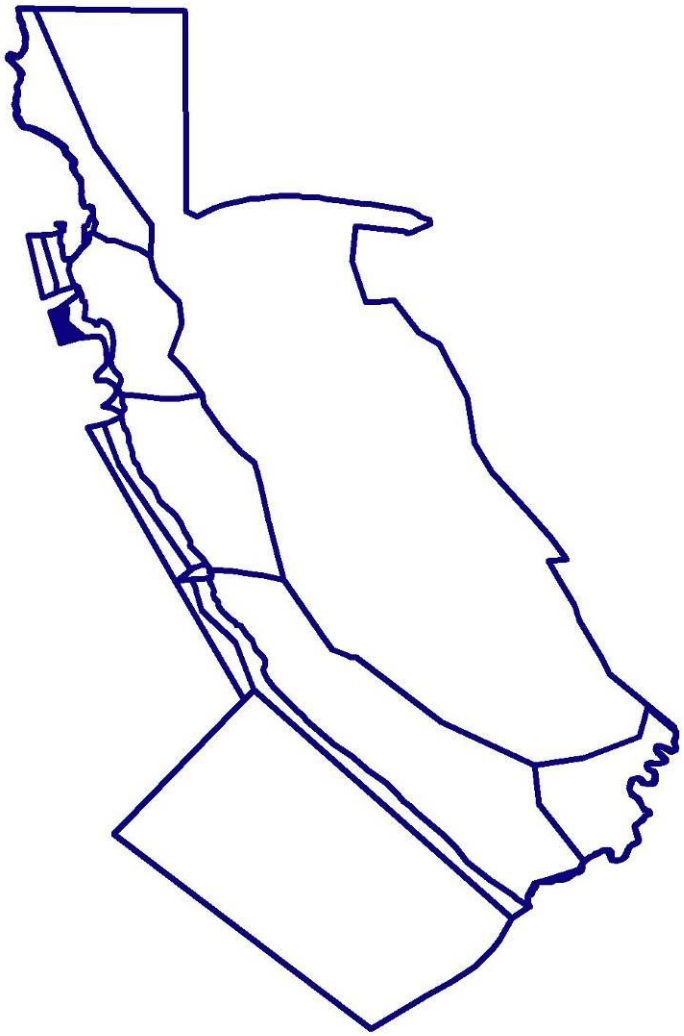

Environmental Management Programme Report for Namdeb's Mining Licence 128B

November 2018

NAMDEB

A Namibia De Beers Partnership

Environmental Management Programme Report for Namdeb's Mining Licences 128B

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Abbreviations and glossary

AA	Anglo American
DEA	Directorate of Environmental Affairs
DMS	Dense Medium Separation
EMP	Environmental Management Plan
EMPR	Environmental Management Programme Report
EMS	Environmental Management System
FAO	Food and Agricultural Organisation
FeSi	Ferrosilicon
GDP	Gross Domestic Product
MDP	Marine Dredging Project
MET	Ministry of Environment and Tourism
MFMR	Ministry of Fisheries and Marine Resources
ML	Mining Licence
MME	Ministry of Mines and Energy
MUN	Mine Workers Union of Namibia
Nemcom	Namdeb Executive Management Committee
NIMPA	Namibian Islands Marine Protected Area
SBP	Strategic Business Plan
SHE	Safety, Health and Environment
SME	Small and Medium Enterprises
SSSI	Site of Special Scientific Interest
TAC	Total Allowable Catch

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Chapter 1 Summary

1.1 Introduction

A series of eight Environmental Management Programme Reports linked to Namdeb's licence areas forms the backbone of Namdeb's Environmental Management System (EMS). This report is an update of the EMPR for ML128A, B and C (the Mid-water licence area) prepared in 2008 for De Beers Marine Namibia. As this is not a conventional environmental assessment for a new project, the environmental assessment process has been adapted. The main report is deliberately concise and refers to supplementary information in a comprehensive annex. This report specifically covers operations in ML128B, with those for ML128A and C covered in separate documents.

1.2 Description of activities

Exploration in the marine licence areas involved the collection of large-scale multibeam bathymetry, seismic data and geological sampling. Following processing and interpretation of the geophysical data a regional geological drilling campaign was undertaken, which opened up several new areas in the mid-water region. Based on the results of the seismics and drill samples, further sampling campaigns were undertaken in late 2014. Test mining is envisaged in ML128B over the next three years.

1.3 The natural environment in ML128B

Biogeographically, the southern Namibian coastline falls into the cold temperate Namaqua Province. The marine ecology of the southern Namibian coastline is shaped by coastal, wind-induced upwelling with communities in the offshore areas being particular only to substrate type or depth zone.

Geophysical surveys and sampling in ML128B and the offshore portions of ML45 have revealed various geological mineralogical zones in the mid-water area. Most of the licence area is dominated by exposed bedrock areas, with areas of resource potential being limited to isolated pockets of unconsolidated sediments.

The structure of benthic communities of soft-bottom substrates is determined primarily by water depth and sediment grain size. Communities are characterised equally by polychaetes, crustaceans and molluscs. On hard substrates to 60m depth communities are dominated by encrusting sponges, starfish, anemones, soft corals, colonial ascidians and rock lobsters. Deepwater reef communities at 100-120m depth include gorgonians, octocorals and reef-building sponges.

1.4 The socio-economic environment

Namdeb's overall contribution to the Namibian economy is substantial, with additional major positive spin-offs on secondary industries such as suppliers, service providers and contractors, a large part of it in the Karas region.

Depending on the activity, the staff complement can range from 5 to 115. The resources are drawn from within Namdeb as well as Debmarine Namibia and De Beers Marine South Africa. This number also includes contractor-vessel employees.

1.5 Environmental management to date

Namdeb's Environmental Section is responsible for environmental protection. Currently seven full-time staff are responsible for planning, performance reporting, assurance, impact monitoring and stakeholder engagement. Although there is no environmental officer directly responsible for ML128B, the licence area currently falls under 'Exploration and Strategic Projects', for which one environmental management coordinator has been made responsible. All Namdeb's operations are ISO14001:2015 certified and follow De Beer's and Anglo American's corporate standards.

1.6 Environmental assessment

The environmental impact assessment followed a process prescribed by Anglo American, using a risk assessment matrix. All activities resulting in "high" and "significant" impacts need to be managed. These are compiled in an impact register. As this is an update of an existing EMPR focus is on new impacts and prioritising of previously identified impacts.

Exploration and test mining in ML128B focuses on unconsolidated seabed sediments with concomitant activities of on-site tailings disposal resulting in impacts on marine habitats and biota. The extent of these impacts have not yet been established with certainty.

1.7 Environmental management plan

The Environmental Management Plan outlines overall environmental tasks, provides management actions for all high and significant impacts and describes monitoring activities.

1.8 Annex

The annex summarises the authors' credentials, presents all applicable legislation, and provides an impact register, reviewed literature and Namdeb's environmental policies and procedures applicable to environmental management in ML128B.

Chapter 2 Introduction

A series of eight Environmental Management Programme Reports linked to Namdeb's licence areas forms the backbone of Namdeb's Environmental Management System (EMS). This report, specifically for ML128B, is an update of the 2008 EMPR for ML128A, B and C. As this is not a conventional environmental assessment for a new project, the assessment process and structure of the report have been adapted. The main report is deliberately concise and refers supplementary information in a comprehensive annex. This report specifically covers operations in ML128B, with those for ML128A and C covered in separate documents.

2.1 Background

The backbone of Namdeb's environmental management is a series of eight comprehensive Environmental Management Programme Reports (EMPRs) linked to each of Namdeb's mining licence areas. These were compiled during 1995-1997. Management actions identified and described in these reports were in subsequent years supplemented by external Environmental Impact Assessments, Namdeb internal risks assessments and amendments to environmental assessments for altered projects. The resulting management actions have been incorporated in an environmental management database, which is the core tool of Namdeb's Environmental Management System (EMS).

Namdeb obtained the Mining Licence for the ML128A, B, and C areas in May 2003, and an EMPR was compiled for these licence areas in 2008 as part of the requirements for the Environmental Contract with the Namibian Ministries of Mines and Energy (MME) and Environment and Tourism (MET). The environmental management of the ML128 concessions at the time was the responsibility of Debmarine Namibia, who handed the environmental management over to Namdeb in late 2008.

Implementation, additions, amendments and closing of management actions happen continuously to keep the EMS up-to-date. Nearly 12 years have passed since the compilation of the first EMPR for ML128A, B and C, and a thorough revision and update of this report was deemed necessary. Environmental management at Namdeb is centred on the ISO14001 certified Environmental Management System. This EMPR will form part of Namdeb's EMS and will be submitted to the authorities for further environmental clearance up until 2021.

2.2 Diversions from traditional approach to environmental assessment reports

Because this report is a revision of an existing EMPR and not linked to a new project, the approach prescribed in Namibia's Environmental Management Act has been adapted to the current situation. Nevertheless, all components of an environmental assessment are included. Scoping is included in this EMPR not as a separate report, but in the form of an impact/risk assessment workshop, which ensured that no major environmental impacts were overlooked. Stakeholder engagement forms part of Namdeb's continuous environmental management (see chapter 6) and no specific public participation process was undertaken. As all mining and related activities described in this report are currently on-going and have been authorised by environmental clearances, no assessment of alternatives was undertaken.

Furthermore, as there is a wealth of information backing this EMPR, this report attempts to be concise and describes the most pertinent aspects that need to be understood by a reader who may not be familiar with the mining operations and the environment in which the activities take place. The report provides the current status of environmental aspects at Namdeb and a view of anticipated activities specifically in ML128B over the next three years.

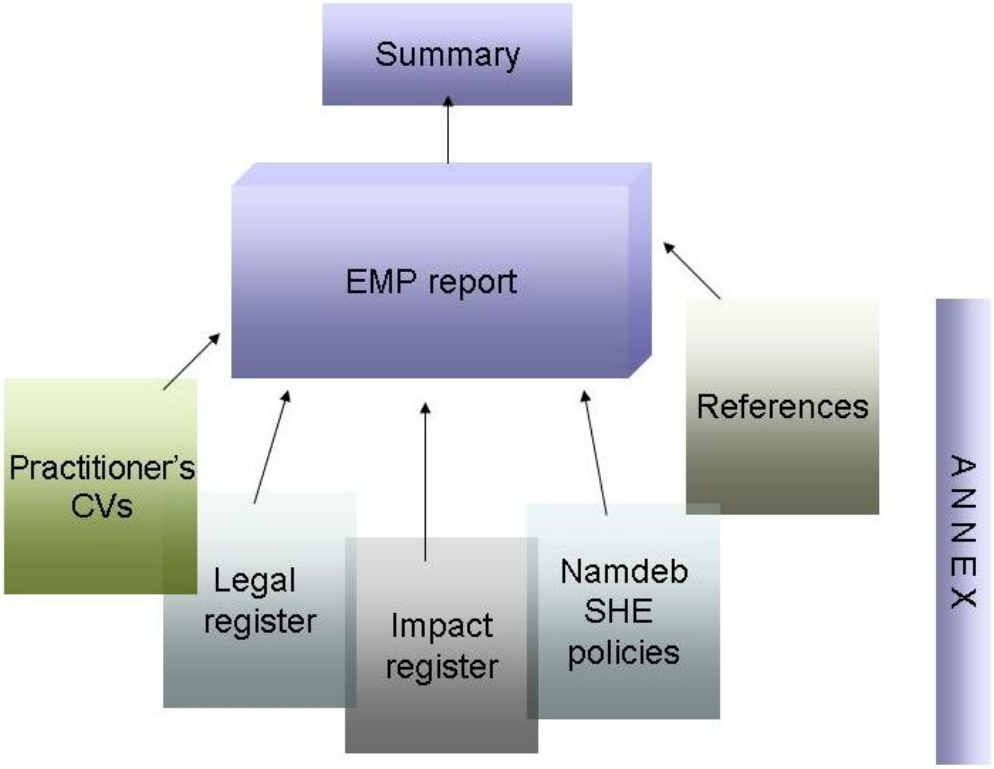

Figure 01. Structure of the Environmental Management Programme (EMP) report.

Relevant supplementary information, such as legal requirements and statutory aspects, corporate policies, guidelines and reporting, as well as more detailed descriptions of the assessed impacts are therefore provided in an annex. The structure of the report is illustrated in the figure above and the table of contents. The consultants who compiled this report have undertaken environmental baselines, assessments and monitoring for Namdeb for two decades and have a combined experience of over 40 years in this area. They are therefore well familiar with all aspects relevant to this assignment (Annex 1).

