

### 5.9.2 ANNUAL LIABILITY

The annual liability comprises of a cost estimate to rehabilitate active mining in the current year of operation (i.e. 1 April 2017 to 31 March 2018) and is based on the costs associated with the last financial period (1 April 2016 to 31 March 2017).

Based on the current mining operations in Mining Right 554MRC, the annual liability is required to cover the rehabilitation related to the following activities:

- coffer dam mining in the intertidal zone (beach and surf);
- shore-based diver assisted operations ("walpomp") in the intertidal zone (beach and surf);
- vessel-based diver assisted operations in Sea Concessions 1a, 2a and 3a; and
- vessel-based remote crawler mining (using *MV Ya Toivo*) in Sea Concession 1b.

The annual liability quantum is calculated to be **R 2 305 850**. A breakdown is provided in Table 5-4 below.

**Table 5-4: Breakdown of the annual liability quantum for Mining Right 554MRC**

1.	Coffer dam mining (two currently in operation)	<b>Cost</b>
	Block 60 (quantum breakdown is provided in Box 5-1)	R 760 350
	Langstrand	R 265 500
	<b>Sub-total</b>	<b>R 1 025 850</b>
2.	Shore-based diver assisted operations ("walpomp")	
	Quantum per contractor	R20 000
	<b>Sub-total for 64 contractors</b>	<b>R 1 280 000</b>
3.	Vessel-based diver assisted operations	No active rehabilitation required *
4.	Vessel-based remote crawler mining	No active rehabilitation required *
5	<b>Total</b>	<b>R 2 305 863</b>

\* Note: All vessel-based operator would also be required to maintain the require Protection and Indemnity (P&I) cover for emergencies (e.g. vessel grounding/collision, oil spill, etc.).

### 5.9.3 FINAL REHABILITATION, DECOMMISSIONING AND CLOSURE PLAN

The final rehabilitation, decommissioning and closure quantum refers to the future costs associated with the rehabilitation of all activities within the Mining Right 554MRC in the event of mine closure), excluding costs related to latent (residual) risks post mine closure.

Post mining land use is detailed in Section 5.1 and Figure 5-1. In order to comply with the intended post closure land use, the closure objective for Mining Right 554MRC is to ensure the environment is returned to a condition similar to that of pre-mining.

Since the intertidal and subtidal areas are expected to recover naturally over time (within seven years) with the implementation of the rehabilitation measures costed for in the annual liability quantum (see Section 5.9.2), no further mechanical intervention is considered necessary for final rehabilitation. Similarly, no further mechanical intervention is necessary for mining in the mid- to deep-water areas (> 30 m water depth). The final rehabilitation of the supratidal zone (which occurs above the high water mark) falls within the onshore Mining Right 550MRC, and is not included in the quantum for Mining Right 554MRC. It should be noted that the final rehabilitation of each “walpomp” site (including new access tracks and tailings stockpiles) is covered in the annual liability quantum.

Thus, the quantum for final rehabilitation, decommissioning and closure relates to post mining monitoring, as described in Mitigation and Management Plan (see Section 4.9). This quantum is calculated to be **R 4 978 908**. A breakdown is provided in Table 5-5 below.

**Table 5-5: Breakdown of the final rehabilitation and closure quantum for Mining Right 554MRC**

1.	Coffer dam monitoring	Cost
	Notes:	
	<ul style="list-style-type: none"> <li>5 samplings over a 7 year period</li> <li>Cost per sampling is provided in Box 5-2.</li> </ul>	
	Block 60	R 620 180
	Langstrand	R 620 180
	Geeldoring	R 620 180
	<b>Sub-total</b>	<b>R 1 860 540</b>
2.	Shore-based diver assisted operations (“walpomp”)	No monitoring requirements
3.	Vessel-based diver assisted operations	No monitoring requirements
4.	Vessel-based remote crawler mining	
	Notes:	
	<ul style="list-style-type: none"> <li>4 samplings over a 12 year period</li> <li>Cost per sampling is provided in Box 5-3.</li> </ul>	R 3 118 368
	<b>Sub-total</b>	<b>R 3 118 368</b>
<b>5</b>	<b>Total</b>	<b>R 4 978 908</b>

### 5.9.4 ENVIRONMENTAL (LATENT) RISK

The primary latent risk is considered to be that at mine closure whilst mining of coffer dams across the 17 beach target areas may be completed, that the monitoring assessment of a limited number (two) coffer dams has not been undertaken. The primary latent residual risks relate to rehabilitation, which will be confirmed by the monitoring described above. Communities are expected to reach at least 80% of the measured pre-



impact baseline levels (and remain at this level for at least three consecutive years) within seven years for the intertidal and subtidal areas. The quantum for latent risk assessment is calculated to be **R 1 240 360**. A breakdown is provided in Table 5-5 below.

The following activities when assessed in the context of latent risk in consideration of the mines and works programme for Mining Right 554MRC are not considered to hold significant latent risk. As such a liability is not established:

- Walpomp mining;
- Diver assisted vessel based mining; and
- Mid-to deep water mining (>30 m).

**Table 5-6: Breakdown of quantum for latent risks in Mining Right 554MRC**

Coffer dam monitoring	<b>Cost</b>
Notes:	
• Breakdown of cost per sampling is provided in Box 5-2.	
Coffer dam location A	R 620 180
Coffer dam location B	R 620 180
<b>Sub-total</b>	<b>R 1 240 360</b>
Walpomp mining	None
Diver assisted vessel based mining	None
Mid-to deep water mining (>30 m).	None
<b>Total</b>	<b>R 1 240 360</b>

**Box 5-1: Coffer dam rehabilitation costs(removal of sea wall rock)**

Category	Number	Unit
Excavator (1)	1 500	R/hr
Dump truck (3)	1 500	R/hr
Total equipment cost	3 000	R/hr
Excavator load rate	240	m <sup>3</sup> /h
Dump truck capacity (3)	240	m <sup>3</sup> /h
Cost	12.5	R/m <sup>3</sup>
Volume to rehabilitate Block 60	60 828	m <sup>3</sup>
Volume to rehabilitate Langstrand	21 241	m <sup>3</sup>
Cost to rehabilitate Block 60	<b>R 760 350</b>	
Cost to rehabilitate Langstrand	<b>R 265 500</b>	