2.3 Locality, company, legal and statutory requirements

Namdeb Diamond Corporation (Pty) Ltd mines alluvial diamonds in the south-western part of Namibia, now in the Tsau/Khaeb (Sperrgebiet) National Park. Mining is also undertaken in the marine portions of mining licence areas ML43, ML44 and ML45, which extend ~5.5km offshore as a narrow strip adjacent to the coast between Oranjemund and Lüderitz. ML128B is situated immediately offshore of the marine portion of ML45 between Wolf Bay and Elizabeth Bay, south of Lüderitz, in water depths ranging from 50-120m. The spatial extent of the ML128B licence area is 54.1km^2.

The company is equally owned by the Government of the Republic of Namibia and De Beers Centenary forming Namdeb Holdings. Namdeb Holdings owns Namdeb and De Beers Marine Namibia. Namdeb is lead by the Chief Executive Officer (CEO), and operations are governed by the OPSCO team (mine managers, strategic projects and mineral resources), headed by the Chief Operating Officer (COO). OPSCO and departmental heads form the Namdeb Executive Management Committee (Nemcom), which reports directly to the Namdeb Holdings Board. The Environmental Manager reports to the department head Mineral Resources and Environment.

Namdeb Holdings holds nine mining licences on land and offshore. Namdeb holds eight of these licences, of which ML128B is one of the totally sea-based licences, the others being ML128A and C.

This EMPR is a requirement of the Minerals Act (1992, Clause 14), Minerals Agreement of 1994 and the Environmental Management Act (Act 7 of 2007). These and all other legislation relevant to this report are provided in Annex 2.

ML128B falls into the Namibian Islands Marine Protected Area (NIMPA) (Currie et al. 2008).

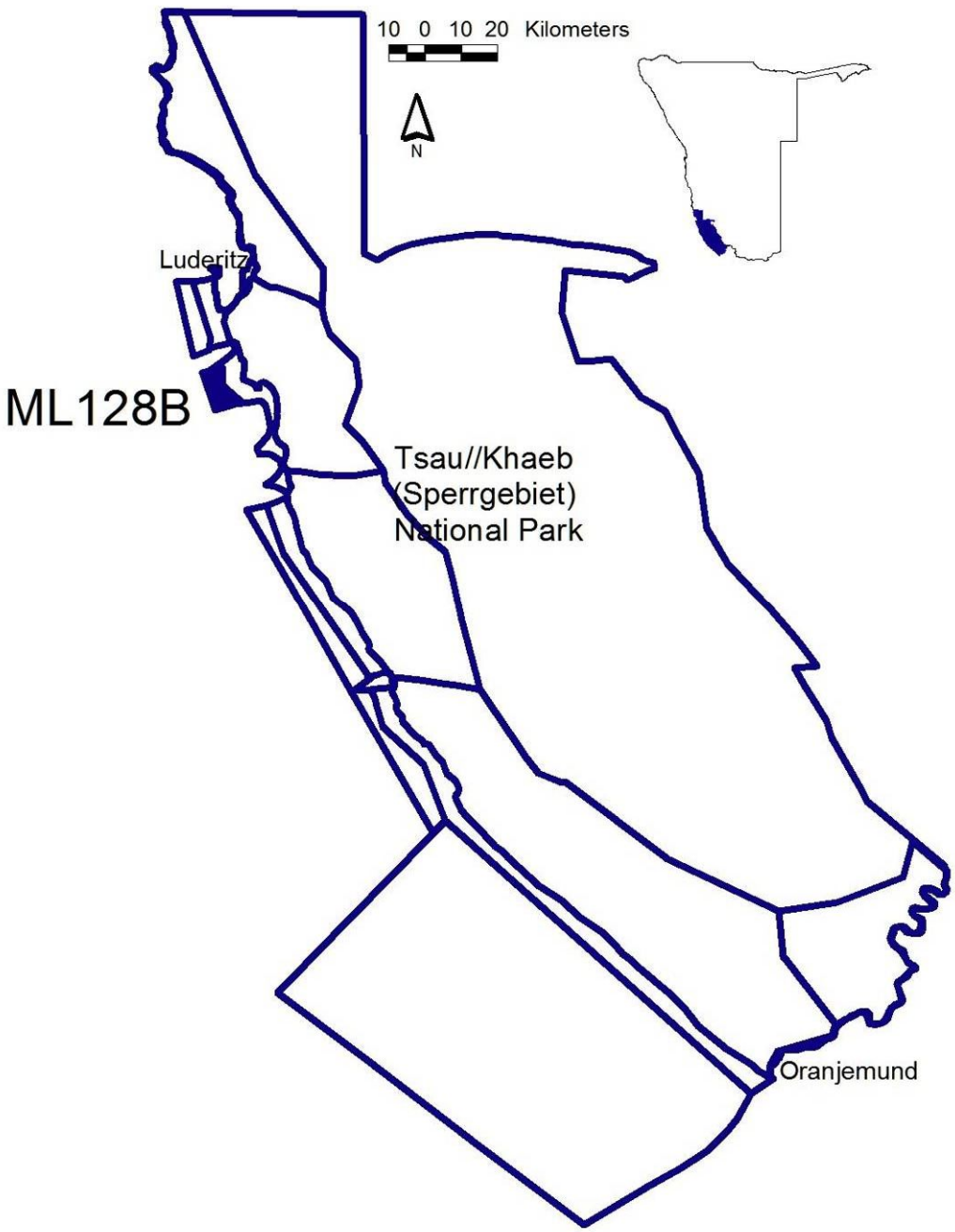

Figure 02. The position of Mining Licence Area 128B in Namibia and the Tsau//Khaeb (Sperrgebiet) National Park.

Chapter 3 Description of activities

Exploration in the marine licence areas involved the collection of large-scale multibeam bathymetry and seismic data. Following processing and interpretation of the geophysical data, a regional geological drilling campaign is undertaken, which opened up several new areas in the mid-water region. Based on the results of the seismics and drill samples, further sampling campaigns were undertaken in late 2014, 2015 and early 2016 and 2018. Test mining is envisaged in ML128B over the next three years.

The powerful natural tidal, current, wave and wind forces shaping the Benguela continental shelf were historically responsible for the deposition of diamond-bearing gravels along ancient beach terraces at various altered past sea levels, and for the subsequent inundation of these deposits with more recent sands and muds carried to sea by major river systems. Sampling and full-scale mining of these submerged diamondiferous deposits was initially focussed on ML47 (Atlantic 1), where it has been ongoing since 1981. In contrast, the marine portions of ML43, ML44 and ML45, and ML128A, B and C, have as yet not been mined on a large scale, although bulk sampling by airlift tools and dredging was undertaken by contracted operators since the mid-1960s.

Only the first two or three stages of the mine life cycle are relevant in Mining Licence 128B over the next three years. However, mining is a dynamic business and these different stages are in a continuous flux of change. The current EMPR provides a snap-shot of the status at this point in time, with a 3-year window until 2021.

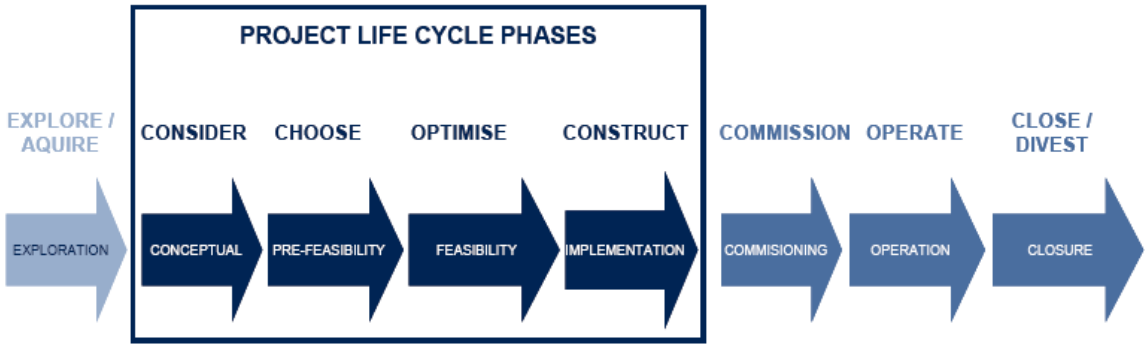

Figure 03. Stages in the life cycle of a mine.

To establish the extent of the future of offshore production mining in their mid-water areas, Namdeb has since 2007, been investigating the resource potential of ML128A, B and C. At present, the establishment of detailed mine plans for ML128B is still in progress, and the specific mining tools to be used have also not yet been decided on and developed.

Exploration activities also take place in the marine portions of ML45. These overlap to some extent with those referred to in more detail here. For consistency, the following classification is used in the EMPRs:

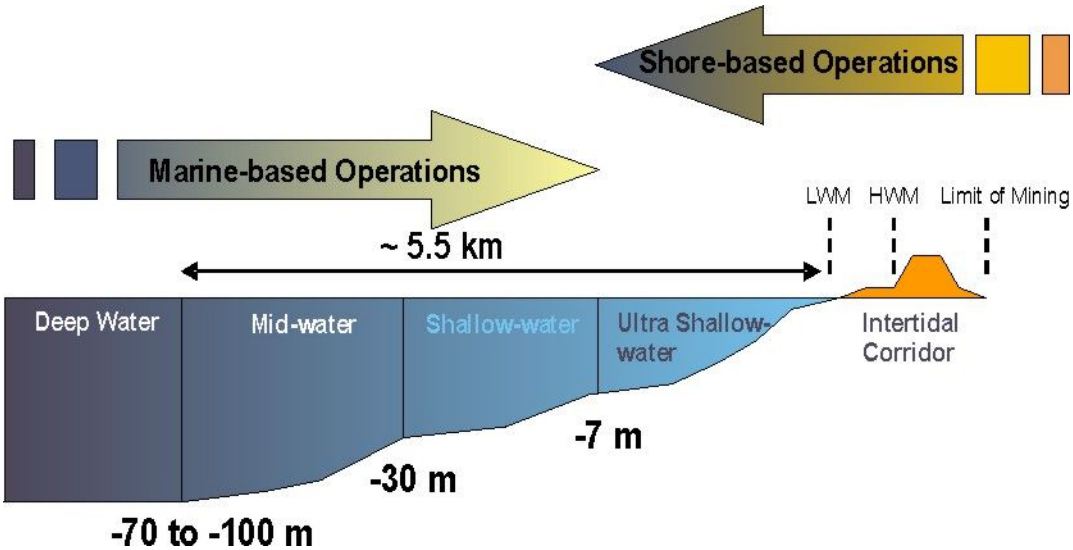

Figure 04. Marine water depth classification used in the EMPRs.

3.1 Exploration and remote mining

3.1.1 History of operations

Prior to 1999 a variety of contractor vessels were used for sampling/prospecting and trial mining activities in ML128C and the mid-water portions of ML44 and ML45. No operations were undertaken in ML128B.

From 2005 to 2008 contracted vessels fitted with fixed-head trenching tools and airlift-dredging systems operated to depths of ~70m off Elizabeth Bay. Although focussing primarily on the deeper regions of ML45, limited bulk-sampling operations extended into the shallower portions of ML128B.

As mining in deeper water cannot proceed until economically viable accumulations of diamond-bearing gravel have been located with some certainty, Namdeb focussed their efforts during 2007 and 2008 on delineating the offshore geology by conducting a large-scale multibeam bathymetry survey over the entire mid-water area. This was supplemented in 2011 with a seismic survey. Following processing and interpretation of the geophysical data in 2012 a regional geological drilling campaign was undertaken beyond -30m depth in 2013. This opened up several new areas in the

mid-water region. Based on the results of the seismics and drill samples, no further sampling campaigns have been undertaken in ML128B since 2014, with subsequent efforts focussed primarily in ML128C (2015).

Table 1. Mid-water areas in ML128B sampled (m^2) since 1999.

Year	No. of Samples	Area Sampled m^2	Tool	Vessel
1999	21	45.4	Megadrill	Douglas Bay
2011	0	--		
2013	14	70	Borer	Explorer
2014	28	140	STR2*	Explorer
2015	0	--		
2016	0	--		
2017	0	--		
2018	0	--		

* STR: Sampling Tool Requirement (version 2)

A variety of tools were developed and implemented during the course of the sampling operations undertaken since 1999. These are described briefly below:

Megadrill: a drill sampling bit typically 3.6m in diameter; during an intensive bulk-sampling programme between 15 - 25 sample holes can be drilled per day, equating to an area of 153 - 255m^2 per day.

Borer: a subsea sampling tool, which comprises a 2.5m diameter drill bit operated from a drill frame structure, which is launched through the moon pool of the support vessel and positioned on the seabed. The tool has a 5m² footprint and can be implemented in water depths up to 180m. The drill frame structure has a base of 6.5 x 6.5m, stands 23m high and weighs 147t. The drill bit can penetrate unconsolidated sediments up to 8m depth above the rock or clay footwall. A sample spacing of as little as 20m can be achieved by the dynamically positioned vessel. Depending on sea conditions and the soil's geotechnical conditions, up to 60 samples can be successfully taken per day.

STR2: a drill bit with six slots of equal dimensions, which is fitted onto the tool in the drill frame structure of the sampling vessel. The tool has a footprint of 5m².

3.1.2 Sampling

Sampling in the mid-water areas is undertaken by a contracted vessel the *MV The Explorer*. With an overall length of 114.4m and a gross tonnage of 4,677t, the vessel is equipped with sampling tools as described above, which are operated from a drill frame structure launched through the moon pool of the support vessel and positioned on the seabed.

Figure 05. The sampling vessel *MV Explorer*.

Figure 06. The 2.5m diameter drill bit within the drill frame structure.

3.1.3 Diamond-gravel processing

The sediments extracted by the sampling tool are fluidised with strong water jets and sucked up riser pipes to the support vessel using compressors to create pressure differentials. The material is discharged onto a series of screens, which separate the oversize (>16mm) and undersize fractions (<1.3mm). All oversized and undersized tailings, which comprise almost 90% of the material pumped to the surface, are immediately discharged back to the sea on site.

The gravel fraction of interest (1.3-16mm plantfeed) is fed through a comminution circuit to fragment the shell, clay and conglomerate components, before being mixed with a high density ferrosilicon (FeSi) slurry and pumped into a Dense Medium Separation (DMS) plant. Low density materials (floats) are separated and discarded overboard. Most of the FeSi is magnetically recovered for re-use in the DMS plant.

The remaining high density fraction is dried and passed through an X-ray sorting machine to separate the diamonds, which fluoresce under X-ray illumination. Non-fluorescent material is discarded overboard and the fluorescent fraction is automatically sealed in cans for transport to shore and final hand sorting. In total, of the material pumped to the surface, over 99% is therefore returned directly to the sea.

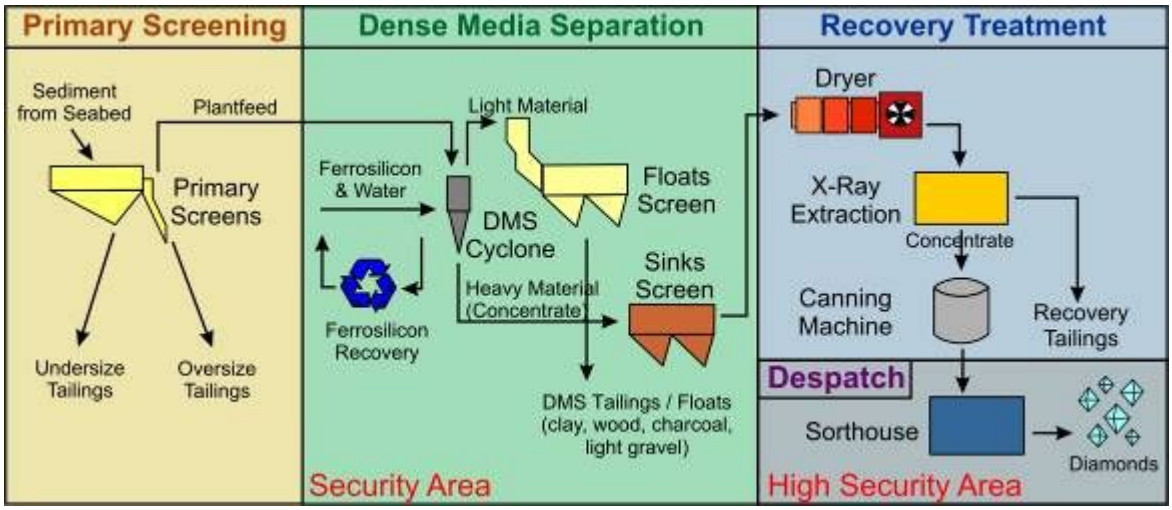

Figure 07. Simplified flowchart of the stages and processes during shipboard processing of marine diamond gravels.

3.1.4 Resource development, delineation and definition

Data collected to date has revealed numerous targets, which have been grouped on the basis of their geological complexity into distinct geological zones. Through an

Advanced Exploration Study and ongoing exploration in ML128A, B and C, the identified targets will be tested and measured against specific resource development criteria to:

- ◊ Determine their resource potential;
- ◊ Assess their prospectivity using available and applicable technology to test the deposits; and
- ◊ Determine their economic potential through an assessment of the sampleability, mineability and processability of the different deposits.

The resource will then be delineated through identification and development of concepts to economically and sustainably exploit the selected targets. Ultimately the resource will be defined through the development and evaluation of options and the selection of the optimal solution to exploit the selected targets.

Further exploration approaches will include:

- ◊ Sonic coring;
- ◊ Geophysical surveys; and
- ◊ Drilling and sampling following development of appropriate tools.

3.1.5 Test mining

Following analysis of the drill samples and establishment of a potential resource, further sampling and/or test mining would be conducted to confirm the economic viability of the resource. Test-mining would be undertaken by a seabed crawler, deployed off a dedicated, contracted mining vessel. The vessel will likely have an overall length of 150m and a gross tonnage of over 9,000t, and be equipped with a track-mounted subsea crawler capable of working to depths up to 200m below sea level. The crawler, which would be fitted with highly accurate acoustic seabed navigation and imaging systems, and equipped with an anterior suction system, would be lowered to the seabed and controlled remotely from the surface support vessel through power and signal umbilical cables. Water jets in the crawler's suction head would loosen seabed sediments, and sorting bars would filter out oversize boulders. The sampled sediments would be pumped to the surface for shipboard processing. The area of seabed to be sampled by crawler can only be determined following analysis of drill samples and development of a resource model.

As ongoing exploration and resource delineation are likely to yield potential test-mining targets in the inshore portions of ML128B, test mining is envisaged for ML128B over the next three years.

Figure 08. A typical mining vessel (above) and seabed crawler (below).

3.1.6 Production mining

Details on the vessels or tools that will ultimately be implemented for production mining operations in ML128B, cannot at present be provided as these have not yet been finalised. Research and development of appropriate sampling and mining tools will form part of the conceptual studies and prefeasibility and feasibility phases of the project following development of the inferred resource.

3.2 Infrastructure and services

3.2.1 Water and energy supply

The contracted exploration vessel is fully self sufficient when at sea. The vessel uses marine gas oil, which is taken on board under controlled conditions in a harbour (Port of Cape Town or Lüderitz). Power is supplied by onboard diesel generators. Although the vessel will take on potable water when in port, it can make its own fresh water at a rate of 22m^3/day *via* an evaporation system on the main engines and reverse osmoses purifiers.

3.2.2 Vessel and equipment maintenance

Vessel and equipment maintenance is undertaken while in the Port of Lüderitz, or when in drydock in Cape Town.

3.2.3 Waste management

The contracted exploration vessel has strict waste management practices in place in compliance with a vessel-specific EMP. Soft waste is burned in an on board incinerator, metal and glass is compacted and regularly transported to shore for disposal or recycling. All oil waste is stored in on-board dirty oil and sludge tanks and regularly transported to shore for recycling.

Sewage is discharged following onboard treatment and food waste is macerated such that it will pass through a 25mm screen. The vessel is thus fully MARPOL compliant as regards disposal of sewage and galley wastes.

Refuelling of the vessel occurs only under controlled conditions in a harbour; no re-fuelling takes place at sea.

Losses of FeSi used in the onboard DMS Plant are highly variable, depending on the substrate being mined. To reduce FeSi loss, the DMS plant has been fitted with ball-mills to fragment shell- and clay-material during sediment processing.

3.2.4 Security

Security cameras are positioned in the onboard mineral recovery plant and at certain critical points of the subsea launch equipment. The cameras record onto a special hard drive system for review and analyses. Security rules on board the exploration and mining vessels are in accordance with the Contract Security Procedures.

3.3 Rehabilitation

As active rehabilitation of the marine environment below the low water mark is neither feasible, nor necessary, no seabed rehabilitation and biodiversity restoration programmes are in place. Recovery within the marine environment occurs naturally with the rate depending on the area impacted, the depth at which the impact occurred and the frequency of natural disturbances (e.g. low oxygen events) (Pulfrich & Penney 2001; Pulfrich et al. 2003; Pulfrich & Branch 2014a, 2014b).

Monitoring the recovery of marine ecosystems of the impacted areas will therefore continue beyond mine closure.

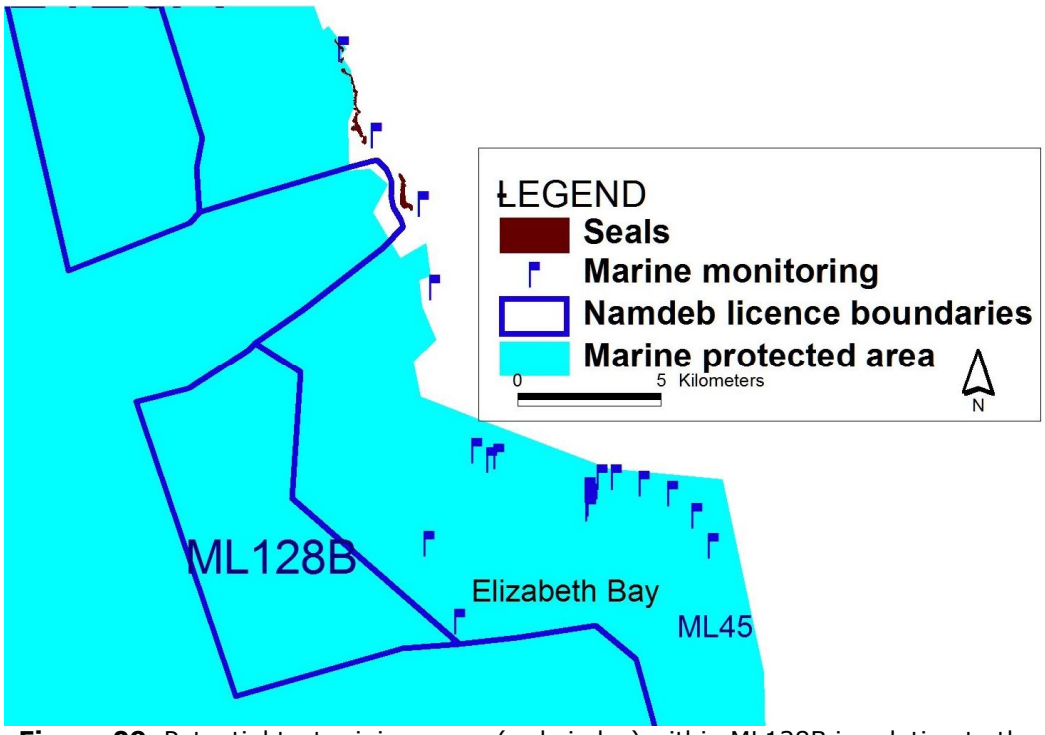

Figure 09. Potential test mining areas (red circles) within ML128B in relation to the Namibian Islands Marine Protected Area, marine monitoring sites and Sites of Special Scientific Interest (sssi's) such as islands, seal and bird breeding sites.

Chapter 4 The natural environment in ML128B

Biogeographically, the southern Namibian coastline falls into the cold temperate Namaqua Province. The marine ecology of the region is shaped by coastal, wind-induced upwelling with communities in the offshore areas being particular only to substrate type or depth zone.

Geophysical surveys and sampling in ML128B and the offshore portions of ML45 have revealed various geological mineralogical zones in the mid-water area. Most of the licences are dominated by exposed bedrock areas, with areas of resource potential being limited to isolated pockets of unconsolidated sediments.

The structure of benthic communities of soft-bottom substrates is determined primarily by water depth and sediment grain size. Communities are characterised equally by polychaetes, crustaceans and molluscs. On hard substrates to 60m depth communities are dominated by encrusting sponges, starfish, anemones, soft corals, colonial ascidians and rock lobsters. Deepwater reef communities at 100-120m depth include gorgonians, octocorals and reef-building sponges.