**Box 5-2: Coffe dam monitoring costs**

		<b>Cost</b>
Field survey	Project management	R 2 320
	baseline field survey	R 55 520
	Macro faunal analysis	R 6 600
	Project administration	R 6 898
	Disbursements	R 4 540
	<b>Sub-total</b>	<b>R 75 878</b>
Report	Project management	R 1 160
	baseline report	R 14 680
	Baseline description	R 3 480
	Project administration	R 1 932
	<b>Sub-total</b>	<b>R 21 252</b>
Impact assessment	Project management	R 1 160
	Specialist assessment	R 14 500
	Project administration	R 1 566
	<b>Sub-total</b>	<b>R 17 226</b>
Meetings / consultation	Workshops	R 3 300
	Presentations	R 3 300
	Disbursements	R 2 200
	Project administration	R 880
	<b>Sub-total</b>	<b>R 9 680</b>
<b>TOTAL</b>		<b>R 124 036</b>

**Assumptions**

- 6 macrofauna samples
- 3 sand samples per site
- 1 beach site

**Box 5-3: Deep-water benthic monitoring costs**

Project management	R 118 120
Project planning	R 16 000
Vessel hire	R 120 000
Equipment hire	R 20 600
Disbursements: travel	R 20 000
Field report	R 8 000
Sampling	R 60 000
Benthos ID	R 100 000
Disbursements: Laboratory	R 11 200
Particle size analysis [PSA]	R 19 400
Sediment size analysis (metals) [SSAM]	R 97 400
Sediment size analysis (Organics) [SSAO]	R 6 000
Benthic report	R 112 000
Marine contingency	R 70 872
<b>Total</b>	<b>R 779 592</b>

**Assumptions**

- Vessel hire: 2 days
- Field survey; 2 days
- Mobilisation: 2 days
- Sample locations: 8
- No. samples Benthic samples: 40
- No. samples PSA: 40
- No. samples SSAM: 40
- No. samples SSAO: 40

## 6 REFERENCES

- ANDERSON, R.J., CARRICK, P., LEVITT, G.J. and A. SHARE, 1997. Holdfasts of adult kelp *Ecklonia maxima* provide refuges from grazing for recruitment of juvenile kelps. *Mar. Ecol. Prog. Ser.*, 159: 265-273.
- ANDERSON, R.J., 2000. The effects of kelp harvesting on the biodiversity of kelp epiphytes. *Proc. 10th S. Afr. Mar. Sci. Symp.*, (SAMSS 2000): pp. 1.
- BARKAI, A. and M.O. BERGH, 1992. The effects of marine diamond pumping operations on the littoral and shallow sublittoral benthos along the South African west coast, Namaqualand region, with special attention to possible effects on the rock lobster resource: a pilot study. UCT Unpublished Report. 43 pp.
- BICCARD, A., CLARK, B.M. and E.A. BROWN, 2016. De Beers Marine Namibia environmental monitoring programme in the Atlantic 1 mining license area: 2014 benthic sampling campaign. Report prepared for De Beers Marine Namibia by Anchor Environmental Consultants. Report no. 1527/4
- BICCARD, A.B. and B.M. CLARK, 2016. De Beers Marine Namibia environmental monitoring programme in the Atlantic 1 mining license area: 2013 benthic sampling campaign. Report prepared for De Beers Marine Namibia by Anchor Environmental Consultants. Report no. 1527/3
- BLANCHARD, A.L. and H.M. FEDER, 2003. Adjustment of benthic fauna following sediment disposal at a site with multiple stressors in Port Valdez, Alaska. *Marine Pollution Bulletin*, 46: 1590-1599.
- BREMNER, J.M. and J.P. WILLIS, 1990. Mineralogy and geochemistry of the clay mineral fraction of sediments from the Namibian continental margin and the adjacent hinterland. *Mar. Geol.*, 115: 85-116.
- BROWN, A.C. and F.J. ODENDAAL, 1994. The biology of Oniscid Isopoda of the genus *Tylos*. *Adv. Mar. Biol.*, 30: 89-153.
- BROSNAN, D.M. and L.L. CRUMRINE, 1994. Effects of human trampling on marine rocky shore communities. *J. Exp. Mar. Biol. Ecol.*, 177: 79-97.
- BRÜCHERT, V., BARKER JØRGENSEN, B., NEUMANN, K., RIECHMANN, D., SCHLÖSSER M. and H. SCHULZ, 2003. Regulation of bacterial sulfate reduction and hydrogen sulfide fluxes in the central Namibian coastal upwelling zone. *Geochim. Cosmochim. Acta*, 67(23): 4505-4518.
- CALVERT, S.E. & N.B. PRICE, 1970. Minor metal contents of recent organic-rich sediments off South West Africa. *Nature*, 227: 593-595.
- CARTER, R.A., 2008. Evaluation of water quality risks in the SASA ML3 Mining Licence Area. Prepared for Pisces Environmental Services on behalf of De Beers Marine, Report No. LT-08-056. pp24.
- CHAPMAN, P. and L.V. SHANNON, 1985. The Benguela Ecosystem. Part II. Chemistry and related processes. *Oceanogr. Mar. Biol. Ann. Rev.*, 23: 183-251.
- CHRISTIE, H., FREDRIKSEN, S. and E. RINDE, 1998. Regrowth of kelp and colonization of epiphyte and fauna community after trawling at the coast of Norway. *Hydrobiologia*, 375/376: 49-58.
- CROFT, B. and B. Li, 2017. Shell Namibia Deepwater Exploration Drilling: Underwater Noise Impact Assessment. Prepared by SLR Consulting Australia Pty Ltd. for SLR Consulting (Cape Town) Pty Ltd. 19pp
- CSIR, 1994. Alexkor Environmental Management Programme. Vol. 3. Environmental Management Programme. Report No. EMAS-C 94037(3), Stellenbosch.
- DAYTON, P. K., TEGNER, M. J., PARNELL, P. E. and P. B. EDWARDS, 1992. Temporal and spatial patterns of disturbance and recovery in a kelp forest community. *Ecol. Monogr.*, 62: 421-445.

- DE GRAVE, S. and A. WHITAKER, 1999. Benthic community re-adjustment following dredging of a muddy-maerl matrix. *Mar. Pollut. Bull.*, 38: 102-108.
- DESPREZ, M., 2000. Physical and biological impact of marine aggregate extraction along the French coast of the Eastern English Channel: short-and long-term post-dredging restoration. *ICES J. Mar. Sci.*, 57: 1428–1438.
- DUNDEE, B.L., 2006. The diet and foraging ecology of chick-rearing gannets on the Namibian islands in relation to environmental features: a study using telemetry. MSc thesis, University of Cape Town, South Africa.
- ELLIS, D.V., 2000. Effect of Mine Tailings on The Biodiversity of The Seabed: Example of The Island Copper Mine, Canada. In: SHEPPARD, C.R.C. (Ed), *Seas at The Millennium: An Environmental Evaluation*. Pergamon, Elsevier Science, Amsterdam, pp. 235-246
- ENGLEDOW, H.R. and J.J. BOLTON, 1994. Seaweed alpha-diversity within the lower eulittoral zone in Namibia: the effects of wave action, sand inundation, mussels and limpets. *Bot. Mar.*, 37: 267-276.
- ENVIRONMENTAL EVALUATION UNIT, 1996. Impacts of Deep Sea Diamond Mining, in the Atlantic 1 Mining Licence Area in Namibia, on the Natural Systems of the Marine Environment. Environmental Evaluation Unit Report No. 11/96/158, University of Cape Town. Prepared for De Beers Marine (Pty) Ltd. 370 pp.
- FINDLAY, K., 2005. Assessment of the Potential Acoustic Impacts of Marine Diamond Prospecting on Marine Mammals of the South African West Coast Region. Prepared by Cetus Projects cc for De Beers Marine (Pty) Ltd. 64pp.
- GRAY, J.S., WU, R.S. and Y.Y. OR, 2002. Effects of hypoxia and organic enrichment on the coastal marine environment. *Mar. Ecol. Prog. Ser.*, 238: 249-279.
- HARTLEY, J., TRUEMAN, R., ANDERSON, S., NEFF, J., FUCIK, K. and P. DANDO, 2003. Drill Cuttings Initiative: Food Chain Effects Literature Review. United Kingdom Offshore Operators Association, Aberdeen, Scotland. 118 pp + Appendices.
- HARVEY, M., GAUTHIER, D. and J. MUNRO, 1998. Temporal changes in the composition and abundance of the macro-benthic invertebrate communities at dredged material disposal sites in the Anse a Beaufils, Baie des Chaleurs, Eastern Canada. *Marine Pollution Bulletin*, 36: 41-55.
- HUTCHINGS L., NELSON G., HORSTMANN D.A. and R. TARR, 1983. Interactions between coastal plankton and sand mussels along the Cape coast, South Africa. In: *Sandy Beaches as Ecosystems*. Mclachlan A and T E Erasmus (eds). Junk, The Hague. pp 481-500.
- HURME, A.K. and E.J. PULLEN, 1988. Biological effects of marine sand mining and fill placement for beach replenishment: Lessons for other uses. *Mar. Min.*, 7: 123-136.
- HYLLEBERG, J. and A. NATEEWATHANA, 1984. Responses of polychaete families to monsoon- and offshore mining associated sediment disturbance. *Ibid.* : 292-302.
- KENNY, A.J. and H.L. REES, 1994. The effects of marine gravel extraction on the macrobenthos: Early post-dredging recolonisation. *Mar. Poll. Bull.*, 28: 442-447.
- KENNY, A.J. and H.L. REES, 1996. The effects of marine gravel extraction on the macrobenthos: Results 2 years post-dredging. *Mar. Poll. Bull.*, 32: 615-622.
- KENNY, A.J., REES, H.L., GREENING, J. and S. CAMPBELL, 1998. The effects of marine gravel extraction on the macrobenthos at an experimental dredge site off north Norfolk, U.K. (Results 3 years post-dredging). *ICES CM 1998/V:14*, pp. 1-8.