Biogeographically, the southern Namibian coastline falls into the cold temperate Namaqua Province, which extends from Cape Point to Lüderitz (Emanuel et al. 1992). The marine ecology of the southern Namibian coastline is shaped by coastal, wind-induced upwelling and is characterised by cold surface waters, high biological productivity, and highly variable physical, chemical and biological conditions (Barnard 1998). Communities within marine habitats are largely ubiquitous throughout the southern African West Coast region, being particular only to substrate type or depth zone. These biological communities consist of many hundreds of species, often displaying considerable temporal and spatial variability (even at small scales).

4.1 Climate

The climate of the southern Namibian coastline is arid with typically low, unpredictable winter rains, strong predominantly southerly winds and frequent occurrence of fog along the coast. Winds at the sea surface are seasonally modulated and significantly influence the oceanography of the Benguela region. Occasionally easterly, hot berg winds blow during the winter months; then temperatures can reach 35ºC, even near the coast.

4.2 Bathymetry

The continental shelf off southern Namibia is variable in width. Off the Orange River the shelf is wide (230km) and characterised by well-defined shelf breaks, a shallow outer shelf and the aerofoil-shaped submarine Recent River Delta on the inner shelf. It narrows to the north reaching its narrowest point (90km) off Chameis Bay, before widening again to 130km off Lüderitz. Detailed multibeam bathymetry data have been collected over most of the ML128B area.

4.3 Coastal and inner shelf geology and seabed geomorphology

The inner shelf between Lüderitz and the Orange River is underlain by Precambrian bedrock, which displays an irregular, erosion surface with relief of up to 15m, overlain with a thin cover of unconsolidated Quaternary sediments of Orange River origin. The middle and outer shelf areas are composed of Cretaceous and Tertiary sediments (Dingle 1973; Birch et al. 1976; Rogers 1977; Rogers & Bremner 1991).

The coastal geology of the area between Chameis Bay and Lüderitz is dominated by meta-sediments and metamorphosed igneous rock of the Precambrian Gariep Group. The coastal formations are largely covered by Quaternary, aeolian sands.

Geophysical surveys and sampling in ML128B and the offshore portions of ML45 have revealed various geological mineralogical zones in the mid-water area from south of Chameis to Lüderitz. Of the 54.1km^2 of seabed in this licence area, in the order of 25% comprises exposed bedrock areas with no economical potential from a diamond resource perspective.

Of the deeper portions of ML128B, about 44% has a comparatively thick overburden of Miocene grits. Most of the remainder of the licence is dominated by exposed bedrock areas, with areas of resource potential being limited to isolated pockets of unconsolidated sediments.

4.4 Biological environment

4.4.1 Unconsolidated sediments

The benthic biota of soft bottom substrates constitutes invertebrates that live on, or burrow within, the sediments, and are generally divided into macrofauna (animals >1mm) and meiofauna (<1mm). The structure and composition of benthic soft bottom communities in offshore unconsolidated sediments off southern Namibia is primarily a function of water depth and sediment grain size (Steffani & Pulfrich 2004a, 2004b; 2007; Steffani 2007a, 2007b, 2009), but other factors such as current velocity, organic content, and food abundance also play a role (Snelgrove & Butman 1994; Flach & Thomsen 1998; Ellingsen 2002).

The description below is drawn from past De Beers Marine Namibia monitoring studies in the mid-water regions (Steffani & Pulfrich 2007; Steffani 2007a; 2007b). There is a distinct difference in benthic invertebrate composition between the inner-shelf (<30m) and mid-shelf (30-150m) areas, with further latitudinal differences also being evident (Steffani 2007b; Karenyi unpublished data). Species diversity, abundance and biomass typically increase from the shore to 80m depth, with communities being characterised equally by polychaetes, crustaceans and molluscs. Off Bogenfels mean abundances of 250/m^2 and biomass of 20g/m^2 have been recorded, whereas at Chameis, abundances and biomass were higher (1,305/m^2 and 33g/m^2, respectively).

Further offshore to 120m depth, the mid-shelf mudbelt is a particularly rich benthic habitat where biomass can attain 60g/m^2 dry weight (Christie 1974). In De Beers Marine Namibia's ML47 offshore of ML43, Steffani (2007b) reported biomass values ranging from 63.5 to 78g/m^2 wet weight from depths of 100m. The comparatively high benthic biomass in this mudbelt region represents a food resource to carnivores such as the mantis shrimp, cephalopods and demersal fish species (Lane & Carter 1999). Outside of this rich zone biomass declines again.

The inner-shelf community, which is affected by wave action, is characterised by various mobile predators (e.g. the gastropod *Bullia laevissima* and polychaete *Nereis* sp.), sedentary polychaetes and isopods. Typical species occurring at depths of up to 60m off Bogenfels included the snail *Nassarius* spp., the polychaetes *Orbinia angrapequensis*, *Micronepthys (=Nephtys) sphaerocirrata*, several members of the spionid genera *Prionospio*, and the amphipods *Urothoe grimaldi* and *Ampelisca brevicornis*. The bivalves *Tellina gilchristi* and *Dosinia lupinus orbignyi* are also common in certain areas. Species at Chameis included the bivalve *Macoma crawfordi*, and polychaetes of the families Lumbrineridae and Cirratulidae. All these species are typical of the southern African West Coast (Christie 1974; 1976; Parkins & Field 1998; Pulfrich & Penney 1999; Goosen et al. 2000; Steffani & Pulfrich 2004a; 2007; Steffani, unpublished data).

The distribution of species within these macrofaunal communities is inherently patchy reflecting the high natural spatial and temporal variability associated with macro-fauna of unconsolidated sediments (e.g. Kenny et al. 1998; Kendall & Widdicombe 1999; van Dalfsen et al. 2000; Zajac et al. 2000; Parry et al. 2003), with evidence of mass mortalities and substantial recruitments recorded on the South African West Coast (Steffani & Pulfrich 2004; Monteiro & van der Plas 2006; Pulfrich et al. 2006). It is likely that the distribution of marine communities in the mixed deposits of the inner and mid-shelf regions is controlled by complex interactions between physical and biological factors at the sediment–water interface, rather than just by the granulometric properties of the sediments themselves (Snelgrove & Butman 1994; Seiderer & Newell 1999). In areas of frequent oxygen deficiency, benthic communities will be characterised either by species able to survive chronic low oxygen conditions, or colonising and fast-growing species able to rapidly recruit into areas that have suffered oxygen depletion. The combination of local, episodic hydrodynamic conditions and patchy settlement of larvae will tend to generate the observed small-scale variability in benthic community structure.

Also associated with soft-bottom substrates are demersal communities that comprise epifauna and bottom-dwelling vertebrate species, many of which are dependent on

the invertebrate benthic macrofauna as a food source for commercially valuable fish species and other higher order consumers. Epifaunal communities reported from depths of 100m and 250m south of the Orange River mouth were characterised by the hermit crabs *Sympagurus dimorphus* and *Parapaguris pilosimanus*, the prawn *Funchalia woodwardi* and the sea urchin *Brisaster capensis* (Lange 2012).

Figure 10. Benthic macrofaunal genera commonly found in sediments on the inner- and mid-shelf include: (top: left to right) *Ampelisca*, *Prionospio*, *Nassarius*; (middle: left to right) *Callianassa*, *Orbinia*, *Tellina*; (bottom: left to right) *Nephtys*, hermit crab, *Bathyporeia*.

The invertebrate macrofauna are important in the marine benthic environment as they influence major ecological processes (e.g. remineralisation and flux of organic matter deposited on the sea floor, pollutant metabolism, sediment stability).

4.4.2 Marine mammals and birds

The marine mammal fauna occurring off the coast of southern Namibia includes several species of whales and dolphins and one seal species, the Cape fur seal (*Arctocephalus pusillus pusillus*). Atlas Bay, Wolf Bay and Long Islands in ML45 together represent the largest breeding concentration (about 68,000 pups) of seals in Namibia. Further colonies are located at van Reenen Bay and Bakers Bay in ML44. Seals are highly mobile animals with a general foraging area covering the continental shelf up to 120 nautical miles offshore (Shaughnessy 1979), with bulls ranging further out to sea than females. Seals are thus likely to be encountered in ML128B. Apart from the resident dolphin species such as the endemic Heaviside's dolphin and

dusky dolphin, the coastline also falls into the migration routes of southern right whales (*Eubalaena australis*) and humpback whales (*Megaptera novaeangliae*) that migrate between Antarctic feeding grounds and warmer breeding ground waters. Whereas the small endemic dolphins are present year round, the migratory whales show a seasonal occurrence off the mining area, abundances peaking between June and September. Although the migration routes occur primarily off the continental shelf, in recent years a number of the sheltered bays along the coast of ML44 and ML45 (e.g. Chameis Bay and Elizabeth Bay) have become popular calving sites for Southern Right whales. Whales are thus likely to be encountered in ML 128B.

The Namibian coastline sustains large populations of breeding and foraging seabird and shorebird species, which require suitable foraging and breeding habitats for their survival. Birds likely to be encountered along the shoreline of ML45 include Bank (*Phalacrocorax neglectus*), Cape (*Phalacrocorax capensis*), White-breasted (*Phalacrocorax carbo*) and Crowned (*Phalacrocorax coronatus*) Cormorants, African Black Oystercatcher (*Haematopus moquini*), Kelp and Hartlaub's Gulls (*Larus dominicanus* and *L. hartlaubii*) and Swift Terns (*Sterna bergii*). Most of the seabird species breeding in Namibia feed relatively close inshore (10-30km). Cape Gannets (*Morus capensis*), however, are known to forage up to 140km offshore (Dundee 2003; Ludynia 2007), and African Penguins (*Spheniscus demersus*) have also been recorded as far as 60km offshore.

4.4.3 Exposed bedrock and rocky outcrops

Due to the difficultly of quantitatively sampling hard substrate habitats in deep water, information on the invertebrate communities inhabiting reefs and rocky outcrops in ML128Bis limited.

Dives conducted with the submersible *Jago* have revealed that communities to 60m depth are dominated by a diversity of encrusting sponges, starfish, anemones, soft corals, colonial ascidians and the West Coast rock lobster (*Jasus lalandii*). Further video footage taken on hard-substrate habitats in 100-120m depth off southern Namibia (Debmarine, unpublished data) suggest that deepwater reef communities include gorgonians, octocorals and reef-building sponges. Such suspension-feeding communities add structural complexity to otherwise uniform seabed habitats thereby creating areas of high biological diversity (Breeze *et al*. 1997; MacIssac *et al*. 2001). As a result of conservative life histories (*i.e*. very slow growing, slow to mature, high longevity, low levels of recruitment) and sensitivity to changes in environmental conditions, such biological communities have been identified as potentially being Vulnerable Marine Ecosystems (VMEs). They are recognised as being particularly sensitive to anthropogenic disturbance (primarily deep-water trawl fisheries and mining), and once damaged are very slow to recover, or may never recover (FAO 2008).

Figure 11. Benthic communities recorded at depths of ~60m off southern Namibia (Photos: Namdeb) include colonial ascidians, sponges, soft corals, anemones and rock lobsters.

Figure 12. Gorgonians and bryozoans communities recorded on deep-water reefs (100-120m) off the southern African West Coast (Photos: De Beers Marine).

4.5 Existing disturbances

Previous sampling and prospecting campaigns in ML128B have involved disturbance of a cumulative area of about 255m^2 or 0.0003km^2, or 0.0005% of the ML128B mining licence area (54.1km^2).

Chapter 5 The socio-economic environment

Namdeb's overall contribution to the Namibian economy is substantial, with additional major positive spin-offs on secondary industries such as suppliers, service providers and contractors, a large part of them in the Karas region.

Depending on the activity, the staff complement can range from 5 to 115. This includes support from various other sections within Namdeb as well as from De Beers Marine and De Beers Marine Namibia.

5.1 Economic contribution

Mining makes a significant contributes to Namibia's Gross Domestic Product (GDP) (12.2% to GDP in 2017, Chamber of Mines 2017), and to infrastructure and community development. It is the dominant economic sector in the Karas Region where Namdeb operates. Although employment rates are slightly above the national average, besides the formal sector (mining, fishing, agriculture) there are few other opportunities for employment as subsistence farming is very marginal in this arid region and developments of other sectors (e.g. tourism, manufacturing) progress very slowly.

Namdeb's turnover in 2017 was N$ 11.5 billion with a corporate tax bill of N$ 1.92 billion, royalty tax amounting to N$ 1.15 billion and export levies to N$ 71 million (Chamber of Mines 2017).

In addition to the direct contribution to Namibia's economy, Namdeb has a profound positive effect on secondary industries through suppliers, contractors and service providers supported by the diamond mining business.