- KENNELLY, S.J., 1987a. Physical disturbances in an Australian kelp community. I. Temporal effects. *Mar. Ecol. Prog. Ser.*, 40: 145-153.
- KENNELLY, S.J. 1987b. Physical disturbances in an Australian kelp community. II. Effects on understorey species due to differences in kelp cover. *Mar. Ecol. Prog. Ser.*, 40: 155-165.
- LANE, S.B. and R.A. CARTER, 1999. Generic Environmental Management Programme for Marine Diamond Mining off the West Coast of South Africa. Marine Diamond Mines Association, Cape Town, South Africa. 6 Volumes.
- LEUNG-NG, S. and S. LEUNG, 2003. Behavioural response of Indo-Pacific humpback dolphin (*Sousa chinensis*) to vessel traffic. *Mar. Env. Res.*, 56: 555-567.
- LEVITT, G.J., ANDERSON, R.J., BOOTHROYD, C.J.T. and F.A. KEMP, 2002. The effects of kelp harvesting on its regrowth and the understorey benthic community at Danger Point, South Africa, and a new method of harvesting kelp fronds. *South African Journal of Marine Science* 24: 71-85.
- LUDYNIA, K., 2007. Identification and characterisation of foraging areas of seabirds in upwelling systems: biological and hydrographic implications for foraging at sea. PhD thesis, University of Kiel, Germany.
- MALME, C.I., MILES, P.R., TYACK, P., CLARK, C.W. and J.E. BIRD, 1985. Investigation of the potential effects of underwater noise from petroleum industry activities on feeding humpback whale behaviour. BBN Report 5851, OCS Study MMS 85-0019. Report from BBN Laboratories Inc., Cambridge, MA, for U.S. Minerals Management Service, NTIS PB86-218385. Bolt, Beranek, and Newman, Anchorage, AK.
- MAURER, D., KECK, R.T., TINSMAN, J.C. and W.A. LEATHEM, 1981a. Vertical migration and mortality of benthos in dredged material: Part I – Mollusca. *Marine Environmental Research*, 4: 299-319.
- MAURER, D., KECK, R.T., TINSMAN, J.C. and W.A. LEATHEM, 1981b. Vertical migration and mortality of benthos in dredged material: Part II – Crustacea. *Marine Environmental Research*, 5: 301-317.
- MAURER, D., KECK, R.T., TINSMAN, J.C. and W.A. LEATHEM, 1982. Vertical migration and mortality of benthos in dredged material: Part III – Polychaeta. *Marine Environmental Research*, 6: 49-68.
- MAURER, D.L., LEATHEM, W., KINNER, P. and J. TINSMAN, 1979. Seasonal fluctuations in coastal benthic invertebrate assemblages. *Estuarine and Coastal Shelf Science*, 8: 181-193.
- MAURER, D., KECK, R.T., TINSMAN, J.C. and W.A. LEATHAM, 1986. Vertical migration and mortality of marine benthos in dredged material: A synthesis. *Int. Revue Ges. Hydrobiologia*, 71: 49-63.
- MOSTERT B.P., BICCARD, A.B., DUNA, O.O., and B.M. CLARK. 2016. Baseline survey of the benthic marine environment in the South African diamond mining Concession areas: 1B and 1C. Report prepared for Alexkor and Placer Resource Management by Anchor Environmental Consultants. Report no. 1696/1.
- MORTON, B., 1996. The subsidiary impacts of dredging (and trawling) on a subtidal benthic molluscan community in the southern waters of Hong Kong. *Mar. Pollut. Bull.*, 32: 701-710.
- MEYZO ENVIRONMENTAL SERVICES (MEYEZO). 2013. Environmental Management Programme Report for the proposed mining activities over Sea Concession 1(C) within the Administrative District of Namaqualand: August 2013, Pretoria.
- NEL, R. and A. PULFRICH, 2002. An assessment of the impacts of beach mining operations on beach macrofaunal communities between the Sout River and Olifants River mouth. Pisces Environmental Services (Pty) Ltd. Report to Trans Hex Operations (Pty) Ltd. September 2002, 38pp.

- NEL, R., PULFRICH, A. and A.J. PENNEY, 2003. Impacts of Beach Mining Operations on Sandy Beach Macrofaunal Communities on the Beaches of Geelwal Karoo. Pisces Environmental Services (Pty) Ltd. Report to Trans Hex Operations (Pty) Ltd. October 2003, 54pp.
- NRC, 2003. Ocean noise and marine mammals. National Academy Press, Washington, DC.
- NEWELL, R.C., SEIDERER, L.J. and D.R. HITCHCOCK, 1998. The impact of dredging work in coastal waters: a review of the sensitivity to disturbance and subsequent recovery of biological resources on the sea bed. *Oceanogr. Mar. Biol. Ann. Rev.*, 36: 127–178.
- PARKINS, C.A. and J.G.FIELD, 1998. The effects of deep sea diamond mining on the benthic community structure of the Atlantic 1 Mining Licence Area. Annual Monitoring Report – 1997. Prepared for De Beers Marine (Pty) Ltd by Marine Biology Research Institute, Zoology Department, University of Cape Town. pp. 44.
- PARKINS, C.A., and G.M. BRANCH, 1995. The effects of the Elizabeth Bay fines deposit on the inter-tidal rock shore in the Bay, and the effects of the contractor diamond divers on the inter-tidal rocky-shore communities of the Sperrgebiet Coast. Report to NAMDEB Diamond Corporation (Pty) Ltd., Oranjemund, Namibia, 56 pp.
- PARKINS, C.A., and G.M. BRANCH, 1996. The effects of diamond mining on the shallow sub-tidal zone: An assessment of the Elizabeth Bay fine-tailings deposit, and the contractor diamond divers, with special attention to the rock-lobster, *Jasus lalandii*. Report to NAMDEB Diamond Corporation (Pty) Ltd., Oranjemund, Namibia, 44 pp.
- PARKINS, C.A., and G.M. BRANCH, 1997. The effects of the Elizabeth Bay fines deposit and contractor diamond diver activities on biological communities: Inter-tidal and sub-tidal monitoring report. Report to NAMDEB Diamond Corporation (Pty) Ltd., Oranjemund, Namibia, 42 pp.
- PEARSON, T.H. and R. ROSENBERG. 1978. Macrobenthic Succession in Relation to Organic Enrichment and Pollution of the Marine Environment. *Oceanogr. Mar. Biol. Ann. Rev.* 16: 229-311.
- PETERSON, C.H., HICKERSON, D.H.M. and G.G. JOHNSON, 2000. Short-Term Consequences of Nourishment and Bulldozing on the Dominant Large Invertebrates of a Sandy Beach. *J. Coast. Res.*, 16(2): 368-378.
- PERRY, J., 2005. Environmental Impact Assessment for Offshore Drilling the Falkland Islands to Desire Petroleum Plc. 186pp
- PISCES ENVIRONMENTAL SERVICES, 2007. Project BEHP/CEA/03/04: Assessment of cumulative impacts of scouring of sub-tidal areas and kelp cutting by diamond divers in near-shore areas of the BCLME region. Final Report to the BCLME mining and petroleum activities task group. 156pp.
- POINER, I.R. and R. KENNEDY, 1984. Complex patterns of change in the macrobenthos of a large sandbank following dredging. *Mar. Biol.*, 78: 335-352.
- POVEY, A. and M.J. KEOUGH, 1991. Effects of trampling on plant and animal populations on rocky shores. *Oikos*, 61: 355–368.
- PRESTEDGE RETIEF DRESNER WIJNBERG (PRDW), 2014. Proposed exploration drilling in Block 1 off the West Coast of South Africa. Oil Spill and Drilling Discharge Modelling Specialist Study. October
- PULFRICH, A. and A.J. PENNEY, 2001. Assessment of the impact of diver-operated nearshore diamond mining on marine benthic communities near Lüderitz, Namibia. Phase III Report to NAMDEB Diamond Corporation (Pty) Ltd., Oranjemund, Namibia, 50pp.2014. 77pp.