5.2 Human resources

5.2.1 Employment and benefits

Depending on the activity, the staff complement of the offshore resources development team can range from 5 to 115. The resources are drawn from the Survey, Resource Evaluation, Environmental and Strategic Projects sections within Namdeb as well as Debmarine Namibia and De Beers Marine South Africa. This number also includes contractor-vessel employees and various consultants.

Since 2017 Namdeb employees can choose between free housing and a housing and utility allowance.

Over 74% of Namdeb's employees are members of the Mine Workers Union of Namibia (MUN). The Union is represented on human resources committees, accommodation and medical schemes.

To address employees' and community expectations Namdeb has set up an incidents and grievance mechanism and is presently formulating an overarching stakeholder engagement plan (C. Neels, pers.comm. August 2018).

5.2.2 Work hours and shifts

Shifts for personnel associated with the mid-water exploration project and operations in ML128B are determined by the contractor operating the exploration and mining vessels.

5.2.3 Skill development and training

Employees qualify for all Namdeb training programmes offering technical and non-technical training.

Namdeb provides bursaries to promising, young Namibians for studies in technical disciplines and it has a graduate trainee programme, which offers graduates job experience and on-the-job training.

5.2.4 Health, safety, medical care and emergency response

All staff can utilise the hospital and other medical facilities in Oranjemund. The hospital is a primary medical care facility and offers emergency, out-patient, dental care and a surgical theatre. Namdeb has an HIV/AIDS awareness and training programme. Occupational health amongst staff is monitored regularly for noise and dust exposure.

Namdeb has a disaster plan and staff trained and allocated to implement an appropriate response in an emergency (e.g. fire, floods, accidents and environmental incidents).

5.2.5 Education

Namdeb supports private pre-primary, primary and secondary schools in Oranjemund and maintains an Educational Assistance Scheme to subsidize school fees. Nearly N$ 19 million was spent in 2017 on private schools in Oranjemund (Namdeb Social Risk Assessment, October 2017).

5.3 Corporate social responsibility

The Debmarine – Namdeb Foundation was formed in 2015 with the vision of being a community partner in socio-economic development. For the year ended December 2017 the Foundation spent some N$ 3.4 million on different projects in its focus areas of education (17%), conservation and biodiversity (44%), youth empowerment (22%) as well as other projects (sport (6%) and disaster relief (11%)). In addition, Namdeb approved over N$ 260,000 under a separate social responsibility programme, largely supporting sports events and access to opportunities, 88% of which are in the Karas region (I. Hucke-Mcfarlane, August 2018).

Namdeb also has a social closure team, which is developing strategies and programmes to deal with the social aspects of mine closure (C. Neels, pers. comm. August 2018).

5.4 Neighbouring licence holders

The mining licence ML45, bordering the ML128B licence on its eastern (inshore) boundary, is also held by Namdeb. The marine areas bordering the southern edge of ML128B comprise several exclusive prospecting licences (EPLs) and the 'island concessions' to the north and south of ML128B are held by Sakawe Mining Corporation (Samicor). The EPL south of ML128B is held by Epangelo Mining Company (Pty) Ltd.

Chapter 6 Environmental management to date

Namdeb's Environmental Section is responsible for environmental protection. Currently seven full-time staff are responsible for planning, performance reporting, assurance, impact monitoring and stakeholder engagement. Although there is no environmental officer directly responsible for ML128B, the licence area currently falls under 'Exploration and Strategic Projects', for which one environmental management coordinator has been made responsible. All Namdeb's operations are ISO14001:2015 certified and follow De Beer's and Anglo American's corporate standards.

Environmental management at Namdeb today encompasses an intricate machine of components relying on and informing each other to address the challenges posed by mining diamonds profitably while taking cognisance of environmental protection. For the purpose of this EMPR the headings below structure this section. All aspects described below apply to ML128B, as well as Namdeb overall.

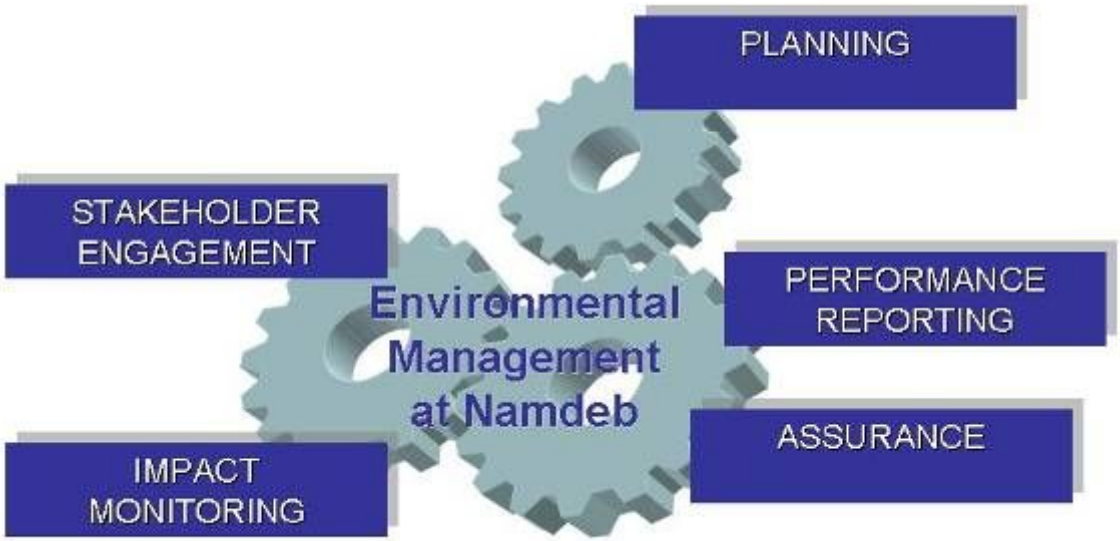

Figure 13. The main components of environmental management at Namdeb.

6.1 Planning

Environmental impact assessments undertaken by external environmental practitioners, internal risk assessments undertaken by Namdeb environmental staff and specialist baseline studies are the tools used to inform projects at a planning stage at Namdeb.

6.2 Performance reporting

Corporate environmental management at Namdeb requires reporting at a multitude of levels internally to De Beers and Anglo American peers, the Namdeb Executive Management Committee (Nemcom scorecard), the OPSCO team and the Head Mineral Resources and Environment and externally to the authorities. The figure below provides a summary of the key reporting tools.

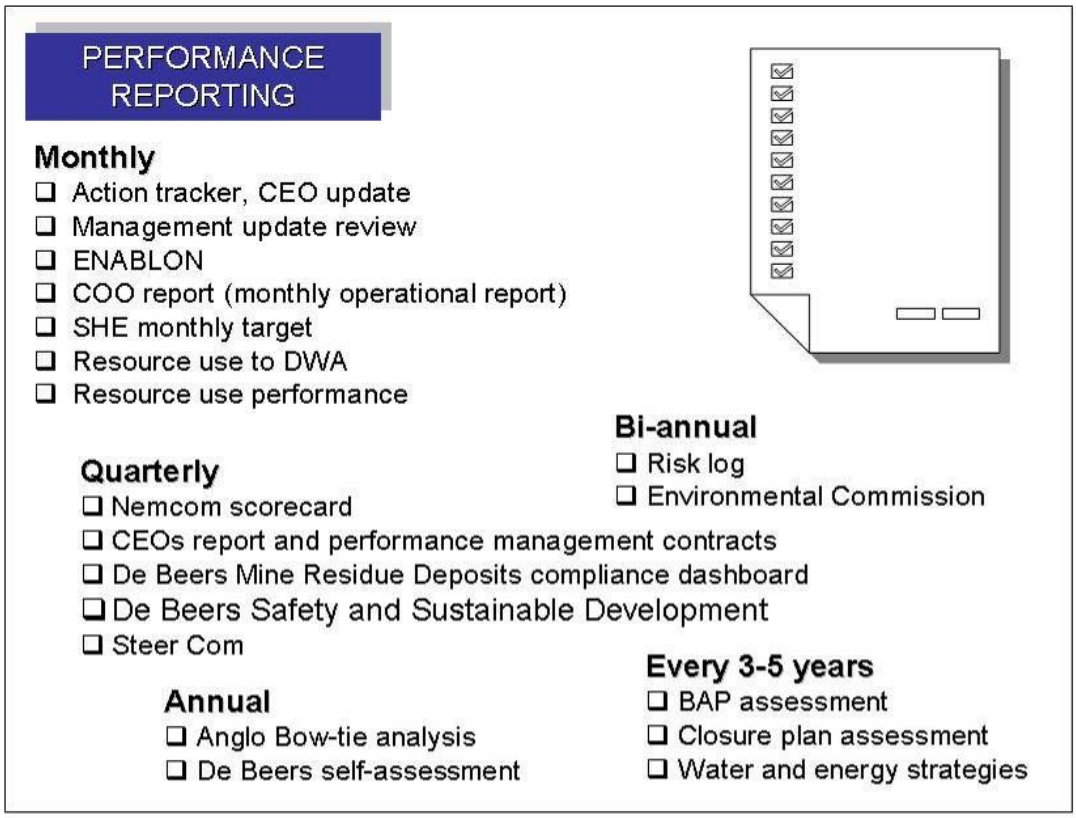

Figure 14. Elements of environmental performance reporting at Namdeb (BAP = Biodiversity Action Plan, CEO= Chief Executive Officer, COO= Chief Operational Officer, DWA= Department of Water Affairs, ENABLON= corporate reporting tool, SHE= Safety, Health and Environment).

ENABLON is Anglo American's computerised environmental platform which facilitates regular updates on-line and thus provides a real-time status of all Anglo-American / De Beers operations.

6.3 Assurance

Environmental performance at Namdeb is certified by auditors, externally and internally and backed by compliance visits from the authorities (e.g. Department of Water Affairs and Forestry) and corporate head office.

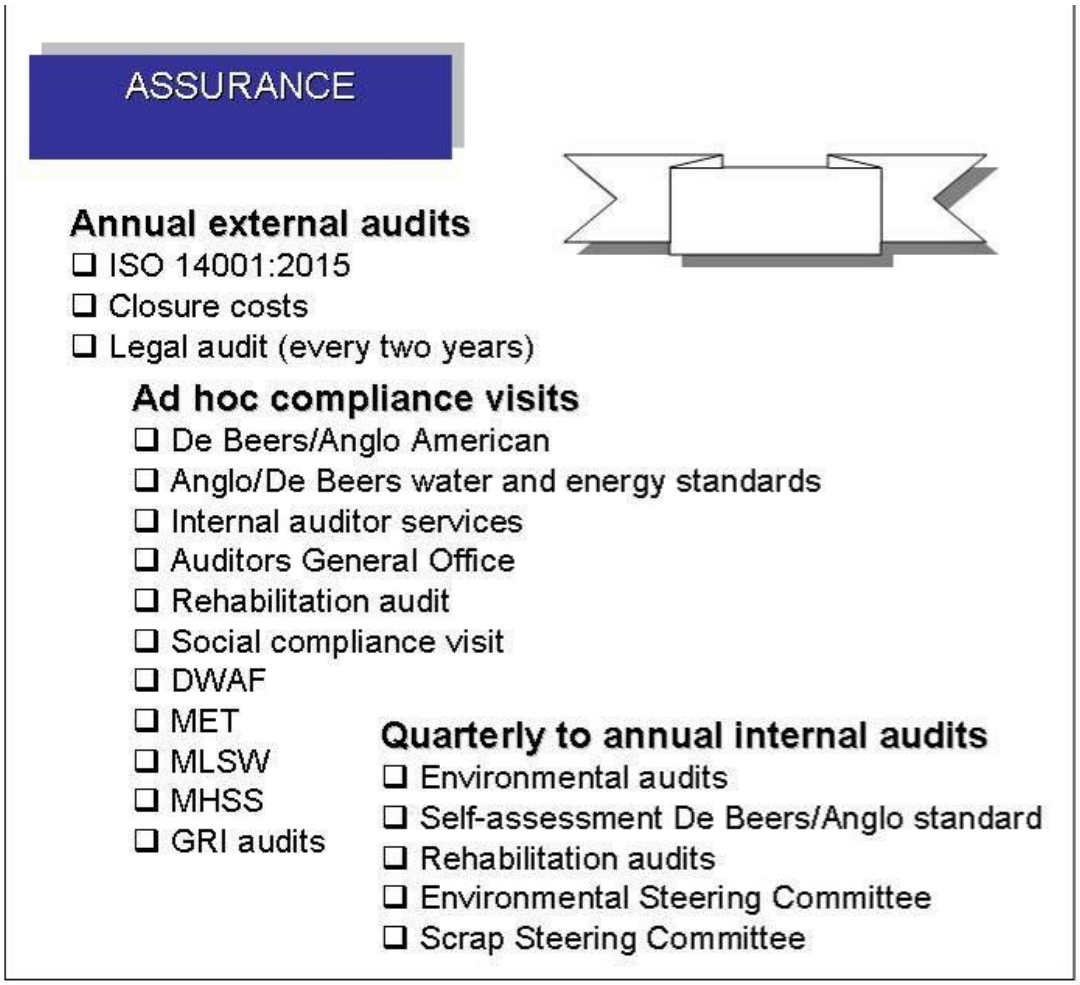

Figure 15. Environmental audits and certification at Namdeb (DWAF= Department of Water Affairs and Forestry, GRI= Global Reporting Initiative, MET= Ministry of Environment and Tourism, MLSW= Ministry of Labour, MHSS= Ministry of Health and Social Services).