- PULFRICH, A., HUTCHINGS, K., A. BICCARD and CLARK, B.M., 2015. Survey of Sandy-Beach Macrofaunal Communities on the Sperrgebiet Coastline: Consolidated Beach Monitoring Report – 2015. Report to NAMDEB Diamond Corporation (Pty) Ltd., Oranjemund, Namibia. 186pp.
- PULFRICH, A., PENNEY, A.J., BRANDÃO, A., BUTTERWORTH, D.S. and M. NOFFKE, 2006. Marine Dredging Project: FIMS Final Report. Monitoring of Rock Lobster Abundance, Recruitment and Migration on the Southern Namibian Coast. Prepared for De Beers Marine Namibia, July 2006. 149pp.
- PULFRICH, A. and A.J. PENNEY, 1999. The effects of deep-sea diamond mining on the benthic community structure of the Atlantic 1 Mining Licence Area. Annual Monitoring Report – 1998. Prepared for De Beers Marine (Pty) Ltd by Marine Biology Research Institute, Zoology Department, University of Cape Town and Pisces Research and Management Consultants CC. pp 49.
- PULFRICH, A. and A.J. PENNEY, 2001. Assessment of the impact of diver-operated nearshore diamond mining on marine benthic communities near Lüderitz, Namibia. Phase III Report to NAMDEB Diamond Corporation (Pty) Ltd., Oranjemund, Namibia, 50pp.
- SEIDERER, L.J. and R.C. NEWELL, 2000. TRANS HEX-SEACORE Mobile Dredging Platform Environmental Impact of Mining Trials at Greenbank Cove, Cornwall, U.K. July-August 2000. Marine Ecological Surveys Limited report to Transhex Group, August 2000, pp. 45.
- SIMONS, R.H. and N.G. JARMAN, 1981. Sub commercial harvesting of a kelp on a South African shore. Proc. 10th Int. Seaweed Symp., 10: 731-736.
- SCHIEL, D.R. and D.I. TAYLOR, 1999. Effects of trampling on a rocky intertidal algal assemblage in southern New Zealand. J. Exp. Mar. Biol. Ecol., 232: 125-140.
- SCHOEMAN, D.S., McLACHLAN, A. and J.E. DUGAN, 2000. Lessons from a Disturbance Experiment in the Intertidal Zone of an Exposed Sandy Beach. Estuar. Coast. Shelf Sci., 50(6): 869-884.
- SCHRATZBERGER, M., REES, H.L. and S.E. BOYD, 2000. Effects of simulated deposition of dredged material on structure of nematode assemblages - the role of burial. Mar. Biol., 136: 519-530.
- SCHRIEVER, G., AHNERT, A., BLUHM, H., BOROWSKI, C. and H. THIEL, 1997. Results of the large scale deep-sea environmental impact study DISCOL during eight years of investigation. Proc. 7th ISOPE Conf., Honolulu, USA: 438-444.
- SHIRAYAM, Y., FUKUSHIMA, T., MATSU, T. and E. KUBOKI, 2001. The responses of deep-sea benthic organisms to experimental removal of the surface sediment. Proc 4th Ocean Mining Sym, Szczecin, Poland: 77-81.
- SINK, K., HOLNESS, S., HARRIS, L., MAJIEDT, P., ATKINSON, L., ROBINSON, T., KIRKMAN, S., HUTCHINGS, L., LESLIE, R., LAMBERTH, S., KERWATH, S., VON DER HEYDEN, S., LOMBARD, A., ATTWOOD, C., BRANCH, G., FAIRWEATHER, T., TALJAARD, S., WEERTS, S., COWLEY, P., AWAD, A., HALPERN, B., GRANTHAM, H. and WOLF, T. 2012. National Biodiversity Assessment 2011: Technical Report. Volume 4: Marine and Coastal Component. South African National Biodiversity Institute, Pretoria.
- SITE PLAN. 2008. Alexkor 2008 – Revised Environmental Management Programme. Report: #2385 EMP/R2, Strand.
- STEFFANI, C.N. and A. PULFRICH, 2004. Environmental Baseline Survey of the Macrofaunal Benthic Communities in the De Beers ML3/2003 Mining Licence Area. Prepared for De Beers Marine South Africa, April 2004., 34pp.



STEFFANI, N., 2007a. Biological Baseline Survey of the Benthic Macrofaunal Communities in the Atlantic 1 Mining Licence Area and the Inshore Area off Pomona for the Marine Dredging Project. Prepared for De Beers Marine Namibia (Pty) Ltd. pp. 42 + Appendices.

STEFFANI, N., 2007b. Biological Monitoring Survey of the Macrofaunal Communities in the Atlantic 1 Mining Licence Area and the Inshore Area between Kerbehuk and Bogenfels. 2005 Survey. Prepared for De Beers Marine Namibia (Pty) Ltd. pp. 51 + Appendices.

STEFFANI, C.N., 2009. Assessment of Mining Impacts on Macrofaunal Benthic Communities in the Northern Inshore Area of the De Beers ML3 Mining Licence Area - 18 Months Post-mining. Prepared for De Beers Marine (South Africa), 47pp.

STEFFANI, C.N., 2010. Assessment of mining impacts on macrofaunal benthic communities in the northern inshore area of the De Beers Mining Licence Area 3 – 2010 . Prepared for De Beers Marine (South Africa). pp 30 + Appendices.

STEFFANI, C.N., 2012. Assessment of Mining Impacts on Macrofaunal Benthic Communities in the Northern Inshore Area of the ML3 Mining Licence Area - 2011. Prepared for De Beers Marine (South Africa), July 2012, 54pp.