All Namdeb's operations are ISO14001:2015 certified. ML128B has not yet been certified but by De Beers Standards would be certified within a year following commencement of operations.

6.4 Impact monitoring

Monitoring of resource use and environmental impacts go hand-in-hand. These are some of the critical functions of Namdeb's environmental section.

6.4.1 Resource use and pollution monitoring

At this stage of the Mid-water Project, resource use and pollution monitoring would apply to the contracted exploration vessel only, and would be the responsibility of the contractor.

6.4.2 Impacts on biodiversity

The first soft-bottom benthic macrofaunal survey in the mid-water region was undertaken in 2001 by De Beers Marine Namibia, on contract to Namdeb. The surveys focussed on the Halifax, Elizabeth Bay, Bogenfels, Chameis and Kerbehuk areas and were repeated annually until 2004, with the objective of assessing mining impacts in areas where mining had taken place, and/or commenced after 2001.

However, owing to poor data availability on historical mining activities, it was not possible to group all of the sampling sites into clear 'impact' (to-be disturbed) and 'control' (not-to-be disturbed) sites. The results of the surveys were thus only effective in describing the macrofaunal communities present, and no link could be made to anthropogenic impacts. From 2005 onwards, the survey design was adapted and the survey separated into i) the Marine Dredging Project (MDP) survey, and ii) the benthic monitoring survey. The 2005 survey focussed on shallow-water target sites off Pomona in the offshore portion of ML44, but it was expanded in 2006 to include two additional sites off Chameis (ML43).

As Namdeb places an emphasis on monitoring the potential impacts of its operations on biodiversity, a marine monitoring programme of benthic macrofaunal communities in unconsolidated sediments was initiated in 2008 as part of their mid-water operations. A further baseline survey, prior to test mining of the Bogenfels and Channel features in the offshore portions of ML44 and ML45, was undertaken in December 2015. However, no surveys have been undertaken to date in ML128B.

Namdeb supported the marine predator monitoring (Southern right whales and selected birds (African Penguin, Bank Cormorant and Cape Gannets)) project in 2015.

The marine life sightings programme at the Ministry of Fisheries and Marine Resources is also supported by Namdeb.

6.5 Stakeholder engagement

Effective environmental management cannot be achieved in isolation. Engaging stakeholders and creating awareness is therefore an important function of Namdeb's environmental staff. In addition to *ad hoc* public consultations related to impact assessments for specific projects, Namdeb has two regular, external fora for information exchange – the Marine Scientific Advisory Committee and the Namdeb Stakeholder Forum.

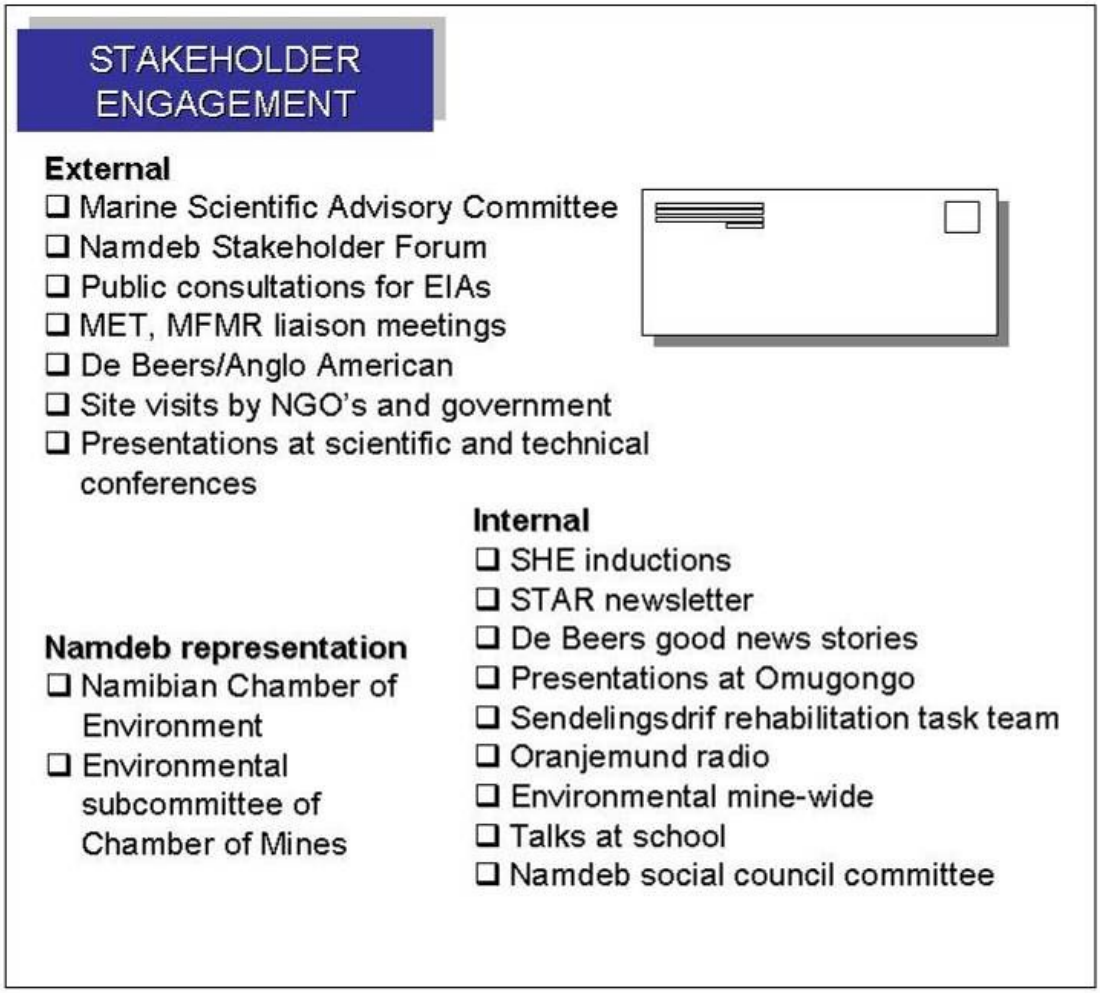

Figure 16. Stakeholder engagement, training and awareness in environmental matters at Namdeb (EIA= Environmental Impact Assessment, MET= Ministry of Environment and Tourism, MFMR= Ministry of Fisheries and Marine Resources, NGO= non-governmental organisation, SHE= safety, health and environment).

Awareness for environmental matters is created through environmental inductions, which form an integral part of the compulsory Safety, Health and Environment (SHE) inductions for all staff and contractors accessing Namdeb's operations. Contributions are also made to regular newsletters, Oranjemund radio, "mine-wides" and presentations. Namdeb is represented on many working groups dealing with environmental matters affecting Namdeb's licence areas. Namdeb has committed to maintaining on-going communication with key stakeholders on the progress of exploration (including marine exploration) and mining operations in ML128B.

Chapter 7 Environmental Assessment

The environmental impact assessment followed a process prescribed by Anglo American, using a risk assessment matrix. All activities resulting in "high" and "significant" impacts need to be managed. These are compiled in an impact register. As this is an update of an existing EMPR focus is on new impacts and prioritising of previously identified impacts.

Exploration and test mining in ML128B focuses on unconsolidated seabed sediments with concomitant activities of on-site tailings disposal resulting in impacts on marine habitats and biota. The extent of these impacts have not yet been established with certainty.

7.1 Approach

Environmental risks at Namdeb are continuously reviewed and updated. Depending on the magnitude of the new disturbances to the environment, this is undertaken either by following the formal environmental assessment process prescribed in the Environmental Management Act or, in the case of minor changes to existing mining and exploration activities, by internal assessments undertaken by Namdeb's environmental staff. To ensure that all environmental risks were covered during this EMPR review, all relevant reports since the previous EMPRs were reviewed, discussed and re-assessed, where necessary, at a risk assessment workshop with Namdeb's Environmental Section in Oranjemund 22-23 September 2015. Activities were reviewed in 2018 and the risk matrix updated accordingly.

Following an agreed level of assessment and assessment methodology, environmental risks are summarised in an impact matrix for each licence area for the natural and socio-economic environment (Table 4 and 5).

7.2 Assessment methodology

Namdeb is obliged to follow Anglo American's corporate procedures, one of which is a pre-scribed risk assessment, referred to as the 5x5 matrix. This 5x5 matrix also underlies the assessment process for environmental aspects in the computerised EMS. The Anglo 5x5 matrix includes the standard criteria "extent", "duration" and "likelihood", which form part of all environmental impact assessment procedures. "Magnitude/severity" is described as "receiving environment/ ecosystem context". An overall significance rating is calculated from the ratings of these individual criteria by averaging the score of extent, duration and receiving environment and multiplying

this with the score for likelihood. During the assessment at Namdeb descriptive criteria were added for the assessment of visual and social impacts and for resource use, as these were inadequately catered for the 5x5 matrix.

Table 2. Environmental assessment criteria from Anglo 5x5 matrix.

Score	Extent	Duration	Likelihood
1	Affecting small area (metres)	Days or less	Rare (7.5%)
2	Limited area (hundreds of metres)	Weeks	Unlikely (15%)
3	Extended area (kilometres)	Months	Possible (30%)
4	Sub-basin scale (marine: regional)	Years	Likely (60%)
5	Whole basin (marine: international)	Permanent	Almost certain (99%)
	Receiving environment		
1	Highly altered with no sensitive habitats and no biodiversity value/ no ecosystem services value		
2	Altered with little natural habitat and low diversity value/low ecosystem services value		
3	Largely natural habitat/moderate biodiversity value/moderate ecosystem services value		
4	Sensitive natural habitat with high biodiversity value/high ecosystem services value		
5	Sensitive natural habitat with very high biodiversity value/very high ecosystem services value		

Table 3. Significance levels based on the Anglo American risk assessment matrix.

Score	Significance
1-5	Low
6-12	Medium
13-20	Significant
21-25	High

This assessment process does not cater for assessing the reversibility of the potential impact. This has been added as an additional criterion in the impact register (Annex 3).

7.3 Environmental risks and their significance

Description of all high and significant impacts is provided in Annex 3. Mitigation measures are included in the Environmental Management Programme (EMP) for all high and significant impacts and some medium and low impacts where mitigation is effective and presently applied.

Table 4 shows the main negative impacts on the natural environment associated with exploration and test-mining activities in ML128B. This is a summary of the detailed impact assessment undertaken using the Anglo 5x5 risk matrix. In this overview activities with identical risk ratings were combined, where feasible, and impacts have been divided into to six major impact categories. More detailed descriptions of individuals impacts are provided for significant impacts in the impact register (Annex 3). No "high" impacts were identified, but a fair number of impacts were rated "significant".

Mining in ML128B would focus on exploitation of discrete localised targets with concomitant activities of tailings disposal back into the sea on site, potentially resulting in significant impacts on marine habitats and biota. The extent of these impacts has not yet been established with certainty.

Table 4. Overall rating of negative environmental impacts associated with exploration and mining in Mining Licence 128B affecting the natural environment (S = significant, M = medium, L = low).

ML128B	Habitat loss	Habitat change	Loss of biota	Effect on biota	Water quality	Natural resource use
MARINE EXPLORATION						
Geophysical surveying				L		
Seabed sampling		S	S			
Oversize disposal to sea during marine exploration			S			
Fines disposal to sea during marine exploration					L	
Ferrosilicon losses with tailings					L	
Effect of marine mining and exploration on NIMPA	L		M			
SERVICES AND INFRASTRUCTURE						
Waste management on vessels					S	
Natural resource use by marine exploration						M
Loss of equipment	L	L				
Air support to mining vessels				L		

Table 5. Positive and negative socio-economic impacts of mining operation in Namdeb's ML128B (S = significant).