US ARMY CORPS OF ENGINEERS, 2015. Charleston Harbor Post 45 Feasibility Report and Environmental Impact Statement. Appendix G: Noise Assessment, pp15.

VAN DER MERWE, D. and D. VAN DER MERWE, 1991. Effects of off-road vehicles on the macrofauna of a sandy beach. S. Afr. J. Sci., 87: 210-213.

WANG, F. and P.M. CHAPMAN, 1999. Biological implications of sulfide in sediment—a review focusing on sediment toxicity. Environ. Toxicol. Chem., 18: 2526-2532.

WATKINS, W.A., 1986. Whale reactions to human activities in Cape Cod waters. Mar. Mamm. Sci., 2(4): 251-262.

WU, R.S.S., 2002. Hypoxia: from molecular responses to ecosystem responses. Mar. Pollut. Bull., 45: 35-45.

## **APPENDIX 1**

### **GENERIC ENVIRONMENTAL CODE OF OPERATIONAL PRACTICE FOR “WALPOMP” OPERATIONS**

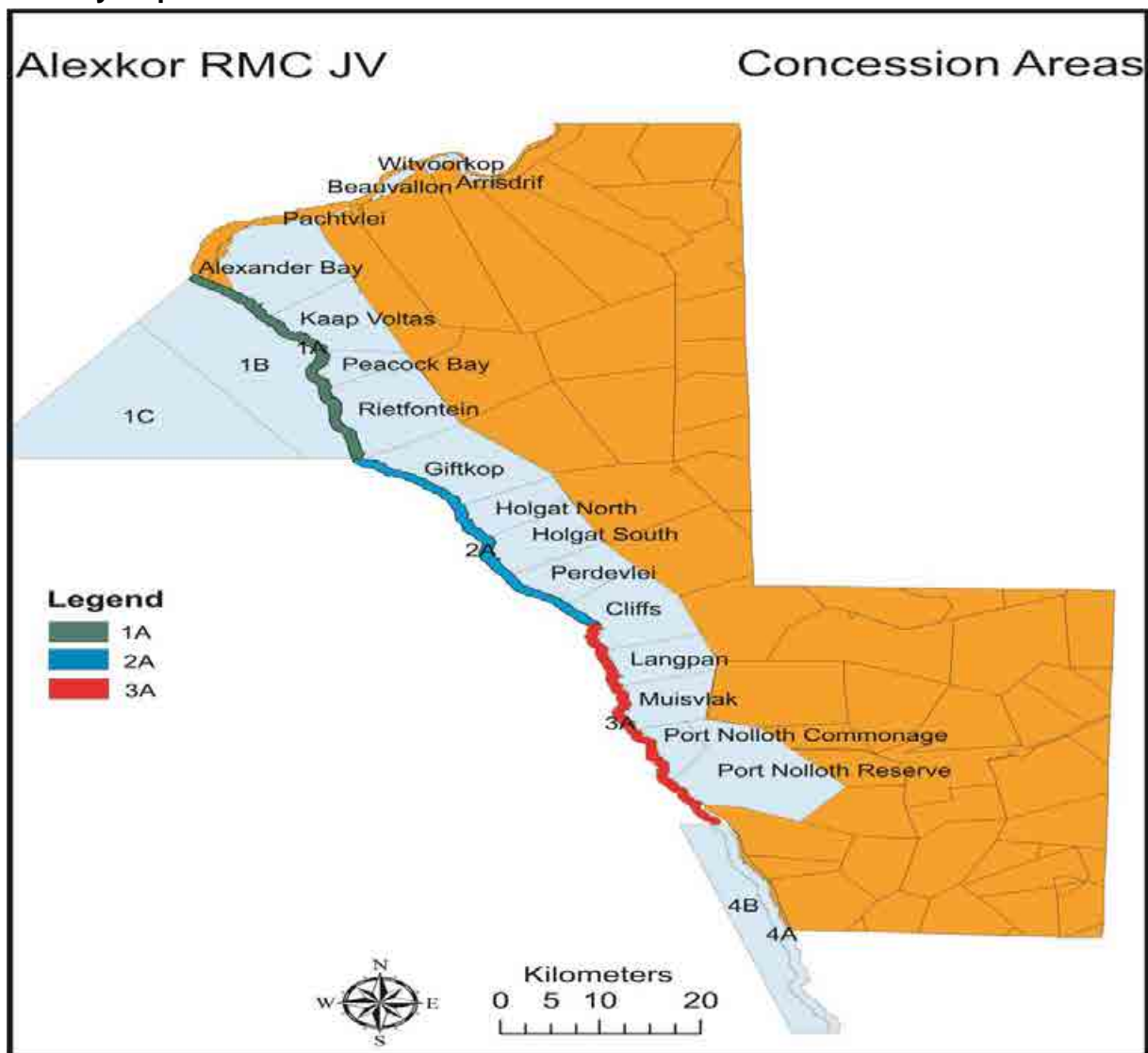
## Generic Environmental Code of Practice for Shore Units

### 1. Mining Location

The Shore units' exploration areas stretch from Alexander Bay to Port Nolloth Reserve (concessions 1A - 3A). These concessions cover an area of approximately 75 Km along the rocky shoreline, where alluvial diamonds are mined by individual contractors.

All the shore unit contractors mining under the host company (Alexkor RMC JV) must adhere to the regulations and guidelines set out by Alexkor RMC JV. Adherence to these regulations and guidelines will maximise mine safety for all personnel and lower the environmental impacts that may stem from the operations.

### Locality Map



Locality map showing the mining concession areas for shore unit operations

## 2. Equipment

- 4x4 tractor
- gravel suction pump
- Gravel classifier
- Compressor
- 100-150m diving airline
- Demand valves (three minimum)
- 30m 6" gravel suction pipes
- Double axel gravel trailer
- Single axel trailer
- Medical emergency kit
- Emergency CO2 kit
- An assortments of tools
- polyurethane 50kg bags
- polyurethane 1000kg tuff bags
- Ablution facility

## 3. Mining Process

Equipment:

- A 4x4 tractor with PTO shaft driving a Centrifugal gravel pump driven by the tractor;
- A prime pump free standing or mounted above the gravel pump;
- A 100litre air LP compressor with airlines and demand valves each secured to harnesses;
- Suction pipes connected from the gravel pump suction end to the sea;
- A delivery pipe between pump and classifier each fitted with couplings; and
- Trailer mounted classifier driven by either diesel or petrol engine.



*Typical classifier used to screen gravel between the fractions of 1.6mm to 25mm.*



*Tractor mounted diving compressor with air-lines and diving harness*

On shore the suction pumps are mounted on the tractors and hydraulic lift and are driven by the tractors engine via PTO shaft. The classifier is a "trommel" sieve above gravel chutes mounted on a trailer and are driven by a small engine. The gravel to be pumped from the seabed is usually loose, but sometimes it needs to be loosened with a jackhammer or crowbar. The gravel goes through the suction pipes to the classifier in various fractions ranging from 1.6mm/less and is collected in gravel bags.

The purpose of the classifier is to separate the finer material, smaller than 1,6mm and the larger material bigger than 25mm. The fraction smaller than 1,6mm are washed away through the overflow and the fractions bigger than 25mm are stockpiled and if conglomerate is present this is collected in gravel bags as well. The gravel bags are then taken to the OHMS Plant for sorting.

The oversize material should be rehabilitated by the responsible contractor, site visits will be done by the Environmental Department to point out oversize backfilling areas.

#### **4. Safety Strategy**

- Safety clothing (P.P.E) is issued to all workers and must be worn at all times on site.
- Only qualified persons are used as EMV (Earth Moving Vehicles) operators and LDV (Light Delivery Vehicles) drivers. Tested and licensed at Alexkor RMC JV.
- The safety representative and supervisor to have once weekly safety toolbox talks with the workers.
- A safety notice board will be posted conspicuously for everybody to see with updated safety information.
- The manager in official hearing will deal with contraventions of regulations.
- LDV's is equipped with flags on long fibre glass sticks to make them easily visible for EMV's, additionally, orange coloured strobe lamps are installed on the roofs of the LDV's.
- LDV's and EMV's are equipped with fire extinguishers as well as the plant and site.
- Mining faces are inspected on regular basis during each shift. Mining regulations will be adhered to regarding the allowable height on vertical faces.
- A lockout protection system for electrical switchgear to protect accidental switch-on while maintenance people are at work in this place. A log book will be kept in this regard.
- A first-aid kit must be onsite.
- Communication to all parties involves radios and cell.
- All COP (code of practice), and safety procedures of the host company must be adhered to.
- Neoprene Thermal Suit (diving)
- Pre-Sea qualification is needed

#### **5. Site and Waste Management**

##### **5.1 Housekeeping**

The orderly appearance/or neatness of the site generally reflects good environmental management and good mine site planning by the contractor. In achieving the above mentioned the following should be done by all shore units:

Avoid littering

- Manage waste
- Avoid unnecessary damage to vegetation
- Good management of fuel and lubricants, especially used oil
- Stick to demarcated/existing roadways/routes
- Remove kelp in a safe manner and demarcate an area for kelp stockpiling

##### **5.2 Fuel and Lubricant Management**

The host company, Alexkor RMC JV, maintains fuel depots at both Alexander Bay and Muisvlak within the security area, contractors draw their fuel supply from these depots either in drums, fuel trailers or fuel tankers for transport to their respective operating sites where the fuel is mostly directly transferred from the transport container into their onsite machinery (tractors, classifier, pumps etc.) for refuelling.

The contractor brings their own lubricants within the security area. Shore units in general have small operations; therefore can be stored in a container within the designated site/area.

Used fuels and oils are disposed of centrally by the host company and accordingly the contractor is responsible for his onsite temporary used fuel and lubricant management within the operational area. The contractor is also responsible for the delivery of such used fuels and lubricants to the collection tanks: Alexander Bay's contractor delivery point is "**Binne Garage/Internal Workshop**", and contractors operating in Muisvlakte should deliver their lubricants and used fuel at the **Security Tank** (west of the R382 road)/the **Internal Earthmoving Workshop** (east as you enter the mine) when their on-site storage containers are filled to capacity.

The host company will further take responsibility in disposing of these lubricants.

### 5.3 On-site fuel receipt, storage and dispensing

In the management of fuel receipt, storage and use the following procedures will be followed, precautions taken and facilities provided for proper management of fuel reception, storage and dispensing.

Following images depict the two fuel drawing point in Alexander Bay and Muisvlakte

#### Alexander Bay Fuel Tank



*Area is a few hundred metres from the mine access area*

## Muisvlakte Fuel Tank



*The fuel tank is situated west of the Port Nolloth-Alexander Bay tar road, close to the Security Complex*

The fuel delivery vehicle driver is cautioned to adhere to safe driving speeds (speed limit of 80 km/hour – LDV's 60km/hour EMV's) from the depot to the mining site, especially under moist (slippery) road and misty conditions.

### 5.4 Refuelling

The site manager must instruct the refuelling staff on the importance of avoiding spillages when refuelling. All equipment, containers and vehicles are to be fitted with suitable pumps and funnel extensions to reduce the risk of spillage during refuelling.

### 5.5 Temporary Storage of used Lubricants

Used lubricants must be collected in suitable containers for temporary storage on-site, where the container is provided with pallets and a plastic under cover with sand to absorb any spillages. The hydrocarbon contaminated sand used to cover the plastic should be removed/ replaced periodically and containerised. The containers once filled should be transported to the internal workshops (north and south).



## 5.6 Hydrocarbon Contamination

In the event of soil contamination, the affected soils are to be removed and either:

- Placed in a suitable container (drum) for disposal at the central company facility
- Treated in situ in case of minor spillages with an in situ treatment product or dispersant. The contractor is required to have this product permanently available on-site. This product is available at the store.