SOCIO-ECONOMIC	Positive
Positive	
Contribution to Namibian economy	S
Increased skills and employment	S
Development of technology	S
Improved scientific knowledge (geology, biodiversity and heritage)	S
Community support and awareness	S
Sustained employment	S
Sustained social services	S

Socio-economic impacts of mining activities in ML128B are largely positive. These also include aspects related to the natural environment such as increased knowledge through long-term ecological monitoring.

7.4 Cumulative effects

7.4.1 External factors

7.4.1.1 Commercial fishing

Commercial fishing undoubtedly has an effect on fish populations. Of particular relevance to the inshore portions of ML128B and particularly ML45 is the rock lobster industry. This makes it difficult to separate the impacts of mining on fish populations from those of commercial fishing.

The commercial rock-lobster fishery in Namibia is centred around Lüderitz, with the most important southern fishing grounds located off Kerbehuk in ML43. Between 40-60% of the annual Total Allowable Catch (TAC) is fished on these southern grounds. Little effort is directed at the ML45 area. Fishing is conducted with rectangular traps set in 10-40m depth from wooden deck boats. The fishery therefore primarily concentrates its efforts inshore of ML128B. The fishery is managed by means of a commercial fishing season from November to April, a size limit of 65mm carapace length, and an annually determined TAC that currently stands at 268t (2016-2017).

While demersal fish species targeted elsewhere by the commercial trawl-fishery do occur in the ML128B licence area, trawling and longlining is prohibited in Namibia in waters shallower than 200m. There are further conditions applicable to hake trawling vessels fishing south of 25° latitude, where the fishing exclusion has been extended to a depth of 300m. Freezer trawlers fishing in this area are confined to fishing in depths of 350m or more (Currie et al. 2008). As ML128B lies well inshore of the 200m isobath, no interaction with commercial fisheries is therefore expected.

7.4.1.2 Climatic variations

The marine environment is most severely affected by changes in climate, which could result in sea level rise, shifts in large currents, changes to the physical conditions of seawater and effects on local climate. Which way these climatic changes will manifest themselves is currently still poorly understood, but there is a potential that these either intensify or alleviate the impacts of changes to the coastline resulting from mining. While a sea level rise would facilitate natural rehabilitation of the mined areas along the coast, a possible change in local weather patterns, such as changes in storm patterns and wind regimes may have the opposite effect. Due to the offshore location and depths of the ML128B licence, this area will not be affected by sea level rise.

7.4.1.3 Other marine mining

The ML128B licence lies directly offshore and adjoining Namdeb's mining licences ML45, and also those licence areas held by Samicor. Activities in these adjoining licences affect many of the same marine habitats such as subtidal reefs and areas of unconsolidated sediments.

7.4.2 Namdeb internal factors

Sampling and test-mining in ML128B would target discrete seabed areas, but as most of the seabed in the licence areas is characterised by emergent bedrock, there is a risk of the sediment disposal from exploration and mining vessels impacting reef areas adjacent to the mining targets. Due to the challenges of quantitatively sampling rocky areas, information on the biodiversity and sensitivity of hard substratum communities is lacking at this stage, making it difficult to confidently predict potential indirect mining effects on these habitats and their associated communities.

Monitoring studies of mining impacts on macrofaunal communities in soft sediments, and their subsequent recovery, have been undertaken by both Namdeb and Debmarine Namibia and De Beers Marine. As these have been only partially successful in shedding light on community recovery following mining, it is important for Namdeb to develop a sound benthic macrofaunal monitoring programme as part of their proposed operations in ML128A, B and C and the mid-water areas.

7.5 Shortcomings

7.5.1 Assumptions

The impact assessment presented here is based on the mine planning information contained in Namdeb's Strategic Business Plan of 2018. In the mid-water areas in particular, the exploration/mining environment changes continuously and this assessment is thus a snap-shot in time.

7.5.2 Uncertainties

The impact assessment has identified a few gaps in knowledge, such as:

- ◊ Lack of baseline information on marine biodiversity for the mid-water areas, particularly for reef habitats,
- ◊ Effects of mobilised mining-related sediments on the offshore reefs, and
- ◊ Namdeb's contribution to the health of the marine ecosystem.

Poorly understood in this area are presently also

- ◊ Natural recovery potential of unconsolidated sediments and rocky outcrops,
- ◊ Natural recovery rates of different marine ecosystems,
- ◊ Contribution of other environmental impacts such as climate change and overfishing, and
- ◊ Ecosystem function and services.

Closing these knowledge gaps is not necessarily Namdeb's responsibility and should take practicalities into account, such as available expertise, identification and curating services in the case of biodiversity baseline information, as results may not be available in the time frame required to manage the anticipated impacts.

Chapter 8 Environmental Management Plan

The Environmental Management Plan outlines overall environmental tasks, provides management actions for all high and significant impacts and describes monitoring activities.

Environmental management tasks are organised according to overall tasks that are necessary for the implementation of the EMP, then by significance and within these according to aspects. These management actions need to be seen in the context of an existing environmental management system, which has been in place for over 20 years and where all measures applicable to common environmental aspects such as waste management, pollution control and protection of habitat, fauna and flora are well entrenched and routine. The management actions in this EMPR therefore focus on new aspects and prioritising existing management actions.

Objectives applicable to all management tasks in this EMP are described below and are not repeated for each task. Impact descriptions are provided in the impact register in Annex 3. All policies and procedures directly referred to in this EMP are provided in Annex 5, while the full suite of standard policies and procedures related to environmental management and applicable to all licence areas is included in the EMPR for ML43. The management objectives link directly to Namdeb's environmental policy.

The management objectives for this EMP are to:

- Protect the environment including pollution prevention and conserving natural habitats, flora and fauna and cultural heritage,
- Have no net loss of significant biodiversity,
- Avoid, substitute or reduce fresh water consumption and reduce carbon emissions from the 2004 baseline,
- Integrate waste management practices to reduce the generation of waste and the impact on the environment,
- Determine and evaluate fulfilment of the compliance obligations,
- Continually improve the effective implementation of the environmental management system,
- Enhance environmental performance,
- Complete internal audits and effectively implement corrective action for nonconformities identified,
- Effectively and expediently report incidents, complete investigations and implement controls,
- Execute rehabilitation programs during mining operations and make provision for mine closure,
- Support environmental research and sustainable development initiatives that are relevant to our business,

- Create environmental awareness amongst our employees, suppliers, contractors and partners,
- Include the consideration of environmental issues in all business strategies and initiatives,
- Assess and, where practicable, reduce the environmental impact of the company's activities, products and services,
- Incorporate life-cycle considerations for significant procured goods and services and control and influence our suppliers and contractors,
- Consult and engage with interested parties on critical environmental matters of mutual concern,
- Make available suitable and adequate resources to achieve our environmental objectives, and
- Report on environmental performance publicly and provide assurance to shareholders.

The following legislation is directly applicable to the management actions (detail in Annex 2) and their link to particular management actions is indicated by the corresponding number (column "legal"):

1. Mineral Act 1992
2. Minerals Amendment Act 8 of 2008
3. Namdeb's minerals agreement
4. Environmental Management and Assessment Act 7 of 2007 and regulations
5. Namibian Constitution Section 95(l)
6. Labour Act 6 of 1992, Act 11 of 2007, and amendment of 2012
7. National Heritage Act 27 of 2004
8. Marine Resources Act 27 of 2000 and regulations
9. Prevention and combating of pollution of the sea by oil Act 6 of 1981
10. Convention on Biological Diversity 2002
11. Ramsar Convention on Wetlands of International Importance especially as Waterfowl habitat, 1971
12. United Nations Framework Convention on Climate Change 1992

The responsibility for implementation of all mitigation measures lies with the Environmental Manager. All tasks are on-going activities.

OVERALL ENVIRONMENTAL TASKS		
Aspect	**Mitigation and control measures**	**Legal**
Implementation of EMP	◊ Incorporate all high and significant management actions in new IsoMetrix EMS database ◊ Identify new management tasks, discuss and explain to all environmental staff with particular attention to natural recovery of marine ecosystems ◊ Make financial provision for potentially new management actions	
Awareness	◊ Adapt environmental inductions to include new environmental aspects and management actions ◊ Broadcast new environmental measures in all available forms of regular communications (briefs, monthly topic, etc.)	
Reporting	◊ Follow ISO14001, MET, Group (Anglo American and De Beers) and Namdeb internal reporting standards (PR-EV-22, PR-EV23)	
I&APs	◊ Present relevant key features of updated EMPR at Namdeb regular stakeholder fora	
Improved management of closure	◊ Allocate operational costs to monitor and demonstrate natural recovery of the seabed through pre- and post-mining benthic faunal and seabed surveys ◊ Provide sufficient funds for a post-closure environmental survey (seabed and/or benthic faunal survey) in the event that on closure or premature closure, the benthic monitoring programme has not been completed or has not been able to demonstrate sufficiently that natural recovery processes are occurring	

SIGNIFICANT ENVIRONMENTAL RISKS		
Aspect	**Mitigation and control measures**	**Legal**
Exploration		
Disturbance of the seabed and associated macrofaunal communities during sampling	◊ Keep easily retrievable spatial record of sampling activities	4,8
Oversize disposal to sea during marine exploration	◊ Keep easily retrievable, spatial record of activity ◊ Avoid disposal of tailings on reefs where possible	4,8
Test-Mining		
Disturbance of the seabed and associated macrofaunal communities during test mining	◊ Keep easily retrievable spatial record of test mining activities to calculate annual and cumulative sampled and test-mined areas ◊ As far as possible avoid mining in the proposed rock-lobster sanctuary ◊ Develop a carefully designed Before-After/Control-Impact benthic macrofaunal monitoring programme and implement this programme before test mining commences ◊ Determine areas that could be considered as "conservation corridors" in consultation with the Namibian government	4,8
Disturbance and loss of habitat, sediment structures and geological record	◊ Keep easily retrievable spatial record of test mining activities to calculate annual and cumulative sampled and test-mined areas ◊ Conduct high resolution geophysical surveys prior to test mining, and of mined areas ~2-3 years post-mining to determine the depth, wall steepness and infilling rates of excavations	4,8
Oversize disposal to sea during test mining	◊ Keep easily retrievable, spatial record of activity ◊ Avoid disposal of tailings on reefs where possible ◊ Conduct high resolution geophysical surveys post-mining to assess the extent of the effects of the discharged tailings on seabed life ◊ If feasible, obtain video footage of potentially affected reef communities, before and after mining to assess the effects of discarded tailings on seabed life.	4,8

Services and infrastructure		
Hydrocarbon spills in the event of a vessel disaster	◊ Have oil spill contingency plan in place ◊ Clean-up of spill as soon as possible following Namdeb policy PO-EV-07 and procedure PR-EV-07	4,8,9
Waste Management and pollution control on sampling/mining vessels	◊ All vessel operations, as well as waste management and pollution control is undertaken in accordance with the procedures and protocols of the prospecting/mining services provider ◊ Adopt standard waste management practices	4,8,9

MEDIUM ENVIRONMENTAL RISKS		
Aspect	**Mitigation and control measures**	**Legal**
Mining		
Effect of marine mining on NIMPA	◊ No actions	
Oversize disposal to sea	◊ Avoid disposal of tailings onto unmined seabed ◊ Avoid disposal of tailings on reefs ◊ Keep easily retrievable, spatial record of activity	4,8
Interaction with the Rock Lobster Fishery	◊ Maintain transparency of operations ◊ Regular interaction at stakeholder fora	4
Natural resource use by marine exploration	◊ Re-use and recycle as far as practicable	4

LOW ENVIRONMENTAL RISKS		
Aspect	**Mitigation and control measures**	**Legal**
Exploration and Test Mining		
Marine geophysical surveys	Develop a procedure to minimise impacts to marine mammals during geophysical surveys. This would include: ◊ Onboard Marine Mammal Observers (MMOs) should conduct visual scans for the presence of cetaceans around the survey vessel prior to the initiation of any acoustic impulses ◊ Pre-survey scans should be limited to 15 minutes prior to the start of survey equipment ◊ "Soft starts" should be carried out for any equipment of source levels greater than 210 dB re 1 µPa at 1 m over a period of 20 minutes to give adequate time for marine mammals to leave the vicinity ◊ Terminate the survey if any marine mammals show affected behaviour within 500m of the survey vessel or equipment until the mammal has vacated the area ◊ The geophysical surveying should largely be undertaken between December and May, thereby avoiding the main migration period of baleen whales from their southern feeding grounds into low latitude waters. However, during the transition periods in June and November, surveying would be possible with stricter mitigation measures. As no seasonal patterns of abundance are known for odontocetes occupying the proposed exploration area, a precautionary approach to avoiding impacts throughout the year is recommended ◊ Ensure that PAM (passive acoustic monitoring), which detects marine mammals through their vocalisations, is incorporated into any surveying taking place between June and November ◊ A MMO should be appointed to ensure compliance with mitigation measures during seismic geophysical surveying. This will also reduce the chances of the vessel colliding with a marine mammal	8
Ferrosilicon losses with tailings	◊ Monitor Ferrosilicon use on an ongoing basis ◊ Maximise Ferrosilicon recycling	4,8

Damage to or destruction of shipwrecks	If shipwreck material is encountered in the course of test mining ◊ Immediately inform the Marine Superintendent or Environment Manager who will inform the National Monuments Council ◊ Retain artefacts recovered and, where possible, maintain a photographic record. Note the date, time, location and types of artefacts found in the logbook ◊ Contract a marine archaeologist to survey the site ◊ Avoid mining or prospecting within 500m from the centre of the site until the area has been surveyed	7
Services and infrastructure		
Loss of equipment from marine vessel	◊ All lost equipment must be accurately recorded in a hazards database, and reported to maritime authorities. ◊ Every effort should be made to recover or remove lost equipment.	8,9
Air support to mining vessel	◊ Flight paths must be pre-planned to ensure that no flying occurs over the Ichaboe, Halifax and Possession Islands or over the Atlas Bay, Wolf Bay and Long Islands seal colonies. [coastal islands or seal colonies] ◊ Extensive low-altitude coastal flights should be avoided. ◊ The flight path between the onshore logistics base in Lüderitz and mining vessel should be perpendicular to the coast ◊ It is recommended that a flight altitude >300m be maintained at all times, except for when the aircraft lands on or takes off from the mining vessel and logistics base ◊ The contractor should comply fully with aviation and authority guidelines and rules ◊ All pilots must be briefed on ecological risks associated with flying at a low level along the coast or above marine mammals	8

ENVIRONMENTAL MONITORING DURING OPERATION			
Aspect	**Parameter**	**Frequency**	**Comments**
Biodiversity			
Marine ecosystems	Benthic macrofauna in unconsolidated sediments and sediment textural analyses	Once every 2 years	
	Benthic fauna on hard substrata	Once every 2 years or when opportunities permit	Collect video footage using ROVs or submersible in rocky areas adjacent to mining targets prior to and after sampling/mining

ENVIRONMENTAL MONITORING AT CLOSURE			
Aspect	**Parameter**	**Frequency**	**Comments**
Marine monitoring			
Physical parameters	Natural infill rates	Every two years	
Biological parameters	Benthic macrofauna in unconsolidated sediments, and Benthic fauna on hard substrata	Every two years	Monitoring until completion criteria are reached

Chapter 9 Annex

The annex summarises the authors' credentials, presents all applicable legislation, and provides an impact register, a list of reviewed literature and Namdeb's environmental policies and procedures applicable to environmental management in ML128B.

Annex 1. The environmental practitioners

Andrea Pulfrich

Academic qualifications

1995: **Dr rer nat** (Ph D), Major: **Fisheries Biology**, Minors: Oceanography, Aquaculture; Department of Fisheries Biology of the Institute for Marine Science at the Christian-Albrechts University, Kiel, Germany.
1987: MSc (Zoology), University of Cape Town, South Africa.
1983: BSc (Hons) (Zoology), University of Cape Town.
1982: BSc (Zoology and Botany), University of Natal, Pietermaritzburg.

Dr Pulfrich is the director of Pisces Environmental Services and has 29 years of professional experience in marine and coastal environmental sciences. Since its founding in 1998, Pisces Environmental Services has successfully completed a broad variety of assignments, ranging from technical field surveys and baseline data collection and environmental assessments, to sophisticated statistical analyses, reporting and public presentation of results. The Company has acquired a reputation among its clients for reliable, efficient, and result-orientated work. A great number of studies have been published in the internationally reviewed scientific literature. Through its links with research and government institutions, universities and industry, the Company keeps pace with advancements in marine sciences and technology, thereby applying up-to-date information and methodologies to its products.

Antje Burke

Academic qualifications

1993: **Dr rer nat** (Ph D), Major: **Landscape Ecology**, Minors: Botany, Geography; Westfälische Wilhelms-Universität, Münster, Germany
1987: Diplom (M Sc equivalent), Major: **Geography**, Minors: Botany, Geology
1984: First degree (B Sc equivalent): Geography, Botany, Geology

Dr Burke has 30 years of professional experience in environmental research and management in Namibia, Germany, Israel, South Africa and Botswana. She has coordinated coordinated and participated in over 50 Environmental Impact Assessments, Management Plans, Audits, Sectoral Reviews and Natural Resource Assessments in Namibia – the majority in the mining and infrastructure sector. She is author of over 70 scientific publications, 50 of these in peer-reviewed, international journals and books, and over 100 popular and educational publications and is a scientific reviewer for eleven international journals. Dr Burke is a scientist widely recognised in her field of expertise. Her strong research background in environmental sciences, combined with in-depth practical experience, has enabled her to always maintain an exceptionally high standard, but unique and realistic approach in all her assignments.

Annex 2. Legislation and statutory requirements

Legislation	Applicability
MINING LEGISLATION	
Mineral Act, 1992	Rehabilitation requirements, environmental status prior to mining/prospecting, pollution control measures, liability for pollution
Minerals (Prospecting and Mining) Amendment Act, 8 of 2008	Requirement of EMPR
Diamond Act 13 of 1999 and regulations, GN 84 of 31 March 2000	Permits for handling diamonds
Environmental clause of Namdeb's Minerals Agreement	Requirement of EMPR
ENVIRONMENTAL LEGISLATION	
Environmental Management and Assessment Act 7 of 2007; List of activities that may not be undertaken without Environmental Clearance Certificate, GN 29 of 2012; Environmental Impact Assessment Regulations, GN 30 of 2012	Requirements for and process of environmental assessments
Draft Regulations for Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA), 2008 and Draft procedures and guidelines for Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP), 2008	Contents of strategic environmental assessments, Environmental Impact Assessments and Environmental Management Plans
Namibian Constitution Section 95(l)	Use of natural resources, protection of environment, biodiversity and ecosystems
Hazardous Substances Ordinance, 14 of 1974	Declaration and handling of hazardous substances
Labour Act 6 of 1992, Regulations relating to the health and safety of employees at work, GN 156, GG 1617 of 1 August 1997	Protection of employees from hazardous substances, incl. asbestos
Atmospheric Pollution Prevention Ordinance, 11 of 1976, prohibition of the import of ozone depleting substances, GN 281, 31 December 2010	Permitting of fuel burning appliances, prohibition of ozone-depleting substances
Atomic Energy and Radiation Protection Act, 5 of 2005; 1A.1 Radiation Protection and Waste Disposal Regulations, GN 221 of 18 November 2011	Handling, transport and disposal of radioactive substances

Legislation	Applicability
Road Traffic and Transport Act, 22 of 1999 and regulations GN53 of 2001	Transportation of dangerous goods
Water Act, 54 of 1956	Permitting for industrial effluents
Water Resources Management Act, 11 of 2013 (not in force yet)	Protection, development and management of water resources; licencing water abstraction, protection of groundwater, water pollution control, obstruction of watercourses, control and use of wetlands
Soil Conservation Act, 76 of 1969	Prevention of soil erosion, no regulations, not enforced
Forest Act, 12 of 2001	Protected trees, permit for mining in forested areas and cutting of trees and shrubs within 100m from river, stream or watercourse
Nature Conservation Ordinance, 4 of 1975	Protected species
National Heritage Act, 27 of 2004	Heritage site protection
MARINE LEGISLATION	
Marine Resources Act, 27 of 2000; 18.1 Regulations relating to the exploitation of marine resources, GN 241 of 7 December 2001; 18.2 Regulations relating to Namibian Islands' Marine Protected Area, GN 316 of 31 December 2012	Protection of marine habitats and animals
Marine Traffic Act 2	No abandoning of ships
Prevention and Combating of Pollution of the Sea by Oil Act, 6 of 1981	Liability, combating and prevention of oil pollution
Wreck and Salvage Act, 5 of 2004	Procedures related to salvage of ships, aircraft and life, preventing damage to marine life
Namibian Ports Authority Act 2 of 1994	Establishment of Namibian Ports Authority and management of ports and lighthouses, protection of the environment in its jurisdiction
Territorial Sea and Exclusive Economic Zone of Namibia Act 3 of 1990	Definition territorial sea and exclusive economic zone
POLICIES AND OTHER	
National Policy on Coastal Management 2012	Protect, maintain and restore health and biological diversity of ocean and coastal ecosystems
Explosives Act, 26 of 1956	Import, storage and transport of explosives
Fire Brigade Services Act, 5 of 2006 and regulations 2010	Maintenance of fire brigade services

Legislation	Applicability
Petroleum Products and Energy Act, 13 of 1990; 5H.1 Petroleum Products Regulations, 2000 and Notice of Application of Specifications and Standards, GN 54 of 2016	Distribution and price control
Red data lists	Plant and animals species classified as vulnerable, threatened or endangered
Oranjemund town business registration regulations, 2013	
Oranjemund town noise control regulations, 2013	Noise control in Oranjemund town
Electricity Act 4 of 2007	Environmental Impact Assessment for electricity installations
Electricity Regulations: Administrative, GN 13 of 16 February 2011	
Electricity Control Board: Namibian electricity safety code, GN 200 of 12 October 2011, Electricity Control Board: Namibian Electricity Safety Code, Amendment, GN 234 of 2012, technical rules, GN 47 of 2016, economic rules, GN 46 of 2016	Electricity generation licences
INTERNATIONAL CONVENTIONS AND PROTOCOLS	
Convention on Biological Diversity, 1992	Protection of biodiversity
United Nations Framework Convention on Climate Change, 1992 13.1 Kyoto Protocol, 1997	No legislation promulgated yet to meet proposed guidelines
Montreal Protocol on substances that deplete the ozone layer, 1987; Amendments 1990 and 1992, Vienna Convention for the protection of the ozone layer 1985	Prohibition of ozone depleting substances
Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat, 1971	Protection of declared wetlands
Law of the Sea Convention, 1982 (United Nations)	Territorial sea limits up to 12 nautical miles, innocent passage through territorial sea, exclusive economic zone, conservation and management of living resources, protection of marine environment
Protocol on Shared Watercourse Systems in the SADC Region	Coordinated and environmentally sound development of shared water resources, basin management committees
International Convention for the Prevention of Pollution from Ships (MARPOL 73/78)	Regulations for prevention of pollution by oil, noxious liquid substances, harmful substances, sewage and garbage
Convention on International Trade with Endangered Species (CITES)	Internationally accepted list of plant and animals species under trade restrictions

Annex 3. Impact register

The impact register provides a description of significant and high impacts. All impacts rated "significant" (S) and "high" (H) require management actions. A description of these impacts is included below, management actions are described in the Environmental Management Plan (Chapter 8). Many activities result in various impacts. In this case, if at least one impact is rated significant, the activity will require management. Other, not significant impacts associated with this activity are then also included in the description. Because this is an update of a previous EMPR, the descriptions are deliberately concise and activities receiving the same impact ratings have been combined, where feasible.

A 4-scale rating has been included here for reversibility (none, low, medium, high) assuming that the management actions for this activity are implemented and thus reflecting an impact assessment with mitigation.

The activities are organized according to overarching categories exploration, mining, infrastructure and services, marine contractors and socio-economic.

Exploration and Test-Mining

Impact category	Description	Significance	Reversibility
	Seabed sampling and test-mining		
Loss of marine biota	Disturbance and loss of biota in sampled/mined sediments	Significant	Medium
	Oversize disposal to sea during marine exploration		
Loss of marine biota	Smothering of reef biota by tailings, change in community composition	Significant	Low-Medium

Services and infrastructure

Impact category	Description	Significance	Reversibility
	Waste management on vessels		
Loss of marine biota Water quality	Loss of marine biota through toxic effects of hydrocarbon spills Pollution of coastal waters through spilled hydrocarbons and litter	Significant	High

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Annex 5. Namdeb environmental policies and procedures referenced in this EMP

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