### General Provisions:

- All operators are to check their equipment for leaks and report such leaks on a daily basis
- No used oil is to be used as dust suppressants in manoeuvring areas
- Oil spills and leaks are to be reported immediately

## 5.7 Solid Waste Management

The host company maintains solid waste disposal sites for both domestic and industrial waste within the security area of the mine. The contractor needs only to collect his/her onsite waste and transport it to the designated disposal site depending on the type of waste.

### 5.7.1 Industrial Waste

The industrial waste includes spares which are hydrocarbon contaminated from all sorts of machinery used onsite. This waste should be containerised and when filled taken to the appropriate disposal site Internal Workshops.

### 5.7.2 Domestic Waste

The domestic waste will be collected in bins located strategically on site, this waste includes; lunch wrappings, refreshment bottles, cans, food papers etc. all these will be collected and disposed off on the company's disposal site.

The waste should be separately stored and disposed of in designated disposal site. Before a contractor is decommissioned all loose items on site should be removed and the site should be left as it was. The loose items could be; gravel suction hoses, site caravans, boots, old diving suits etc.

---

Leilani J Swartboo

Environmental Manager

---

Contractor:

Company:



# APPENDIX 1

## OIL SPILL PROCEDURE AND REPORTING

## BEACH MINING AND SHORE UNIT: OIL SPILL PROCEDURE AND REPORTING

Oil spills endanger public health, imperil drinking water, devastate natural resources, and disrupt the economy. Because we use vast quantities of oils, they are usually stored and transported in large volumes. During storage or transport, and occasionally as the result of exploration activities, oils and other oil-based products are sometimes spilled onto land or into waterways. When this occurs, human health and environmental quality are put at risk. Every effort must be made to prevent oil spills and to clean them up promptly once they occur.

In some areas, environments can recover quickly. In other environments, however, recovery from persistent or stranded oil may take years. These detrimental effects are caused by both petroleum and non-petroleum oil.

Two major steps involved in controlling oil spills are containment and recovery.

### **Containment:**

When an oil spill occurs on water, it is critical to contain the spill as quickly as possible in order to minimize danger and potential damage to persons, property, and natural resources. Containment equipment is used to restrict the spread of oil and to allow for its recovery, removal, or dispersal. The most common type of equipment used to control the spread of oil is floating barriers, called booms.

Containment booms are used to control the spread of oil to reduce the possibility of polluting shorelines and other resources, as well as to concentrate oil in thicker surface layers, making recovery easier. In addition, booms may be used to divert and channel oil slicks along desired paths, making them easier to remove from the surface of the water.

Barriers can be improvised from whatever materials are at hand. Although they are most often used as temporary measures to hold or divert oil until more sophisticated equipment arrives, improvised booms can be an effective way to deal with oil spills, particularly in calm water such as streams, slow-moving rivers, or sheltered bays and inlets. Improvised booms are made from such common materials as wood, plastic pipe, inflated fire hoses, automobile tires, and empty oil drums. They can be as simple as a board placed across the surface of a slow-moving stream, or a berm built by bulldozers pushing a wall of sand out from the beach to divert oil from a sensitive section of shoreline.

### **Recovery:**

Sorbents are materials that soak up liquids. Natural organic sorbents include peat moss, straw, hay, sawdust, ground corncobs, feathers, and other carbon-based products. They are relatively inexpensive and usually readily available.

They can be used to recover oil through the mechanisms of absorption, adsorption, or both. Absorbents allow oil to penetrate into pore spaces in the material they are made of, while adsorbents attract oil to their surfaces but do not allow it to penetrate into the material. To be useful in combating oil spills, sorbents need to be both oleophilic (oil-attracting) and hydrophobic (water-repellent). Although they may be used as the sole clean-up method in small spills, sorbents are most often used to remove final traces of oil. Once sorbents have been used to recover oil, they must be removed from the water and properly disposed of on land or cleaned for re-use. Any oil that is removed from sorbent materials must also be properly disposed of or recycled. Once an oil spill has been contained, efforts to remove the oil from the water can begin.

## Reporting:

Step 1: if you notice an oil spill phone - CCR (027)831 8363-8365

EM (027)831 8383-0724600495

Radio Channel 1 at all hours

Step 2: You will need to provide as much information as possible.

Tell the operator:

- your contact details
- when and where the pollution occurred
- the type of substance discharged
- extend of the pollution
- any other relevant information available

The incident will be investigated and a suitable response made, such as:

- allowing the spill to naturally dissipate
- use of recovery equipment

For More Information Feel Free To Contact: Leilani Swartbooi (Environmental Manager - EM).

*A small spill or leak can be the first step toward a disaster, not only for you but also for your co-worker.*

## APPENDIX 2

### **Weekly Environmental Management System**

## Weekly Environmental Management System

### A. Used Oil/Lubricants:

No.	Concerns	Yes	No	Mitigation/corrective measure
1	Are all workshop waste oils collected and transferred to waste oil storage tank?			
2	Are drip trays used in-field?			
3	Are all oil contaminated items being degreased prior to disposal?			
4	Are oil trap capacities monitored regularly?			
5	Are oil traps cleaned regularly?			
6	Has capacity of waste oil tank been checked?			
7	Have all parties involved received training on correct procedures?			

### B. Mine Process Residue:

No.	Concerns	Yes	No	Mitigation/corrective measure
1	Has preference been given to conveyed direct backfill?			
2	Has option of backfill been considered in nearby old excavations/trenches?			
3	Is the log of slimes dam inspections up to date?			

### C. Roads:

No.	Concerns	Yes	No	Mitigation/corrective measure
1	Does the company make use of existing roads?			
2	If no, above, have a road plan been presented to the Environmental Manager?			

### D. Prospecting and Mining:

No.	Concerns	Yes	No	Mitigation/corrective measure
1	Did the Environmental Department assess site sensitivities?			
2	Did the contractor inform the staff on site sensitivity issues as per ECOP?			
3	Have employees been instructed to limit vehicular activity?			

---

Site Supervisor/Manager  
Date:

---

Environmental Manager/Officer  
Date: